Quantifying migration cost shocks: Macroeconomic evidence for the UK and Germany

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Abstract

EU net immigration into the UK decreased by almost 40 percent since the introduction of a net immigration target and the Brexit vote. In Germany EU immigration reached unprecedented high numbers that mirror the good labor market conditions. However, migration diversion might have played a key role, too, since the Brexit vote has raised immigration costs immediately by increasing the uncertainty about the future status of immigrants. In the paper we study to what extent the German labor market benefited from worsening immigration prospects in the UK by disentangling the effects of higher immigration cost in the UK and favorable labor market conditions in Germany on migrants’ destination choice. To that end we build a two-country DSGE model of immigration for the UK and Germany. We estimate the model using quarterly bilateral migration data for different geographic regions. We are able to separate two different types of migration shocks: One that is corridor-specific and one that increases migration into the whole corridor. This allows us to study the counterfactual scenario of immigration to Germany in the absence of the British vote to leave the EU. In Germany migration diversion explains 5 percent of additional net migration, in UK it can account for around 10 percent of the migration drop.

Keywords: Labor Migration, Business Cycles, Migration Diversion

\textit{JEL:} E24, F22, F41

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1. Introduction

The 2016 Brexit vote considerably increased the political uncertainty with respect to future immigration rules for EU migrants. Subsequent to the vote, EU migration to the UK decreased considerably. In Germany EU immigration remained at relatively high levels. The historical episode therefore provides an interesting case to study the impact of migration cost and relative business cycle fluctuations on business cycle related migration patterns.

The legal framework of the European Union in principle endows EU citizens with the right to move freely for the purpose of living, working, studying and retiring. It substantially reduces their migration costs and lays the foundation for a potentially high labor mobility in the euro area. Traditionally, the United Kingdom is one of the main net immigration countries in the European Union, attracting high numbers of immigrants from other EU members as well as third countries. At the same time the UK is a prominent case for the fears and concerns that are raised by opening up national labor markets to immigrants. Critics fear a downward pressure on wages and growing unemployment among natives as a consequence of a continuing positive net immigration.\(^2\) In response to these growing concerns in 2010 the government formulated a net migration target of an annual maximum of 100,000. However, up today the target has not been met due to its limited enforceability. While access to the UK is restricted via a visa system for third country nationals, it is unrestricted for citizens of other EU members. Regaining control over immigration was one of the main campaign promises of Brexit proponents and the immigration issue is regarded to be one of the key drivers for the British vote to leave the European Union in 2016.

In principle, the Brexit vote gives leeway to negotiate new immigration rules for EU members. The spectrum of future immigration regimes ranges from maintaining the status quo, i.e. the freedom of movement of

\(^1\)Article 21 and Article 45 TFEU.

\(^2\)Empirical evidence on the effects of immigration on British workers is mixed and overall does not support the existence of large negative effects. See Br"ucker et al. (2014), Dustmann et al. (2016), Dustmann et al. (2008) and Wadsworth et al. (2016).
workers such as established between the European Union and countries like Switzerland that have full access to the common market, and a visa scheme such as for third countries (see IAB, 2016). Irrespective of the final arrangement, the room to maneuver immediately increased political uncertainty and thereby raised migration cost for EU migrants. Uncertainty about the future status of EU immigrants affected the decisions of both, potential migrants in origin countries and agents that migrated to the UK in the past.

Descriptive statistics support the notion, that the Brexit vote immediately affected migration patterns of the UK with the EU28. EU net immigration into the UK decreased by almost 40 percent since the introduction of a net immigration target and the Brexit vote. In Germany EU immigration remained at relatively high levels that mirror the good labor market conditions. However, migration diversion might have played a key role, too, since the Brexit vote has raised immigration costs immediately by increasing the uncertainty about the future status of immigrants.

In the paper we study to what extent the German labor market benefited from worsening immigration prospects in the UK by disentangling the effects of higher immigration cost in the UK and favorable labor market conditions in Germany on migrants’ destination choice. To that end we build a two-country dynamic stochastic general equilibrium (DSGE) model of immigration for the UK and Germany. We estimate the model using quarterly bilateral migration data for different geographic regions. We are able to separate two different types of migration shocks: One that is corridor-specific and one that increases migration into the whole corridor. This allows us to study the counterfactual scenario of immigration to Germany in the absence of the British vote to leave the EU.

The paper is structured as follows: Section 2 reviews the literature on migration divergence and DSGE models with migration, Section 3 presents statistics on immigration to the UK and Germany pre and post the 2016 EU referendum, Section 4 describes the theoretical model, Section 5 presents the Bayesian estimation of the model and Section 6 concludes.
2. Literature Review

This paper investigates the impact of relative migration cost and relative business cycle fluctuations for migration patterns to the UK and Germany. Migration diversion for the UK and Germany has been analyzed before by Baas and Brücker (2012) for the case of the 2004 Eastern Enlargement of the EU in an empirical CGE model. Location specific emigration patterns have been addressed from an empirical perspective mostly in the context of gravity models of migration. Bertoli and Fernández-Huertas Moraga (2013) establish the term multilateral resistance to migration to refer to the influence of other destinations on bilateral migration flows. Mayda (2010) refers to the concept as multilateral pull. The insight that bilateral migration flows are affected by the relative attractiveness of other destinations relates to a similar concept in the trade literature (e.g. Anderson and Wincoop, 2003).

While empirical models of bilateral migration flows can control for multilateral resistance to migration, they cannot take into account the structural interrelation. Recently, there is a growing number of DSGE models with business-cycle migration. Mandelman and Zlate (2012) model immigration of unskilled Mexicans to the U.S. in a two-country RBC model. In a NK model with bilateral migration Hauser (2014) shows that a technology shock spills-over from one location to another via its effect on the direction of the labor force movement. These papers rely on the assumption of a neoclassical international labor market that is characterized by fully flexible wages and the absence of real labor market frictions and treat the migration and the labor supply decision as integrate by modeling a destination specific labor supply decision of the agents. In general, the labor supply decision hinges critically on the formulation of the preferences in the utility function. With the conventional preferences of King et al. (1988) type business cycle shocks lead to a countercyclical labor supply response that is not in line with empirical observations.

Gali et al. (2012a) introduce unemployment into Smets and Wouters (2007) model and propose a shifting parameter that limits the short run wealth effect on the labor supply. Building on this modeling approach

\footnote{The approach bases on Gali (2011) and models cyclical variations in unemployment via time-varying markups on competitive equilibrium that occur as a consequence of labor market frictions and rigidities.}
Clemens and Hart (2018) propose a model of business-cycle migration that sequentially separates a migration decision and a subsequent labor supply decision. Another strand of the business-cycle migration literature models migration and unemployment in labor markets with real frictions from search and matching in line with Mortensen and Pissarides (1994). Chassamboulli and Palivos (2013, 2014) follow this approach to analyze the equilibrium effects of an exogenous migrant inflow on natives’ labor market outcomes. Braun and Weber (2016) study the labor market adjustment subsequent to an exogenous expellee inflow in a two-region search and matching model with migration. Hauser and Seneca (2019) investigate interstate mobility in the United States and the implications for monetary policy that follows a simple rule. In Clemens and Hart (2019) we model bilateral migration of unemployed and employed agents over the business cycle in the euro area.

3. Empirical facts

To investigate the characteristics and determinants of EU migration in Germany and the United Kingdom we first provide some descriptive statistics for migration data from both national statistical offices. We start by comparing net migration in the UK and Germany between 2010 and 2018 (see Figure 1). The whole time period can be divided in two subperiods. First, after the expiry of a transitional period subsequent the 2004 EU Eastern Enlargement, 2011 was the first year in which workers from Poland, Czech Republic and other Eastern EU countries were allowed to search for employment and to work in Germany without restrictions. During 2011 and 2013, this led to strong increases in the German net migration balance with the EU (left graph, blue bar) while it remained stable in the UK (right graph). Additionally, in 2014/15 Germany opened its labor markets for workers from Romania, Bulgaria and Croatia which increased the net migration in this period even further. However, the

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4 In 2004 the EU Eastern Enlargement was accompanied by free labor mobility for the new member states. The UK opened its labor markets immediately which led to a large increase of net migration gains with the EU (see left graph, blue bar). Germany was allowed to protect its labor market for a transitional phase of 2+3+2 years, because it was still struggling with the reformation process due to the German reunification.

5 Romania, Bulgaria and Croatia joined the EU in 2007/08 and the UK opened its labor markets immediately, while Germany took use of a transitional phase of 2+3+2 years.
strong net migration in that time period is also related to good labor market conditions due to business cycle boom in Germany. In the years 2013 to 2015 net migration to the UK increased as well. The second subperiod ranges from the years 2016 to 2018, where EU net migration drops in both countries. In Germany the drop it is not an EU-specific phenomenon and can be observed for non-EU and EU migrants likewise. Against, the UK experienced a reduction in the net migration from the EU that was caused by a strong reduction in EU immigration co-occurring with a strong increase in EU emigration, while non-EU net immigration increased further.

For the two subperiods different drivers of migration patterns can be discussed for Germany and the UK. For Germany, in the period 2010 - 2015 the reduction of migration cost led to an increase of immigration, especially of EU-10 and EU-3 citizens. The pure cost reduction effect phased out. Additionally, while the economy in many EU countries was in a recession, the Germany economy was strong and labor markets were tight and amplified the pure migration cost effect. Starting 2016 this business cycle effect weakens because in the origin countries and other EU destination countries output gaps converge and Germany’s economy loses momentum. Furthermore, the refugee inflow has increased fear of migration in parts of the German society, leading to higher acceptance of political right wing parties. This could have deterred potential EU immigrants to move to Germany. For the UK the main reason is the fear of migration which finally led to the Brexit vote in 2016. Since then, we observe a marked reduction in EU net migration. Therefore, the main question we want to tackle is threefold: First, to what extent did the Brexit vote reduce net migration in the UK. Second, did the Brexit vote have an migration diversion effect on Germany’s net migration. Third, what are the main economic effects from the Brexit vote due to less EU migration in UK.

In a first step, we want to analyze the general labor market conditions of EU and non-EU migrant and natives.

*Demographic decomposition*

By comparing migrant stocks (see Table A.3), we can state that recent labor market developments in both countries crucially depend on both, EU and non-EU migrants. Without migrants, the share of working-age
people in both countries decreased faster than EU-28 average, by almost 2 percentage points between 2010 and 2018. EU and non-EU Migrants compensate this trend in the EU, but especially in Germany and UK. Until 2016, the working-age population share of EU migrants in Germany and the UK was around 87 percent. After 2016, the share has decreased immediately in the UK while in Germany it continues to rise. There are at least two potential explanations. First, while UK opened its labor market for Bulgaria, Romania and Croatia already in 2007, starting with the opening of the Germany labor market in 2014/15, emigrants from those countries may have chosen Germany rather than the UK. Second, the Brexit vote could also have led to a lower EU immigration into and higher emigration out of the UK, especially of the young people who are either in education or just started their career. For non-EU migrants the picture is slightly different. Overall, their share of the working-age population increased in both countries, not only because they are younger than natives, but also because they are getting younger over time. However, in Germany the share of working-age persons has reduced strongly since 2016, while it has increased in the UK. This effect can be mainly explained by the large refugee inflow 2015/2016, where almost one third were children below 16 years. Overall, the working-age population decomposition shows, that the in the migrant population the share of the working-age
population increased. As a next step we want to investigate whether this also translated into a higher potential labor force.

**Labor force decomposition**

The simple answer for EU migration in Germany and UK is that it does. In Germany, the labor force participation rate of native persons has increased steadily between 2010 and 2018. This is mostly due to an increasing labor market participation of women and older persons. In the UK participation of natives is increasing for similar reasons but at lower growth rates. In both countries other EU citizens have an even higher and increasing participation rate. Thus, the EU migrant population boosts the overall labor force participation. Non-EU citizens have lower participation rates than natives in the UK and in Germany in particular. At least for Germany this can be partly explained by the low female participation rate and higher average number of children per family.

**Unemployment decomposition**

Finally, we consider the labor demand by looking at unemployment rates. The unemployment rate of EU migrants in Germany is slightly higher than the rate of natives leading to a positive EU migrant-native unemployment gap. Over time, this gap has decreased which either points to higher job-to-job EU migration, higher job finding rates of EU immigrants or shorter durations of stay for unemployed EU migrants. However, in all cases recent EU migration flows seem to align with labor market needs. In the UK this argument is more distinct, since the unemployment rate of EU migrants is even lower than the native unemployment rate, leading to a negative EU migrant-native unemployment gap. Non-EU migrants in both countries have a higher but also decreasing unemployment rate than native citizens. In Germany the unemployment rate for the non-EU migrant population is higher than in UK, but still lower as in the EU on average.

In summary, we can record that EU migration in Germany and UK not only increases the working-age population and thus potential output quantitatively. Higher and increasing participation rates and relatively low and decreasing unemployment rates point also to qualitative employment gains. In terms of the Brexit vote, we find that between 2016-2018 the age structure of EU migrants in the UK changed. We do not find a significant change in patterns in terms of labor force participation and unemployment rates.

However, the picture changes if we look at growth rates of the labor
Table 1: labor market conditions for migrants and natives in Germany and the UK, 2010-2018

<table>
<thead>
<tr>
<th></th>
<th>Natives</th>
<th>EU migrants</th>
<th>Non-EU migrants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Periods</strong></td>
<td>10-12</td>
<td>14-15</td>
<td>16-18</td>
</tr>
<tr>
<td><strong>Working-age population share</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU-28</td>
<td>73.9</td>
<td>73.6</td>
<td>73.3</td>
</tr>
<tr>
<td>EU-15</td>
<td>72.9</td>
<td>72.7</td>
<td>72.6</td>
</tr>
<tr>
<td>EA-12</td>
<td>77.8</td>
<td>77.5</td>
<td>77.4</td>
</tr>
<tr>
<td>DE</td>
<td>75.5</td>
<td>74.7</td>
<td>73.8</td>
</tr>
<tr>
<td>UK</td>
<td>72.8</td>
<td>72.5</td>
<td>71.1</td>
</tr>
<tr>
<td><strong>Labor force participation rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU-28</td>
<td>63.1</td>
<td>63.7</td>
<td>64.3</td>
</tr>
<tr>
<td>EU-15</td>
<td>64.0</td>
<td>64.4</td>
<td>65.0</td>
</tr>
<tr>
<td>EA-12</td>
<td>62.9</td>
<td>63.4</td>
<td>64.0</td>
</tr>
<tr>
<td>DE</td>
<td>66.9</td>
<td>68.5</td>
<td>70.1</td>
</tr>
<tr>
<td>UK</td>
<td>68.1</td>
<td>68.5</td>
<td>68.7</td>
</tr>
<tr>
<td><strong>Unemployment rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU-28</td>
<td>9.3</td>
<td>9.6</td>
<td>7.2</td>
</tr>
<tr>
<td>EU-15</td>
<td>9.2</td>
<td>9.8</td>
<td>7.7</td>
</tr>
<tr>
<td>EA-12</td>
<td>9.8</td>
<td>10.8</td>
<td>8.6</td>
</tr>
<tr>
<td>DE</td>
<td>5.5</td>
<td>4.5</td>
<td>3.2</td>
</tr>
<tr>
<td>UK</td>
<td>7.8</td>
<td>6.2</td>
<td>4.3</td>
</tr>
</tbody>
</table>

The net migration rate is defined as immigration minus emigration divided by 1000 population. – denotes missing data. Source: Eurostat.
force and unemployment data in levels for single years between 2016 and 2018 (see Table 2). The labor force and unemployment of EU migrants has strongly decreased. The labor force reduction can be mainly explained by strong negative net migration between 2017 and 2018, because labor force does not fluctuate as much for other reasons than migration. The causes for the reduced number of unemployed EU citizens is ambiguous, because a significant part may be explained with better general labor market conditions, since at the same time the unemployed native population has decreased by 6 percent.

Table 2: labor market dynamics for EU migrants in Germany and the UK, 2010-2018

<table>
<thead>
<tr>
<th>EU migrants</th>
<th>periods</th>
<th>2011-2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Working-age population share (percentage change)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DE - EU Migrants</td>
<td></td>
<td>6.4</td>
<td>12.2</td>
<td>2.4</td>
<td>6.9</td>
</tr>
<tr>
<td>UK - EU Migrants</td>
<td></td>
<td>9.6</td>
<td>9.4</td>
<td>3.9</td>
<td>-5.4</td>
</tr>
<tr>
<td>DE - Natives</td>
<td></td>
<td>6.4</td>
<td>12.2</td>
<td>2.4</td>
<td>6.9</td>
</tr>
<tr>
<td>UK - Natives</td>
<td></td>
<td>9.6</td>
<td>9.4</td>
<td>3.9</td>
<td>-5.4</td>
</tr>
<tr>
<td><strong>labor force participation rate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DE - EU Migrants</td>
<td></td>
<td>7.5</td>
<td>14.2</td>
<td>2.5</td>
<td>7.6</td>
</tr>
<tr>
<td>UK - EU Migrants</td>
<td></td>
<td>10.6</td>
<td>10.0</td>
<td>5.0</td>
<td>-3.9</td>
</tr>
<tr>
<td><strong>Unemployment rate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DE - EU Migrants</td>
<td></td>
<td>0.9</td>
<td>-2.3</td>
<td>-7.7</td>
<td>-2.4</td>
</tr>
<tr>
<td>UK - EU Migrants</td>
<td></td>
<td>4.6</td>
<td>-1.9</td>
<td>-7.1</td>
<td>-20.4</td>
</tr>
</tbody>
</table>

The net migration rate is defined as immigration minus emigration divided by 1000 population. – denotes missing data.

Source: Eurostat.

In a further step we have compare quarterly output gap estimations (see Figure 2, blue bar) and cyclical net migration (red bar), that is actual migration minus trend migration. We can see that output gaps in

6The labor force participation of natives has increased rather steadily by around 0.4 percent.
7Output gap data comes from the OECD Economic Outlook.
Germany and UK are highly correlated with EU net migration.\textsuperscript{8} However, since 2015 output gap and cyclical EU migration are decoupled in Germany and in UK. One reason for that is lower migration-friendly societal climate. The Migration Policy Uncertainty Index (dark blue) and the Migration Fear Index (light blue) are proxies for resentments of the population against migration. They are depicted in the lower graphs and show a strong spike around in 2016/17, when in Germany the right-wing organizations planned public processions and the UK voted for the Brexit. At least from that picture, it seems that both events have also increased EU immigrants perceived immigration costs.

\begin{figure}[ht]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Business cycle migration and political migration costs in Germany and the United Kingdom, 2010-2018}
\end{figure}

4. A Model of Migration and Location Choice

This section presents a two country version of a stylized New Keynesian model with unemployment for the UK, referred to as country \( a \),

\textsuperscript{8}We hereby confirm our previous results that EU migration has business cycle component. See Clemens and Hart (2018). Here, we do not consider the output gap of the sending country. Considering relative output gaps would make the picture more distinct.
and Germany, referred to as country $b$. A novel feature is the introduction of endogenous immigration to both countries from a third country, referred to as country $f$, which represents the group of EU-28 countries without the UK and Germany. For the agents from $f$ the location specific emigration decision is modeled according to the approach presented in Clemens and Hart (2018), that treats the migration and the labor supply as sequentially separate decisions. A representative household in country $f$ compares the relative return of working abroad in country $a$ and $b$ and allocates families between both labor markets and the home labor market. The existence of adjustment cost of moving labor cross borders accounts for the fact that large business cycle shocks such as during the Great Recession trigger stronger migration movements than small shocks. Over the business cycle the relative return of working in either country varies with country specific wages and employment rates that in the NK framework are linked to the aggregate demand. Since changes in the third country labor market affect the allocation of families to both labor markets $a$ and $b$ in a similar direction, we do not model the third country labor market explicitly and instead introduce a shock that accounts for changes in the overall attractiveness to migrate. Additionally, we abstract from a migration decision of agents born in country $a$ and $b$ and hold the native population constant.

The general structure of the model is similar to a Smets and Wouter model as in Galí et al. (2012a). This model introduces unemployment in the spirit of Galí (2011) which extends the wage-setting set-up in Erceg et al. (2000) and reinterprets the intensive as extensive margin. In this specification structural unemployment arises, because the market power of differentiated types of labor gives rise to wages above their equilibrium level. Other sources of unemployment such as labor market frictions are not accounted for. In presence of nominal frictions, the positive average wage markup varies over the business cycle. By insuring the idiosyncratic unemployment risk of agents, the framework preserves the representative household paradigm (Andolfatto, 1996; Merz, 1995). We model two structurally symmetric countries $a$ and $b$ that have bilateral trade in goods.

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9We expect the increased uncertainty due to the Brexit vote to also represents a large shock that in the framework results in a stronger migration movement.

10Due to the symmetry assumption households and firms in both countries face uniform optimization problems. All equations are derived for economy $a$, denoted by
with zero external balances in the steady state. The trade block of the model is a simplified version of de Walque et al. (2017).

4.1. Emigrants location choice

In $f$ we abstract from all other economic decisions and focus on the migration decision only. The economy is populated by a representative household with a large number of identical families indexed by $k \in 0,1$]. The household maximizes the utility of all families, derived by integrating over all families’ and their members’ utilities, and determines a fraction $\gamma^a_t$ of families to move to the labor market of country $a$ and $\gamma^b_t$ of families to move to the labor market of country $b$. Thus, $1 - \gamma^a_t - \gamma^b_t$ families remain in the country and $\gamma_t = \gamma^a_t + \gamma^b_t$ denotes the emigrant share from the perspective of economy $f$. Alternatively: Thereby, the household determines the total emigration rate $\gamma_t = \gamma^a_t + \gamma^b_t$. The emigration rate of country $f$ equals the change in the emigrant stock over time:

$$Em_t = (\gamma^a_t + \gamma^b_t) - (\gamma^a_{t-1} + \gamma^b_{t-1})$$

Similar to economy $a$ and $b$ that are described in the Model Appendix Appendix B each family in $f$ has a continuum of infinitely lived members represented by the unit square and indexed by a pair $(i,j) \in 0,1 \times 0,1$ where the first dimension $i$ describes the type of labor service in which a member is specialized and the second dimension $j$ measures her disutility of working. When determining the time-varying emigration shares $\gamma^a_t$ and $\gamma^b_t$ of families, we assume that the household cannot observe type-specific wages and unemployment rates, but only averages for native and migrant workers.\footnote{This assumption can be justified by the timing convention, where the household determines $\gamma^a_t$ and $\gamma^b_t$ before agents of each type $i$ learn about their ability to reset their wage in a given period. Since each type can reset their wage with the same probability irrespective of location and duration of the current wage contract. Consequently, if the number of agents is large enough they earn the average migrant wage.} Therefore, the emigration rate is the same for all types of workers $i$. Introducing this assumption into the welfare function and abstracting from other economic decisions by the household in $f$ the

subscript $a$, and analogously apply to economy $b$. In case of variables where country of supply and origin differ, the superscript denotes the location of the supply and the subscript denotes the location of the origin or birth in case of agents. Except the emigration rate, third country variables other have have subscript.
The objective for the migration decision is:

$$U_t = E_0 \sum_{t=0}^{\infty} \beta^t \left( \gamma^a_t \log C_{f,t}^a + \gamma^b_t \log C_{f,t}^b - \chi f_t \Xi f_{t-1} \right)$$

$$- \chi \gamma \left( \gamma^a_t \right)^{1+\psi} + \chi \gamma \left( \gamma^b_t \right)^{1+\psi} - \phi_{\gamma,t} \left( \frac{\gamma^a_t}{\gamma^a_{t-1}} \right) \gamma^a_t - \phi_{\gamma,t} \left( \frac{\gamma^b_t}{\gamma^b_{t-1}} \right) \gamma^b_t$$

(2)

$L_{f,t}$ is the average labor force participation rate of family members in the home economy and $\epsilon_{f,t} = 1 - u_{f,t}$ is the corresponding employment rate, thus $L_{f,t} \epsilon_{f,t}$ refers to average employed native workers of family $k$. Accordingly, $L_{f,t}^{a(b)} \epsilon_{f,t}^{a(b)}$ with $\epsilon_{f,t}^{a(b)} = 1 - u_{f,t}^{a(b)}$ refers to the employed emigrant workers in country $a(b)$. $\chi f_t$ is an exogenous preference shifter that affects the labor supply of all workers of home nationality equally and that in logs follows an AR(1) process with an i.i.d.-normal error structure. $\Xi f_{t-1}$ is an endogenous preference shifter defined as

$$\Xi f_{t-1} = \frac{Z_{f,t}}{C_{f,t}}$$

with: $Z_{f,t} = Z_{1-v} C_{f,t}^v$ that allows to reduce the short-term wealth effect on labor supply whose influence is governed by parameter $v \in [0,1]$. In line with empirical observations, for low values of $v$ the short term wealth effect is weak and the labor supply response is procyclical. $\psi_{n(m)}$ is the inverse Frisch elasticity of native and migrant labor supply. To capture the relative preference of living in the home country, we introduce a disutility of living abroad that is increasing in the share of emigrant families. $\chi \gamma$ is a scaling parameter and $\psi \gamma$ is a parameter determining the shape of the distribution of living abroad disutilities across families. The model accounts for the costliness of adjusting the share of labor abroad and the quadratic cost function is

$$\phi_{\gamma,t} \left( \frac{\gamma_{t}^{a(b)}}{\gamma_{t-1}^{a(b)}} \right) = 0.5 \phi_{\gamma} \phi_{\gamma,t} \left( \frac{\gamma_{t}^{a(b)}}{\gamma_{t-1}^{a(b)}} - 1 \right)^2.$$

The corresponding intratemporal budget constraint is:

$$\gamma^a_t P_{c,a,t} C_{f,t}^a + \gamma^b_t P_{c,b,t} C_{f,t}^b = \gamma^a_t W_{f,t}^a L_{f,t}^a \epsilon_{f,t}^a + \gamma^b_t W_{f,t}^b L_{f,t}^b \epsilon_{f,t}^b.$$

(3)

Maximizing (2) subject to the budget constraint gives the first-order con-
ditions for the emigrant shares are:

$$
\lambda_t^a W_{f,t}^a L_{f,t}^a e_{f,t}^a - \Xi_{f,t}^a \chi_{f,t} \left( \frac{(L_{f,t}^a e_{f,t}^a)^{1+\psi_m}}{1 + \psi_m} \right) - (a.) = \epsilon_{mig,t}^{tot} e_{mig,t}^{div}
$$

(4)

$$
\lambda_t^b W_{f,t}^b L_{f,t}^b e_{f,t}^b - \Xi_{f,t}^b \chi_{f,t} \left( \frac{(L_{f,t}^b e_{f,t}^b)^{1+\psi_m}}{1 + \psi_m} \right) - (b.) = \epsilon_{mig,t}^{tot} e_{mig,t}^{div}
$$

(5)

(6)

with \((a.) = \chi_{f,t}(\gamma_1^a)\psi + \phi_{f,t} \left( \frac{\gamma_1^a}{\gamma_{t-1}^a} \right) + \phi_{f,t} \left( \frac{\gamma_1^a}{\gamma_{t-1}^a} \right) - \beta \phi_{f,t} \left( \frac{\gamma_{f,t+1}^a}{\gamma_{t-1}^a} \right) \left( \frac{\gamma_{f,t+1}^a}{\gamma_{t-1}^a} \right)^2 \) and

\((b.) = \chi_{f,t}(\gamma_1^b)\psi + \phi_{f,t} \left( \frac{\gamma_1^b}{\gamma_{t-1}^b} \right) + \phi_{f,t} \left( \frac{\gamma_1^b}{\gamma_{t-1}^b} \right) - \beta \phi_{f,t} \left( \frac{\gamma_{f,t+1}^b}{\gamma_{t-1}^b} \right) \left( \frac{\gamma_{f,t+1}^b}{\gamma_{t-1}^b} \right)^2 \). To capture changes in the relative attractiveness of the home economy we introduce the shock term \(\epsilon_{mig,t}^{tot}\), that has a similar impact on the emigration rate to country \(a\) and \(b\). E.g. more favorable labor market conditions in the foreign labor market will reduce emigration to \(a\) and \(b\) likewise. Additionally, we introduce a migration diversion shock that captures changes in the relative attractiveness of labor market \(a\) and \(b\) that are not related labor market.

The optimality conditions implies that the household allocates families to the foreign labor markets as long as the marginal return of working in the foreign economy net of the idiosyncratic family disutility of living abroad exceeds the marginal return of working in the home economy as captured by the shock term \(\epsilon_{mig,t}^{tot}\). Thereby, the household takes into account that migrating agents face a risk to become unemployed and consequently differences in the marginal returns are mainly driven by the country specific employment probability per family and the real wage. Families are ordered sequentially based on their idiosyncratic disutility of living abroad, with family \(k\) experiencing a disutility of \(1_{f,k} \chi_{f,k} \psi\) with indicator function \(1_{f,k}\) being one if the family lives abroad and zero otherwise.\(^{12}\) The family with the lowest utility cost of moving migrates first and with each additional family moving abroad the marginal returns of working in home and in foreign are further balanced out for two reasons: A higher emigrant share raises the migrant unemployment in foreign and, since labor unions react to the worsening labor market conditions, lowers the nominal wages. For the marginal emigrant family the returns of working in both countries net of migration cost are equal.

\(^{12}\)Integrating over all families gives the disutility term in the household welfare function \(\int_0^{\gamma_t} \chi_{f,k} \psi k \, dk = \chi_{f,k}^{\gamma_t+\psi_t} \).
When deciding about the optimal emigration rate, the household takes the wage setting behavior of the unions and the labor supply rule of the workers as given and chooses the rate such that the per family employment is optimal. Substituting the first-order conditions for the per family emigrant employment, i.e. $\chi_{f,t}^{a}\Xi_{f,t}(L_{a,f,t}^{a},e_{a,f,t})\psi_{m}^{a} = \lambda_{a}^{a}W_{a,f,t}$ and $\chi_{f,t}^{b}\Xi_{f,t}(L_{b,f,t}^{b},e_{b,f,t})\psi_{m}^{b} = \lambda_{b}^{b}W_{b,f,t}$ into (4) and (5) finally yields:

$$\frac{\psi_{m}^{a}}{1 + \psi_{m}^{a}}\chi_{f,t}^{a}\Xi_{f,t}(L_{a,f,t}^{a},e_{a,f,t})^{1+\psi_{m}^{a}} - (a) = \frac{\epsilon_{mig,t}^{a}}{\epsilon_{mig,t}^{div}}$$

$$\frac{\psi_{m}^{b}}{1 + \psi_{m}^{b}}\chi_{f,t}^{b}\Xi_{f,t}(L_{b,f,t}^{b},e_{b,f,t})^{1+\psi_{m}^{b}} - (b) = \frac{\epsilon_{mig,t}^{b}}{\epsilon_{mig,t}^{div}}.$$  

(7) (8)

4.2. Linearized location specific migration decision

Introducing the labor supply condition into (7) and log-linearising gives an expression for the percent point deviation (denoted by a tilde) of the emigrant share from its steady state value as a function of the weighted unemployment and real wage deviation:

$$\tilde{\gamma}_{t}^{a} = \Theta^{-1}\left(-\Gamma_{m,\psi_{m}^{a}}\frac{\bar{u}_{a,f,t}}{1 - \bar{u}_{a,f}} + \Gamma_{m}\left(\bar{u}_{a,f,t} - \bar{p}_{c,a,t}\right) + \Gamma_{a} + \epsilon_{mig,t}^{a} - \epsilon_{mig,t}^{div}\right),$$

$$\tilde{\gamma}_{t}^{b} = \Theta^{-1}\left(-\Gamma_{m,\psi_{m}^{b}}\frac{\bar{u}_{b,f,t}}{1 - \bar{u}_{b,f}} + \Gamma_{m}\left(\bar{u}_{b,f,t} - \bar{p}_{c,b,t}\right) + \Gamma_{b} + \epsilon_{mig,t}^{b} + \epsilon_{mig,t}^{div}\right),$$

where $\Theta, \Gamma_{m} > 0$. In equation (9) and (10) we do not include variables for net benefit of working in the home economy explicitly but rather introduce the term $\epsilon_{mig,t}^{tot}$ that follows an AR-1. Note, that $\epsilon_{mig,t}^{tot}$ has a similar effect on the emigration rate to $a$ and $b$. Among other factors, the shock process captures all changes that originate in the labor market in $f$ that affect the net benefit of working for natives in $f$. Improved labor market conditions in $f$ will manifest themselves either in a higher real wage or a lower unemployment rate and will reduce the emigration rates to countries $a$ and $b$ likewise.

Keeping this interpretation in mind, changes in migrant wages and unemployment rates can be interpreted as differentials from the native values in $f$. According to (9) and (10) an increase in the unemployment differential between

---

13Additionally, the term captures changes external to countries $a$, $b$ and $f$ that affect the attractiveness of other destination countries e.g. via an increased internal migration in the group of EU28-UK,DE or an increased emigration to third-countries (e.g. Australia, Swiss, United States).
native wages in $f$ and immigrant wages in $a$ respectively $b$ increases the emigration rate to country $a$ respectively $b$. Similarly, a relative increase of the migrant wages in $a$ or $b$ over the native wages in $f$ raises the emigration rate. The expression (9) underlines that percentage changes in the unemployment differential have a stronger impact on the emigration rate than in the real wage differential since the latter is weighted down by the inverse labor supply elasticities.

Finally, migration diversion from country $a$ to $b$ is captured by the shock term $\epsilon_{\text{mig},t}$ that drives a wedge between the emigration rate to both countries. The term captures changes in the migration rate that can not be attributed by observable labor market variables, such as the Brexit vote that mainly affects political uncertainty and expectations formed about the future. The rationale behind the diversion shock is that a shock to the immigration cost to country $a$ that makes it less attractive to migrate to this country causes return migration to country $f$ and increases native unemployment and reduces native wages in country $f$. Due to the reduced attractiveness of the $f$, the share of families for which the net benefit of emigration to country $b$ is positive increases. Hence, a shock originating in $a$ translates into higher migration to country $b$.

4.3. Immigration countries

Immigration from $f$ increases the population in destination country $a$ with $\text{pop}_{a,t} = 1 + \gamma^a_t$. The immigration rate in country $a$ is defined by the change in the immigrant stock over time:

$$\text{Im}_{a,t} = \gamma^a_t - \gamma^a_{t-1}$$

A negative immigration rate corresponds to return migration, i.e. a reduction in the share of emigrating families from $f$ over time and decreases a country’s total population.\(^{15}\)

The economy of the destination country $a$ is described by a two country version of the Galí et al. (2012a). The full set of model equations is described in the Model Appendix Appendix B. In the following, we present the migration related model equations.

4.3.1. Intermediate good firms and immigrants’ labor market

There are two types of firms, intermediate good firms and homogenous good assemblers. The homogeneous good assemblers operate in a perfectly competi-

\(^{14}\)All equations similarly apply to the structurally symmetric country $b$.

\(^{15}\gamma^a_t \geq 0$ implies that $\text{Pop}_{a,t} \geq 1 \forall t$ since we abstract from emigration of natives from $a$.\)
tive environment and demand a continuum of domestic and foreign intermediate inputs to produce homogenous domestic and foreign good.

There is a continuum of monopolistically competitive firms which produce a differentiated intermediate good \( z \in [0, 1] \) and face a uniform price setting decision. In home, the firm \( z \) uses capital \( K_{a,t} \) rented out by the household at rental rate \( R_{k,a,t} \) and composite labor \( N_{a,t}(z) \) at the aggregate wage rate \( W_{a,t} \) to produce its intermediate good:

\[
Y_{a,t}(z) = \epsilon_{a,t} (K_{a,t})^\alpha N_{a,t}(z)^{1-\alpha},
\]

where \( \epsilon_{a,t} \) is the country specific exogenous technology parameter that in logs follows an AR(1) process. Cost minimization gives the optimal capital-labor ratio that is equal across all firms:

\[
\frac{K_{t}}{N_{t}} = \frac{\alpha}{1-\alpha} \frac{W_{t}}{R_{k,t}}.
\]

We allow for labor mobility in the firm production as in Ottaviano and Peri (2012). Thus, the composite labor employed by each firm \( z \) in the production function (B.11) is a CES index of native and immigrant workers:

\[
N_{t}(z) = \left( (1 - \omega_{n}) \left( N_{a,t}(z) \right)^{\frac{1}{\theta_{n}}} + \omega_{n} \left( N_{a,f,t}(z) \right)^{\frac{1}{\theta_{n}}} \right)^{\frac{\theta_{n}}{\theta_{n}-1}}.
\]

The parameter \( \omega_{n} \in [0,1) \) denotes the share of immigrant workers in the production and governs their income share. \( \theta_{n} \in (0, \infty) \) is the aggregate elasticity of substitution between native and immigrant workers. For given type-specific wages \( W_{a,t}(i) \) and \( W_{a,f,t}(i) \) of natives and immigrants, expenditure minimising subject to the labor indexes gives the home firms’ demand functions for native and immigrant labor types and labor composites:

\[
N_{a,t}(i, z) = \left( \frac{W_{a,t}(i)}{W_{a,t}} \right)^{-\epsilon_{aw,t}} N_{a,t}(z), \quad N_{a,t}(z) = (1 - \omega_{n}) \left( \frac{W_{a,t}}{W_{t}} \right)^{-\theta_{n}} N_{t}(z), \quad (15)
\]

\[
N_{a,f,t}(i, z) = \left( \frac{W_{a,f,t}(i)}{W_{a,f,t}} \right)^{-\epsilon_{aw,f,t}} N_{a,f,t}(z), \quad N_{a,f,t}(z) = \omega_{n} \left( \frac{W_{a,f,t}}{W_{t}} \right)^{-\theta_{n}} N_{t}(z), \quad (16)
\]

where the aggregate wage index is \( W_{t} = \left( (1 - \omega_{n}) W_{a,t}^{1-\theta_{n}} + \omega_{n} W_{a,f,t}^{1-\theta_{n}} \right)^{1/(1-\theta_{n})} \) with the wage indices of the native labor composite (19) and the corresponding

---

\(^{16}\)If \( \theta_{n} > 1 \) native and immigrant workers are gross substitutes.
immigrant expression. Aggregating over all firms $z$ in home gives the demand for native and immigrant labor types and composites. Subsequent the migration decision, unions representing workers of each labor type $i$ determine the native and emigrant wage as in Erceg et al. (2000). The native labor composite is defined as CES aggregate of differentiated worker types $N_{h,t} = \left( \int_0^1 N_{h,t}(i) \frac{e_{wn,t}^{-1}/\gamma_{wn,t}^{-1}}{e_{wn,t}^{-1}/\gamma_{wn,t}^{-1}} \right)^{\gamma_{wn,t}^{-1}/\gamma_{wn,t}^{-1}}$ with elasticity of substitution $\gamma_{wn,t}$. Similarly, the immigrant labor composite with migrant elasticity of substitution $\gamma_{wn,t}$ is defined as $N_{f,t} = \left( \int_0^1 N_{f,t}(i) \frac{e_{wn,t}^{-1}/\gamma_{wn,t}^{-1}}{e_{wn,t}^{-1}/\gamma_{wn,t}^{-1}} \right)^{\gamma_{wn,t}^{-1}/\gamma_{wn,t}^{-1}}$. Since different types of native and emigrant workers are imperfect substitutes the labor unions determine their nominal wages with a positive markup. As formalised by Calvo (1983), workers specialised in type $i$ labor can reset their wages with a constant probability $1 - \xi_{wi}$ each period. $\xi_{wi}$ is independent across time, location and labor types. As in Galí et al. (2012a), non-optimized wages are indexed to productivity growth and the price inflation rate according to $W_{t+k}^z = W_{t+k-1}^z \Pi_i^z (\Pi_{t-1}^z)^{\gamma_w} (\Pi_{t-1}^z)^{1-\gamma_w}$ where $\Pi^z$ denotes the steady-state (gross) growth rate of productivity, $\Pi_{t-1}^z$ is the previous period’s (gross) rate of price inflation, $\Pi^P$ is the steady state price inflation and $\gamma_w \in (0, 1]$ denotes the degree of price indexation.

Workers from home of a type $i$ who are able to reset their native nominal wage in period $t$ choose their optimal wage $W_{a,t}^O$ and $W_{f,t}^O$ in order to maximise their household utility subject to the flow budget constraint and the aggregate firm labor demand for their labor type $N_{h,t}(i)$ (B.14) and $N_{f,t}(i)$ (B.15) as derived below.\(^{17}\) All types of labor $i$ from home that reset their native wage in period $t$ set the same wage level. The first-order condition associated with the native and immigrant wage setting problems are:

$$\sum_{k=0}^{\infty} (\beta_{\gamma_{wn}})^k E_t \left\{ \frac{N_{a,t+k}}{1 - \gamma_{1+k}} Z_{t+k} \left( \frac{W_{a,t+k}^O}{P_{c,t+k}} - \mathcal{M}_{n,t+k}^W \right) - \mathcal{M}_{n,t+k}^W MRS_{a,t+k} \right\} = 0,$$

(17)

$$\sum_{k=0}^{\infty} (\beta_{\gamma_{wm}})^k E_t \left\{ \frac{N_{f,t+k}}{1 - \gamma_{1+k}} Z_{t+k} \left( \frac{W_{f,t+k}^O}{P_{c,t+k}} - \mathcal{M}_{f,t+k}^W MRS_{f,t+k} \right) = 0, \right. \}

(18)

with time varying native and immigrant wage markups $\mathcal{M}_{n,t}^W = \frac{\epsilon_{wn,t}}{\epsilon_{wn,t-1}} > \mathcal{M}_{f,t}^W = \frac{\epsilon_{wm,t}}{\epsilon_{wm,t-1}}$. Natives and emigrants who set wages in $t$ ground their wage setting deci-

\(^{17}\)To transfer the aggregate native labor demand $N_{a,t}(i)$ in per family terms that are used in the household welfare function use the relation $N_{a,t}(i) = L_{a,t}(i) e_{a,t}(i)$, and similarly for immigrants $N_{f,t}(i) = L_{f,t}(i) e_{f,t}(i)$.
sion on different rates of substitution \( MRS_{a,t+k|t} = \chi_{t+k}(L_{a,t+k|t}a_{t+k|t})^{\psi_a}Z_{t+k} \) and \( MRS_{f,t+k|t} = \chi_{f,t+k}(L_{f,t+k|t}a_{f,t+k|t})^{\psi_a}Z_{t+k} \). While emigrant and native workers both evaluate their wage to their home consumption, differences arise due to varying labor demand across countries and the expected future wage and unemployment paths of the domestic and foreign country.

In our formulation of the household welfare function the labor disutility is expressed in per family terms and the share of immigrating families acts as a scaling factor. Therefore, when further developing the first-order expressions the \( \gamma^a \) terms cancel out. Nevertheless, the immigration rate has an effect on the wage setting via the unemployment rate. The relation derives from the fact that the employment (and thus the employment rate) enters the marginal rate of substitution. The aggregate native wage in home is a weighted average of optimized and non-optimized native wage profiles:

\[
(W_{a,t})^{1-\epsilon_{wn,t}} = (1 - \xi_{wn})(W^{D}_{a,t})^{1-\epsilon_{wn,t}} + \xi_{wn}(W_{a,t-1})^{1-\epsilon_{wn,t}}. \tag{19}
\]

Combining (19) with the recursive formulation of the optimal wage expression (17) and log-linearising gives the native wage inflation rate\(^{18}\) in home:

\[
\tilde{\pi}^W_{a,t} = \gamma_w\tilde{\pi}^P_{t-1} + \beta \left( E_t\tilde{\pi}^W_{a,t+1} - \gamma_w\tilde{\pi}^P_{t} \right) - \lambda_{wn}\psi_n\frac{1}{1 - u_a}(\tilde{u}_{a,t} - \tilde{u}_{nat}^{a,t}), \tag{20}
\]

with \( \lambda_{wn} = \frac{(1-\xi_{wn})(1-\beta\xi_{wn})}{\xi_{wn}(1+\epsilon_{wn}\psi_n)} \). Combined with (24) this expression makes the relation between wages and the emigrant share explicit. An increase in the emigrant share reduces the unemployment rate and the improved labor market position of natives translates into a higher wage inflation rate. For immigrants combining (18) with an expression similar to (19) yields an expression for the immigrant wage inflation rate:

\[
\tilde{\pi}^W_{f,t} = \gamma_w\tilde{\pi}^P_{t-1} + \beta \left( E_t\tilde{\pi}^W_{f,t+1} - \gamma_w\tilde{\pi}^P_{t} \right) - \lambda_{wm}\psi_m\frac{1}{1 - u_f}(\tilde{u}_{f,t}^a - \tilde{u}_{f,t}^{nat,a}). \tag{21}
\]

\(^{18}\)The wage inflation rate is defined as \( \tilde{\pi}^W_{a,t} \equiv w_{a,t} - w_{a,t-1} \) where small letters denote variables in logs, a hat denotes the log-deviation from the steady-state value, a tilde denotes the absolute deviation from the steady state and the superscript \( nat \) denotes the natural level in the absence of nominal rigidities.
with $\lambda_{wm} = \frac{(1-\xi_{wm})(1-\beta\xi_{wm})}{\xi_{wm}(1+\epsilon_{wm}\psi_m)}$. For immigrants an increase in $\gamma_t$, the share of emigrants from $f$, raises unemployment and lowers their wage inflation rate. According to the aggregate wage index the aggregate wage Phillips curve of the home country is a weighted average of native and immigrant wage inflation:

$$\Pi_t^{W} = (1 - \omega_n)\Pi_{n,t}^{W} + \omega_n\Pi_{f,t}^{W,a}. \quad (22)$$

Workers are only willing to participate in the labor market if the real wage exceeds their disutility of labor measured in units of the aggregate consumption good. The per family native and emigrant labor supply of type $i$ from home is determined by the marginal supplier of native and emigrant labor $i$:

$$L_{a,t}(i) = \left(\frac{W_{a,t}(i)}{P_{c,t}} - \frac{1}{\chi_t Z_t}\right)^{\frac{1}{\psi_n}} , \quad L_{n,t}(i) = \left(\frac{W_{f,t}(i)}{P_{c,t}} - \frac{1}{\chi_t Z_t}\right)^{\frac{1}{\psi_m}}. \quad (23)$$

Note, that the individual labor supply does not depend on the emigration rate because the emigration rate has a proportional effect on the wage and the disutility and thus cancels out. The aggregate native labor supply equals the per family labor supply times the number of native families, which is normalized to one, with $L_{a,t}^{tot} = 1 \cdot L_{a,t}$ with $L_{a,t} = \int_0^1 L_{a,t}(i) di$ and similarly for the aggregate immigrant labor supply equals the per family labor supply times the number of native families $L_{f,t}^{tot,a} = \gamma_{a} L_{f,t}^{a}$ with: $L_{f,t}^{a} = \int_0^1 L_{f,t}^{a}(i) di$.

When supplying their labor, workers of all types take the nominal wage and the labor demand as given. The labor demand is pinned down in section (4.3.1) by the optimal capital labor ratio and the relative wages of natives and immigrants. The resulting native and migrant unemployment rates are defined as:

$$u_{a,t} = 1 - \frac{N_{a,t}}{L_{a,t}}, \quad (24)$$

$$u_{f,t}^{a} = 1 - \frac{N_{f,t}^{a}}{\gamma_{a} L_{f,t}^{a}}, \quad (25)$$

and encompass all agents who are not employed but would prefer to work taking into account the benefit of working to their household.
5. Results

5.1. Data and estimation

The model is estimated using a Bayesian full-information maximum likelihood approach as in Galí et al. (2012b) and Smets et al. (2014). In the theoretical model all real variables are detrended with a constant deterministic trend. Nominal variables are divided by their specific deflator. The non-linear model is linearized via Taylor-Approximation and solved using Pertubation methods. Interest, inflation, unemployment and migration rates are expressed as deviation from their steady state in percentage points. All other variables are denoted as percentage deviation from their steady state. The theoretical model is linked to macroeconomic time series via measurement equations in order to form a state-space system. Kalman filtering techniques are used to calculate the likelihood function of the observed series. By implementing Bayes' rule the likelihood function is combined with prior information about the parameters derive a posterior distribution. In the last step we search for parameters that optimize the posterior density function via Markov Chain Monte Carlo (MCMC) methods.¹⁹

Structural parameters, as depreciation rates, openness, government share are calibrated similar as in Galí et al. (2012b). In both countries the share of EU migrants in total working-age population is set to $\omega = 0.02$ according to the observed EU citizen share.

All other parameters are estimated via Bayesian techniques (see table A.4 in Appendix Appendix A). Priors for standard business cycle parameters are set according to Smets et al. (2014). For migration-specific parameters we use starting values from the micro literature. For example the empirical estimates of the elasticity of substitution underline that in the euro area natives and immigrants within the same skill group are imperfect substitutes. E.g. for Germany Brücker et al. (2014) estimate the elasticity to be 6.7, which is slightly lower than the value of 7.0 obtained by Brücker and Jahn (2011) and 7.4 by Felbermayr et al. (2010).

Additionally, we use priors for the inverse Frisch elasticity of native and migrant labor supply such that they capture the average migrant-native unemployment gaps, we set the inverse Frisch elasticity of migrant

¹⁹Further details of the data collection and estimation strategy are described in the Appendix A.
labor supply lower than for natives to $\psi_m = 4.32$. The prior of the wage markup of migrants $\mu_{wm} = 1.40$ is chosen in order to match the empirically observed average native-migrant wage gap of 3.2% (Dustmann et al., 2010; Jean et al., 2010).

5.2. Dynamic responses to shocks

In this section we describe the interrelation of two distinct migration shocks. Therefore, we simulate the behavior of domestic aggregate variables to a total migration shock and a migration diversion shock to business cycle dynamics from the perspective of the German economy. We want to explain how different migration shocks affect total net migration, the labor market and the business cycle.

Although we implicitly estimate the effects of further typical business cycle and labor market shocks, we do not analyze the economic causes for EU emigration in the origin countries, although in principle the model can be used to it. Here, we focus on the location choice, even though we do not analyze typical business cycle and labor market shocks in destination countries and their effect on migration.

Figures A.3 - A.6 in Appendix A.1 show the impulse responses of output, and real wages as well as wage and unemployment differentials between Germany and the UK and their net migration rates.

**EU total migration shock**

The total migration shock is (see Figure A.3) modeled as a symmetric decrease of migration costs in both countries, which increases net migration. One important component are the business cycle and labor market conditions in the origin country, which are symmetric from the perspective of both destination countries and are assumed to be exogenous. Furthermore we can imagine that symmetric migration costs are

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20The steady state aggregate unemployment rate of 5% in Germany and 6.0% in UK which is a workforce-weighted average of the native unemployment rate (4.4% and 6.1%) and the EU immigrant unemployment rate (6.3% for Germany and 5.6% for UK).

21All shocks are uniquely identified.

22For interested reader we refer to Clemens and Hart (2018), where we also analyze the effect of different business cycle and labor market shocks in origin and destination countries on migration.

23See Clemens and Hart (2018) for the role of shocks with a migrant decision that takes origin country-specific conditions into account.
some EU-wide institutional burden which are exogenously in the model. A positive total migration shock can thus represent e.g. a reduction of the EU-wide institutional burden. It could also reflect a common increase of attitudes in favor of immigration ("culture of welcome") in both countries which increases EU migrants utility from moving abroad. The macroeconomic effects of a total migration shock can clearly be disentangled from those of typical labor market shocks, because it causes a positive correlation between labor supply and net migration.\footnote{This is also driven by the fact that euro area migration is mainly labor market related. Therefore, EU migrants have higher participation rates than native workers.} A reduction of its costs will increase consumption directly after some periods. Additional output can be produced at lower labor costs than without migrants. Thus, a EU total migration cost reduction, which increases the net migration rate by 0.015 percentage points\footnote{With a steady state EU migrant to native population ratio of 0.02, this would be an increase by 0.75 percent.} increases output by around 0.15 percent on a 5-year average.\footnote{While net migration, unemployment rate and labor force participation rate data are denoted in percentage point deviation, all other variables are denoted in percent.}

\textit{EU migration diversion shock}

The migration diversion cost shock (see Figure A.4) is assumed to lead to an asymmetric increase of net migration in Germany and the UK. The migration diversion shock subsumes all migration costs that are country-specific, such as preferences for working in Germany or the UK e.g. due to language skills. It could also represent some country-specific institutional burden or policy which arises exogenously in the model. A negative migration diversion shock can thus be interpreted as reduction of the preference to work in Germany, due to some exogenous event changes in the societal attitudes in favor of migration. It could also be the consequence of reducing real country-specific integration costs, e.g. by improving the process of admission of foreign education degrees, that increase the willingness to move to Germany instead of UK. The shock can be clearly identified, because it distinguishes from the total migration shock by the sign of the net migration and output reaction in the second destination country, here the UK. Instead of symmetric aggregate responses in both destination countries, it drives production costs, wages and to-
tal output in different directions. Regarding our parameter estimates, a country-specific migration cost reduction in Germany of 0.01 percentage point (by 0.5 percent) would reduce net migration in UK by 0.008 (by 0.4 percent) percentage points. Such a migration diversion shock would increase German output by roughly 0.1 percent and reduce UK output by 0.7 percent.

5.3. Historical shock decomposition

In order to analyze the potential effects of the Brexit vote on net migration in Germany and UK we decompose the country-specific shocks to the net migration rate of Germany and the UK. We thereby distinguish more broadly between supply, demand, labor market, total migration cost and migration diversion shocks. The decomposition is depicted in Figure A.5 and A.6 in Appendix A.2. Three aspects are noteworthy: First we find that even if we neglect origin countries economic states, business cycle dynamics in destination explain on average roughly 30 percent of total fluctuation of the net migration rate. Second, the total migration shock explains on average more than 60 percent of overall net migration variation. The contribution is relatively large, because it contains not only common institutional burden in destination countries but also origin countries business cycle and labor market dynamics. Third, we find evidence for a small migration diversion effect after the Brexit vote. In Germany it explains 5 percent of additional net migration, in UK can account for around 10 percent of the migration drop.

6. Conclusions

This paper proposes a new approach to model the location choice of migrants over the business cycle in a two-country setting. In particular, we focus on migration diversion from the UK to Germany. By starting with a summary of the empirical evidence on recent EU migration flows and patterns in both countries, we find evidence for a reduction of migration flows and diversion between both countries. This observation points towards the importance of a theoretical migration model that can disentangle EU-wide and country-specific push and pull factors and internalized key driving forces of migration over the business cycle.

We extend a two-country dynamic stochastic general equilibrium model of business cycle migration as in Clemens and Hart (2018) by an explicit
migrants location choice. The model is able to distinguish a total migration cost shock from a migration diversion shock. The former leads to a symmetric increase of net migration in both countries with similar effects on the macroeconomy. In contrast, the latter leads to an asymmetric net migration response. By estimating the model with German and UK quarterly data from 1Q1995 to 4Q2017 we are able to identify the shock contribution of migration diversion on total net migration rates.

We find that business cycle dynamics in destination countries explain on average roughly 30 percent of total fluctuation of the net migration rate. The total migration shock explains on average more than 60 percent of overall net migration variation. The contribution is relatively large, because it contains business cycle and labor market dynamics of origin countries. Finally, we find evidence for a small migration diversion effect after 2016, i.e. the Brexit vote. In Germany it explains 5 percent of additional net migration, in UK it can account for around 10 percent of the migration drop.
### Appendix A. Empirical part

Table A.3: Net migration and unemployment in the euro area between 2009 and 2012

<table>
<thead>
<tr>
<th>Immigration reasons</th>
<th>EU*</th>
<th>Non-EU</th>
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* without home country
– denotes missing data.
Source: EU LFS.
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Table A.4: Estimated parameters
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Table A.5: Estimated parameters
Appendix A.1. Impulse response functions

Figure A.3: EU migration shock - output, wages, differentials
Figure A.4: EU migration diversion shock - output, wages, differentials
Appendix A.2. Historical decomposition

Figure A.5: Historical decomposition - EU migration to Germany
Figure A.6: Historical decomposition - EU migration to United Kingdom
Appendix B. Baseline Model

Appendix B.1. Households

Capital stock:

\[ K_t^p = (1 - \delta)K_{t-1}^p + \eta_t^i \left[ 1 - S \left( \frac{I_t}{I_{t-1}} \right) I_t \right], \quad \text{(B.1)} \]

The consumption good and the investment goods are composites of the domestic good bundle \( y_{h,t} \) and the imported good bundle \( y_{f,t} \):

\[ C_t = \left( (1 - \omega) \frac{1}{\lambda} (C_{h,t})^{\lambda-1} + \omega (1 - \phi_{C,t})(C_{f,t})^{\lambda-1} \right)^{1/\lambda}, \quad \text{(B.2)} \]
\[ I_t = \left( (1 - \omega) \frac{1}{\lambda} (I_{h,t})^{\lambda-1} + \omega (1 - \phi_{I,t})(I_{f,t})^{\lambda-1} \right)^{1/\lambda}, \quad \text{(B.3)} \]

where \( \omega \in (0, 1) \) denotes the share of the foreign good in the aggregate good and \( \lambda \) denotes the elasticity of substitution between domestic and foreign goods. As in de Walque et al. (2017) \( \phi_{C,t} \) and \( \phi_{I,t} \) denote cost that occur in the adjustment of imported consumption and investment goods with standard quadratic form.

For given prices \( p_{h,t} \) and \( p_{f,t} \) of the home and foreign produced composite good, expenditure minimising subject to the CES-aggregate gives the consumption and investment demand functions for domestic and foreign composite goods:

\[ C_{h,t} = (1 - \omega) \left( P_{h,t} / P_{c,t} \right)^{-\lambda} C_t, \quad C_{f,t} = \omega \left( P_{f,t} / P_{c,t} \right)^{-\lambda} C_t \quad \text{(B.4)} \]
\[ I_{h,t} = (1 - \omega) \left( P_{h,t} / P_{c,t} \right)^{-\lambda} I_t, \quad I_{f,t} = \omega \left( P_{f,t} / P_{c,t} \right)^{-\lambda} I_t \quad \text{(B.5)} \]

and the aggregate consumption price is \( P_{ct} = \left( (1 - \omega) P_{h,t}^{1-\lambda} + \omega P_{f,t}^{1-\lambda} \right)^{1/(1-\lambda)} \).

Optimal bond holdings are described by the Euler equations where \( \Lambda_t = (C_t - hC_{t-1})^{-1} \) denotes the marginal utility of consumption:

\[ \Theta_t = \beta E_t \left\{ \frac{\Lambda_t}{\Lambda_{t+1}} \frac{P_{c,t}}{P_{c,t+1}} \right\}, \quad \Theta_t^* = \beta E_t \left\{ \frac{\Lambda_t}{\Lambda_{t+1}} \frac{P_{c,t}}{P_{c,t+1}} \right\}, \quad \text{(B.6)} \]
Appendix B.2. Firms

The homogeneous good assemblers operate in a perfectly competitive environment and demand a continuum of domestic and foreign intermediate inputs to produce a domestic $Y_{dh,t}$ and a foreign $Y_{df,t}$ good. While the domestic bundle is demanded by final users in home for all types of expenditures, the foreign bundle is used for consumption and investment only:

\begin{align}
Y_{dh,t} &= C_{h,t} + I_{h,t} + G_t + \phi_k(u_t)K_{t-1}^p, \quad \text{(B.7)} \\
Y_{df,t} &= C_{f,t} + I_{f,t}. \quad \text{(B.8)}
\end{align}

For given prices of the home and foreign produced varieties, cost minimization subject to the Kimball (1995) aggregators

\[ \int_0^1 G \left( \frac{y_{dh,t}^{d}(z)}{y_{h,t}^{0}}, \epsilon_{p,t} \right) = 1 \]

and

\[ \int_0^1 G \left( \frac{y_{df,t}^{d}(b)}{y_{f,t}^{0}}, \epsilon_{p,t} \right) = 1 \]

gives the demand functions:

\begin{align}
Y_{h,t}^{d}(z) &= Y_{h,t}^{d} \left( \frac{P_{h,t}^{d}(z)}{P_{h,t}^{0}} \tau_{h,t} \right) \quad \text{where: } \tau_{h,t} = \int_0^1 G' \left( \frac{Y_{h,t}^{d}(z)}{Y_{h,t}^{0}} \right) \frac{Y_{h,t}^{d}(z)}{Y_{h,t}^{0}} dz, \quad \text{(B.9)} \\
Y_{f,t}^{d}(b) &= Y_{f,t}^{d} \left( \frac{P_{f,t}^{d}(b)}{P_{f,t}^{0}} \tau_{f,t} \right) \quad \text{where: } \tau_{f,t} = \int_0^1 G' \left( \frac{Y_{f,t}^{d}(b)}{Y_{f,t}^{0}} \right) \frac{Y_{f,t}^{d}(b)}{Y_{f,t}^{0}} db, \quad \text{(B.10)}
\end{align}

$\epsilon_{p,t}$ is a nonnegative variable that in logs follows an exogenous ARMA(1) process and affects the frictionless price markup via changes in the elasticity of demand.

In home, the monopolistically competitive firms $z$ uses capital $K_t$ rented out by the household at rental rate $R_k^t$ and composite labour $N_t(z)$ at the aggregate wage rate $W_t$ to produce its final good:

\[ Y_{h,t}(z) = \epsilon_{a,t}(K_t)^{a} \left( \gamma_{N}^{t} N_t(z) \right)^{1-a} - \gamma_{N}^{t} \phi_{p}, \quad \text{(B.11)} \]

where $\epsilon_{a,t}$ is the country specific exogenous technology parameter that in logs follows an AR(1) process, $\gamma_{N}^{t}$ is a labour-augmenting deterministic growth trend and $\phi_{p}$ is a fixed cost parameter.

\[ ^{27}G \text{ is strictly increasing and concave with } G(1) = 1 \]
Cost minimization gives the optimal capital-labor ratio that is equal across all firms:

\[ K_t = \frac{\alpha}{1 - \alpha} \frac{W_t}{R_t^k} N_t. \]  

(B.12)

We allow for labour mobility in the firm production as in Ottaviano and Peri (2012). Thus, the composite labour employed by each firm \( z \) in the production function (B.11) is a CES index of native and immigrant workers:

\[ N_t(z) = \left( (1 - \gamma)^{\frac{1}{\theta}} (N_{h,t}(z))^{\frac{\theta - 1}{\sigma}} + \gamma^\frac{1}{\theta} (N_{f,t}(z))^{\frac{\theta - 1}{\sigma}} \right)^\frac{\sigma}{\theta - 1}. \]  

(B.13)

The parameter \( \gamma \in (0, 1) \) is the aggregate elasticity of substitution between native and immigrant workers.28

Demand functions for native and immigrant labour types and labour composites are:

\[ N_{h,t}(i, z) = \left( \frac{W_{h,t}(i)}{W_{h,t}} \right)^{-\epsilon_{wn,t}} N_{h,t}(z), \quad N_{h,t}(z) = (1 - \gamma) \left( \frac{W_{h,t}}{W_t} \right)^{-\theta} N_t(z), \]  

(B.14)

\[ N_{f,t}(i, z) = \left( \frac{W_{f,t}(i)}{W_{f,t}} \right)^{-\epsilon_{wm,t}} N_{f,t}(z), \quad N_{f,t}(z) = \gamma \left( \frac{W_{f,t}}{W_t} \right)^{-\theta} N_t(z), \]  

(B.15)

The average real marginal cost of production are independent of the level of production:

\[ MC_{h,t} = \frac{R_t^k W_t^{1-\alpha}}{\epsilon_{w,t} \alpha - \alpha (1 - \alpha)^{-\alpha}}. \]  

(B.16)

and the problem simplifies to:

\[ \max E_t \left\{ \sum_{k=0}^{\infty} (\xi_p)^k \Theta_{t+k} \left[ \frac{P_{h,t+k|t}(z)}{P_t} - MC_{h,t} \right] Y_{h,t+k}(z) \right\}. \]  

(B.17)

\[ {28} \text{If } \theta > 1 \text{ native and immigrant workers are gross substitutes.} \]
The optimal price evolves according to the following difference equation:

\[
P_{h,t} = (1 - \xi_p)(P_{h,t}^0)G'^{-1}\left(\frac{P_{h,t}^0}{P_{h,t}}\tau_{h,t}\right) + \xi_p P_{h,t|t-1}G'^{-1}\left(\frac{P_{h,t|t-1}}{P_{h,t}}\tau_{h,t}\right).
\]

(B.18)

Combining equation B.18 with the first order condition associated with the problem (B.17) gives the standard non-linear price inflation rate of the home good:

\[
\hat{\pi}^P_{h,t} = \gamma_p \hat{\pi}^P_{t-1} + \beta_p \left(\hat{E}_t \hat{\pi}^P_{h,t} + \gamma_p \hat{\pi}^P_{t-1} - \lambda_p (\hat{m}_{c,h,t} - \hat{m}_{nat})\right),
\]

(B.19)

with \(\lambda_p = \frac{(1 - \xi_p)(1 - \beta^2_p)}{\xi_p(1 + (\lambda \lambda_p - 1)\sigma_p)}\), where \(\lambda \lambda_p\) and \(\mu_{ph,t}\) respectively denote the price markup and the logarithm of the average price markup and \(\sigma_p\) is the curvature of the Kimball aggregator.

**Appendix B.2.1. International trade and financial markets**

Exports of the home economy correspond to a share of the foreign import demand and to changes in the demand from the Rest of the World:

\[
X_t = M_t \beta_{m} \varepsilon_{nt,t}
\]

(B.20)

with sensitivity parameter \(\beta_{m}\) and exogenous shock process \(\varepsilon_{nt,t}\). Introducing a transit good \(X^*_t\) with a share \(\omega_m\) in the home imports, allows to account for the comovement between home and foreign exports:

\[
M_t = \left((1 - \omega_m)^{1/\lambda_m}(Y_{f,t})^{\lambda_m-1/\lambda_m} + \omega_m^{1/\lambda_m}(X^*_t)^{\lambda_m-1/\lambda_m}\right),
\]

(B.21)

where \(\mu_m\) denotes the elasticity of substitution between both import goods. Correspondingly, the export aggregator is:

\[
X_t = \left((1 - \omega_x)^{1/\lambda_x}(Y_{h,t})^{\lambda_x-1/\lambda_x} + \omega_x^{1/\lambda_x}(X^*_t)^{\lambda_x-1/\lambda_x}\right),
\]

(B.22)

where \(\omega_x\) denotes the share of transit goods in exports and \(\lambda_x\) the corresponding elasticity of substitution. The price of the transit good is assumed to equal the price of foreign consumption goods, thus \(P_{f,t}\) denotes
the price of the import aggregate and the price for the export aggregate is:

\[ P_{x,t} = \left( (1 - \omega_x)(P^*_{x,t})^{1-\lambda_x} + \omega_x(P^*_{f,t})^{1-\lambda_x} \right)^{\frac{1}{1-\lambda_x}}. \] (B.23)

The trade balance is given by \( TB_t \equiv P_{x,t}X_t - P_{f,t}M_t \) and the terms of trade are defined as \( S_t = \frac{P_{x,t}}{P_{f,t}} \).

Optimal bond holdings are described by the Euler equations where \( \Lambda_t = (C_t - hC_{t-1})^{-1} \) denotes the marginal utility of consumption:

\[ \Theta_t = \frac{\Theta^*_t}{\phi_{b,t}}. \] (B.24)

Combining the optimal bond holding conditions for home and foreign bonds yields the uncovered interest rate parity.

The nominal resource constraint is derived by inserting the firm profits into the aggregate budget constraint. It pins down the net foreign assets in relation to the trade and the income balance:

\[ \Theta^*_t B_{f,t} = TB_t + IB_t + B_{f,t-1}. \] (B.25)

According to the real resource constraint, production equals demand. It is derived by assuming market clearing for each home produced good varieties \( z \in [0, 1] \) and using equations B.9 and the foreign country counterpart of equation (B.10):

\[ Y_{h,t} = \int Y_{h,t}(z)dz = s_{h,t}Y_{h,t}^d + s^*_{h,t}Y^*_d, \] (B.26)

where \( \Delta^C = \int G^{-1}\left( \frac{P_{x,t}}{T_{x,t}} \right)dz \) is a price dispersion measure and \( Y_{h,t}^d \) and \( Y^*_d \) are defined by equations (B.7) and (B.8).

Native and immigrant labour market clearing \( N_{h,t} = \int_0^1 \int N_{h,t}(i,z)didz \) and \( N_{f,t} = \int_0^1 \int N_{f,t}(i,z)didz \) implies:

\[ N_{h,t} = \Delta^W_{h,t} \int_0^1 N_{h,t}(z)dz, \quad N_{f,t} = \Delta^W_{f,t} \int_0^1 N_{f,t}(z)dz, \] (B.27)

with native and immigrant wage dispersion terms \( \Delta^W_{h,t} = \left( \frac{W_{h,t}(i)}{W_{h,t}} \right)^{-\epsilon_{wn,t}} \)

and \( \Delta^W_{f,t} = \left( \frac{W_{f,t}(i)}{W_{f,t}} \right)^{-\epsilon_{wm,t}}. \)
Combined with the production function (B.11) and the demand for the firm specific variety (B.9) the aggregate relation between aggregate employment and output is

$$N_t = \left( \frac{Y_t}{\epsilon_{a,t}} \right)^{1 \over 1-\alpha} \Delta_t^p,$$

with price dispersion term $\Delta_t^p = \int \left( \frac{P_{h,t}(z)}{P_{h,t}} \right)^{-c_p \over 1-\alpha} dz$.

Finally, the central bank can influence the nominal interest rate in order to stabilise the price inflation and the output to their target rates:

$$\frac{1 + i_t}{1 + i} = \left( \frac{1 + i_{t-1}}{1 + i} \right)^{\rho_1} \left[ \frac{\Pi y_t y_2}{\Pi y} \right]^{1-\rho_1} \left( \frac{y_t / y_{t-1}}{y_{t-1} / y_{t-1}} \right) \epsilon_{m,t},$$

(B.29)
References


