Macroeconomic Stability and the Single European Labor Market

Marjan Aikimbaeva and Timo Baas

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The Single European Labor Market is seen more and more as an instrument to face short-term challenges like diverging unemployment rates and asymmetric business cycles. Most labor economists, however, agree that the common labor market is far from completion even though migration has increased strongly after EU-enlargement. It is, therefore, an open question to which extent this unfinished common market performs its function. In this paper, we analyze the impact of economic conditions on bilateral migration from Poland to Germany by estimating a two-country DSGE model using Bayesian methods. Our findings imply that migration, indeed, follows cyclical patterns and that it fosters economic stability. This, however, only holds true for the country of origin, as macroeconomic shocks of the destination country have a minor impact on migration.

JEL code: F22, F41, E32.

1 Introduction

Labor mobility in the European Union has increased substantially in the last decade. In 2013, 3.2 percent of EU-citizens lived in another EU member state in comparison to 1.7 percent a decade earlier. EU-Enlargement and the opening of labor markets after the end of transitional periods contributed to this increase. Compared to the United States, nevertheless, mobility is still low. Within a year, more than two percent of US-Americans move from one state to another while only 0.2 per cent of EU-citizens do the same. This contributes to the widespread view among labor economists that there is a long way to a Single European Labor Market. In this paper, by using Bayesian methods, we analyze the impact of macroeconomic shocks on migration from Poland to Germany. Our findings imply that a common labor market already exists, as, by comparing two DSGE models with and without the internal market, we can show, that migrants link labor markets of member states by choosing the optimum location for the provision of labor. The shock absorbing properties of the common market, however, benefits foremost the home rather than the host country of migrants.

The creation of a common European Labor Market started already in 1957 by allowing workers to accept job-offers in other member states and to move freely within the territory of the European Communities (EC). This right was stepwise enhanced till the Treaty of Maastricht granted the EU citizenship and the freedom of movement in 1999. Differences in social security systems, taxation and the recognition of qualifications among member states, nevertheless, still constitute obstacles to the free movement of workers. These obstacles are strong and still prevent people from moving. The above mentioned strong increase in labor mobility is caused foremost by EU-Enlargement and the end of transitional periods that closed labor markets of some member countries for a transitional period. Without the accession of new member states in 2004 and 2007, the number of EU-citizens living in another member state than that in which they were born would have been just 1.8 per cent. A value only slightly higher than the one observed a decade earlier. The reason for stronger internal migration is a more heterogeneous union. Wages in the accession countries of 2004 are one third of wages in the member states that had acceded prior to this date and the average wage of members that acceded in 2007 is one fifth, only. Given these differences, up till now it is an open question whether migrants are influenced by business cycles or if other factors like networks or the recognition of qualifications are more important. Migrants could move regardless of the state of the economy in the destination country which would contradict the common market hypothesis.

Analyzing the impact of the business cycle on migration has a long tradition. Jerome (1926) documents the business cycle properties of European migration to the US in the 19th and early 20th century, where migration decreased significantly during US recessions. Easterlin (1966), Kelley (1965), Gallaway and Vedder (1971) all confirm the finding that the business cycle in the destination country is more important in determining migration than that of the home country. Thomas (1973), instead, reaches a different conclusion. A recession in the country of origin fosters emigration which, in turn, leads to labor inflow and a boom in the host country. By analyzing migration in a multi-sector economy, Borjas (2001) provides a framework that analyzes the location decision of migrants. As regions are close substitutes after affording the initial fixed migration costs, migrants chose the region offering the highest real wage. In this model, migration increases with a recession in the country of origin, while the country of destination is likely to be in a boom offering high wages. As institutions play a big role in fostering or preventing migration, Mandelman and Zlate (2014) find that an increase in border control between Mexico and the US increase the volatility of wages and the unemployment rate of unskilled workers. Similarly, after the opening-up of labor markets, Barrett and Kelly (2010) arrive at the implication that migrants increased labor market flexibility in Ireland by being more responsive to macroeconomic shocks. Alongside a drop in immigration, however, migrants were more vulnerable to a worsening in economic condition which fostered out-migration. Bertoli et al. (2013) see a diversion of migrants after the recession in southern European countries that heads towards Germany. This result implies that labor of natives and migrants is not fully substitutable. Brücker et al. (2014) find that the elasticity of substitution is low in Germany and high in the UK.

Having this theoretical and empirical literature in mind, we build a simple two-country DSGE model that examines the business cycle fluctuations of labor. Households in the low-income country can choose to supply labor at home and abroad. Labor supply depends on the differential of real wages, but migrants and natives are imperfect substitutes. The migrants remit their income and increase the utility of the households in the country of origin. Prices are sticky according to Calvo Price setting and, therefore, need time to adjust. With this setting, the model is parsimonious but reflects essential characteristics of intra-EU migration. We estimate the model using data from Poland and Germany, as both countries share a common border and migration is significantly large. We observe significant differences in real wages among both countries, migration costs are low and migration has a long tradition. It is an open question whether migration does follow business cycle pattern and to what extent business cycles of the host or the country of origin are more important.

To answer these questions, we estimate the model using Bayesian techniques with data on employment of Polish migrants in Germany and macroeconomic indicators from both countries. In East-West migration in Europe, we have the problem of short time series. To cope with this problem we use a mixed-frequency approach, where we combine monthly data of employment and those macroeconomic variables where monthly data is available with quarterly data of the rest of the variables. Our results indicate that the labor productivity shock in the foreign country is the main driving force of migration. In some periods, nevertheless, preference shocks in home and foreign countries play a crucial role which makes them the second driving forces of migration. Interestingly, the shocks of the destination country have only a minor impact on the decision to migrate.

The remainder of this paper is organized as follows. In the next section we describe the two-country DSGE model. In section 3 we describe the data used for our estimation, the calibration of the model and the selection of priors. We also discuss prior and posterior distributions in this section. The contribution of each shock to the variance of the observable variables is discussed in section 4, section 5 presents the estimated impulse response functions and the historical decomposition showing the historical contribution of each shock to output, labor and, most important, migration and in section 6, we present our concluding remarks.

2 The Model

The model follows the lines of the standard new Keynesian framework. The novel characteristic of the model is the presence of labor mobility in such a setting. Similar to Mandelman and Zlate (2012), foreign labor can migrate from home to foreign. But in distinction to this model, labor provided by migrants and natives is not fully substitutable. This feature is especially relevant for the valuation of our model, as Ottaviano and Peri (2012) and Brücker et al. (2014) find imperfect substitution of migrant and native labor for European Labor markets. To avoid stochastic singularity, as standard, there are as many shocks as the data series used in the estimation.

2.1 Households

Both economies are inhabited by a representative household maximizing lifetime utility as a function of consumption and labor supply. As wages are higher in the destination country, migrants move from foreign to home, only. In diaspora, migrants remit all their money to maximize the utility of the household in their country of origin.[1]The representative household maximizes a utility function of the form:

$$\max \quad \mathbb{E}_0 \ \textstyle\sum_{t=0}^{\infty} \beta_t \ \kappa_t \left\{ \ln c_t + \psi \ \omega_t \ \ln(1 - l_t) \right\} \tag{1}$$

where $\mathbb{E}_0$ is the conditional expectation operator, c_t is consumption, l_t is labor and β is the discount factor. A similar function holds for the household in foreign albeit that aggregate labor l_t^* consists of labor used in the country of origin $l_{f,t}^*$ and labor used in the host country $l_{d,t}^*$. Utility maximization is subject to a sequence of intertemporal budget constraints. For the domestic household, the budget constraint takes the form:

[1] If we relax this assumption and introduce altruism according to Mandelman and Zlate (2012) results differ only slightly. The location of consumption scarcely matters for households. Foreign output tends to be lower, but due to exchange rate adjustments, this effect is hardly noticeable.

$$\int_0^1 \left[p_{d,t}(i)c_{d,t}(i)\right] di + k_{d,t+1} = w_t l_{d,t} + r_{d,t}k_{d,t} + (1-\delta)k_{d,t} \tag{2}$$

where $w_{d,t}$ is the wage rate paid to domestic labor, $r_{d,t}$ is the rental rate of capital and $k_{d,t}$ is capital. Capital follows the law of motion:

$$k_{d,t+1} = i_{d,t} + (1-\delta)k_{d,t}. \tag{3}$$

We assume a monopolistic production sector, where atomistic firms produce varieties of the consumption good. The optimum allocation of expenditures with regard to these varieties follows the demand functions:

$$c_{d,t}(i) = \left(\frac{p_{d,t}(i)}{p_t}\right)^{-\eta} c_t\ . \tag{4}$$

The price index $p_t$is defined as $p_t \equiv \left(\int_0^1 p_{d,t}(i)^{1-\epsilon}\right)^{\frac{1}{1-\epsilon}}$. Accounting for optimum expenditures, we can rewrite the sequence of intertemporal budget constraints as follows:

$$p_t c_{d,t} + k_{d,t+1} = w_{d,t}l_{d,t} + r_{d,t}k_{d,t} + (1-\delta)k_{d,t}. \tag{5}$$

Thus, the household chooses $\{c_t, k_t, l_t\}_{t=0}^{\infty}$ to maximize utility subject to equation 5 for all $t = 0, 1, 2, ...$ The first order conditions for this problem are:

$$\vartheta_t = \beta\mathbb{E}_t\left\{\vartheta_{t+1}\Big(r_{d,t+1} + 1 - \delta\Big)\right\} \tag{6}$$

and

$$c_t\ \omega_t\ \psi = w_{d,t}\Big(1 - l_{d,t}\Big) \tag{7}$$

where ϑ_t denotes the stochastic discount factor

$$\vartheta_t = \frac{\kappa_t}{c_{d,t}p_t}.$$

In the foreign country, households are faced with an identical problem to the one outlined above. We can, therefore, derive a set of analogous conditions characterizing the solution of the consumers problem. Foreign households, however, face the problem of providing labor for use in home and foreign. As we did not include fixed costs of migration, wages retrieved from labor provided abroad have to equal wages at home.

2.2 Production of intermediate good firms

Intermediate good firms use capital and labor for the production of a homogeneous good. In the domestic economy, the firm can chose to employ native and migrant labor. We follow Card and Lemieux (2001) and use a nested production function common in the literature on the labor market effects of migration (Ottaviano and Peri, 2008; Brucker and Jahn, 2011; Brücker et al., 2014) . As we are interested in the business-cycle properties of the movement of labor rather than the impact of migration on wages of natives and migrants, it seems suitable to use a production function with two nests and to abstain from including skills and experiences. The aggregate technology to produce goods is given by a linear homogeneous production function

$$y_t = \left[\alpha k_t^{\phi} + (1-\alpha) L_t^{\phi}\right]^{\frac{1}{\phi}},$$

where y_t is output,k_t is capital L_t is aggregate labor and $\phi = 1 - \frac{1}{\sigma_{KL}}$ with σ_{KL} being the elasticity of substitution between capital and labor. In line with Borjas (2001), Ottaviano and Peri (2008) and Borjas et al. (2008), we assume that $\sigma_{KL} = 1$ so that the CES function collapses to the Cobb-Douglas form. The upper nest production follows a Cobb-Douglas function by combining capital k_t and a labor aggregate L_t :

$$y_{d,t} = e^{z_t} k_t^{\alpha} L_t^{1-\alpha}.$$

In the lower nest, labor L_t is specified as a Arrow et al. (1961) CES aggregate containing domestic $l_{d,t}$ and migrant $l_{f,t}$ labor:

$$L_t = \left\{ \gamma l_{d,t}^{\theta} + (1-\gamma) l_{f,t}^{\theta} \right\}^{1/\theta}$$

where γ is a distribution parameter (Levine et al., 2010) and $\sigma > 0$ is the elasticity of substitution between domestic and foreign labor in the domestic country. We can now retrieve the relation of domestic and foreign labor as a function of wages, the exchange rate, the distribution parameter and the elasticity of substitution.

$$\frac{l_t^*}{l_t} = \left(\frac{w_t}{e_t w_t^*}\right)^{\sigma} \left(\frac{1-\gamma}{\gamma}\right)^{\sigma}.$$

As it can be easily seen, migration employed in the intermediate good sector is determined by the wage differential between native and migrant labor, where the cost of migrant labor depends on the wage in foreign and the exchange rate. The firm is a price taker on labor markets, the wage is determined by the labor supply equations of households in home and foreign and reflects the disutility of labor.

2.3 Retail Firms

There is a continuum of monopolistically competitive retailers on the unit interval indexed by i. Each retailer purchases goods from the intermediate goods-producing firms and transforms it into a differentiated retail good using a linear technology which is then resold to the households. During each period $t = 0, 1, 2, \ldots$ each retailer i sells $Y_t(i)$ units of the retail good at the nominal price $P_t(i)$. Let Y_t denote the composite of individual retails goods which is described by the CES aggregator of Dixit and Stiglitz:

$$Y_t = \left[\int_0^1 Y_t(i)^{(\varsigma-1)/\varsigma} di\right]^{\varsigma/(\varsigma-1)},$$

where $\varsigma > 1$ is the elasticity of substitution across the differentiated retail goods. Then, the demand curve facing each retailer i is given by

$$Y_t(i) = \left[\frac{P_t(i)}{P_t}\right]^{-\varsigma} Y_t,$$

where P_t is the aggregate price index

$$P_t = \left[\int_0^1 P_t(i)^{1-\varsigma} di\right]^{1/(1-\varsigma)}$$

for all $t = 0, 1, 2, \ldots$. As we use Calvo price setting, only a randomly and independently chosen fraction $1 - \nu$ of the firms in the retail is sector is allowed to set their prices optimally whereas the remaining fraction ν adjust their prices by charging the previous period's price times the steady-state inflation. Hence, a retail firm i, which can choose price in period t, chooses the price $P_t^*(i)$ to maximize

$$E_t \sum_{j=0}^{\infty} (\beta\nu)^j \beta_{t,t+j} \left[\left(\frac{P_t^*(i)}{P_{t+j}} \right)^{-\varsigma} Y_{t+j} \left(\frac{P_t^*(i)}{P_{t+j}} - \epsilon_{t+j} \right) \right],$$

where β_{t+j} is the discount factor used by the firms and ϵ_t is the real marginal costs. The first-order condition for this problem is

$$P_t^*(i) = \frac{\varsigma}{(\varsigma - 1)} \frac{\sum_{j=0}^{\infty} (\nu\beta)^j E_t(\lambda_{t+j} P_{t+j}^{\varsigma} Y_{t+j} \epsilon_{t+j})}{\sum_{j=0}^{\infty} (\nu\beta)^j E_t(\lambda_{t+j} P_{t+j}^{\varsigma-1} Y_{t+j})}.$$

Log-linearizing the equation around the steady state and performing some algebra enables us to derive the New Keynesian Philips Curve:

$$\pi_t = \beta E_t \pi_{t+1} + \frac{(1-\nu)(1-\nu\beta)}{\nu} \hat{\epsilon}_t,$$

where a 'hat' denotes percentage deviation from the steady-state.

2.4 The central bank

The central bank in both countries conducts monetary policy using a modified Taylor (1993) rule

$$\ln(R_t/R) = \rho_r \ln(R_{t-1}/R) + \rho_y \ln(Y_t/Y) + \rho_\pi \ln(\pi_t/\pi) + \epsilon_{r_t},$$

where R, Y and π are the steady-state values of the gross nominal interest rate, output and gross inflation rate. $\epsilon_{r_t} \overset{i.i.d.}{\sim} N(0, \sigma_{r_t}^2)$ is a shock to monetary policy. The degree of interest rate smoothing ρ_r and the reaction coefficients to inflation and output, ρ_π and ρ_y, are assumed to be positive.

2.5 Shocks

Both economies are hit by three different kinds of shock. The household is affected by a labor supply shock ω_t which follows an AR(1) process:

$$\omega_t = \rho_\omega \omega_{t-1} + \epsilon_{\omega,t} \ , \epsilon_{\omega,t} \sim N(0,1) \tag{8}$$

Second, we assume a preference or demand shock, κ_t which follows an AR(1) process:

$$\kappa_t = \rho_\kappa \kappa_{t-1} + \epsilon_{\kappa,t} \ , \epsilon_{\kappa,t} \sim N(0,1) \tag{9}$$

Finally, the production function is subject to a technology shock z_t that follows an AR(1) process:

$$z_t = \rho_z z_{t-1} + \epsilon_{z,t} \ , \epsilon_{z,t} \sim N(0,1).$$

3 Bayesian Estimation

The parameters of the model are estimated using the Bayesian estimation technique that relies on a general equilibrium approach and addresses identification issues of reduced form models. First, we define the unknown parameter set Θ. We assign distributions,$P(\theta)$, to these parameters based on our beliefs concerning what values these parameters could take before observing the data,Y_t. We gather the data, Y_t, to update the beliefs about the priors using the Bayes' theorem.

$$P(\theta|Y_t) \propto \mathcal{L}(Y_t|\theta)P(\theta)$$

The likelihood function, $\mathcal{L}(Y_t|\Theta)$, which is a restriction that the data imposes on our model is calculated by using the Kalman Filter. The likelihood principle ensures that only observed y is relevant to inference about θ which is the corner stone of Bayesian inference (Bauwens et al).Combining the likelihood function with prior information, one obtains the posterior distributions of the parameters.

First we solve our model and log-linearize the first order conditions and market clearing conditions around the steady state. Then, we present the solution of our model in a state-space representation in terms of state equations and the observation equations (Guarron-Quintana):

$$S_t = FS_{t-1} + Q\epsilon_t$$

$$Y_t = M + HS_t + \epsilon_{u,t}$$

where S_t is the state that represents the state of the model at any given time, Y_t is the vector of observable variables, H is the matrix that relates the model's definitions to the data and $\epsilon_{u,t}$ are the shocks to the observables. If the state equations and observable equations are linear and shocks are normally distributed, the likelihood function can be computed using the Kalman Filter.

The likelihood combined with the prior information allows one to evaluate the posterior distribution. Markov Chain Monte Carlo Metropolis-Hastings (MH) algorithm is used to approximate $P(\theta|Y_t)$. The first step is to obtain the posterior by combining the likelihood and prior then, the posterior can be used as a starting point Θ_0 such that $\mathcal{L}(Y_0|\Theta)P(\Theta_0)$ can be used to generate draws from the posterior distribution. We run the MH algorithm for a number of iterations. After that, we obtain an approximation of the posterior and are able to make inference.

3.1 Data

To estimate our model we use a special data set on border movement as a proxy for migration flows from Poland to Germany. The data set is at monthly frequency covering the period from January 2006 to January 2014 and it is obtained from the German Federal Statistics Office (DESTATIS). In Bayesian Estimation, there is a need to match the number of shocks with the number of observable variables to overcome stochastic singularity issue. Thus, we construct a data set with six time-series to match the six shocks in our model.

$$\{\Delta \log L, \Delta \log l_{fd}, \Delta \log c, \Delta \log c_f, \Delta \log y, \Delta \log y_f\}$$

We select per capita GDP $\{y, y_f\}$ and per capita consumption $\{c, c_f\}$, employed population in Germany and migration flows $\{L, l_{fd}\}$ as observable variables.

Employed population data for Germany is provided by the Federal Employment Agency (BA); GDP, consumption time series and exchange rate data are obtained from EUROSTAT.

Migration, employment and exchange rate time series are available at monthly frequency however, this does not hold for GDP and consumption data. Therefore, we carry out Bayesian Estimation using a mixed frequency approach, whereby the following variables enter estimation at quarterly frequency:

$$\{\Delta \log c, \Delta \log c_f, \Delta \log y, \Delta \log y_f\}$$

The quarterly series are seasonally adjusted and the time series are linearly detrended as in Smets and Wouters (2007). To implement mixed frequency estimation, we include the quarterly time series in the data set and treat the months 3, 6, 9 and 12 as observed and the rest as missing. Then Kalman Filter treats those observations as missing values and infers their values given the observables (Durbin, J. and Siem J. Koopman, 2012; Pfeifer, 2014).

3.2 Calibration

Following the literature, we keep a set of the parameters constant. These parameters define the steady state relationships in the model and are hard to estimate using our observable variables since the likelihood can not provide more information about them.

As standard in the literature, the following parameters are calibrated and do not enter the estimation; the discount factor, the depreciation rate of physical capital, the partial elasticities of the Cobb-Douglas function, the size of the Germany economy and the Calvo parameter;

$$\Delta_1 = \left\{ \beta, \alpha, \delta, \iota, \phi \right\}$$

The fixed parameters are calibrated at monthly frequency as we use a mixed frequency estimation strategy where parameters have to be calibrated at the highest frequency. Preferences of the domestic and foreign countries are assumed to be symmetric thus, the fixed parameters are identical unless stated otherwise. The discount factor, β, is calibrated at 0.9967 which indicates an annual steady state interest rate of 4%. The discount factor, δ , is calibrated at 0.0083 indicating an annual depreciation rate of 10% which is the standard value in the literature. We calibrate the partial elasticity of the production function with regard to capital, α, using national accounts. The value for Germany is 0.33, while Poland has a slightly higher share of 0.38. As typical in the literature, the Calvo parameter ,ϕ, is calibrated at 0.75 which is in line with (Gali et al. (2001)) so that the average length of contract is one year.

The following parameters are estimated; the share of migrant labor in the composite labor, the elasticity of substitution between foreign and home labor, AR(1) processes and standard deviation of shocks in addition to Taylor rule parameters:

$$\Delta_2 = \left\{ \gamma, \sigma, \rho_\omega, \rho_\kappa, \rho_z, \rho_y, \rho_\pi, \rho_r \right\}$$

3.3 Prior Selection, Prior and Posterior Distributions

The selection of prior distributions is based on the evidence from the model and corresponds to the econometric literature (Smets and Wouters, 2003; Adolfson et al., 2007).The choice of prior distribution is restricted by the values the parameters could get. For parameters that are bound to be positive such as standard deviation of shocks, we assign a inverse gamma distribution; for parameters that are bound between 0 and 1, such as persistence parameters, we assign a beta distribution and for the rest, the parameters that are non-bounded, we assign a normal distribution (see table (1) columns $3-4$). Thus, the standard deviations of shocks follow the inverse gamma distribution with mean 0.1 and standard deviation 2. All persistence parameters are assumed to be beta distributed with mean 0.85 and a standard deviation of 0.1. The elasticity of substitution between foreign and domestic labor is based on estimates of Brucker and Jahn (2011). We assume this parameter to be inverse gamma distributed with mean 2.86 and a standard deviation of 0.633. We used the foreigner statistics of the German federal office for migration and refugees to calculate the share of the labor force with a Polish citizenship residing in Germany. We assume that this parameter follows a gamma distribution with mean 0.0263 and a standard deviation of 0.01.

The last four columns in table 2 show the posterior mode obtained by maximizing the posterior kernel and the 5 and 95 percentile of the posterior distribution computed by the Metropolis Hastings algorithm based on $100,000$ draws. In general, the posteriors are definite from priors except for the γ parameter (share of foreign labor in domestic labor), indicating that the data is informative on estimates. The elasticity of substitution σ is estimated at 9.53, higher than its prior value which indicates a higher elasticity of substitution between foreign and domestic labor. Our estimates, thus, are between Brücker et al. (2014) and the findings of Borjas (2003). In sum, the foreign technology shock is more persistent (ρ_m = 0.9405) and more volatile (σ_m = 11.93) than the domestic technology shock. This is a typical characteristic for transition economies. Interestingly, this also holds for the foreign labor supply shock that is more persistent (ρ_γ = 0.9944) than the domestic labor supply shock indicating that the inflow in and outflow of inactivity is higher in Poland than in Germany. Irrespectively from the country, business cycle fluctuations are mainly by technology and labor supply shocks. It seems the preference shock is more important to the German economy while for the Polish economy, labor supply shocks matter more in comparison to technology shocks.

Table 1 on page 24 about here

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4 Variance Decomposition

In this section, we examine the contribution of each shock to the variance of our observable variables. The rows show the observable variables and the columns show the shocks used in the estimation. Table (2) gives the variance decomposition for period 100. We observe that domestic output is foremost driven by the domestic preference shocks. These shocks explain 88.43 percent of the variance of output. The main drivers of Polish output are domestic preference shock with 96.43 percent followed by domestic productivity shock with 3.49. Domestic labor in Germany is affected foremost by domestic preference shocks (84.79 percent), while immigration is driven foremost by foreign preference shocks (71.40 percent) and domestic preference shocks (23.36 percent).

The labor supply shock has almost no effect on migration.

Table 2 on page 25 about here

5 The Effects of Shocks

In this section, we examine the driving forces of migration and we illustrate the impact of migration on other macroeconomic variables like output, consumption, composite labor, foreign labor, wages, capital and interest rates. In detail, we proceed in describing the estimated impulse-response functions that describe the adjustment of our model to a variety of macroeconomic shocks. The following section shows the historic contribution of shocks to the variance of output and migration.

5.1 Impulse Response Functions

In this subsection, we describe the adjustment of key variables of the model to three transitory macroeconomic shocks; a neutral technology shock, a labor supply shock and a preference shock.

5.1.1 Positive Technology shock

We consider a positive transitory technology shock that increases total factor productivity. The impulse response functions are calculated from a posterior sample of 2500 draws and are plotted with the 5 to 95 percent confidence interval. Figure (1) shows the response of six macroeconomic variables, domestic output (y), foreign output (y_f), domestic composite labor (L), migration from foreign to home (l_{fd}) foreign(c_f) and domestic consumption (c). The unexpected shock increases output in the domestic country. As the marginal product of labor and capital grows, both, domestic composite wages and the real interest rate on physical capital, rise. The expansion in domestic wages enhance the benefits of migration which, in turn, reduces the impact of the shock on average wages. The impact of such a shock on the provision of labor in the domestic country, however, is unclear. As wages rise, opportunity costs of leisure also intensifies which should boost labor supply of households. On the other hand, an accelerating production, higher consumption, as well as a reduction in the impact on prices due to migration, may result in a decrease of labor supply. In Figure (1) we see that aggregate labor is first increasing and then decreasing. The reason for this phenomenon may be grounded in the period considered here. The financial and economic crises, as the most severe crises of the last decades, did not strongly affect employment in the countries considered here. Consequently, the recovery was accompanied by a less than to be expected increase in employment.Aggregate labor, using the estimated parameters, does not increase after a positive technology shock. Migration, instead, increases but it is not strong enough to drive composite labor.

Figure 1 on page 26 about here

Figure (2) shows the responses to a positive technology shock in the foreign country. The reaction of macroeconomic variables is similar to the domestic country; output increases as total factor productivity rises, wages increase and labor supply decreases. In the case of the foreign country, however, the increase in wages results in a decrease in migration. The impact of the foreign technology shock on migration flows, nevertheless, is much stronger than the domestic productivity shock analyzed earlier in this section. Aggregate domestic labor, therefore, has to adjust resulting in rising domestic wages.

Figure 2 on page 27 about here

5.1.2 Labor supply shock

An unexpected shock to the preference parameter of leisure results in a reduction of labor supply by domestic households. As we see in Figure (8), households feel a non-optimum division of leisure and consumption. As demand for consumption goods falls, firms reduce production and labor demand shrinks. The effect on wages is unclear and depends on the factor price of capital. If households reduce savings, capital is also reduced and labor might be the abandon factor. We also see a depreciation of the currency, which reduces wages of migrants and reduces migration. As the impact on migration depends on wages and the exchange rate, the aggregate effect is unclear. In our model, we see a sharp decrease in migration right after the shock which is due to imperfect labor markets, where migrants are the abandon factor. In the second step, migration recovers but falls shortly thereafter as the effect of the shock on output is rather persistent in the domestic country.

Figure 3 on page 28 about here

5.1.3 Preference shock

Figure (4) shows the impulse responses to a household time preference shock. Households get more impatient and increase consumption today while reducing savings. As capital gets scarce, the interest on physical capital has to rise which results in higher prices and reduces overall demand. As households save by providing a consumption good to firms, consumption can increase purely by shifting demand from investment to consumption. The overall impact of production, however, is negative, migration increases and falls thereafter. As prices increased in the first place, the central bank, in return, decreases the interest rate to balance inflation.

Figure 4 on page 29 about here

Figure (5) shows the impulse responses to a household preference shock in the foreign economy. The impact is similar with the difference that we see a strong increase in migration right from the beginning.

Figure 5 on page 30 about here

5.2 Historical Decomposition

The figures below show the historical contribution of each shock to the growth of output and labor expressed as deviation from trend growth over the sample period. As we see in Figure (6), output in Germany was subject to a severe negative technology shock following the financial market crisis. Capital utilization and labor hording account typically for a large fraction of the fall in TFP during deep recessions (Fernald, 2012). As we see in the periods after the financial market crisis, TFP recovers and preference, foreign technology or domestic labor supply shocks negatively affect GDP growth. In the last quarter of 2013, however, TFP is contributing in a negative way to GDP growth which is the result of a short economic downturn in the end of 2013. A time preference shock starting from mid-2010 increased domestic demand, which dampens this effect while starting from mid-2013 labor supply positively accounts to GDP growth.

Figure 6 on page 31 about here

The GDP growth of Poland during the sample period is mainly driven by preference and technology shocks (Figure (7)). We also see a strong negative impact of the financial market crisis in October 2013 hitting a country that experienced a strong 1.5 per cent growth. The impact of the financial market crisis, therefore, was only short living. Labor hording and capital utilization reduced TFP which had a negative impact on GDP. Poland recovered from this shock quickly; it was the only European country to avoid recession. During the years after the financial market crises, Poland was not able to fully seal its economy from the negative impact of the government debt crisis affecting predominantly southern European countries. We see an economic downturn in 2008/2009 and one in 2012/2013 both short living and accompanied by a decrease in TFP indicating capital utilization and labor hording.

Figure 7 on page 32 about here

Migration of Polish citizens to Germany, during the sample period, is strongly affected by Polish shocks (Figure (8)). This contradicts conventional wisdom that the main reason for choosing a destination country are economic conditions. A reason for this phenomenon could be that the labor market for medium skilled migrants is extraordinary in Germany. The specific apprenticeship system makes entry into this market costly, as recognition of qualifications is difficult and costly. Furthermore, Polish migrants have a long migration history with Germany, which, typically reduces the cost of movement. Information on both sides of labor markets steadily increases since the fall of the Berlin wall. If migrants bear the extra costs related to the apprenticeship system, the reward is higher than in other European countries. The specific group of Polish migrants, consequently, may not see many alternative destinations for themselves so that the decision to migrate is essentially a decision to migrate to Germany.

Figure 8 on page 33 about here

Migration significantly affects the adjustment of labor supply during the business cycle. In Figure (9) we see that the foreign productivity shocks contribute in a positive way and foreign preference shocks usually in a negative way to the growth of total labor supply. The domestic technology shock, instead, has a negative impact. The impact of domestic labor supply and preference shocks is mixed. The throughout positive impact of the Polish technology shock is surprising. As we see in Figure (8), the technology shock can have a negative impact on migration. A reason for this effect could be a substitution of Polish migrants by migrants from other countries. This could also explain the stability of labor supply in Germany.

Figure 9 on page 34 about here

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6 Conclusions

In the aftermath of the financial market crises, the benefits of a functioning single European labor market has become obvious. Labor mobility is seen as an instrument to face short-term challenges like diverging unemployment rates and asymmetric business cycles. Most labor economists agree that the common labor market is far from completion, even though migration increased strongly after EU-enlargement. It is, therefore, an open question to which extend the common market helps to face those short-term challenges. The model proposed here bridges an existing gap between business-cycle research and immigration theory addressing the question to what extend migration is driven by macroeconomic shocks. The decision to migrate is endogenous in our model and depends on the real wage differences. During the sample period, the growth of Polish citizens moving to Germany depends foremost on the shocks affecting the home country of the migrant. This result is somehow surprising, as immigration theory suggests that economic conditions of the country of destination should play a more important role. A reason for this phenomenon might be the rather nontransparent labor markets for skilled workers. If migrants have to bear information costs, it is more unlikely that they choose destinations according to economic conditions after paying such costs. This implies that the country of origin is able to smooth business cycles through migration. Furthermore, the destination country is affected by the shocks hitting migrants' country of origin reducing macroeconomic stability there. This effect, nevertheless, is weak as Germany is host to migrants from a large number of countries. Labor supply, therefore, is roughly stable over time.

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7 Tables and Figures

Table 1: Prior and Posterior Distributions

Description		Prior Distributions			Posterior Distributions	
	Parameter	Density	Mean	Std.Dev.	Mean	Std.Dev.
Elasticity of Substitution	σ	Inv. Gamma	2.86	0.633	9.53	1.77
Share of Foreign Labor	γ	Normal	0.0263	0.01	0.22	0.01
Tech.Shock (D)	ρ_z	Beta	0.75	0.10	0.72	0.03
Preference Shock (D)	ρ_κ	Beta	0.75	0.10	0.95	0.004
Labor Supply Shock(D)	ω_μ	Beta	0.75	0.10	0.99	0.0044
Tech.Shock (F)	ρ_m	Beta	0.75	0.10	0.54	0.107
Preference Shock (F)	ρ_λ	Beta	0.75	0.10	0.27	0.07
Labor Supply Shock (F)	ρ_χ	Beta	0.75	0.10	0.66	0.14
Calvo parameter (D)	η_f	Beta	0.75	0.10	2.96	0.02
Elast.of Subst.goods (F)	η_f	Gamma	2	0.75	2.22	0.012
Taylor rule output (D)	ρ_y	Normal	0.125	0.05	0.125	0.07
Taylor rule inflation(D)	ρ_π	Normal	1.5	0.125	1.5	0.115
Taylor rule int.rate(D)	ρ_r	Beta	0.75	0.10	0.78	0.1
Taylor rule output (F)	ρ_{yf}	Normal	0.125	0.05	0.1250	0.049
Taylor rule inflation (F)	ρ_{π_f}	Normal	1.5	0.125	1.5	0.126
Taylor rule int.rate (F)	ρ_{rf}	Beta	0.32	0.10	0.30	0.104

Table 2: Variance Decomposition

Obs. Variable	ϵ_z	ϵ_m	ϵ_ω	ϵ_κ	ϵ_{κ_f}	
Output (D)	10.42	0.03	0.84	88.43	0.29	
Output (F)	0.01	3.49	0.00	0.04	96.34	
Domestic Labor (D)	1.98	0.34	3.64	84.79	9.25	
Immigrants (D)	2.51	2.61	0.09	23.36	71.40	

Variance decomposition for period 100

Figure 1: Impulse response functions to a positive technology shock in the domestic country with 5 to 95 per cent confidence intervals. Notes: Each panel shows the response of the model variables to a technology shock of one. The horizontal axes measure time, expressed in months.

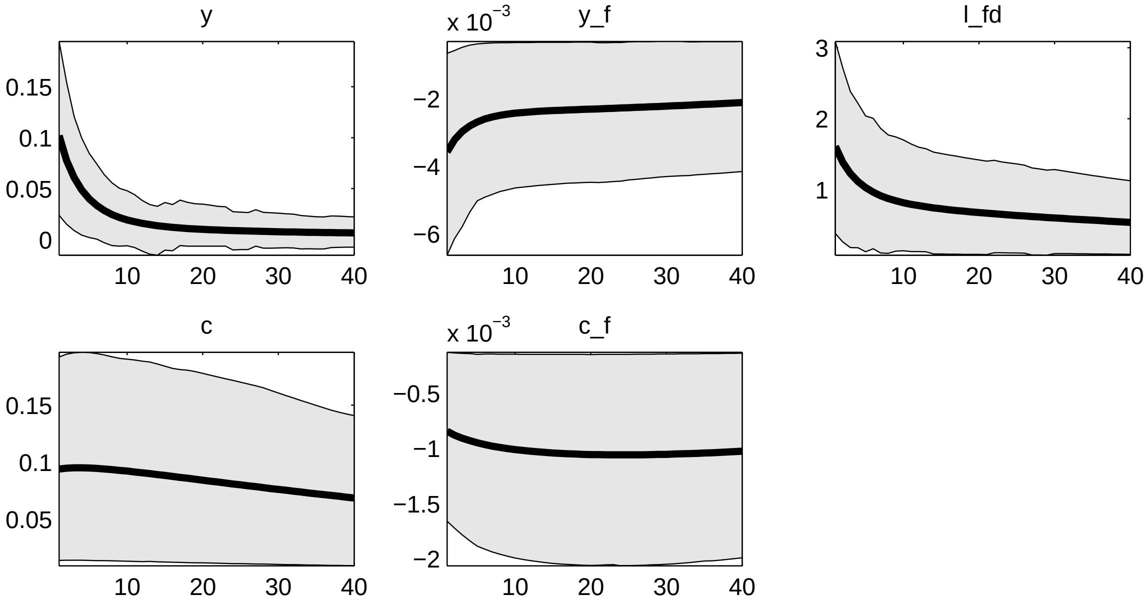


Figure 2: Impulse response functions to a positive technology shock in the foreign country with 5 to 95 per cent confidence intervals. Notes: Each panel shows the response of the model variables to a technology shock of one. The horizontal axes measure time, expressed in months.

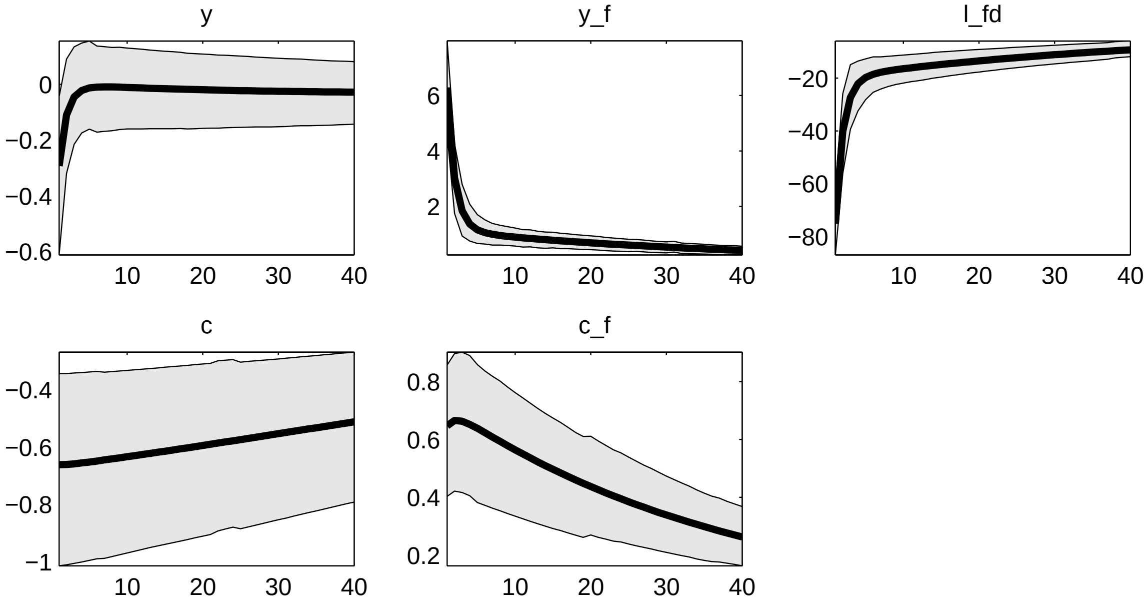


Figure 3: Impulse response functions to a labor supply shock in the domestic country with 5 to 95 per cent confidence intervals. Notes: Each panel shows the response of the model variables to a technology shock of one. The horizontal axes measure time, expressed in months.

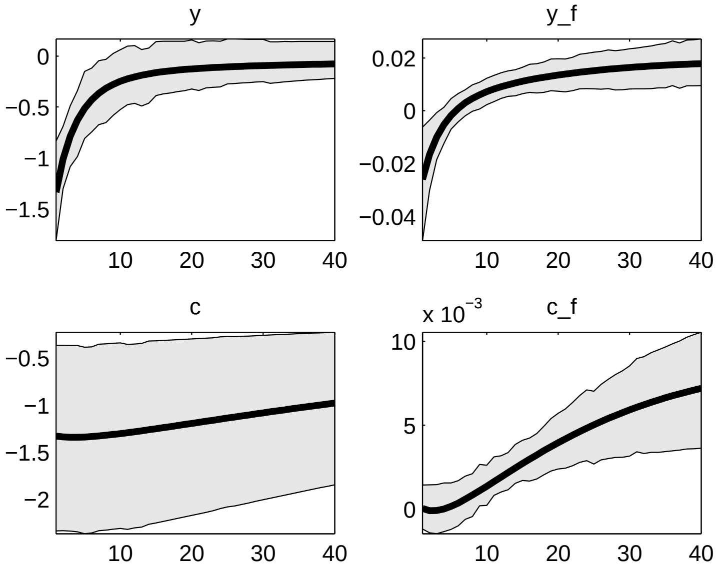


Figure 4: Impulse response functions to a household preference shock in the domestic country with 5 to 95 per cent confidence intervals. Notes: Each panel shows the response of the model variables to a technology shock of one. The horizontal axes measure time, expressed in months.

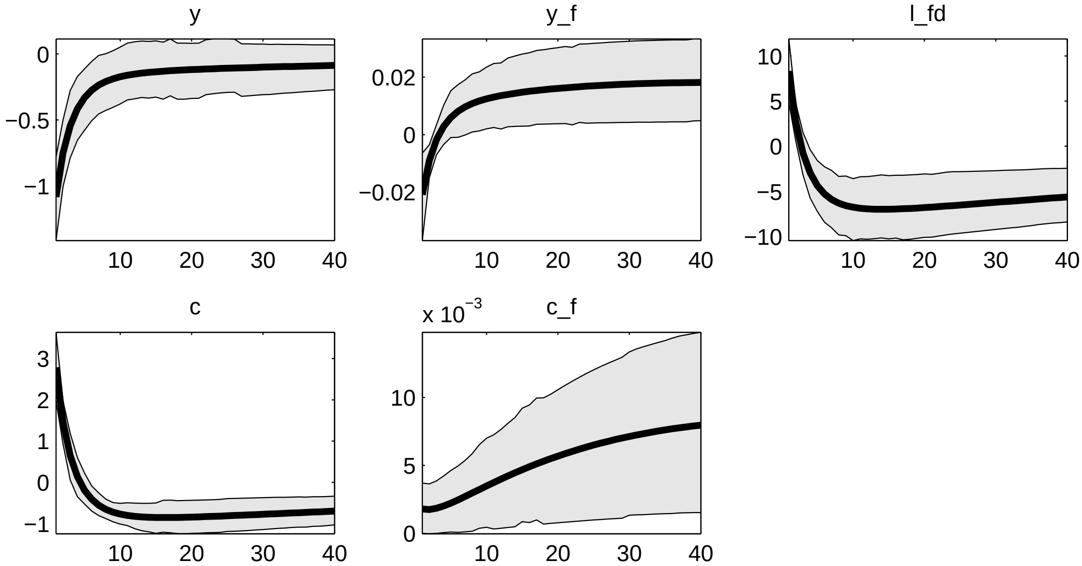


Figure 5: Impulse response functions to a household preference shock in foreign country with 5 to 95 per cent confidence intervals. Notes: Each panel shows the response of the model variables to a technology shock of one. The horizontal axes measure time, expressed in months.

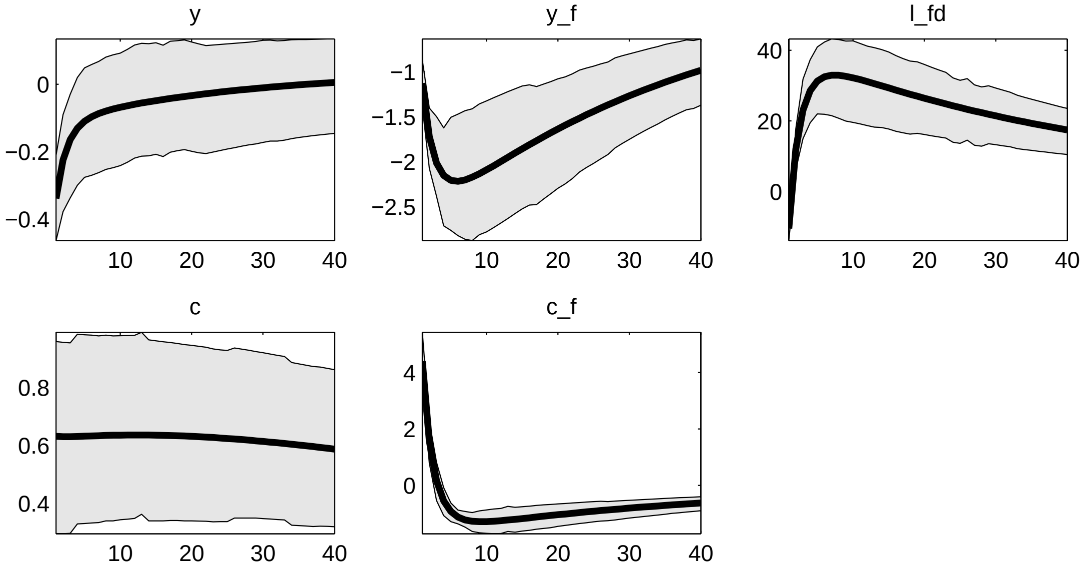


Figure 6: Historical decomposition of output for Germany

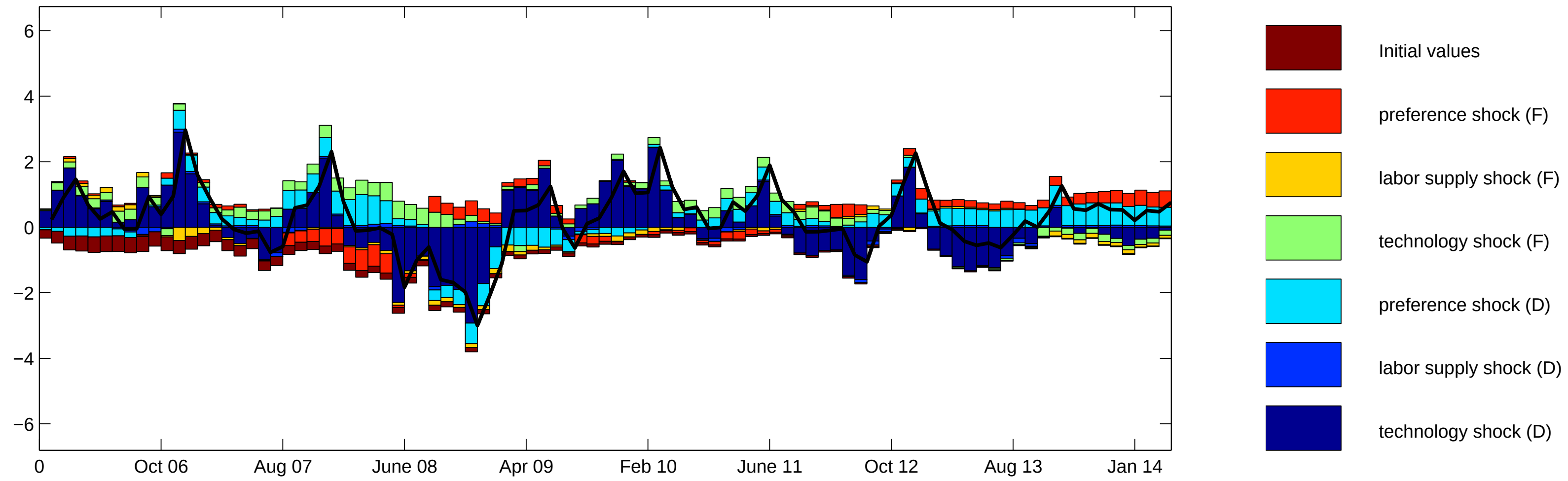


Figure 7: Historical decomposition of output for Poland

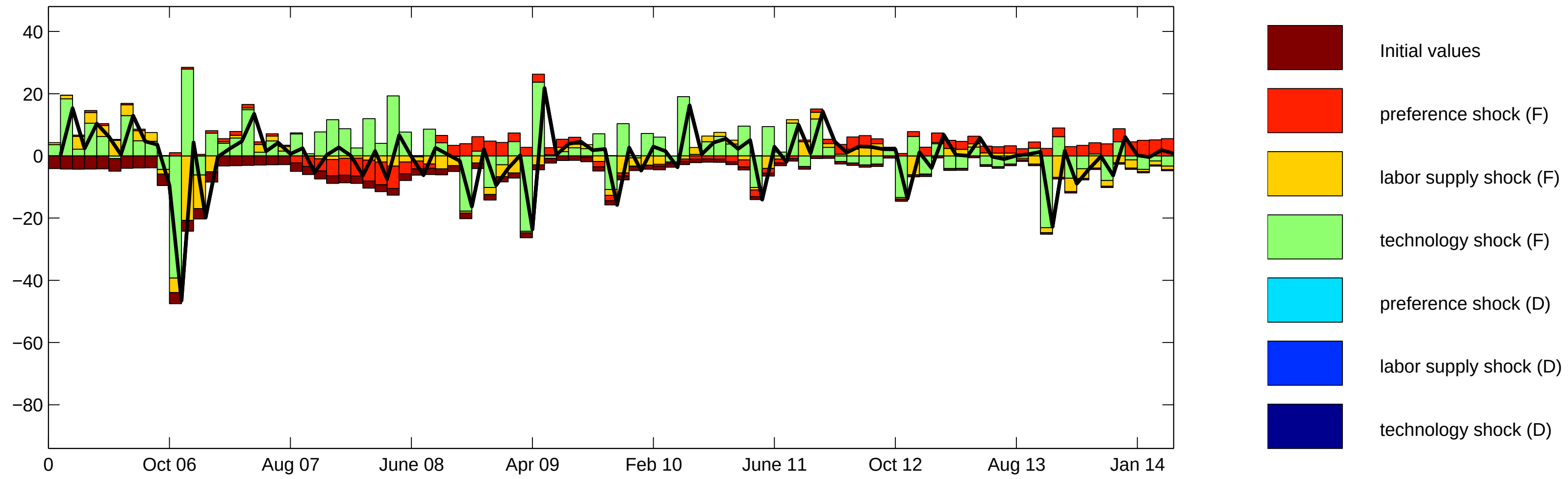


Figure 8: Historical decomposition of Migration of Polish citizens to Germany

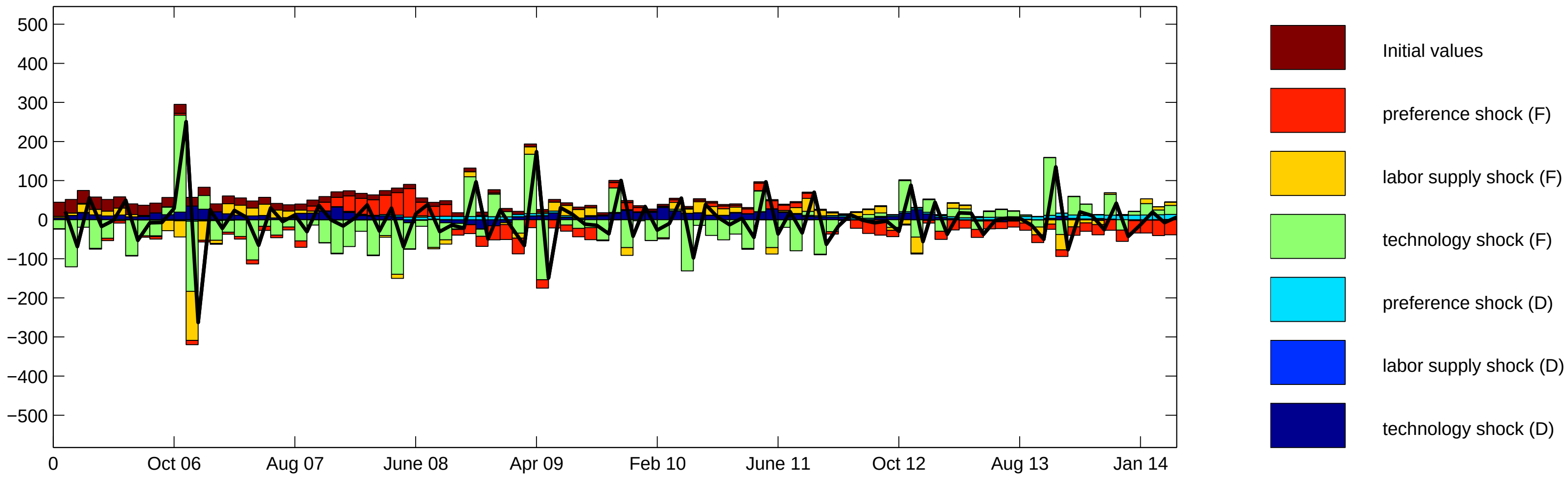
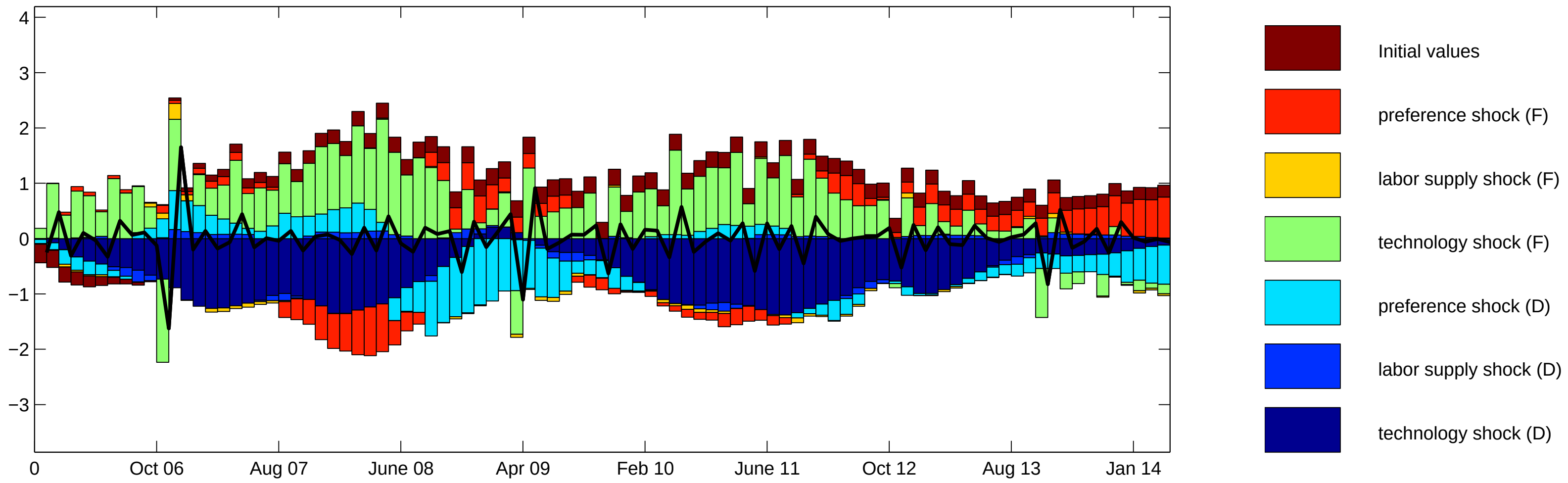


Figure 9: Historical decomposition of composite labor in Germany



8 Appendix

8.1 The Linearized Model

In this section, we present the model equations in log-linearized form. The set of equations hold for both countries. The first order conditions are given as;

$$c_t + \hat{l_{d,t}} * \frac{\bar{l_d}}{1 - \bar{l_d}} + \hat{\omega}_t = \hat{w_{d,t}}$$

with Euler equation:

$$\hat{\kappa_{t-1}} + \hat{c_{t+1}} = \hat{c}_t + \left(\hat{R_{t+1}} - \hat{\Pi_{t+1}} \right) + \hat{\kappa}_t$$

where R is the interest rate:

$$\bar{R}\hat{R}_t = \alpha \frac{\bar{y}_t}{\bar{k}} \left(\hat{y}_t - \hat{k}_t \right)$$

The production function is given as:

$$\hat{y}_t = \alpha \hat{k}_t + (1 - \alpha)\hat{L}_t$$

where composite labor equation becomes:

$$\hat{L}_t \bar{L} = \gamma \hat{l_{f,d,t}} \bar{l_{f,d}} + (1 - \gamma)\hat{l_{d,t}} \bar{l_d}$$

the capital evolves subject to:

$$\hat{k_{t+1}} \bar{k} = (1 - \delta)\bar{k}\hat{k}_t + \bar{inv}\hat{inv}_t$$

The log-linearized form of the New Keynesian Phillips Curve is:

$$\hat{\Pi_{H,t}} = \beta \hat{\Pi_{H,t+1}} + \left(\frac{(1 - \beta + \phi)}{\phi} \right) \left((1 - \alpha)\hat{w}_t + \alpha \hat{r}_t - z \right)$$

The log-linearized form of Taylor rule is:

$$\hat{R}_t = \rho_r \hat{R_{t-1}} + \rho_y \hat{y}_t + \rho_\pi \hat{\Pi_{H,t}}$$

The terms of trade relation is given as:

$$\hat{\Pi}_t = \hat{\Pi_{H,t}} - \iota\left(\hat{y_{f,t}} - \hat{y_{f,t-1}} - \hat{y_{d,t}} + \hat{y_{d,t+1}}\right)$$

9 Empirical Performance of the Model

In this section, we assess the model fit and compare the model with a similar model that does not include migration. The comparison of models should address the question whether migration really contributes to the fluctuation of macroeconomic variables during the business cycle.

9.1 The Fit of the Model

To assess the fit of the model, we compare the unconditional theoretical moments of the simulated benchmark model to that of the data. Table 3 and 4 show, respectively, the comparison of standard deviations between the data and the estimated model and the correlations across variables. We can observe that the statistics from the estimated model compare well to the data. We observe that the composite labor is positively correlated with domestic output and negatively correlated with foreign output. Immigrant labor is negatively correlated with foreign output (Mandelman and Zlate, 2012).

Table 3: Unconditional Moments: Std. Deviations

Obs. Variable	Data	Model
Output (D)	0.01709	0.0498
Output (F)	0.01753	0.0472
Composite Labor (D)	0.000591	1.5067
Immigrants (D)	0.3933	0.5156

9.2 Model Comparison

In this section, we compare two models; the benchmark model, Model A whose results we have presented above and Model B that is nested within Model A without

Table 4: Unconditional Moments: Correlations

Output (D)	1			
Output (F)	-0.0115	1		
Composite Labor (D)	0.1238	-0.0097	1	
Immigrants (D)	-0.000	-0.0283	0.0041	1

migration framework; assuming $\gamma = 0$, there is no foreign labor taking part in composite labor. Thus, in Model B, the domestic country employs only domestic labor and foreign country employs only foreign labor. In Bayesian approach, the main tool for model comparison is marginal likelihood (Rabanal and Rubio-Ramirez, 2005). After computing the posterior distributions, it is possible to compare models using posterior odds ratio. Given, each model's log marginal data density is given as;

$$\ln p(Y|M_i) = \int \ln p(Y|\theta, M_i)p(\theta|M_i)d\theta$$

for $i = A, B$;

the posterior odds ratio equals;

$$\frac{p(A|Y)}{p(B|Y)} = \frac{p(A)p(Y|A)}{p(B)p(Y|B)}$$

We use random walk Metropolis Hastings algorithm of $200,000$ draws from each model's posterior distributions. To calculate the marginal data density of each model, we use (Geweke, 1999) modified harmonic mean estimator. We focus on Bayes factor (posterior odds = Bayes factor * prior odds) to determine which model explains, the best, the behavior of the observable variables. More on Bayes factor, see Kass and Wasserman (1995). The model comparison results are shown in Table 5.

Table 5: Model Comparison

	Model B	Model A
Log Marginal Density	-1464.3	-1459.2
Bayes Ratio	1.000000	164
Posterior Model Probability	0.006	0.993

The benchmark model outperforms the model without migration specification based on the log marginal density −1459.2 and Bayes factor 164.