A search and matching approach to business-cycle migration in the euro area

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Abstract

Recently migration patterns in the euro area changed markedly in response to increasing unemployment disparities and reinforced the interest in labor mobility as stabilization tool. In a data set of 55 bilateral migration corridors in the euro area over the period 1980-2010 we find evidence for business-cycle related fluctuations in net migration flows and the crucial role of unemployment and vacancies in shaping migration patterns. We propose a two-country DSGE model with circular migration that is able to replicate the empirical facts on business-cycle migration. In this model unemployment arises from search and matching frictions. We endogenize migration via the unemployed workers choice on which labor market to search for a job. Additionally, we allow for migration as a consequence of successful on-the-job search abroad. The framework allows to account for wage and unemployment gaps between natives and immigrants over the cycle as well as for factors such as language barriers that hinder the labor market integration of foreigners. We find that the impact of migration on country-specific average wages and unemployment depends crucially on the characteristics of immigrants and natives as well as the institutional characteristics of the total corridor, i.e. search efficiency. We show that the ratio of employed migration to unemployed migration crucially shapes the size of the unemployment rate differential in response to business cycle shocks. The model will be used to analyze the effects of immigration policies, that either address unemployed or employed migrants, on migration patterns and welfare.

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1. Introduction

European policy makers continue to highlight migration as a means to increase overall employment against the background of heterogeneous labor market conditions. The legal framework of the European Union guarantees free movement of persons and lays the foundation for a potentially high mobility in the euro area. The interest in labor mobility was reinforced during the recent European crisis episode where migration patterns in the euro area changed markedly in response to increasing unemployment disparities. Therefore, understanding the drivers of internal migration in the euro area is crucial in order to assess this important adjustment mechanism.

Against this background three stylized facts about internal migration in the euro area stand out from the empirical literature. First, even though the importance of internal migration has increased over time, cross-country migration flows are smaller than interstate migration flows in the United States. Second, migration has a temporary and often circular nature. Third, migration flows react to relative business cycle fluctuations in the euro area and are mainly motivated by employment probabilities and wages.

To gain more insights into the impact of the business cycle on the direction and size of migration flows, we carry out a comprehensive empirical analysis of the interrelation of wages, unemployment and vacancies with migration patterns in the euro area over the business cycle for the period 1980 to 2010. Our analysis of 55 bilateral migration corridors reveals that on average wage and unemployment differentials are negatively correlated with net migration. The correlation of net migration and vacancies is positive. In combination with the unemployment pattern this points towards the important role of relative labor market tightness for migration decisions.

A theoretical model of internal migration and the business cycle in the euro area has to be able to replicate these empirical findings. We propose a two-country dynamic stochastic general equilibrium (DSGE) model with migration that features unemployment arising from search and matching frictions. We endogenize migration via the unemployed workers choice on which labor market to search for a job and the employed workers' choice to search for a job abroad. Thereby, migrants take into account all relevant information on relative labor market conditions (wages, employment and separation probabilities).

The inclusion of labor market frictions crucially shapes the migration patterns in this model. Immigrant workers face uncertainty to become unemployed and by modeling a constant outflow of employed and unemployed migrants we are able to capture the temporary nature of migration. Furthermore our approach lowers the migration flows compared to the case of a frictionless labor market for two interrelated reasons. By modeling a distinct matching process for migrants we are able to account for language barriers and other factors that hinder the labor market integration of foreigners. This feeds back to the migration decision in which agents take into account that it might take time to form a match abroad. Additionally, we can show that migration affects the relative business cycle fluctuations via a wage bargaining channel. As an outside option the possibility to migrate changes the workers' negotiation position in the wage bargaining process. If the labor market situation in the foreign economy improves relative to the home economy then the value of the outside option and the native workers' wages increase.

The calibrated version of our model is able to replicate key facts about the migration cycle in the euro area. It matches the empirically observed wage and unemployment gaps between native and immigrant workers and reproduces aggregate macro and labor market facts in the steady state and over the cycle. Simulations of our model show the interaction of emigration and return migration flows with labor market variables in response to a productivity shock. We find that a higher labor mobility decreases the unemployment fluctuation while it increases the output and employment fluctuation. A shock that improves the wage bargaining position of native workers via a higher emigration value at the same time decreases the negotiation position of emigrant workers. Therefore we observe opposing wage effects of a higher emigration and return migration rate. Overall, we find that the impact of migration on country-specific average wages and unemployment depends crucially on the characteristics of immigrants and natives and their interaction as well as the institutional characteristics of the total corridor, i.e. search efficiency. The model bridges the literature on migration in the search and matching framework to the literature on two-country DSGE models.

The paper is structured as follows: Section 2 reviews the literature on migration patterns in the euro area, on unemployment and migration in DSGE models, and on migration in search and matching models, Section 3 presents business cycle statistics on migration in the euro area with respect to unemployment, vacancies and wages, Section 4 describes the theoretical model, Section 5 discusses the parametrization and the model results with respect to the impact of parameters, the dynamic responses and the correspondence with business cycle facts and Section 6 concludes.

2. Literature overview

A theoretical model of internal cross-country migration in the euro area has to be able to replicate three empirical findings that stand out from the empirical literature. Firstly, even though the importance of internal migration has increased over time migration flows are smaller than the inter-state flows in the United States. In a panel of OECD countries over the period 1980-2010, Beine et al. (2013) find empirical evidence of the Schengen agreement and the introduction of the euro to have increased internal migration in the European Union (EU). Beyer and Smets (2015) employ a multilevel factor model to document that in the EU the contribution of cross-country mobility to a national labor demand shock has increased over time to approximately one third of the adjustment which is lower than the benchmarks of regional mobility in the EU or inter-state mobility in the United States. Reasons are seen in the cultural, language and institutional difference in Europe as well as in imperfections in the housing and rental market and liquidity constraints (Bartz and Fuchs-Schündeln, 2012; ECB, 2012; Huber, 2007).

Secondly, migration has a temporary and often circular nature (Brücker et al., 2014b; OECD, 2014). The term temporary migration refers to a variety of phenomena[1] whose documentation is limited by data availability (Constant et al., 2013; Dustmann and Görlach, 2016). A report by the OECD (2008) finds that in the 1990s the share of migrants that leave their host country within the first five years after arrival was on average higher in European countries than in the United States, Canada or New Zealand.[2] A distinct pattern noted by Dustmann and Görlach (2016) is that the temporariness of migration increases with economic and cultural similarities between the destination and the source country. With respect to economic indicators, the group of euro members is more homogenous than the EU-28 as a whole.[3] For Germany, the high relevance of temporary migration from other EU countries is documented by Brücker et al. (2014b) and Constant and Zimmermann (2011), who explain the shorter migration periods by the lack of legal migration restrictions and low migration cost.

[1]Constant and Zimmermann (2011)[p. 498] distinguish return, repeat and circular migration. While return migration is defined as a final return to the migrant home country, repeat migration refers to migrants who "frequently and repeatedly move to foreign countries" and circular migration "describes the systematic and regular movement of migrants between their homelands and foreign countries typically seeking work".

[2]The reported outmigration rate after five years is 60.4 percent in Ireland, 50.4 percent in Belgium and 28.2 percent in the Netherlands.

[3]The membership in the euro area is conditional on the fulfillment of economic convergence criteria.

Thirdly and closely connected to the temporariness of migration patterns, migration flows react to relative business cycle fluctuations in the euro area and are mainly motivated by employment probabilities and wages (Brücker et al., 2014b; OECD, 2014).[4]. Beine et al. (2013) find current and future business cycle and employment dynamics to influence bilateral migration flows.[5] Additionally, during the recent European financial and debt crisis growing labor market disparities among the members of the euro area were mirrored by a marked change in the size and direction of migration flows (Bertoli et al., 2013; OECD, 2014).

In the growing theoretical literature on business cycle migration many contributions abstract from unemployment and rely on the assumption of a frictionless international labor market that is characterized by fully flexible wages. Mandelman and Zlate (2012) model immigration of unskilled Mexicans to the U.S. in a RBC model. In a New-Keynesian (NK) model, Binyamini and Razin (2008) and in a similar vein Engler (2009) assess the effects of immigration respectively emigration on the Phillips curve and find it to be flatter in both cases. The flatter Phillips curve in presence of labor mobility is a key insight from integrating migration into the NK model. Because of the inflow of workers a lower wage increase is needed to raise the labor force compared to the case without labor mobility. In a two-country model of internal U.S. labor 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. However, this result

Another group of business cycle migration models accounts for the role of labor market frictions. In the DSGE framework two approaches to introduce unemployment can be distinguished. One approach (e.g. Galí, 2011) reinterprets the DSGE model with staggered wage setting formulated by Erceg et al. (2000) where the market power of differentiated types of labor gives rise to a positive average wage markup and unemployment. Bentolila et al. (2008) include real wage rigidity in an ad hoc manner in their derivation of an empirically testable NK Phillips curve. They find that immigration alters the slope and intercept of the Phillips curve via a different labor supply elasticity and bargaining power of immigrants. In Clemens and Hart (2015) we model migration by allowing agents to set a native and a migrant wage. Even though this model is able to match aggregate business cycles suitably well, it gives a rather implicit description

[4]For Germany Brücker et al. (2014b) finds that in the group of repeated migrants and of migrants from other EU countries the dominant migration motive is taking up a job or searching for a job.

[5]According to their panel estimation a 1 % rise in the ratio of employment rates between destination and origin country in a migration corridor increases the bilateral migration rate by 5 %.

of how migrants respond to relative labor market fluctuations. The more common approach to introduce unemployment into the DSGE framework is to model real frictions from search and matching in line with Diamond (1982), Mortensen (1982), Pissarides (1985), Mortensen and Pissarides (1994) (e.g. Christiano et al., 2016; Faia and Rossi, 2013; Gertler et al., 2008; Krause and Lubik, 2007; Walsh, 2005).[6] In the migration literatur Ortega (2000) uses a dynamic two-country labor matching model where workers can choose to search at home or abroad with information asymmetries to show that this set-up gives rise to multiple Pareto-ranked steady-states with and without immigration. Chassamboulli and Palivos (2013, 2014) analyze skill-biased immigration inflows in a model with search and matching and skill heterogeneity and the contribution by Battisti et al. (2014) investigates the welfare effect of immigration of workers who are perfect substitutes within skill classes. Braun and Weber (2016) use a dynamic search and matching model of two regions to analyze the historical episode of massive expellees inflow to post-war Germany.

The advantage of the search and matching approach is that it delivers a detailed description of the labor market processes over the business cycle. This is particular helpful in the context of migration, because it allows us to explicitly model the migration flows in response to relative employment probability and wage fluctuations. Further, it allows to take into account different employment dynamics (e.g. separation rate) for migrants and natives over the cycle.[7] We differ from these set-ups by modeling the interaction of two economies over the business cycle and by allowing for migration in both directions in response to relative business cycle fluctuations and differences in employment probabilities. Thereby, we bridge the literature on unemployment in two-country DSGE models to the literature on migration in a search and matching framework. Including unemployment in the analysis has nontrivial consequences because unemployment rates exhibit a different dynamic pattern than wages.

[6]There exist versions with and without the assumption of rigid wages. Shimer (2005) and Hall (2005) propose wage rigidity as one way to introduce the empirically observed negative correlation of unemployment and vacancies ('Beveridge curve') into the search and matching model.

[7]While the wage patterns for migrants and natives follow similar patterns over the cycle they differ with respect to employment probabilities. Dustmann et al. (2010) find that in Germany the unemployment response to labor market shocks is stronger for immigrants than for natives within the same skill group. Prean and Mayr (2016) obtain a similar result for Austria that even holds after controlling for industry and job characteristics. This is in line with the general finding, that immigrants tend to be hit hard and immediately in an economic downturn (OECD, 2013).

3. Empirical observations

3.1. Compiling the data set

To investigate the migration business cycle in the euro area we compile a large data set with bilateral migration and macroeconomic variables[8] in a similar vein as Beine et al. (2013) but with a focus on the euro area. The data set contains observations for the years 1980-2010 and covers 12 euro area countries (EA-12[9]). Due to the lack of availability of quarterly[10] bilateral migration data we rely on annual data from the United Nations and the OECD Migration database. Each pair of countries is referred to as a migration corridor and our set of countries gives rise to $12 \cdot 11/2 = 66$ potential migration corridors. Due to data limitations the number of actual corridors in the panel reduces to 55.[11] For each bilateral migration corridor we define the net migration as the difference of immigration and emigration between the two countries and normalize it by the average labor force in the migration corridor.

The data series for the macroeconomic variables real GDP, real consumption, unemployment rate, employment, labor force, real wage, price inflation, wage inflation, and trade balance were drawn from the AMECO database. Real compensation per employee serves as a proxy for real wages.[12] Vacancy data for the euro area can be obtained from Eurostat for the years 2001 onwards. However, this data is neither seasonally adjusted nor harmonized and lacks observations for France and Italy. As an indicator for vacancies that overcomes these shortcomings[13] we use the series of employers' perception of labour shortages in manufacturing data from the European Commissions' Surveys of Business Confidence. This data is widely used and has been shown to be highly correlated with official vacancy series (e.g. Bonthuis et al. (2013)).

For the migration business cycle relative fluctuations of variables in source and destination countries matter. Therefore, we construct differentials of output, real wage,

[8] See Appendix 7.1 for a description of the data.

[9] The EA-12 refers to Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, Luxembourg, Netherlands, Portugal and Greece.

[10] The empirical investigation of short-run migration flows is limited by the fact, that data on a business cycle frequency is still very rare. Therefore, most studies use data on an annual basis from 1980 until now. For Germany there is a new data set with monthly data.

[11] There are still some missing years in that panel. In the period 1980-2010 there are 42 corridors without missing observations, in 1990-2010 the number increases to 50 corridors and in 1996-2010 to 55 corridors.

[12] Galí (2011) points out, that compensation per employee is a wage concept that comprises other employment-related cost to the employer than wages and exhibits stronger volatility than earnings-based concepts.

[13] Because this indicator bases on a percentage share of firms it is not affected by country size. However, the series does not provide data for Ireland and might be subject to a memory effect ECB (2002).

unemployment rate and vacancies for each migration corridor. The differentials are defined as the difference in a variable, normalized by its corridor average. The wage and the unemployment differentials act as empirical proxies for non observable time-varying migrants wage/unemployment differentials.[14] All variables are in real terms and in terms of the cyclical component, i.e. the deviation of the variable from its trend. In order to extract the cyclical component we take logs of all level variables and apply the HP filter with a smoothing parameter of $\lambda = 400$.[15] EA-12 averages are obtained as unweighted averages of all corridors.

3.2. Business cycle statistics for the euro area

In the following we present business cycle facts for the euro area that help to asses whether internal migration patterns vary systematically with the business cycles and how wages, unemployment, vacancies and migration patterns are interrelated over the business cycle. Because the empirical literature points towards the importance of employment dynamics for net migration we include vacancies in our analysis. Our interest is twofold, we want to identify characteristic patterns of the average EA-12 migration corridor and consider heterogeneity across corridors.

There is evidence for a migration cycle in the EA-12 because the net migration rate displays a relatively strong volatility. According to Table 1 (column four) net migration is positively correlated with the output differential, thus internal migration seems to be procyclical.[16] Over the cycle the net migration rate displays a strong negative correlation with the unemployment rate differential that is mirrored by a positive correlation with the employment differential. Additionally, net migration is positively correlated with the indicator of vacancies over the cycle, while vacancies on average exhibit a negative correlation with the unemployment rate of 0.54, i.e. the Beveridge curve is downward sloping. Combined, vacancies and unemployment point towards the importance of

[14]While comparable data in source and destination countries is available for average wages, there is a lack of data on skill-specific wage differentials. Grogger and Hanson (2011) provide an approach to construct such a measure. We justify our approach by findings of Dustmann et al. (2010) who find little evidence for differential wage patterns of skilled and unskilled native workers and migrants. Thus the average real wage measures is an indicator for the wage dynamics of all four groups.

[15]Thereby we follow Beine et al. (2013) who also use a value of $\lambda = 400$ for the analysis of business cycle migration with annual data. We check the robustness of our results with respect to the smoothing parameter and find that our results do not change fundamentally with $\lambda = 100$ and $\lambda = 6.25$.

[16]However, Hauser (2014) demonstrates for the U.S. labor market that while unconditional labor mobility is procyclical, the picture is less clear for conditional labor mobility. Her SVAR analysis of all migration corridors in the U.S. reveals that subsequent a technology shock some states face a net inflow of workers while others face an outflow. A similar SVAR exercise should be carried out for the EA-12 labor markets.

labor market tightness for the net migration patterns. As we would expect from the literature review, the correlation of net migration with real wages is lower than with the unemployment rate. Surprisingly, the correlation of real wage and net migration is negative.

Table 1: Dynamic correlations - Net migration rate (nm)

	τ						
Statistic	-3	-2	-1	0	1	2	3
$\rho(dy_{t+\tau}, nm_t)$	0.010	0.058	0.113	0.167	0.100	0.041	-0.019
$\rho(du_{t+\tau}, nm_t)$	-0.012	-0.138	-0.274	-0.307	-0.199	-0.054	0.093
$\rho(dv_{t+\tau}, nm_t)$	0.032	0.111	0.110	0.089	-0.011	-0.033	-0.049
$\rho(dw_{t+\tau}, nm_t)$	-0.072	-0.118	-0.131	-0.099	-0.071	0.008	0.087

$\rho(dx_{t+\tau}, nm_t)$ denotes the correlation of net migration and the τth lag (lead) of the differential of variable x if τ is negative (positive).

To further investigate the dynamic behavior of net migration and the differentials of real output, unemployment rate, vacancies and real wage, Table 1 displays the dynamic correlations up to the third lag and lead. The net migration rate is positively correlated with output and negatively correlated with unemployment at various lags and leads. In both cases the contemporaneous is the peak correlation. As a first intuition, the negative correlation between the unemployment differential and net migration can be explained by assuming that unemployment is c.p. causal for the migration decision. In the euro area, an exogenous negative labor demand shock decreases output and increases unemployment in one country and consequently native households decide to emigrate to another country with higher output and lower unemployment. This view is supported by the fact that the vacancy differential has the maximum correlation 0.11 at the first and second lag and thus leads the net migration. The negative correlation between the real wage differential and the net migration rate can be observed for the third lag up to the first lead.[17] The maximum correlation -0.13 at the first lag indicates that the wage differential leads the net migration rate by one to two periods. Instead of assuming the wage conditions to be causal for the migration decision, a shock that increases wages and decreases net migration e.g. via an increased unemployment can explain the observed pattern. The observation that the wage differential is negatively

[17]This result only changes slightly by using different time periods and smoothing parameters. The correlation of net migration with the unemployment and the wage differential decreases with a lower λ and a shorter time period.

correlated with net migration at three lags and positive starting with the second lead speaks against the hypothesis, that the average negative correlation of net migration and wages stems from the negative effect of immigration on wages.

Figure 1: Correlation between the cyclical component of net migration and real wage, vacancy and unemployment differential for 55 euro area corridors

Figure 1 highlights the heterogeneity across migration corridors. The 55 migration corridors are sorted by sign and size of the contemporaneous correlation of the net migration rate and the differential of the real wage (left), unemployment (middle), vacancies (right). With respect to wages the heterogeneity across corridors is highest with approximately two thirds of all corridors exhibit a negative correlation and some corridors displaying a positively correlation of up to 0.5. With respect to wages the picture more clear with a majority of corridors displaying a negative correlation. For vacancies we again find more heterogeneity and the lowest maximum correlations compared to the other variables. The signs of net migration correlation with wages and vacancies can act as dimensions to classify migration corridors into four types and we observe that in a majority of corridors migration flows are directed towards a high labor market tightness (see Figure 3 in the appendix).

Overall, the business cycle facts underline that the analysis of wages alone is not sufficient to understand the cyclical migration patterns in the euro area. Our results points towards the importance of relative unemployment and labor market tightness fluctuations. In line with these findings we develop a two-country dynamic stochastic general equilibrium model of internal business cycle migration in the euro area and allow for unemployment that arises from search and matching frictions.

4. A two-country business cycle model with unemployment and migration

4.1. Model system

In discrete time we build a stylized two-country New Keynesian model with cross-country labor mobility and labor markets characterized by search and matching frictions as in the Mortensen and Pissarides (1994) framework. The existence of migration cost drives a wedge between the value of being employed as a migrant and a native such there is a constant incentive for unemployed and employed workers to migrate to the foreign labor market. To simplify the model we abstract from on-the-job search within a country as modelled by (Krause and Lubik, 2006). Both economies are symmetric[18], form a migration corridor and have bilateral trade in goods with zero external balances in the steady state. The trade block of the model is a simplified version of de Walque et al. (2017). In each country the general structure of the labor market and production sector follows Christoffel et al. (2009). The migrant flow is composed of unemployed workers who can either search in the home or the foreign labor market and of employed migrants, who move after successfully searching on the job.

4.2. Emigration and return migration

With free movement of labor, the native working-age population of each country consists of employed and unemployed in the home and the foreign labor market (i.e. emigrants) and its size equals $1 = n_{h,t} + u_{h,t} + n^*_{h,t} + u^*_{h,t}$. The national labor force deviates from the native working-age population and is defined as sum of native and immigrant employed and unemployed workers, $l_t = n_{h,t} + u_{h,t} + n_{f,t} + u_{f,t}$. The difference between the native population and the labor force is the net migrant stock $nms_t = n_{f,t} + u_{f,t} - (n^*_{h,t} + u^*_{h,t})$ and consequently, the net migration rate of a country is defined as the change in the net migrant stock over time:

$$nm_t = [n_{f,t} + u_{f,t} - (n^*_{h,t} + u^*_{h,t})] - [n_{f,t-1} + u_{f,t-1} - (n^*_{h,t-1} + u^*_{h,t-1})]. \tag{1}$$

[18]Due to the symmetry assumption all equations are derived for the home economy. They analogously apply to the foreign economy. In general, home variables do not have a superscript and foreign variables are denoted by a * superscript. In case of variables where country of supply and origin differ, the superscript denotes the location of the supply and the subscript (h or f) denotes the location of the origin or birth in case of agents.

We take into account cross-boarder migration of unemployed and employed workers.[19] In line with observations for the euro area we introduce a circular migration schedule such that immigration and emigration flows from natives and foreigners to both countries coexist. For simplicity we assume that the return migration rate of unemployed emigrants as well as the search intensity of employed emigrants are exogenous and time invariant. Consequently, at any point in time the emigration flow of a country comprises a share of unemployed native workers μ_t who move to the foreign labor market and a share of employed native workers $f^*_{h,t} si^*_{h,t}$ who where successful at searching for employment abroad on the job , where $si^*_{h,t}$ denotes the fraction of employed workers who search for a job abroad. Additionally, an exogenous share of unemployed immigrants γ^* and of employed immigrants $f^*_{f,t} si^*_f$ returns to foreign. Analogously, the immigration flow is composed of a share μ^*_t of unemployed workers from f, a share $f^*_{f,t} si^*_{f,t}$ of employed native workers from f as well as a share γ of unemployed emigrants and a share $f^*_{h,t} si^*_h$ of employed emigrants who return home. The time pattern from the perspective of the the home household is depicted in figure 2. Given the fact that most EU migrants

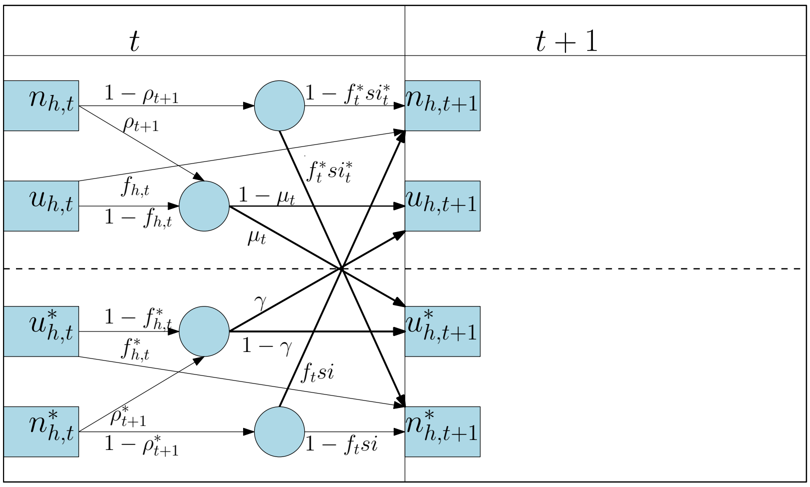

Figure 2: Timing of migration

do not leave their home country forever, we assume that with probability γ a migrant will return to her home country. Emigrant workers who return reduce the unemployed migrant stock in the foreign country but increase the unemployed native stock in the domestic country. On-the-job migration affects the unemployment rate via its impact on

[19] In the migration literature with search and matching it is a common approach to abstract from job-to-job migration (e.g. Braun and Weber, 2016; Chassamboulli and Palivos, 2014).

the job finding probability in the home and foreign labor market. An increased abroad search activity of employed native workers lowers the job finding probability of migrants in foreign and increases the job finding probability of workers in the home labor market because firms post vacancies to stabilize employment.
The stock of native unemployed evolves according to the following law of motion:

$$u_{h,t+1} = (1-\mu_t)[u_{h,t} - f_{h,t}u_{h,t} + \rho_t n_{h,t}] + \gamma_t[u^*_{h,t} - f^*_{h,t}u^*_{h,t} + \rho^*_t n^*_{h,t}], \tag{2}$$

$$u^*_{h,t+1} = (1-\gamma_t)[u^*_{h,t} - f^*_{h,t}u^*_{h,t} + \rho^*_t n^*_{h,t}] + \mu_t[u_{h,t} - f_{h,t}u_{h,t} + \rho_t n_{h,t}], \tag{3}$$

where the job finding probability $f_{h,t}$ decreases and the job separation rate ρ_t increases the next-period unemployment stock. Equation (2) and the foreign emigrant counterpart of equation (3) determine total domestic unemployment $u_t = u_{h,t} + u_{f,t}$.

4.3. Household preferences and decisions

The identical households are distributed along the unit interval and consist of a continuum of individual workers $i \in 0,1]$. We assume that native and emigrant workers from one household pool their labor income in order to insure each other and consume the same average consumption level (Andolfatto, 1996; Merz, 1995). Each household maximizes the sum of all household members' expected intertemporal utilities:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{(c_t - hc_{t-1})^{1-\sigma}}{1-\sigma} - \chi_L \left(\int_0^{n_{h,t}} \frac{h_{h,t}(i)^{1+\varphi_n}}{1+\varphi_n} di + \int_0^{n^*_{h,t}} \frac{h^*_{h,t}(i)^{1+\varphi_m}}{1+\varphi_m} di \right) \right), \tag{4}$$

χ_L is a scaling parameter for the disutility of labor, $h_{h,t}(i)$ refers to the hours worked by native worker i, accordingly $h^*_{h,t}(i)$ are the hours worked by emigrant worker i from the perspective of the home country and $\varphi_n, \varphi_m > 0$ denote the corresponding inverse Frisch elasticities of native and migrant labor supply. $h \in [0,1)$ represents consumption habit, σ is the inverse of the intertemporal elasticity of substitution, c_t is the consumption aggregate that is a composite of the domestic and the imported good bundle:

$$c_t = \left((1-\omega_c)^{\frac{1}{\theta_c}} (c_{h,t})^{\frac{\theta_c - 1}{\theta_c}} + \omega_c^{\frac{1}{\theta_c}} (c_{f,t})^{\frac{\theta_c - 1}{\theta_c}} \right)^{\frac{\theta_c}{\theta_c - 1}}, \tag{5}$$

where $\omega_c \in 0,1)$ is the share of the foreign good in the aggregate good and θ_c denotes the elasticity of substitution between domestic and foreign goods.

The household's budget constraint is:

$$P_{c,t}c_t + T_t + P_{h,t}\left(\kappa_t(v_{h,t}+v_{f,t}) + \left(\tilde{c}^{\mu}_{h,t}+\tilde{c}^{\gamma}_{h,t}\right)\frac{b}{2}\right) + \frac{B_{h,t}}{\varepsilon^b_t R_t} + S_t\frac{B_{f,t}}{\varepsilon^b_t R^*_t} + S_t\frac{\Delta^*}{2}\left(\frac{B_{f,t}}{R^*_t}\right)^2 \leq$$

$$\int_0^{n_{h,t}} W_{h,t}(i)h_{h,t}(i)di + S_t\int_0^{n^*_{h,t}} W^*_{h,t}(i)h^*_{h,t}(i)di + P_{c,t}b(1-n_{h,t}-n^*_{h,t})$$

$$+ B_{h,t-1} + S_t B_{f,t-1} + R^k_t k + Div_t, \quad (6)$$

Household income is used to purchase units of the consumption bundle at price $P_{c,t}$, to pay a lump-sum tax T_t, to finance the migration cost $(\tilde{c}^{\mu}_{h,t}+\tilde{c}^{\gamma}_{h,t})b/2$ (we introduce them in section 4.5.4) and the total vacancy posting cost for natives and immigrants $\kappa_t(v_{h,t}+v_{f,t})$. The time-variant real cost per vacancy κ_t equal κ in the steady state and in logs follow an AR(1) process with i.i.d. normal error structure. The household invests in nominal riskless domestic and foreign bonds $B_{h,t}$ and $B^*_{h,t}$ that each pay the risk-free rate R_t and R^*_t and are denominated in the currency of the issuing country. ε^b_t is an exogenous shock to the risk premium that in logs follows an AR(1) process with i.i.d. normal error structure. We assume international quadratic transaction cost on foreign assets which can occur due to a structural international financial market taxation.[20] The home household's labor income is generated by native workers, where agent i earns the hourly nominal wage $W_{h,t}(i)$ times the corresponding hours, and by emigrant workers, where agent i receives the hourly wage $W^*_{h,t}(i)$ times the corresponding hours. The labor income of emigrant workers is multiplied by the nominal exchange rate S_t in order to convert it to the home currency. Additionally, the household receives unemployment benefit b per unemployed family member that is paid according to the nationality of worker and thus is equal for natives and emigrants.[21] The household's capital income equals the return R^k_t on the fixed[22] effective capital stock k rented to the firms, returns on past bond holdings and dividends from owning labor and intermediate good firms. All firms in the home economy are owned by the households and total profits are generated

[20]Δ^* is positive to avoid non-stationarity of the model but set close to zero in order to minimize the influence on the dynamic pattern. See Melitz and Ghironi (2005).

[21]This assumption is justified by EU legislation that allows workers to search abroad while receiving the domestic unemployment benefit. Further this assumption helps to abstract from the role of unemployment benefits for the migration decision and to focus on the effect of employment probabilities instead.

[22]We follow Linde and Trabandt (2018) and in the stylized model fix the capital stock to abstract from endogenous capital accumulation.

by the native and immigrant labor good sector and the intermediate good sector:

$$Div_t = \int_0^{n_{h,t}} Div_t^n(i)di + \int_0^{n_{f,t}} Div_t^m(i)di + \int_0^1 Div_t(z)dz. \tag{7}$$

The household's behavior is described by the standard first-order conditions for consumption allocation and bond holdings:

$$c_{h,t} = (1-\omega_c)\left(\frac{P_{h,t}}{P_{c,t}}\right)^{-\theta_c} c_t, \tag{8}$$

$$c_{f,t} = \omega_c \left(\frac{P_{f,t}}{P_{c,t}}\right)^{-\theta_c} c_t, \tag{9}$$

$$\lambda_t = \varepsilon_t^b R_t \beta E_t \left[\lambda_{t+1}\frac{P_{c,t}}{P_{c,t+1}}\right], \tag{10}$$

$$\lambda_t(1+\Delta^* B_{f,t}) = \varepsilon_t^b R_t^* \beta E_t \left[\lambda_{t+1}\frac{S_{t+1}}{S_t}\frac{P_{c,t}}{P_{c,t+1}}\right], \tag{11}$$

where $\lambda_t = (c_t - hc_{t-1})^{-\sigma}$ is the marginal utility of consumption and the aggregate consumption price is $P_{c,t} = \left((1-\omega_c)P_{h,t}^{1-\theta_c} + \omega_c P_{f,t}^{1-\theta_c}\right)^{1/(1-\theta_c)}$. Combining (10) and (11) yields the uncovered interest-parity (UIRP):

$$R_t = \frac{R_t^*}{1+\Delta^* B_{f,t}}\beta E_t \left[\frac{S_{t+1}}{S_t}\frac{P_{c,t}}{P_{c,t+1}}\right]. \tag{12}$$

This arbitrage condition on bond returns pins down the nominal exchange rate.

4.4. *Firms*

We assume three types of firms. In a perfectly competitive environment, labor good firms employ one worker to produce the labor good that serves as in input to the intermediate good sector. Firms in the intermediate goods sector use capital and the labor good to produce differentiated intermediate goods under monopolistic competition and Calvo frictions. In the retail sector, homogenous good assemblers use domestic or foreign intermediate goods in order to produce a country specific aggregate good.

4.4.1. *Homogenous good assemblers*

The homogeneous good assemblers operate in a perfectly competitive environment and demand a continuum of domestic and foreign intermediate inputs to produce a domestic composite good with technology $y_{h,t} = \left(\int_0^1 y_{h,t}(z)^{(\epsilon_p - 1)/\epsilon_p} dz \right)^{\epsilon_p/(\epsilon_p - 1)}$ and a foreign composite good with technology $y_{f,t} = \left(\int_0^1 y_{f,t}(z)^{(\epsilon_p - 1)/\epsilon_p} dz \right)^{\epsilon_p/(\epsilon_p - 1)}$ where $\epsilon_p > 1$ is the own-price elasticity of demand. For given prices of the home and foreign produced varieties, cost minimization gives the demand functions:

$$y_{h,t}(z) = \left(\frac{P_{h,t}(z)}{P_{h,t}} \right)^{-\epsilon_p} y_{h,t}, \tag{13}$$

$$y_{f,t}(z) = \left(\frac{P_{f,t}(z)}{P_{f,t}} \right)^{-\epsilon_p} y_{f,t}. \tag{14}$$

The prices of the home and foreign composite good are $P_{h,t} = \left(\int_0^1 P_{h,t}(z)^{1-\epsilon_p} dz \right)^{1/(1-\epsilon_p)}$ and $P_{f,t} = \left(\int_0^1 P_{f,t}(h)^{1-\epsilon_p} dh \right)^{1/(1-\epsilon_p)}$. While the domestic bundle is demanded by final users in home for all types of expenditures, the foreign bundle is used for consumption only:

$$y_{h,t} = c_{h,t} + \varepsilon_t^g \bar{g} + \kappa_t (v_{h,t} + v_{f,t}) + 0.5 \left(\tilde{c}_{h,t}^{\mu} + \tilde{c}_{h,t}^{\gamma} \right) b, \tag{15}$$

$$y_{f,t} = c_{f,t}. \tag{16}$$

4.4.2. Labor good firms

There are native and immigrant labor firms, each firm employs exactly one worker. In t there are $n_{h,t}$ native firms, indexed by $i \in 0, n_{h,t})$, that produce a homogenous native labor good:

$$l_{h,t}(i) = \varepsilon_t^a h_{h,t}(i)^{\alpha_L}, \tag{17}$$

and $n_{f,t}$ immigrant firms, indexed by $i \in 0, n_{f,t})$, that produce a homogenous native labor good:

$$l_{f,t}(i) = \varepsilon_t^a h_{f,t}(i)^{\alpha_L}, \tag{18}$$

with $\alpha_L \in 0, 1)$ and labor augmenting productivity ε_t^a that is identical over both types of firms and their matches and in logs follows an AR(1) process with an i.i.d.-normal error structure. The profits of a native and a migrant labor firm matched to a worker who earns nominal wage $W_{h,t}(i)$ respectively $W_{f,t}(i)$ are:

$$Div^n(i)(W_{h,t}(i)) = \Psi^n \varepsilon_t^a h_{h,t}(i)^{\alpha_L} - W_{h,t}h_{h,t}(i) - P_{c,t}\Phi, \tag{19}$$

$$Div^m(i)(W_{f,t}(i)) = \Psi^m \varepsilon_t^a h_{f,t}(i)^{\alpha_L} - W_{f,t}h_{f,t}(i) - P_{c,t}\Phi. \tag{20}$$

4.4.3. *Intermediate firms and immigrants*

In the intermediate firm sector there is a continuum of monopolistically competitive firms which produce a differentiated good $z \in 0,1]$ and face a uniform price setting decision. The representative firm z uses capital $k(z)$ at rental rate R_t^K and the composite labor good $l_t^d(z)$ at price Ψ_t^L to produce with the following technology:

$$y_t(z) = k(z)^{\alpha} l_t^d(z)^{1-\alpha}, \tag{21}$$

where $\alpha \in 0,1)$ is the partial production elasticity of capital.

We allow for labor mobility in the firm production production as in Ottaviano and Peri (2012). Thus, the composite labor employed by each firm z in the production function (21) is a CES index of native and immigrant labor goods:

$$l_t^d(z) = \left((1-\gamma)^{\frac{1}{\theta}}(l_{h,t}^d(z))^{\frac{\theta-1}{\theta}} + \gamma^{\frac{1}{\theta}}(l_{f,t}^d(z))^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}. \tag{22}$$

The aggregate labor good price index is $\Psi_t^L = \left((1-\gamma)(\Psi_t^n)^{1-\theta} + \gamma(\Psi_t^m)^{1-\theta}\right)^{1/(1-\theta)}$ with the prices $\Psi^n{}_t$ of native labor and $\Psi^m{}_t$ of immigrant labor.

The parameter $\gamma \in 0,1)$[23] denotes the share of immigrant workers in the production and governs their income share. $\theta \in 0,\infty)$ is the aggregate elasticity of substitution between native and immigrant workers.[24]

According to the Calvo (1983) mechanism, each firm resets the price of its produced variety in any given period with a constant probability $1-\xi_p$. As in Smets and Wouters (2007) prices of firms that are unable to re-optimize in a given period are partially indexed to the previous period's inflation and the steady state inflation $P_{h,t+k|t} = P_{h,t+k-1|t}(\Pi_t^P)^{\gamma_p}(\Pi^P)^{1-\gamma_p}$ where $\gamma_p \in 0,1]$ denotes the degree of price indexation. A firm z that is allowed to change its price in period t, chooses an optimal price $P_{h,t}^O(z)$ to maximize its real life time value subject to the production function (21) and a se-

[23]We calibrate the model such that the state state of the endogenous emigrant share equals the this parameter.

[24]If $\theta > 1$ native and immigrant workers are gross substitutes.

quence of demand constraints from domestic and foreign final goods firms for its variety $y_{t+k}(z) = y_{h,t+k}(z) + y^*_{h,t+k}(z)\ \forall k = 0,1,\dots$ that are defined by (13).
Cost minimization gives the optimal capital-labor ratio that is equal across all firms since the fix capital stock can be freely allocated across all firms z:

$$\frac{k}{l_t^d} = \frac{\alpha}{1-\alpha}\frac{\psi_t^L}{r_t^k}, \tag{23}$$

with the real capital rental rate r_t^k and real price of the labor good ψ_t^L both measured in units of the aggregate consumption good. The average real marginal cost of production are independent of the level of production:

$$mc_{h,t} = \varepsilon_t^c \frac{\left(r_t^k\right)^\alpha \left(\psi_t^L\right)^{1-\alpha}}{\alpha^\alpha (1-\alpha)^{1-\alpha}}, \tag{24}$$

where ε_t^c is a cost push shock that in logs follows an AR(1) process with an i.i.d.-normal error structure.
Therefor, the firm's problem simplifies to:

$$\max E_t \left\{ \sum_{k=0}^{\infty} \xi_p^k \beta_{t+k,t} \left[\frac{P^O_{h,t+k|t}(z)}{P_{c,t+k}} - mc_{h,t+k} \right] y_{t+k}(z) \right\}, \tag{25}$$

with stochastic discount factor $\beta_{t+k,t} = \beta^k \frac{\lambda_{t+k}}{\lambda_t}$. Since all differentiated firms produce with the same production technology, the optimal price would be chosen by all firms resetting their price in t and the aggregate producer price level for the home economy evolves according to the following difference equation:

$$P_{h,t} = (1-\xi_p)(P^O_{h,t}) + \xi_p P_{h,t|t-1} (\Pi_t^P)^{\gamma_p} (\Pi^P)^{1-\gamma_p}. \tag{26}$$

Combining (26) with the first order condition associated with the problem (25) gives the standard non-linear price inflation rate of the home good:

$$\hat{\pi}^p_{h,t} = \gamma_p \hat{\pi}^p_{t-1} + \beta \left(E_t \hat{\pi}^p_{h,t+1} - \gamma_p \hat{\pi}^p_t \right) - \lambda_p (\hat{mc}_{h,t} - \hat{\mu}_t^{p,nat}), \tag{27}$$

with $\lambda_p = \frac{(1-\xi_p)(1-\beta\xi_p)}{\xi_p}$ and the logarithm of the average price markup μ_t^p. Total profits of the intermediate good firms equal the sum of profits generated in the home and the foreign market:

$$\int_0^1 Div_t(z)dz = \int_0^1 \left\{ \left(P_{h,t}(z) - P_{c,t}mc_t \right) \left(y_{h,t}(z) + y^*_{h,t}(z) \right) \right\} dz. \tag{28}$$

4.5. Labor market and immigration

The domestic labor market is subject to search and matching frictions. We endogenize migration via the unemployed workers choice on which labor market to search for a job.

4.5.1. Search and matching

In order to form a new employment relationship, unemployed workers can search either in the domestic or the foreign labor market ($u_{h,t}$,$u^*_{h,t}$). Firms post separate vacancies $v_{h,t}$ and $v_{f,t}$ for natives and immigrants. In line with key findings from the empirical literature on migration patterns in the euro area we consider job market differences of both groups. The segmented labor market between native and immigrant workers is captured by separate Cobb-Douglas matching functions:

$$m_{h,t} = \sigma^n (u_{h,t} + si_h n^*_{h,t})^{\delta} (v_{h,t})^{1-\delta}, \tag{29}$$

$$m_{f,t} = \sigma^m (u_{f,t} + si_{f,t} n^*_{f,t})^{\delta} (v_{f,t})^{1-\delta}. \tag{30}$$

σ^n and σ^m are measures for the matching efficiency of both worker types. They capture structural factors, e.g. relocation costs and language, that lead to significantly different job creation and job finding rates for migrants. $\delta \in (0,1)$ is the match elasticity with respect to unemployment and does not vary between natives and immigrants.[25] It is time consuming to form a match and therefore new matches become productive in the next period. The evolution of domestic aggregate native and immigrant employment is:

$$n_{h,t+1} = (1 - \rho_{t+1})(1 - f^*_{h,t} si^*_{h,t}) n_{h,t} + M_t m_{h,t}, \tag{31}$$

$$n_{f,t+1} = (1 - \rho_{t+1})(1 - f^*_{f,t} si^*_f) n_{f,t} + M_t m_{f,t}. \tag{32}$$

For natives and migrants job separations occur at an exogenous rate ρ_t that equals ρ in the steady state and in logs follows an AR(1) process with an i.i.d.-normal error

[25] This is our starting point, later we will consider differences in the match elasticity between natives and immigrants.

structure.[26]

The labor market tightness for natives and immigrants is defined as $\theta_{h,t} \equiv \frac{v_{h,t}}{u_{h,t}+si_h n^*_{h,t}}$ and $\theta_{f,t} \equiv \frac{v_{f,t}}{u_{f,t}+si_{f,t} n^*_{f,t}}$. The characteristics of the Cobb-Douglas matching function imply that firms fill their posted vacancies for natives with a probability $q_{h,t} \equiv \frac{m_{h,t}}{v_{h,t}} = \sigma^n \theta_{h,t}^{-\delta}$ and for immigrants with a probability $q_{f,t} \equiv \frac{m_{f,t}}{v_{f,t}} = \sigma^m \theta_{f,t}^{-\delta}$. Similarly, native and immigrant workers find a job with the probabilities $f_{h,t} = \theta_{h,t} q_{h,t}$ and $f_{f,t} = \theta_{f,t} q_{f,t}$.

4.5.2. Wage setting

Each worker-firm match shares the surplus of the match by determining the native or immigrant wage rate taking into account the presence of nominal wage rigidity. As formalized by Calvo (1983), new and preexisting matches can reset the wage with a constant probability $1 - \xi_w$ each period. ξ_w is independent across time, location and labor types. As in Galí et al. (2012), non-optimized nominal wages are indexed to productivity growth and the price inflation rate according to $W_{h,t+k|t} = W_{h,t+k-1|t} (\Pi^P_{t-1})^{\gamma_w} (\Pi^P)^{1-\gamma_w}$ where Π^P_{t-1} denotes the previous period's (gross) rate of price inflation, Π^P is the steady state price inflation and $\gamma_w \in 0,1]$ refers to the degree of price indexation. A firm and a native or immigrant worker in a newly formed or preexisting match that are able to reset the wage, determine the nominal wage rates $W^o_{h,t}$ and $W^o_{f,t}$ according the Nash bargaining solution. The Nash bargaining solution splits the overall surplus of the match in order to maximize the Nash product which for the native worker is given by

$$\max_{W_{h,t}(i)} [\Delta_{h,t}(W_{h,t}(i))]^{\eta_t} [J_{h,t}(W_{h,t}(i))]^{1-\eta_t}, \tag{33}$$

where η_t represents the time-varying bargaining power of workers in the home labor market that has the steady state value η and in logs follows an AR(1) process with an i.i.d.-normal error structure.[27] The optimization takes into account that under right-to manage wage bargaining native and immigrant labor firms adjust the hours worked op-

[26]We start with the simplifying assumption of a separation rate for both types of workers. Later we want to introduce an immigrant separation rate that is anti-cyclical in line with findings by Dustmann et al. (2010) and Prean and Mayr (2016).

[27]We assume the same bargaining power for natives and immigrants but the framework allows to consider differences. For a native match the first order condition for the wage setting is $\Delta_{h,t}(W^o_{h,t}(k))\delta^F_t(i) = \frac{\eta_t}{1-\eta_t} J_{h,t}(W^o_{h,t}(k))\delta^W_t(i)$ where $\delta^F_t(i) = \frac{J_{h,t}(i)}{\partial W_{h,t}(i)}$ and $\delta^W_t(i) = \frac{\Delta_{h,t}(i)}{\partial W_{h,t}(i)}$ measure the marginal change in the value of the firm respectively the surplus of the worker in match i when changing the wage.

timally in each period such that the marginal cost of labor equal the marginal product:

$$W_{h,t}(i) = \Psi_t^n \varepsilon_t^a \alpha_L h_{h,t}(i)^{\alpha_L - 1}, \quad W_{h,t}^*(i) = \Psi_t^m \varepsilon_t^a \alpha_L h_{h,t}^*(i)^{\alpha_L - 1}. \tag{34}$$

The value of a firm that has a match with a worker who is paid nominal wage $W_{h,t}(i)$ is:

$$\begin{aligned} J_{h,t}(W_{h,t}(i)) = \frac{Div_t^n(W_{h,t}(i))}{P_{c,t}} + E_t\{\beta_{t,t+1}(1-\rho_{t+1})(1-f_{h,t}^* si_{h,t}^*)\left[\xi_w J_{h,t+1}(W_{h,t}(i)(\Pi_t^{\gamma_w}\Pi^{1-\gamma_w}))\right. \\ \left. +(1-\xi_w)J_{h,t+1}(W_{h,+1}^O)\right]\}. \end{aligned} \tag{35}$$

For the family the value of native worker employed at wage $W_{h,t}(i)$ equals:

$$\begin{aligned} V_t^E(W_{h,t}(i)) =& \frac{W_{h,t}(i)}{P_{c,t}} h_{h,t}(i) - \chi_t \frac{h_{h,t}^{1+\varphi_n}}{(1+\varphi_n)\lambda_t} - c_{h,t}^{si,*} \\ &+ E_t\left\{\beta_{t,t+1}(1-\rho_{t+1})(1-f_{h,t}^* si_{h,t}^*)\left[\xi_w V_{t+1}^E(W_{h,t}(i)(\Pi_t^{\gamma_w}\Pi^{1-\gamma_w})) + (1-\xi_w)V_{t+1}^E(W_{h,t+1}^O(i))\right]\right\} \\ &+ E_t\left\{\beta_{t,t+1}(1-\rho_{t+1})f_{h,t}^* si_{h,t}^*\left[\xi_w^* V_{t+1}^E(W_{h,t}^*(\Pi_t^{*\gamma_w}\Pi^{*1-\gamma_w})) + (1-\xi_w^*)V_{t+1}^E(W_{h,t+1}^{O*}(i))\right]\right\} \\ &+ E_t\left\{\beta_{t,t+1}\rho_{t+1}\left[(1-\mu_{t+1})U_{h,t+1} + \mu_{t+1}\left(U_{h,t+1}^* - c_{h,t+1}^{\mu,*}\right)\right]\right\}. \end{aligned} \tag{36}$$

Correspondingly, the value of native unemployed worker equals:

$$\begin{aligned} U_{h,t} =& b + E_t\left\{\beta_{t,t+1} f_{h,t}[\xi_w V_{t+1}^E(W_{h,t}(\Pi_t^{\gamma_w}\Pi^{1-\gamma_w})) + (1-\xi_w)V_{t+1}^E(W_{h,t+1}^O)]\right\} \\ &+ E_t\left\{\beta_{t,t+1}(1-f_{h,t})[(1-\mu_{t+1})U_{h,t+1} + \mu_{t+1}\left(U_{h,t+1}^* - c_{h,t+1}^{\mu,*}\right)]\right\}. \end{aligned} \tag{37}$$

The value of being a native unemployed comprises the unemployment benefit and the discounted values of being employed in the domestic labor market and the values of being unemployed in the domestic or the foreign labor market in the next period, each weighted by their probability of occurrence. The expected value of searching as native or as emigrant are weighted by the migration probability. The value of being unemployed as a migrant in foreign is defined correspondingly but the weighting factor for future values of unemployment is the return migration rate. The marginal surplus of working net of the marginal surplus of being unemployed $\Delta_{h,t}(W_{h,t}(i)) \equiv V_t^E(W_{h,t}(i)) - U_{h,t}$ is:

$$\begin{aligned}\Delta_{h,t}(W_{h,t}(i)) =& \frac{W_{h,t}(i)}{P_{c,t}} h_{h,t}(i) - c_{h,t}^{si,*} - b - \chi_t \frac{h_{h,t}^{1+\varphi_n}}{(1+\varphi_n)\lambda_t} \\ &+ E_t\left\{\beta_{t,t+1}(1-\rho_{t+1})\xi_w\left[V_{t+1}^E(W_{h,t}(i)(\Pi_t^{\gamma_w}\Pi^{1-\gamma_w})) - V_{t+1}^E(W_{h,t+1}^O)\right]\right\} \\ &+ E_t\left\{\beta_{t,t+1}(1-\rho_{t+1})f_{h,t}^* si_{h,t}^*\left[\Delta_{h,t}(W_{h,t+1}^{O*}) - \Delta_{h,t}(W_{h,t+1}^O) - c_{h,t+1}^{\mu,*}\right]\right\} \\ &+ E_t\left\{\beta_{t,t+1}(1-\rho_{t+1})f_{h,t}^* si_{h,t}^* \xi_w^* \left[V_{t+1}^E(W_{h,t}^*(\Pi_t^{*\gamma_w}\Pi^{*1-\gamma_w})) - V_{t+1}^E(W_{h,t+1}^{O*})\right]\right\} \\ &- E_t\left\{\beta_{t,t+1}(1-\rho_{t+1})f_{h,t}^* si_{h,t}^* \xi_w\left[V_{t+1}^E(W_{h,t}(i)(\Pi_t^{\gamma_w}\Pi^{1-\gamma_w})) - V_{t+1}^E(W_{h,t+1}^O)\right]\right\} \\ &- E_t\left\{\beta_{t,t+1} f_{h,t}\xi_w\left[V_{t+1}^E(W_{h,t}(\Pi_t^{\lambda_w}\Pi^{1-\lambda_w})) - V_{t+1}^E(W_{h,t+1}^O)\right]\right\} \qquad (38) \\ &+ E_t\left\{\beta_{t,t+1}(1-\rho_{t+1}-f_{h,t})\Delta_{h,t+1}(W_{h,t+1}^O)\right\} - E_t\left\{\beta_{t,t+1}(1-\rho_{t+1}-f_{h,t})\mu_{t+1}\left(\Delta_{h,t}^E - c_{h,t+1}^{\mu,*}\right)\right\},\end{aligned}$$

with net value of a job with optimized wage $\Delta_{h,t+1}(W_{h,t+1}^O)$ and with surplus of emigration defined as $\Delta_{h,t}^E \equiv U_{h,t}^* - U_{h,t}$. The first and second term on the left hand side of the equation are standard in the search and matching literature. The marginal surplus of workers measured in consumption units is the difference of the wage and the unemployment benefit and the future value of having the job. The option to migrate when unemployed gives rise to a third term $\Delta_{h,t}^E$ that describes the marginal surplus of emigration. It is as an additional outside option for the native worker in the wage bargaining process and is defined as the value of searching a job as immigrant in the foreign country net of the value of searching a job as a native in the home country.

Inserting (37) and the corresponding value of being unemployed as an emigrant, the surplus sharing rule and the marginal surplus of a filled vacancy (44) in the definition of the marginal surplus of emigration yields:[28]

$$\begin{aligned}\Delta_{h,t}^E =& E_t\left\{\beta_{t,t+1} f_{h,t}^* \xi_w [V_{t+1}^E(W_{h,t}^*((\Pi_t^*)^{\gamma_w}\Pi^{*1-\gamma_w})) - V_{t+1}^E(W_{h,t+1}^{O*})]\right\} \\ &- E_t\left\{\beta_{t,t+1} f_{h,t}\xi_w [V_{t+1}^E(W_{h,t}(\Pi_t^{\gamma_w}\Pi^{1-\gamma_w})) - V_{t+1}^E(W_{h,t+1}^O)]\right\} \\ &+ E_t\left\{\beta_{t,t+1} f_{h,t}^* \Delta_{h,t}(W_{h,t}^{O*})\right\} - E_t\left\{\beta_{t,t+1} f_{h,t}\Delta_{h,t}(W_{h,t}^O)\right\} \\ &+ E_t\left\{\beta_{t,t+1}\left[1-(1-f_{h,t}^*)\gamma_{t+1} - (1-f_{h,t})\mu_{t+1}\right]\Delta_{h,t+1}^E\right\}. \qquad (39)\end{aligned}$$

The marginal surplus of emigration increases in the bargaining power abroad and decreases with the bargaining power at home. Additionally, a higher job market tightness

[28]The model set up and our calibration ensure that $\frac{1-\mu_t(1-f_{h,t})-\gamma_t(1-f_{h,t}^*)}{1+i_t} < 1 \forall t$ such that expectations on future surplus converges to a unique steady state.

in foreign increases the value of emigration because it goes along with a high job finding rate abroad. Higher cost of posting vacancies in foreign stabilize the match, because it increases the value of a filled vacancy in foreign. The future value of emigrate is irrelevant for workers who emigrate and those who will return in the next period. With a higher return migration rate the share of unemployed emigrants who return increases. Similarly, with higher migration rates a higher share of native unemployed will emigrate in future periods. Therefore, the future marginal surplus of emigration has a lower influence on the current emigrant value if the migration and return migration rates are high. The expected domestic and foreign job finding rates influence the future marginal surplus. The higher the job finding rate is, the lower is c.p. the measure of native and emigrant unemployment. Therefore, the absolute expected marginal surplus will be small.

The impact of the migration scheme on the wage setting can be demonstrated by means of $\Delta^E_{h,t}$. The relation becomes evident in the final expression for the optimal bargaining wage:[29]

$$\begin{aligned} W^O_{h,t} =& \eta_t \left(\Psi^n_t \varepsilon^a_t \alpha_L {h_{h,t}}^{\alpha_L - 1} - \Phi + P_{h,t} \kappa_t \theta_{h,t} \right) \\ &+ (1 - \eta_t) \left(\chi_t \frac{h^{1+\varphi_n}}{(1+\varphi_n)\lambda_t} + b + \mu_t (1 - \rho_t - f_{h,t}) E_t \beta_{t+1} \Delta^E_{h,t} \right). \end{aligned} \tag{40}$$

Similarly, the emigrant wage is derived as:

$$\begin{aligned} W^{O*}_{h,t} =& \eta^*_t \left(\Psi^{m*}_t \varepsilon^a_t \alpha_L {h^*_{h,t}}^{\alpha_L - 1} - \Phi^* + P_{f,t} \kappa^*_t \theta^*_{h,t} \right) \\ &+ (1 - \eta^*_t) \left(\chi_t \frac{(h^*)^{1+\varphi_m}}{(1+\varphi_m)\lambda_t} + b^* - \gamma_t (1 - \rho^*_t - f^*_{h,t}) E_t \beta_{t+1} \Delta^E_{h,t} \right). \end{aligned} \tag{41}$$

The intuition behind the wage equation is straightforward. Migration poses an additional outside option in our model. If the employment probabilities in the foreign economy improve relative to the domestic economy, the value of emigration (the outside option) increases. Similar to the case of a higher unemployment benefit this strengthens the worker's negotiation position and leads to higher wages. While with or without labor mobility domestic workers participate from improvements in the production process and the labor market situation in the domestic economy with a weight η_t, labor mobility connects the domestic wages to the relative foreign economy labor market situation.

[29]For reasons of clarity we ignore the terms $\delta^W_{h,t}$ and $\delta^F_{h,t}$ and abstract from wage rigidity.

For emigrants from home the argument holds with a reverse direction of causality. An increase in the relative labor market situation in foreign reduces their outside option to return home and thus lowers their wage negotiation position.

4.5.3. *Vacancy posting*

The evolution of native and immigrant employment at firm level corresponds to that of aggregate employment. Since firms can decide about the vacancies for a given vacancy filling rate, the laws of motion of native and immigrant employment can be written as

$$n_{h,t+1} = (1-\rho_{t+1})(1-f^*_{h,t} si^*_{h,t}) n_{h,t} + v_{h,t} q_{h,t}, \tag{42}$$

$$n_{f,t+1} = (1-\rho_{t+1})(1-f^*_{f,t} si^*_{f}) n_{f,t} + v_{f,t} q_{f,t}. \tag{43}$$

For every posted vacancy the firm pays a time-invariant cost κ_t that is equal for native and immigrant workers and linear with respect to the number of vacancies posted.

The representative firm in the labor good sector maximizes its present value of discounted profit flows. Under the assumption of the free entrance condition the job creation conditions for native and immigrant jobs are:

$$\frac{\kappa_t}{q_{h,t}} \frac{P_{h,t}}{P_{c,t}} = E_t \beta_{t,t+1} \xi_w J_{h,t+1}(W_{h,t}(k)(\Pi_t^{\gamma_w} \Pi^{1-\gamma_w})) + (1-\xi_w) J_{h,t+1}(W^O_{h,t+1}(k)), \tag{44}$$

$$\frac{\kappa_t}{q_{f,t}} \frac{P_{h,t}}{P_{c,t}} = E_t \beta_{t,t+1} \xi_w J_{f,t+1}(W_{f,t}(k)(\Pi_t^{\gamma_w} \Pi^{1-\gamma_w})) + (1-\xi_w) J_{f,t+1}(W^O_{f,t+1}(k)). \tag{45}$$

The job creation conditions state that firms increase vacancies until the benefit from employing an additional worker is equal to the cost of posting a vacancy. As in Christoffel et al. (2009) we assume that with probability $1-\xi_w$ a new match can bargain the wage and pays the indexed average wage otherwise.

4.5.4. *Endogenous migration decisions*

In this section of the paper we endogenize the migration rates of unemployed and employed workers by modeling their migration decision. Our approach is close to the motivation of the net migration rate in Braun and Weber (2016). In this set up workers choose the location of being unemployed and searching for a job by comparing the expected value of being unemployed abroad and at home. Workers pay idiosyncratic migration cost when changing their location. The better the relative labor prospects in the foreign economy the more workers can afford to migrate because the surplus of emigration exceeds their cost of migration.

At the end of the period before the migration decision is taken unemployed workers in home receive a signal about their individual emigration cost $c^{\mu}_{h,i,t}$. The migration cost are draws from a time-invariant distribution with support $c^{\mu}_{h,i,t} \in [0, a^{\mu}]$, c.d.f. $F(c^{\mu}_{h,t})$ and uniform density $f(c^{\mu}_{h,t})$. This allows to derive the migration thresholds up to which it is beneficial for an unemployed worker to move abroad. The emigration cost threshold $\tilde{c}^{\mu}_{h,t}$ is determined as follows:

$$\tilde{c}^{\mu}_{h,t} = E_t \beta_{t+1} \Delta^{E}_{h,t+1}. \tag{46}$$

All workers with idiosyncratic migration cost below the threshold value have an incentive to migrate and since we assume a uniform distribution the threshold relates to the emigration rate $\mu_t = \frac{\tilde{c}^{\mu}_{h,t}}{a^{\mu}}$ and the total number of unemployed native emigrants from h is $\mu_{h,t} u_{h,t}$. When expressing the migration cost of the household we use the fact that for a given migration threshold the expected migration cost of agents who migrate can be expressed as:

$$c^{\mu}_{h,t} = E[c^{\mu}_{h} | c^{\mu}_{h} < \tilde{c}^{\mu}_{h,t}] = \frac{\tilde{c}^{\mu}_{h,t}}{2} \tag{47}$$

In a similar manner employed workers in home receives a signal about their individual emigration cost as a fraction of the unemployment benefit $c^{si,*}_{h,i,t}$. The on-the-job search cost are draws from a time-invariant distribution with support $c^{si,*}_{h,i,t} \in [0, a^{si}]$, c.d.f. $F(c^{si,*}_{h,t})$ and uniform density $f(c^{si,*}_{h,t})$. This allows to derive the thresholds up to which it is beneficial for an employed worker to move abroad. Employed workers compare their idionsicratic cost of on-the-job search with the value of employed migration:

$$\tilde{c}^{si,*}_{h,t} = f^{*}_{h,t} \left(\xi^{*}_{w} V^{E}_{t+1}(W^{*}_{h,t}(\Pi^{*\gamma_w}_{t} \Pi^{*1-\gamma_w})) + (1 - \xi^{*}_{w}) V^{E}_{t+1}(W^{O*}_{h,t+1}(i)) - \xi_{w} V^{E}_{t+1}(W_{h,t}(i)(\Pi^{\gamma_w}_{t} \Pi^{1-\gamma_w})) - (1 \tag{48}$$

All workers with idiosyncratic on-the-job search cost below the threshold value have an incentive to search for a job abroad and since we assume a uniform distribution the threshold relates to the on-the-job search intensity $si^{*}_{h,t} = \frac{\tilde{c}^{si,*}_{h,t}}{a^{si,*}}$. We assume that only workers who successfully find a job abroad count as migrant such that the total number of employed native emigrants from h is $f^{*}_{h,t} si^{*}_{h,t} n_{h,t}$.

4.6. Final good sector and international trade

As in de Walque et al. (2017) international trade is modeled with an ad hoc assumption on the goods demand from the Rest of the world and transit goods. To bring the model in accordance with trade data, 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:

$$x_t = m_t^{*}{}_{h,t}^{\beta_m} \varepsilon_t^{nt}, \tag{49}$$

with sensitivity parameter β_m and exogenous shock process ε_t^{nt}. Introducing a transit good $x_{f,t}$ with a share ω_m in the home imports, allows to account for the comovement between home and foreign exports:

$$m_t = \left((1 - \omega_m)^{1/\theta_m} (y_{f,t})^{\frac{\theta_m - 1}{\theta_m}} + \omega_m^{1/\theta_m} (x_{f,t})^{\frac{\theta_m - 1}{\theta_m}} \right), \tag{50}$$

where θ_m denotes the elasticity of substitution between both import goods. Correspondingly, the export aggregator is:

$$x_t = \left((1 - \omega_x)^{\frac{1}{\theta_x}} (y_{h,t})^{\frac{\theta_x - 1}{\theta_x}} + \omega_x^{\frac{1}{\theta_x}} (x_{f,t})^{\frac{\theta_x - 1}{\theta_x}} \right), \tag{51}$$

where ω_x denotes the share of transit goods in exports and θ_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:

$$P_{x,t} = \left((1 - \omega_x)(P_{h,t}^{*})^{1-\theta_x} + \omega_x (P_{f,t})^{1-\theta_x} \right)^{\frac{1}{1-\theta_x}}. \tag{52}$$

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 $s_t = \frac{P_{m,t}}{P_{x,t}}$ and the real the real exchange rate is equal to the quotient between the foreign and domestic consumption price level $q_t = \frac{P_{c,t}^{*}}{P_{c,t}}$. The nominal exchange rate is assumed to be constant and is normalized to one for the corridor.[30]

[30] In the sample period from 1980 to 2010 the corridors changed their monetary system from mostly pegged exchange rates to a monetary union. Although this regime change may also influence the relationship between net migration and its main determinants it is of minor interest in this paper. For most corridors there has been a relatively stable nominal exchange rate between 1980 and 2010. In an extended

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:

$$B_{f,t} = TB_t + IB_t + B_{f,t-1}, \tag{53}$$

where the latter is given by the difference between the factor incomes of home and foreign emigrants $IB_t = S_t \int_0^{n^*_{h,t}} h^*_{h,t}(i) W^*_{h,t}(i) di - \int_0^{n_{f,t}} h_{f,t}(i) W_{f,t}(i) di$.

One can show that households in both countries smooth consumption over time and diversify between countries:

$$c_t = c^*_t q_t. \tag{54}$$

The latter describes the international portfolio condition in case of perfect financial markets.[31]

4.6.1. Equilibrium

The government budget constraint is described by:

$$T_t + B_{h,t} + B^*_{h,t} + S_t \frac{\Delta^*}{2} \left(\frac{B_{f,t+1}}{R^*_t} \right)^2 = P_{h,t} \varepsilon^g_t \overline{g} + P_{c,t} b (u_{h,t} + u^*_{h,t}) + (B_{h,t-1} + B^*_{h,t-1}) R_{t-1}. \tag{55}$$

The government raises a lump-sum tax and the cost of financial market transactions and issues new debt in order to finance government spending and unemployment benefits and service on previous debt. We assume that the government has a constant spending $\overline{g}$ that could change over time due to random government spending shocks ε^g_t that in logs follow an i.i.d. AR(1) process.

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 13 and the foreign country counterpart of equation (14):

$$y_{h,t} = \int y_{h,t}(z) dz = d_{h,t} y^d_{h,t} + d^*_{h,t} y^{d*}_{h,t}, \tag{56}$$

approach we separate the total period in two sub-periods before and after the Euro introduction. The first sub-period is modeled with a pegged exchange rate system, in the second sub-period we assume a common monetary policy. This does not change our results according to the average relationship between the bilateral migration flows and its main determinants. However, by simulating the transitory regime shift, we are able to explain time-varying migration cycle correlations.

[31] We assume both countries to have symmetric initial conditions.

where $d_{h,t} = \int \left(\frac{P_{h,t}(z)}{P_{h,t}} \right)$ is a price dispersion measure and $y^{d}_{h,t}$ and $y^{d*}_{h,t}$ are defined by equations (15) and (16).

The model is closed by assuming that the central bank supplies a monetary asset[32] and that due to its systemic position, the central bank can influence the nominal interest rate in order to stabilize the price inflation and the output to their target rates. As in Christoffel et al. (2009) the central bank follows a simple Taylor-rule of the form:

$$\log(R_t) = (1-\gamma_R)\log\left(\frac{\bar{\Pi}}{\beta}\right) + \gamma_R \log(R_{t-1}) + \gamma_{\Delta y}\log\left(\frac{y_t}{y_{t-1}}\right) + (1-\gamma_R)\left[\frac{\gamma_\pi}{4}\log\left(\frac{\Pi_t^{yoy}}{\bar{\Pi}^4}\right) + \frac{\gamma_y}{4}\log\left(\frac{y_{h,t}}{y_{h,t}^{flex}}\right)\right] + \log\varepsilon_t^m, \quad (57)$$

where $\bar{\Pi}$ is the consumer price inflation rate target, y_t^{flex} is the output level with flexible prices and wages, ε_t^m is a country-specific aggregate money supply shock that follows an AR(1) process in logs and ρ_R denotes the degree of interest rate smoothing. The target variables are the steady state values. Therefore, the target price inflation is equal to zero and the target output is steady state output. The target weights are set exogenously by empirically observed parameters for the Euro area.[33]

5. Impulse Response Functions and Discussion of Results

5.1. Calibration

The proposed model follows the literature on open economy DSGE models with either search and matching or migration.[34] Before applying Bayesian estimation techniques to the full model version and data for particular migration corridors in the next section, we calibrate the model to quarterly data and a hypothetical average euro area migration corridor in order to analyze the theoretical shock responses. The effects of migration are isolated by assuming all firm and trade parameters to be symmetric across countries.

[32]The monetary asset can be understood as contract between the central bank and the agents of the economy. Everyone is legally obligated to hold one unit of that good on which the central bank pays an interest.

[33]See Taylor (1993), Woodford (2001), Taylor and Williams (2010).

[34]See e.g. Christoffel et al. (2009), Mandelman and Zlate (2012), Hauser (2014), Dustmann and Görlach (2016), Chassamboulli and Palivos (2014) and Battisti et al. (2014).

Our calibration[35] of the stylized model follows Christoffel et al. (2009). We target an average unemployment rate of 9.16 % and want to match a migrant-native unemployment ratio of 1.17.[36] With the target of an average immigrant share of 7 %[37] this corresponds to a native unemployment rate of 9.05 % and an immigrant unemployment rate of 10.59 %. As in Christoffel et al. (2009) we target a mean job-filling rate $q_h = q_f = 0.7$ that is equal for natives and migrants. The steady state vacancy posting cost and the efficiency of native and migrant matching σ^n and σ^m are chosen in line with the targets for the native and migrant unemployment rates and job-filling rates. The relative immigrant productivity parameter is set to account for a native-migrant wage ratio of 1.032.[38] The share of migrants in the production of the composite labor good $\gamma = 0.07$ is calibrated to coincide with the average migrant share. The elasticity of substitution of native and migrant workers is set to $\theta = 7$. Taking into account the more homogenous educational attainment in the euro area we choose a higher value than Mandelman and Zlate (2012) who assume the substitution elasticity between Mexican and U.S. American workers to be 1.55. 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. (2014a) 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). Further, we calibrate the labor supply elasticity and bargaining weight to be equal for natives and migrants. The emigration cost are calibrated to $\tilde{c}_h^{\mu} = 0.003$ in order to match the empirically observed annual average internal emigration rate of the EA-12 $\mu = 0.015$ and a return migration rate of $\gamma = 0.2$. The latter reflects the observation that close to 50 % of migrants return to their country of origin after five years.[39]

The trade related parameters are set in accordance to empirical EA averages. We set the degree of openness to $\omega_c = 0.25$ and the trade elasticity to $\psi = 1.5$. In line with de Walque et al. (2017) the share of transit goods in imports and exports is calibrated to $\omega_m = \omega_x = 0.3$. The corresponding elasticities of substitution of imports and exports are $\theta_m = 3$ and $\theta_x = 0$ since we follow the assumption that the demand for transit goods has a one-to-one relation with the demand for export goods.

[35]See Table 7 and 6 in Appendix 7.2 for the model parametrization.
[36]See Table 8 in the Appendix.
[37]See ECB (2014).
[38]See Dustmann et al. (2010), Jean et al. (2010).
[39]See OECD (2008).

5.2. Migration and the business cycle

In this section we describe the effects of three different shocks on migration and the business cycle dynamics from the perspective of the home economy.[40] First, we are interested in the effects of typical macroeconomic shocks on migration and the macroeconomic variables. Therefore, we subsume specific shocks into three categories as supply, demand and labor market shocks. Initially, we choose parameter values as defined in Tables 7 and 6 in order to mimic a hypothetical (average) euro area migration corridor and simulate the impulse response functions of domestic aggregate variables for varying shares of on-the-job migration in total migration. Thereby we also look at different dynamic patterns for varying degrees of on-the-job migration in relation to overall migration. Second, we distinguish between two scenarios. A baseline scenario where the emigration and return migration costs are set such that the steady state migration rates match the empirically observed values ($\mu = 0.015$ and $\gamma = 0.2$). The second scenario is characterized by high migration costs under which almost no household uses migration as instrument for cross-country risk-sharing. We thereby discuss the influence of migration barriers on the EA business cycle.

Supply shocks

Figure 4 depicts the effects of a positive domestic labor productivity shock which increases the supply of the native and migrant labor good and reduces their price. As a consequence of the high substitutability of native and migrant labor the impact of the productivity shock on both types of workers is qualitatively the same. The profit of native and migrant labor good firms increases and they post more vacancies which in a frictional labor market leads to a gradual employment increase. Native and migrant workers capture a share of the higher productivity by bargaining higher wages which raises the hourly labor cost. Labor firms on impact reduce the hours of native and migrant workers since overall the marginal cost of labor increase stronger than its marginal product. The dampened increase in the marginal product of labor is caused by the price rigidity in the intermediate goods sector which weakens the increase in the demand of the two types of labor goods despite their lower prices.[41] For native and

[40]All variables are in percentage changes except the emigration rate, the return migration rate, the migrant on-the-job search intensity and the return on-the-job search intensity which are in percentage point changes. Since the steady state of the net migrant stock is zero, the dynamic pattern of this variable equals the combined percentage changes of its components.

[41]It is well known from the business cycle literature that in case of sluggish prices and wages, productivity shocks can lead to a temporary decrease of total labor input, see Erceg et al. (2000), Galí (1999) and

migrant workers the job finding probability increases due to higher vacancy posting. Combined with the higher wages this raises the actual and future surplus of emigration for foreign workers. Overall, the more favorable labor market conditions in the home economy induce an immigration flow that is composed of foreign native emigrants and return migrants of home nationality. Focusing on the cyclical relationships in case of supply shocks, the net migration flow is negatively correlated with the unemployment differential and positively correlated with the wage differential over the cycle. Because of labor mobility, the unemployment rate in home and foreign is reduced. However, the dynamic pattern varies with the ratio of on-the-job migration to unemployed migration. When the share of on-the-job migrants is low (depicted by the black line) the decrease in the unemployment rate in foreign is much more pronounced than in the case when the share is very high (depicted by the dashed blue line). In the latter case, the emigration of employed workers destroys matches and induces firms to post new vacancies to stabilize employment. This vacancy chain reduces unemployment in the foreign labor market but the effect is much more muted than the direct effect of an outflow of unemployed workers. Compared, the impact on the unemployment rate in the home labor market is relatively equal for different values of the on-the-job migrant ratio the home labor market absorbs the new entrants quickly. Overall, the unemployment differential is lower for a lower share of on-the-job migration.

In case of a negative cost push shock (dotted line) the qualitative pattern is similar and again a positive net-migration flow co-occurs with a negative unemployment differential and a positive wage differential.

Demand shocks

We analyze the impact of a negative risk premium (solid line) and a positive government spending shock (dotted line) on migration patterns. The former changes the intertemporal consumption decision of the household[42] and the latter affects the intratemporal aggregate resource constraint. The corresponding impulse response functions can be found in Figure 5. Firms increase their labor demand and post additional vacancies. In expectation of higher wages and lower unemployment the actual and future surplus of emigration for foreign workers will increase. Therefore, the net migration reaction is positive. In contrast to supply shocks, demand shocks drive output and price inflation

Galí (2010).

[42]In a model with flexible capital, the risk premium shock also affects the value of capital and generates a comovement of investment and consumption.

in the same direction, notwithstanding the cyclical pattern of net migration is rather similar. Therefore, the main difference between demand and supply shocks - the price reaction - does not seem to have qualitative impact on the migration decision.

The difference between risk premium and government spending shocks can be seen by looking at the consumption reaction. The risk premium shock changes the intertemporal consumption pattern of the household in favor of current consumption. The government spending shock instead increases production and crowds out consumption. The consumption reaction leads to a distinct migration pattern. Although the consumption pattern of migrant and natives cannot be disentangled exactly, the relatively small reaction of net migration rate after a government spending shock is a partly driven by the consumption reaction. Lower expected consumption leads to a smaller expected migration surplus and prevents worker to search in the home economy.[43] The decrease in consumption leads agents from the home economy to accept lower wages in order to increase the hours and to stabilize consumption. Therefore, the wage differential is slightly negative in case of a government spending shock. Combined with a negative unemployment differential the net migration flow is positive but lower than in case of a risk premium shock.

Labor market shocks

We also investigate specific labor market shocks as discussed in Christoffel et al. (2009) in Figure 6. An increase in the wage bargaining power (solid line) raises the bargained wages of natives and migrant workers and thus, unit labor costs in the production process. In a frictional labor market, firms immediately reduce hours and gradually cut employment via posting less vacancies. The increase in the number of unemployed workers implies that the pool of potential migrants rises. Additionally, higher unemployment lowers the job finding rate in the home economy and makes it less likely for both, new entrants and unemployed agents who stayed in the home labor market, to profit from the higher wages in the home labor market. Therefore, workers in the home economy have a positive marginal surplus of migration and an incentive to move to the foreign. Correspondingly, the return migration of workers of home nationality and the emigration of foreigners decreases. The changes in the migration rates cause an

[43]Since emigrant and native workers are members of the same household, they share the same discount factors and risk premium. Therefore, we use the common notation that workers consume at home and implement migrants consumption by considering higher bilateral trade and the income balance in the aggregate resource constraint.

outflow of unemployed workers on impact of the wage markup shock. Therefore, the unemployment rate differential is negative in the first two quarters and turns positive once the reduced vacancy posting lowers employment. In sum, in response to a positive wage mark-up shock the home economy displays a decreasing net migrant stock and the net migration rate is negatively correlated with both the wage differential and the unemployment differential. In the analyzed scenario the migrant response is shaped by the unfavorable unemployment pattern that dominates the favorable wage response.

The pattern subsequent a shock to the vacancy cost (depicted by the dotted line) is similar to a wage markup shock in terms of the unemployment and the migration response. The main difference is a slight decrease in the real wage that translate into a small negative real wage differential. Since the wage and unemployment response drive the migration incentives in the same direction, we observe a more pronounced change in the emigration and the return migration rates on impact. Consequently, the net migrant stock decreases stronger.

An increase in the job separation rate (depicted by the dashed line)decreases native and migrant employment immediately. Additionally, slightly lower wages are bargained since the lower survival rate reduces the value of worker-firm matches. The labor firms try to stabilize the production of the labor good by increasing hours and posting more vacancies. The latter increases the job finding rate and makes it more favorable for unemployed workers to search in the home labor market despite the small negative wage differential. This is reflected by a decrease in the marginal surplus of emigration for households of home nationality and an inverse increase for foreign households. Consequently, a job separation rate shock reduces the emigration rate and increased the return migration rate of home households while it has the reversed effects on the foreign emigration and return migration rate. The net migrant stock in the home economy is jointly determined by both, the potential pool of migrants in the home and foreign labor market and the corresponding migration rates. While the increase in the unemployment in the home labor market increases the number of potential migrants, the lower outflow of workers via the reduced emigration rate counterbalances it. Overall, the net migrant stock increases slightly in response to higher job separations, even though the wage differential is slightly negative and the unemployment rate differential is positive in the first quarters.

Finally, within our model framework we can identify a migration cost shock (7). Here, it is assumed that the cost of relocating labor to the home labor market are reduced temporarily, e.g. via a migrant attracting policy. The cost reduction increases the net migration rate immediately via a higher immigration of foreigners and a higher return migration of workers with home nationality. Upon the inflow of workers firms start to post more vacancies and increase employment by filling jobs with immigrant searchers. Due to the higher supply of the native and migrant labor goods their prices fall and real wages in the home economy decrease. At the same time the lower unit labor costs and the increase in consumption of home produced goods lead to higher output. Despite the rise in employment the unemployment rate will initially increase, because all migrants are searchers by assumption. However, the home labor market is able to absorb the additional workers and the unemployment rate differential turns negative after six quarters. This process is enhanced by the fact that unemployed workers who are already in the home labor market respond to the worsening labor market conditions, i.e. mainly the lower job finding rates, subsequent the migrant inflow with increased migration rates to the foreign labor market. Overall, the dynamic pattern of an immigration shock is characterized by the negative correlation of the net migration rate with the real wage differential and the unemployment differential.

Scenario analysis

In the next step we compare our baseline result (black line) with a second scenario (blue line) in which migration costs are very high such that almost no emigration or immigration occurs (Figure 8). Higher migration costs in the model entail that migration reacts less strongly to shocks. Therefore, with very high migration costs, the steady state emigration rate is almost zero.[44] We concentrate on a prototype business cycle shock, namely a reduction in the risk premium of bonds.

Qualitatively, a typical business cycle shock shows the equal pattern as in the baseline. However, with migration the fluctuations of output and employment are larger. The inflow of additional workers increases the job filling rate of firms and facilitates to adjust the labor input via the extensive margin. The higher supply of the labor good reduces the increase in the price of the labor good and the real wage. Therefore, the real wage differential is slightly lower. Additionally, the free allocation of workers to the labor market with more favorable conditions balances the unemployment differential between the home and the foreign economy in the first eight quarters.

[44]For stability and determinacy reasons emigration and immigration can not be zero. However, due to our symmetric country assumption the net migration is zero in steady state.

5.3. Model fit

Finally, we assess the quality of the model by comparing the theoretical business cycle statistics of the calibrated model with the empirical facts presented in section 3.2. To that end, we draw country-specific shocks from their distributions and simulate 1000 periods to extract the standard deviations conditional on all shocks and the correlations from the structural model.[45] The results are summarized in Table 2 and 3. Table 2

	$\sigma(x)/\sigma(y)$		$\rho(x,y)$	
Variable (x)	EA-12 data	Model	EA-12 data	Model
Real output (y)	1	1	1	1
Real consumption (c)	0.81	0.6	0.76	0.7
Employment (n)	0.76	0.11	0.69	0.53
Unemployment rate (u)	0.48	0.11	-0.68	-0.53
Vacancies (v)	0.80	0.56	-0.54	-0.63
Real wage (w)	0.68	0.62	0.17	0.98

Model refers to the symmetric calibration of the model.

Table 2: Theoretical vs. Empirical Moments of the EA-12 countries business cycle 1980-2010 - The symmetric case

depicts the empirical and simulated relative standard deviations (column one and two) and correlations (columns three and four) of the average EA-12 business cycle for the period 1980-2010. The model matches the empirical fluctuation relations and correlations quite well. Although the business cycle volatility of consumption, employment and unemployment in relation to output are too low, the cross relations are similar. The former results from not considering the marginal rate of substitution between consumption and hours in the household decision. Additionally, nominal and real rigidities would increase the fluctuation of quantities rather than prices and wages. This would also lower the correlation of the real wage and output over the cycle. Table 3 summarizes the empirical and simulated relative standard deviations and correlations of the average EA-12 migration cycle for the period 1980-2010. The comparison reveals three notable results: First, the model predicts the relative fluctuations and correlation of net migration and the GDP quite well. Second, the model understates the fluctuations of

[45] In order to compare the theoretical model with the empirical unconditional standard deviations we simulate the time series including all shocks. Therefore, the reactions of macroeconomic variables are not conditional on a specific shock. To compare the true conditional reactions, we would have to compare the extracted theoretical standard deviations in case of a single shock with the empirical counterparts resulting from a structural VAR.

net migration over the cycle. Furthermore, it does not predict the negative correlation with respect to the wage differential. Third, the model predicts the negative sign of the correlation between net migration and the unemployment differential. Intuitively, both shortcomings of the model - the relatively high wage correlation and the relatively low unemployment fluctuation - indicate the existence of at least one additional channel that increases the volatility of unemployment and decreases the volatility of wages and thus has a significant impact on net migration fluctuations and correlations within the euro area.

	$\sigma(x)/\sigma(y)$		$\rho(x,y)$	
Variable (x)	EA-12 data	Model	EA-12 data	Model
Output (y)	1.55	0.19	0.17	0.21
Unemployment (u)	-	-	-0.31	-0.34
Vacancies (v)	-	-	-0.08	0.56
Real wage (w)	-	-	-0.10	0.23

Model refers to the symmetric calibration of the model.

Table 3: Theoretical vs. Empirical Moments of the EA-12 countries cyclical migration from 1980-2010

Summarizing our results, we find that our model fits suitable to describe migration flows over the business cycle in the euro area. However, both, standard deviations and correlations, point towards the need to improve the wage and unemployment specification in our model. In line with this finding, introducing nominal or real rigidities appears as a valuable extension. Rigidities as modeled by Gertler et al. (2008), Krause et al. (2008) and Galí (2010) generate a lower wage fluctuation due to price and wage adjustment costs. With time-varying mark-up wages, unemployment fluctuates over time and leads to a higher variation of employment over the cycle.

6. Conclusions

This paper proposes a new approach to model the fluctuation of migration and unemployment over the business cycle in a two-country setting. In particular, we focus on search and matching frictions as sources of unemployment. By starting with a summary of the empirical evidence on euro area migration patterns, we find internal migration to have increased over time, and be mostly work-related and of temporary nature. Our subsequent empirical analysis of bilateral migration and macroeconomic data over the years 1980-2010 supports this notion. We present several key business cycle facts for the EA-12 that provide evidence for business cycle related fluctuations in net migration flows and the crucial role of unemployment differentials in shaping intra-euro area migration patterns. On average, we find a negative correlation of the net migration rate with both, the unemployment and the wage differential, at various lags and leads. Additionally, we find a positive correlation with respect to vacancies which lead net migration over the cycle. We interpret this as evidence for the importance of the relative labor market tightness for net migration flows.

In line with these findings we develop a two-country dynamic stochastic general equilibrium model of internal business-cycle migration in the euro area and allow for unemployment that occurs as a consequence of search and matching frictions in both countries. Furthermore we can identify a migration cost shock which has a distinct business cycle pattern. Calibrated to the EA-12 average corridor the model is able to replicate key facts about the migration cycle in the euro area. It matches the empirically observed wage and unemployment gaps between native and immigrant workers and reproduces aggregate macro and labor market facts in the steady state and over the cycle.

The investigation of impulse response functions sheds light on several transmission channels and parameters that affect the observed migration patterns in the euro area. The model features supply, demand and labor market shocks that give rise to the negative relationship between unemployment differentials and net migration. It also explains the positive correlation between net migration flows and the vacancy differentials over the cycle. Additionally, we investigate the effects of migration costs on the business cycle and the labor market tightness. With respect to the business-cycle fluctuations we find three noteworthy facts. First, lower migration costs dampen the cyclical fluctuations of output and unemployment, but increase the fluctuations of employment in case of business cycle shocks, i.e. a risk premium shock. Second, a lower share of on-the-job migration reduces the wage differential in response the business cycle shocks. Third, we analyze the direct effect of a migration cost reduction. We find that the subsequent increase in the net migration rate increases output and the labor force participation. The initially higher unemployment rate shrinks after around one year. The pattern of the migration cost shock is clearly different from all other business cycle and labor market shocks, because net migration has a procyclical pattern and is negatively correlated with wage and unemployment differentials as well as positively correlated with the vacancy posting.

7. Appendix

7.1. Data description

Output: Gross domestic product at 2010 market prices per head of population (RVGDP) (2010=100) multiplied by total population (National accounts) (NPTD) (1000 Persons), AMECO database, 2015.
Consumption: Total consumption at 2010 prices (OCNT) (in national currency 2010=100), AMECO database, 2015.
Employment: Employment, persons: total economy (National accounts) (NETN) (1000 Persons), AMECO database, 2015.
Labor force: Total labour force (Labour force statistics) (NLTN) (1000 Persons), AMECO database, 2015.
Unemployment rate: Unemployment rate: total :- Member States: definition EUROSTAT (ZUTN), AMECO database, 2015.
Vacancies: Employer perception of labour shortages (total manufacturing), European Commission's Surveys of Business Confidence, Quarterly questionnaire, 2016
Real wages: Real compensation per employee, deflator GDP: total economy (RWCDV) (2010=100), AMECO database, 2015.
CPI inflation: Percentage change of national consumer price index (All-items) (ZCPIN) (2010=100), AMECO database, 2015.
Wage inflation: Percentage change of Compensation of employees: total economy (UWCD), AMECO database, 2015.
Output differential: Difference of domestic output and foreign output normalized by the average corridor output.
Unemployment differential: Difference between the domestic unemployment rate and the foreign unemployment rate.
Vacancy differential: Difference of domestic vacancies and foreign vacancies.
Wage differential: Difference of domestic real wage and foreign real wage normalized by the domestic real wage normalized by the average corridor real wage.
Immigration/Emigration: Bilateral immigration/emigration flows, "'International Migration Flows to and from Selected Countries: The 2008 Revision"', United Nations, 2008. Missing values for the periods after 2008 are estimated by OECD Migration database, OECD, 2015. Additionally, we use the immigration data as proxy for missing emigration data in between of periods.
Net migration: Difference of immigration and emigration normalized by the average corridor as a share of foreign population.

	AT	BE	DE	EL	ES	FI	FR	IE	IT	LU	NL	PT	∑
AT	–	80(B)	80(F)	[96(F)]	83(F)	80(B)	[96(F)]	86(F)	[96(F)]	80(B)	80(B)	[96(F)]	7(11)
BE	80*(F)	–	80(F)	80*(B)	80*(F)	80(B)	80*(F)	80(F)	80*(F)	80(F)	80(B)	80*(B)	11(11)
DE	80*(F)	80(B)	–	80*(F)	80*(F)	80(B)	80*(F)	80(F)	80*(F)	80(F)	80(B)	80*(F)	11(11)
EL	[96(F)]	80(B)	80(F)	–	83(F)	80(B)	85*(F)d	85(F)xx	86(F)	x	80(B)	85*(F)xx	6(10)
ES	85*(F)	80(B)	80(F)	85*(F)	–	80(B)	85*(F)	88(F)	86(F)	80(F)	80(B)	85*(F)	11(11)
FI	80*(F)	80(B)	80(F)	80*(F)	80*(F)	–	80*(F)	80(F)	80*(F)	80(F)	80(B)	80*(F)	11(11)
FR	[96(F)]	80(B)	80(F)	x	83(F)	80(B)	–	x	86(F)	80(F)	80(B)	92*(F)	8(9)
IE	[96(F)]	80(B)	80(F)	x	83(F)	80(B)	92(F)xx	–	86(F)	x	80(B)	x	6(8)
IT	86*(F)	80(B)	80(F)	86*(F)	83(F)	80(B)	86*(F)	86(F)	–	80(F)	80(B)	86*(F)	11(11)
LU	80*(F)	80(B)	80(F)	80*(F)xx	80*(F)	80(B)	80*(F)	80(F)xx	80*(F)	–	80(B)	80*(F)	9(11)
NL	80*(F)	80(B)	80(F)	80*(B)	80*(F)	80(B)	80*(F)	80(F)	80*(F)	80(F)	–	80*(B)	11(11)
PT	[96(F)]	80(B)	80(F)	x	83(F)	80(B)	92(F)	x	86(F)	80(F)	80(B)	–	8(9)
∑	7(11)	11(11)	11(11)	6(8)	11(11)	11(11)	8(11)	7(9)	10(11)	9(9)	11(11)	8(10)	110(124)

Row: sending country; column: receiving country
Corridors in parenthesis [] are not considered in the baseline estimation due to limited time periods. They are considered within the robustness check.
x: No data available
Corridors with xx are dropped because of the missing net migration value.
80 denotes the initial year of data availability: 1980
* estimated with immigration/emigration statistics from the receiving country
(F): Only foreign citizens
(B): Both, foreign and domestic country citizens
Austria (AT), Belgium(BE), Germany (DE), Greece (EL), Spain (ES), Finland (FI), France (FR), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PT)

Table 4: List of all corridors

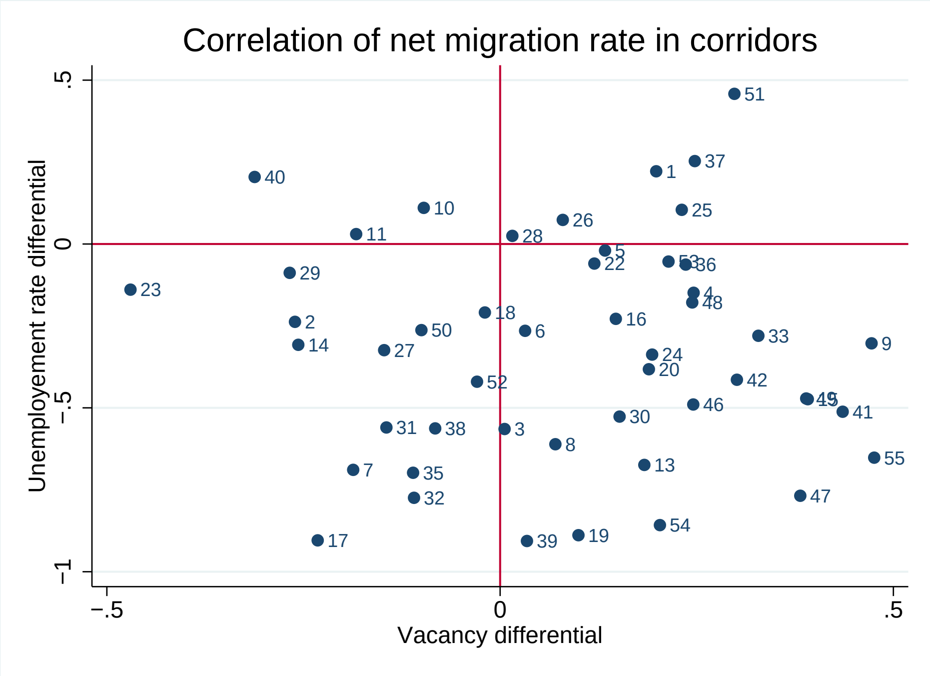

Figure 3: Four types of migration corridors

id	Countries	id	Countries	id	Countries	id	Countries
1	AT BE	16	BE PT	31	FR PT	46	IT LU
2	AT FI	17	BE ES	32	FR ES	47	IT NL
3	AT DE	18	FI FR	33	DE EL	48	IT PT
4	AT IT	19	FI DE	34	DE IE	49	IT ES
5	AT LU	20	FI EL	35	DE IT	50	LU NL
6	AT NL	21	FI IE	36	DE LU	51	LU PT
7	AT ES	22	FI IT	37	DE NL	52	LU ES
8	BE FI	23	FI LU	38	DE PT	53	NL PT
9	BE FR	24	FI NL	39	DE ES	54	NL ES
10	BE DE	25	FI PT	40	EL IT	55	PT ES
11	BE EL	26	FI ES	41	EL NL		
12	BE IE	27	FR DE	42	EL ES		
13	BE IT	28	FR IT	43	IE IT		
14	BE LU	29	FR LU	44	IE NL		
15	BE NL	30	FR NL	45	IE ES		

Belgium(BE), Germany (DE), Ireland (IE), Greece (EL), Spain (ES), France (FR), Italy (IT), Luxembourg (LU), Netherlands (NL), Austria (AT), Portugal (PT), Finland (FI)

Table 5: List of all corridors

7.2. Basic parametrization

Parameter		Value	Target/Source
Autocorrelations of shocks			
labor productivity shock	ρ_a	$= 0.60$	Christoffel et al. (2009) mean of estimation
cost push shock	ρ_p	$= 0.4$	Christoffel et al. (2009) calibration
government spending	ρ_g	$= 0.73$	Christoffel et al. (2009) mean of estimation
risk premium shock	ρ_b	$= 0.79$	Christoffel et al. (2009) mean of estimation
monetary policy shock	ρ_i	$= 0.2$	Christoffel et al. (2009) calibration
bargaining weight shock	ρ_η	$= 0.09$	Christoffel et al. (2009) mean of estimation
vacancy posting cost shock	ρ_κ	$= 0.78$	Christoffel et al. (2009) mean of estimation
separation rate shock	ρ_ρ	$= 0.51$	Christoffel et al. (2009) mean of estimation
migration cost shock	ρ_{mig}	$= 0.67$	
Standard deviations of innovations			
labor productivity shock	ς_a	$= 0.39$	Christoffel et al. (2009) mean of estimation
cost push shock	ς_p	$= 1.94$	Christoffel et al. (2009) mean of estimation
government spending	ς_g	$= 0.48$	Christoffel et al. (2009) mean of estimation
risk premium shock	ς_b	$= 0.26$	Christoffel et al. (2009) mean of estimation
monetary policy shock	ς_i	$= 0.12;$	Christoffel et al. (2009) mean of estimation
bargaining weight shock	ς_η	$= 43.48$	Christoffel et al. (2009) mean of estimation
vacancy posting cost shock	ς_κ	$= 7.62;$	Christoffel et al. (2009) mean of estimation
separation rate shock	ς_ρ	$= 3.47;$	Christoffel et al. (2009) mean of estimation
migration cost shock	ς_{mig}	$= 0.15$	

Table 6: Calibration

Parameter		Value	Target/Source
Preferences			
Time preference	β	$= 0.992$	Christoffel et al. (2009) calibration
Inv. labor supply elasticity natives	φ_n	$= 1.63$	Christoffel et al. (2009) mean of estimation
Inv. labor supply elasticity migrants	φ_m	$= 1.63$	Christoffel et al. (2009) mean of estimation
Risk aversion	σ^c	$= 1.44$	Christoffel et al. (2009) mean of estimation
External habit persistence	h	$= 0.22$	Christoffel et al. (2009) mean of estimation
Scaling factor to disutility of work	χ	$= 18.6$	target $h = 1/3$
Labor good			
Labor elasticity of production	α	$= 0.66$	Christoffel et al. (2009) calibration
El. of matches w.r.t. unemploym.	δ	$= 0.6$	Christoffel et al. (2009) calibration
Calvo parameter wages	ξ_w	$= 0.68$	Christoffel et al. (2009) mean of estimation
Quarterly separation rate	ρ	$= 0.03$	Christoffel et al. (2009) calibration
Workers' wage bargaining power	η	$= 0.5$	Hosios condition, conventional value
Native match efficiency	σ^n	$= 0.42$	reconcile m_h with $u_h = 0.08$ (i.e. $ur_h = 0.09$) and $q_h = 0.7$
Immigrant match efficiency	σ^m	$= 0.38$	reconcile m_f with $u_f = 0.07$ (i.e. $ur_f = 0.11$) and $q_f = 0.7$
Immigrant relative productivity	Θ	$= 0.985$	Native-immigrant wage gap $\frac{\overline{w}_h}{\overline{w}_f}$
Vacancy posting cost	κ	$= 0.045$	reconciles m_h with target for u_h and q_h
Technology	a	$= 0.919$	targets output $y = 1$
Input share of capital in revenue		$= 0.33$	Christoffel et al. (2009) calibration
Fixed cost associated with labor		$= 0.0069$	Christoffel et al. (2009) calibration
Wage indexation	γ_w	$= 0.44$	Christoffel et al. (2009) mean of estimation
Share of migrants	γ	$= 0.07$	EA average migrant stock
El. of substitution natives and migrants	θ	$= 7$	
Emigration transfer net of fix cost	f_h^μ	$= 0.05$	
Return migration transfer net of fix cost	f_h^γ	$= 0.3501$	
Intermediate good			
El. of subst. good varieties	ϵ_p	$= 11$	Christoffel et al. (2009) calibration
Calvo parameter prices	ξ_p	$= 0.69$	Christoffel et al. (2009) mean of estimation
Price indexation	γ_p	$= 0.17$	Christoffel et al. (2009) mean of estimation
Government			
Response to inflation	γ_π	$= 1.62$	Christoffel et al. (2009) mean of estimation
Response to output gap	γ_y	$= 0.43$	Christoffel et al. (2009) mean of estimation
Response to output growth	$\gamma_{\Delta y}$	$= 0.43$	Christoffel et al. (2009) mean of estimation
Interest rate smoothing	γ_R	$= 0.8$	Christoffel et al. (2009) mean of estimation
Government spending	$\bar{g}$	$= 0.2$	Christoffel et al. (2009) calibration
	b	$= 0.335$	target replacement rate $b/(w_h h_h) = 0.65$
Trade			
Openness	ω_c	$= 0.25$	EA average
Share of transit good in imports	ω_m	$= 0.3$	de Walque et al. (2017) calibration
Share of transit good in exports	ω_x	$= 0.3$	de Walque et al. (2017) calibration
Trade elasticity	θ_c	$= 1.5$	
Elasticity of substitution of imports	θ_m	$= 3$	de Walque et al. (2017) calibration
Elasticity of substitution of exports	θ_x	$= 0$	de Walque et al. (2017) calibration
Sensitivity home exp. to foreign imp.	β_m	$= 0.15$	de Walque et al. (2017) calibration

Table 7: Calibration

Country	Native UR	Immigrant UR	Unemployment ratio
Austria	5.6	6.68	1.20
Belgium	9.5	14	1.47
Finland	12.1	12.3	1.01
France	11.9	11.25	0.94
Germany	7.7	9.1	1.2
Greece	11.1	14.9	1.34
Ireland	8.5	7.6	0.9
Italy	11.5	16.5	1.4
Luxembourg	2.4	3.2	1.29
Portugal	6.7	7.8	1.16
Spain	13.9	15.1	1.09
Euro average	9.9	10.8	1.17

Table 8: Intra EA-12 Native vs. immigrante unemployment rate

* Source: OECD Migration Database. OCED Data are extracted from the labour force surveys, provided by Eurostat and averaged over the period 1998-2002. ** Data for Intra-EA-12 immmigrant unemployment are not available for the Netherlands.

7.3. Impulse response functions

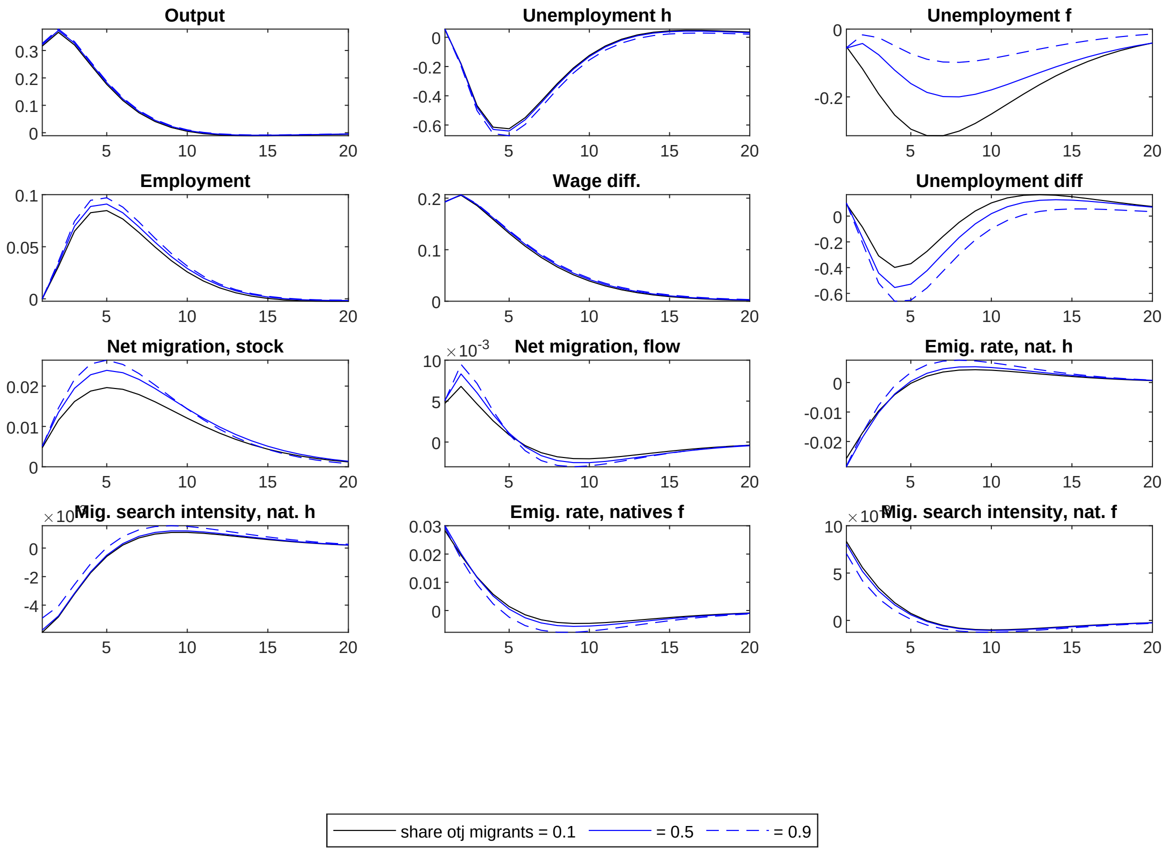

Figure 4: Positive technoloy shock home

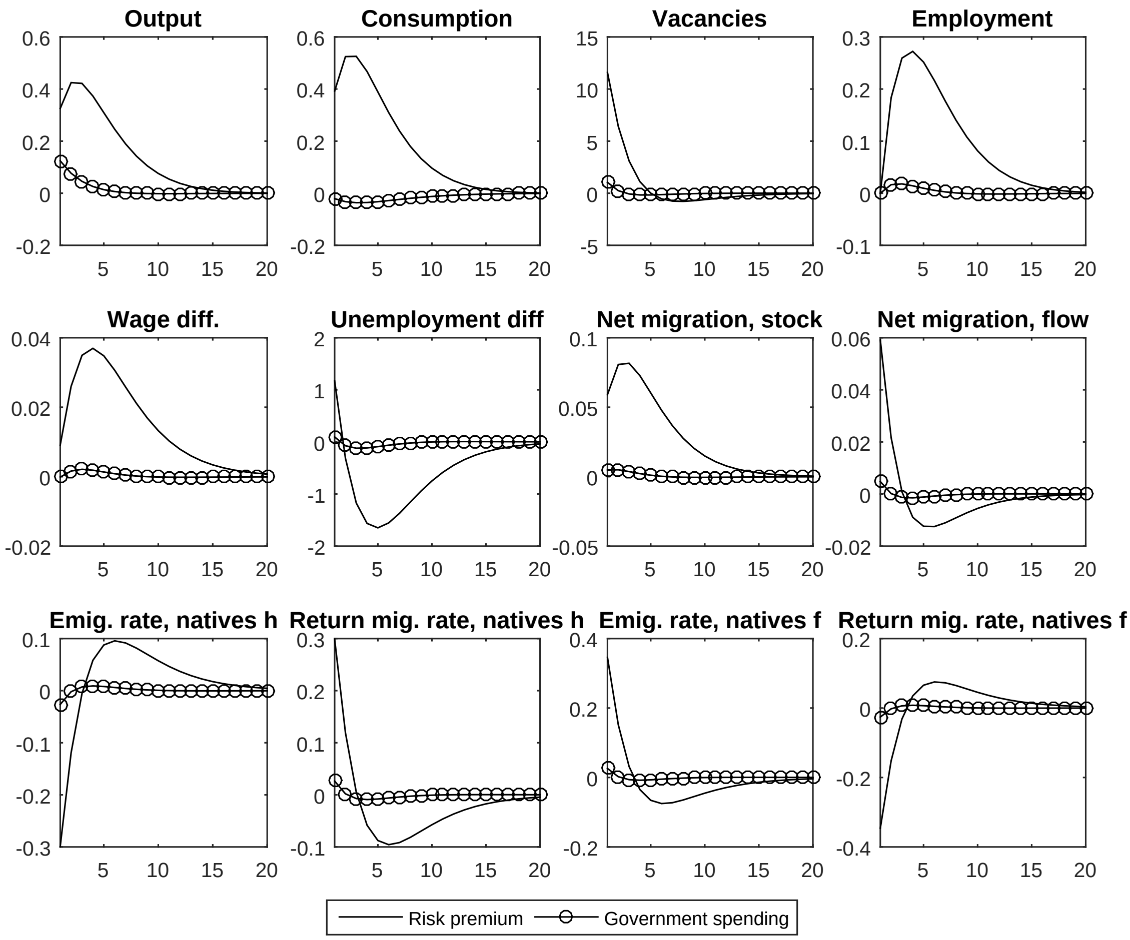

Figure 5: Negative risk premium shock home (share otj migrants = 0.5)

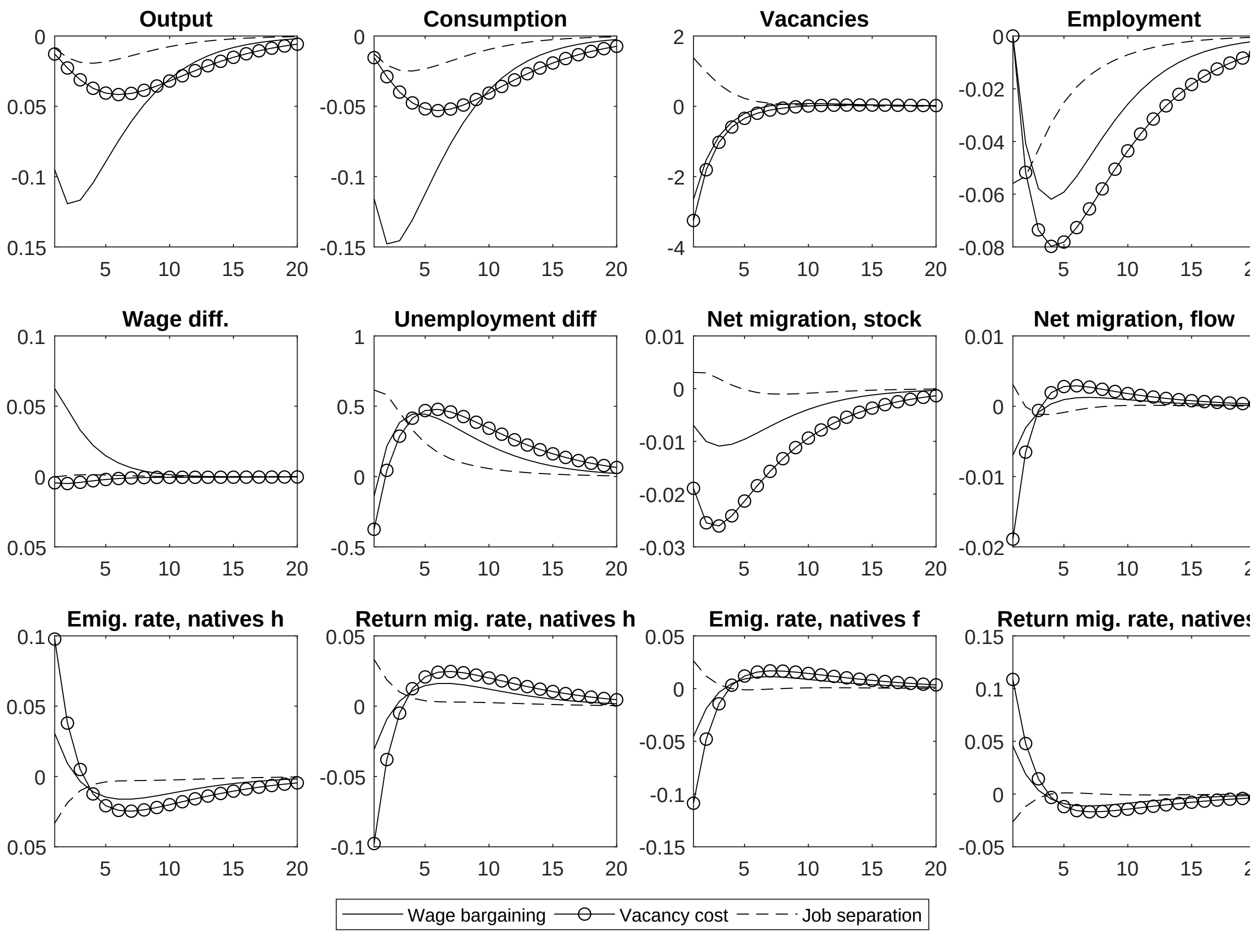

Figure 6: Labor market shocks home (share otj migrants = 0.5)

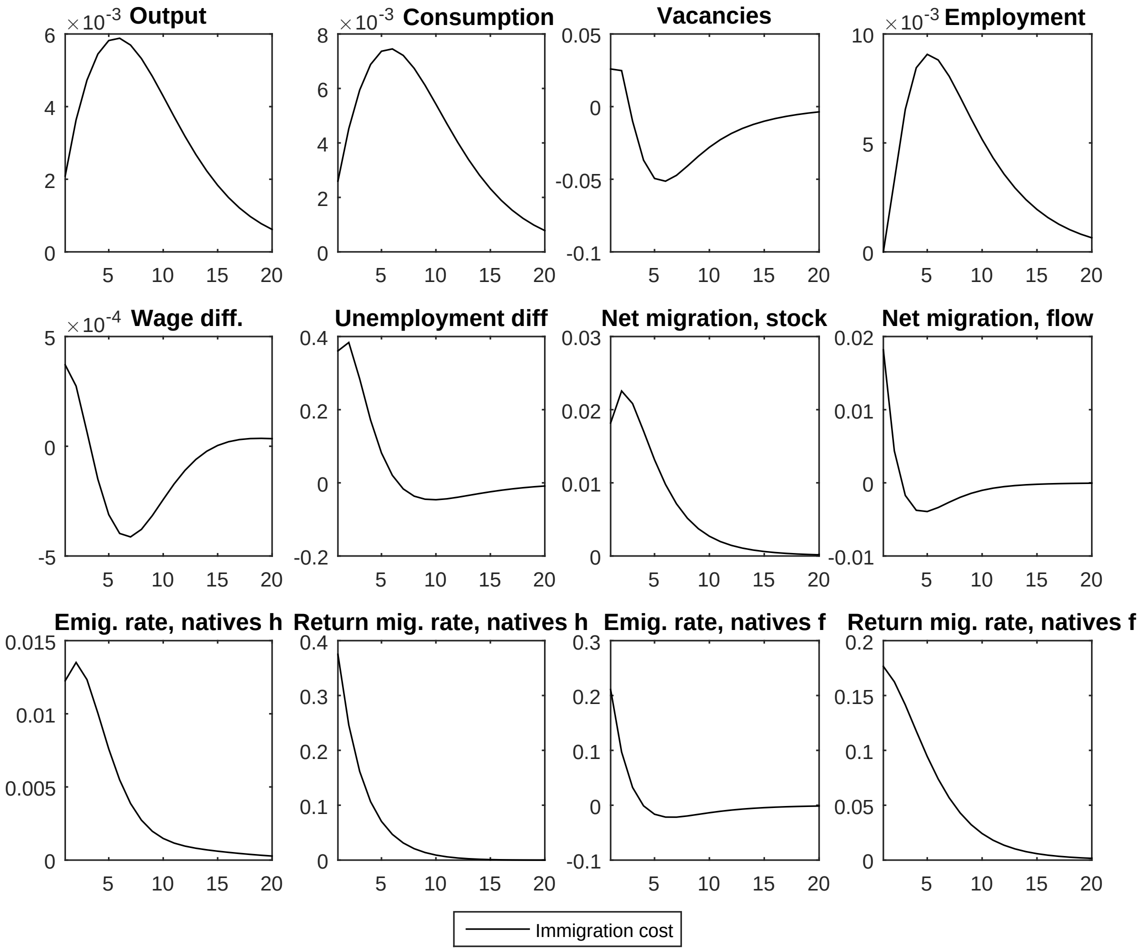

Figure 7: Migration cost reduction shock

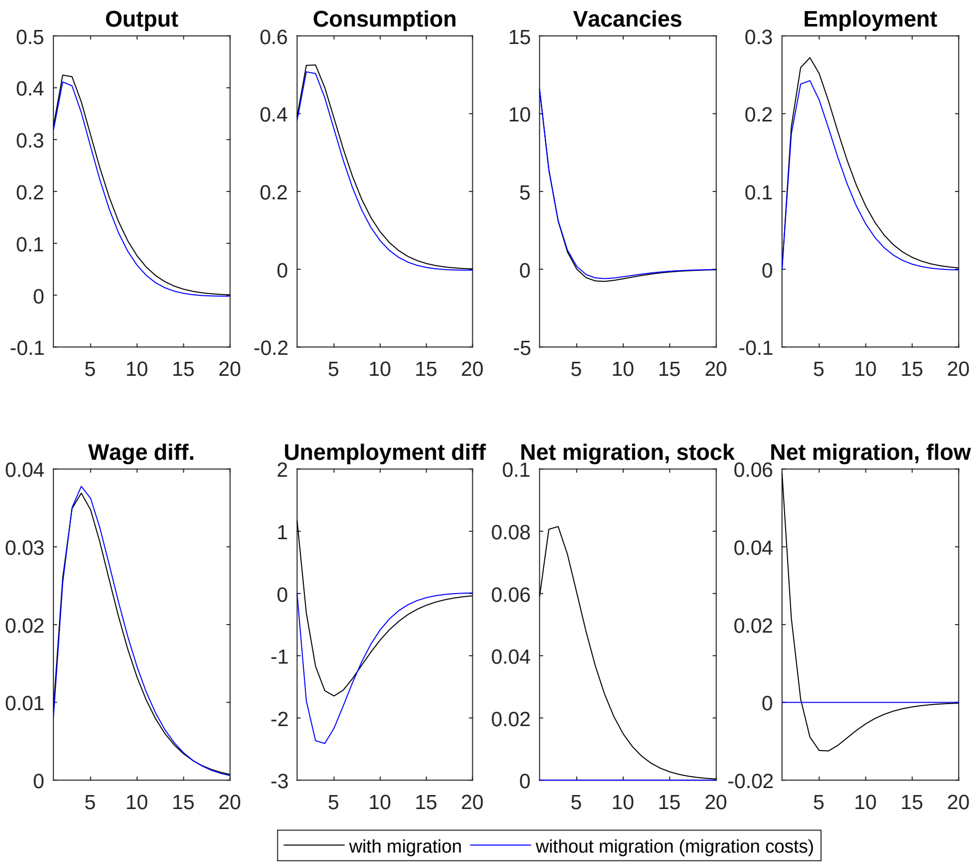

Figure 8: Risk premium shock home - Scenarios

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