German Wage Moderation and European Imbalances: Feeding the Global VAR with Theory

Timo Bettendorf and Miguel A. León-Ledesma

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Timo Bettendorf
Deutsche Bundesbank

Miguel A. León-Ledesma
School of Economics and MaGHiC
University of Kent

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Abstract

German labor market reforms in the 1990s and 2000s are generally believed to have driven the large increase in the dispersion of current account balances in the Euro Area. We investigate this hypothesis quantitatively. We develop an open economy New Keynesian model with search and matching frictions from which we derive robust sign restrictions for a wage bargaining shock. We then impose these restrictions on a Global VAR consisting of Germany and 8 EMU countries to identify a wage bargaining shock in Germany. Our results show that, although the German current account was significantly affected by wage bargaining shocks, their contribution to European current account imbalances was negligible. We conclude that the reduction in bargaining power of German unions after labor market reforms cannot be the lone driver of European imbalances.
Keywords: European imbalances, German wage moderation, DSGE, Global VAR, sign restrictions.
JEL classification: F10, F32, F41.

Non-technical Summary

It is widely acknowledged that internal current account imbalances in Europe were an important factor behind the financial distress experienced by countries in the Eurozone. What is more controversial, however, is what the main drivers of these imbalances were. Several institutions mention the increase in German competitiveness since the late 1990s as an important determinant of these imbalances driven by German labor market reforms. Particularly, the decline in German real wages, relative to the Euro Area partners, is cited as a key factor. The decline in real wages can mainly be attributed to a shift from collective bargaining to concession bargaining and the introduction of opening clauses in employment contracts. In order to assess the merits of this explanation, we test the contribution of shocks to the German labor market in the form of a reduction in workers' wage bargaining power to Eurozone current account imbalances.

We make use of a so-called Global Vector Autoregressive (GVAR) model for 9 Euro Area countries in order to measure the spillover effects of wage bargaining power shocks using a sample ranging from 1992Q1 to 2007Q2. A GVAR is an econometric tool to analyze the dynamic interaction between macroeconomic variables within the context of a multi-country model. It thus allows us to see how shocks to a specific country spillover onto others in the system. We identify the German wage bargaining shocks by imposing minimal robust theory restrictions on the GVAR. The theory restrictions are derived from a small open economy New Keynesian dynamic stochastic general equilibrium (DSGE) model incorporating search and matching frictions in the labor market. The use of a structural GVAR, i.e. a GVAR where we impose theory restrictions to identify shocks, is advantageous because it achieves identification from theory but allows the responses of variables to specific shocks to be mostly data-driven. This is a more agnostic approach that avoids the reliance on overly restrictive structural models and allows us to assess whether the role of spillovers from German labor market reforms is quantitatively important.

We show that negative shocks to bargaining power in Germany do generally cause an improvement of the domestic (i.e. German) current account, while foreign responses are heterogeneous. However, and most importantly, they account only for a very small fraction of the variation in current account balances. Counter-factual analysis shows that the effect of these shocks on the increasing dispersion of the Eurozone current accounts before the crisis is essentially negligible. Hence, German wage moderation cannot be the lone driver of external imbalances in the Eurozone.

1 Introduction

It is widely acknowledged that internal current account imbalances in Europe were an important factor behind the financial distress experienced by countries in the Eurozone (see Figure 1). What is more controversial, however, is what the main drivers of these imbalances were. The IMF (2012) and ILO (2012) mention the increase in German competitiveness since the late 1990s as an important determinant of these imbalances driven by German labor market reforms. Particularly, the decline in German real wages, relative to the Euro Area partners, is cited as a key factor. In contrast, other commentators such as Wyplosz (2013) doubt this view and argue that changes in competitiveness were the consequence and not the cause of the problem.[1]

We test the contribution of shocks to the German labor market, in the form of a reduction in workers' wage bargaining power, to Eurozone current account imbalances. We make use of a Global VAR (GVAR) for 9 EA countries[2] in order to measure the spillover effects of these shocks. Identification of wage bargaining power shocks in Germany is achieved by deriving minimal robust sign restrictions from a small open economy New Keynesian DSGE model with search and matching frictions. These restrictions are then imposed on the GVAR (see Eickmeier and Ng (2015)) and we analyze the response of Eurozone current accounts and quantify the contribution of these shocks to European imbalances. This identification method follows Canova and Paustian (2011) and has the advantage of being more agnostic about the model structure than estimated DSGE models which often requires knowledge of the exact specification of decision rules and are riddled with identification and specification problems. The structural GVAR approach is also best suited for analyzing shock spillovers within the context of multi-country models.

We show that negative shocks to bargaining power in Germany do generally cause an improvement of the domestic current account, while foreign responses are heterogeneous. However, they account only for a very small fraction of the current account balance forecast error variances. Counterfactual analysis shows that the effect of these shocks on the increasing dispersion of the Eurozone current accounts before the crisis is essentially negligible. Hence, German wage moderation cannot be the lone driver of European imbalances.

Related literature. While the role of the German wage moderation during the late 1990s and early 2000s has been widely discussed by policy institutions (see IMF (2012) and ILO (2012)), the literature on its international effects is scarcer. As mentioned above, the IMF and ILO as well as Bundesbank (2011) point out that the German wage moderation has increased German competitiveness and

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[1]See Chen, Milesi-Ferretti, and Tressel (2012) and Hobza and Zeugner (2014) for an overview of trade and capital flows within the Eurozone.

[2]We model Austria, Germany, Spain, Finland, France, Greece, Italy, The Netherlands and Portugal. Due to a lack of data, we do not model Belgium and Luxembourg.

Figure 1: Total current account balance as a percentage of GDP for 9 Eurozone countries (1992Q1-2007Q2)
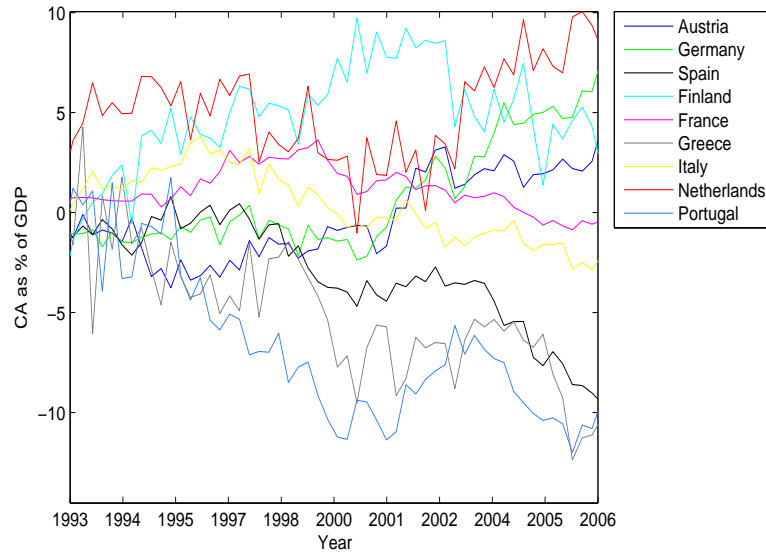
thus translated into high current account surpluses, while the current account balances of many other European countries deteriorated. Similar conclusions are reached by Sabbatini and Zollino (2010). Vogel (2011) employs a three-region version of QUEST to investigate possible strategies for re-balancing the Euro Area. Among other strategies, he investigates the theoretical outcome of wage moderation. His results indicate that wage moderation should generally help to re-balance current accounts, as it affects marginal cost of firms, which leads to competitiveness gains. This is in line with Ivanova (2012) who, using panel regressions for 60 countries for the 1970-2009 period, finds that countries with more flexible labor markets tend to have larger current account surpluses.

Closer to our approach, Kollmann, Ratto, Roeger, in't Veld, and Vogel (forthcoming) analyze the German current account balance by estimating a three-region DSGE model for Germany, the Rest of the Euro Area, and the Rest of the World. Their results indicate that the German current account surplus is mainly driven by shocks to the German savings rate, the rest of the world's demand for German exports, and supply shocks associated with labor market reforms. An estimated DSGE framework allows for the identification of a large number of structural shocks, which is a clear advantage over our approach. However, as noted above, standard problems such as parameter identification and model uncertainty render these estimates generally fragile. DSGE models also impose a more rigid structure on the data and are hence more prone to model mis-specification problems when compared to our more agnostic approach. Also, a three-region model is unable to trace shock spillovers to specific countries.

Our approach here differs in that we use the flexibility of the SVAR approach combined with minimal theoretical restrictions and a multi-country model. Gadatsch, Stähler, and Weigert (2014) and Busl and Seymen (2013) make use of policy simulations within a two-country monetary union DSGE model to analyze the effect of German labor market reforms on its current account balance and that of other member states. Their findings are in line with ours as they find very limited roles effects for these reforms in driving current account imbalances.[3]

Overall, thus, the evidence is still controversial regarding the effects of the German labor market reforms on European imbalances through gains in competitiveness and spillover effects on other member states. Our approach focuses on analyzing the effect of these shocks and remains silent about other possible sources of these imbalances. However, the use of a GVAR with minimal theory restrictions provides a more robust data based approach to estimating the dynamic effects of shocks without relying on overly restrictive models. This allows us to assess whether the role of spillovers from German labor market reforms is quantitatively important.

In the following section, we provide a brief overview of German labor market reforms that provide the motivation behind investigating the effects of shocks to workers' bargaining power. We then present the small open economy New Keynesian model with labor market frictions from which we derive robust sign restrictions. Section 4 explains the GVAR model and identification strategy. Sections 5 and 6 present the results and counter-factual analysis, and 7 concludes.

2 German wage moderation policies in the 1990s and 2000s

During the 1980s and 1990s, the job market in Germany provided high protection for employees, with prevalence of permanent jobs with dismissal protection, social insurance, and collective bargaining. Eichorst and Marx (2009) point out that these conditions led to low labor utilization, which affected the service sector in particular. Due to the high requirements for firms, labor intensive personal services, for instance, were mainly provided by family members rather than market services.

In 1996, the country was governed by a coalition of the Christian Democratic Union (CDU) and the Free Democratic Party (FDP). At the time, rigid labor markets were attributed a key role in explaining Germany's poor economic

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[3]There is also an important literature on the effects of German labor market reforms on the labor market. Krebs and Scheffel (2013) find that the Hartz IV reform (see below) led to a lower unemployment rate and a higher job finding rate, which supports our assumption that the labor market reforms increased matching efficiency. Fahr and Sunde (2009) come to the same conclusion by analyzing the Hartz I/II and III reforms.

performance. To increase flexibility, the government started reforming the labor market by increasing the maximum duration of fix-term contracts and the threshold number of employees which is required to apply for dismissal protection. Moreover, new minor employment contracts, which have the advantage of lower non-wage labor costs, became frequently used by firms. Additionally, collective bargaining became more flexible, as firms could introduce alternative methods for reducing in working time. With a broader introduction of concession bargaining, firms could dampen wage growth directly (see Eichorst and Marx (2009) and Jacobi and Kluve (2006)).

During the following recovery period, the Social Democratic Party (SPD) and the Alliance 90/The Greens came to power in 1998. At the beginning of the legislative period, the coalition reintroduced dismissal protection in 1999 as well as a restriction on fixed-term contracts to initial hirings in 2001. With the start of a new recession, however, the government embarked on a new reform to allow for more flexibility. The package of reforms became known as the "Agenda 2010", which also contained the so called "Hartz" labor market reforms. Besides introducing stricter job search monitoring and harsher sanctions such as reductions in unemployment benefits, the government also reduced the period of unemployment insurance pay-outs. However, the main force that increased labor market flexibility was the transition to less bargaining coverage and unionization. The share of workers with opening clauses, which allowed for deviations from the collective contracts, increased strongly. In particular, clauses which allowed for working-time adjustments as well as reductions in nominal and real wages became common. According to the IAB Establishment panel from 2005, almost 29% of firms in West-Germany and 21% of East-German firms had these opening clauses in their contracts. Among the firms having opening clauses, 52% had already made use of the new opening clauses by 2005 (see Eichorst and Marx (2009), Kohaut and Schnabel (2007), and Jacobi and Kluve (2006)).

The effect of these reforms can be seen as a loss in union power and an increase in labor market flexibility. This was thus reflected in a change in wage bargaining power in favor of firms to the detriment of unions. Hence, we focus on the dynamic transmission of shocks that represent a change in bargaining power. To do so, we rationalize these events using the DSGE model with labor market frictions we present in the following section and that we use to impose robust sign restrictions on our structural GVAR.

3   A New Keynesian small open economy model

We now introduce the DSGE model that we use to identify the wage bargaining shock later on in our GVAR model. We follow the lines of Krause, Lopez-Salido, and Lubik (2008), Ravenna and Walsh (2011) and Campolmi and Faia (2011) to build an open economy New Keynesian model with search and matching

frictions. It displays several standard real and nominal rigidities such as habits in consumption and price rigidities together with labor market frictions. There are preference, labor supply, productivity, wage bargaining, and monetary policy shocks. The model has domestically produced and imported consumption goods, and is technically a semi-small open economy (SOE) since domestic producers have market power to set prices of differentiated goods.

It is important to discuss why we use a SOE model given that Germany is a large economy within the Eurozone. The key reason is that we use the model only to derive robust restrictions for the response of *domestic* variables in Germany to a shock with *domestic origin*. Since Germany can be considered a small economy for the World as a whole and Germany trades with both the Eurozone and the rest of the World, in order to understand the effects of a German shock on German variables, we should consider a SOE model. We then impose the identification restrictions only on the German VAR part of the GVAR to analyze how they spillover to other European countries. Thus, our GVAR estimates capture any spillover effects from an identified German shock since we allow the GVAR to freely determine any cross-country spillovers (see Chudik and Pesaran (2014)). As Germany's exchange rate regime changed throughout the period, we present two versions of the model to check whether the sign restrictions are robust to changing the monetary regime. Thus, one version is for the case of flexible nominal exchange rates and the other for the case of a monetary union. The following sub-sections explain the building blocks of the model.

3.1 Search and matching

Firms fill open positions with identical workers by publishing adverts and screening, which is cost intensive. The number of matches is given by the Cobb-Douglas function

$$M_t = \bar{m}_t S_t^\nu V_t^{1-\nu}, \tag{1}$$

where $log(\bar{m}_t) = (1 - \rho^m)log(\bar{m}) + \rho^m log(\bar{m}_{t-1}) + \epsilon_t^m$ denotes matching efficiency, M_t the share of matches, S_t, V_t the shares of searching workers and vacant positions and ϵ_t^m a shock to matching efficiency, respectively. ν with $0 < \nu < 1$ stands for the elasticity of the matching function. A firm fills a position with probability $q(\theta_t) = \frac{M_t}{V_t} = \bar{m}\theta_t^{-\nu}$, which is decreasing in labor market tightness $\theta_t = \frac{V_t}{S_t}$. The law of motion of aggregate employment is given by

$$N_t = (1 - \rho)N_{t-1} + M_t = (1 - \rho)N_{t-1} + p(\theta_t)S_t = (1 - \rho)N_{t-1} + \theta_t q_t(\theta_t)S_t, \tag{2}$$

where ρ is the exogenous separation rate. The number of searching workers is thus given by

$$S_t = 1 - (1 - \rho)N_{t-1}. \tag{3}$$

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An unemployed worker finds a position with probability $p(\theta_t) = \frac{M_t}{S_t} = \theta_t q_t(\theta_t)$, which is increasing in labor market tightness. The unemployment rate is defined as $U_t = (1 - N_t)$.

3.2 The household

Each household is a continuum of workers that is distributed over the unit interval. A household maximizes lifetime utility

$$J_0^H = E_0 \sum_{t=0}^{\infty} \beta^t \epsilon_t^P \left\{ \frac{(C_t - \omega C_{t-1})^{1-\sigma}}{1 - \sigma} - \epsilon_t^L N_t \frac{H_t^{1+\varphi}}{1 + \varphi} \right\} \tag{4}$$

where β^t denotes the discount factor, C_t is the composite consumption aggregator, ωC_{t-1} an index of external habits, N_t is labor, H_t hours worked, σ the elasticity of intertemporal substitution, and φ the inverse Frisch elasticity of labor supply. ϵ_t^P and ϵ_t^L are preference and labor supply shocks respectively that affect the discount factor and the dis-utility of work. We assume that both shocks follow an AR(1) process with persistence ρ_L and ρ_P respectively. The household faces the following (real) budget constraint:

$$C_t + \frac{D_t}{P_t} + \frac{e_t B_t}{P_t} = \frac{D_{t-1}}{P_t}(1+R_{t-1}) + \frac{e_t B_{t-1}}{P_t}(1+R_{t-1}^*)\phi_{t-1} + W_t N_t H_t + (1-N_t)b + \frac{\Pi_t}{P_t} + T_t \tag{5}$$

as well as

$$N_t = (1 - \rho)N_{t-1} + \theta_t q_t(\theta_t)S_t. \tag{6}$$

Here, P_t denotes the aggregate price level, D_t domestic bond holdings, B_t foreign bond holdings, e_t the nominal exchange rate defined as units of domestic currency per unit of foreign currency, R_t the domestic interest rate, R_t^* the foreign interest rate, W_t real wages, b unemployment benefits of the $U_t = (1 - N_t)$ unemployed household members, Π_t profits from the firms and T_t transfers or lump sum taxes. As suggested by Kollmann (2002) and Schmitt-Grohe and Uribe (2003), we introduce $\phi_t = \exp(-\gamma(Q_t))$ with $Q_t = \frac{e_t B_t}{P_t}$ as foreign debt elastic interest rate premium to ensure stationarity of the stock of net foreign assets.

The composite consumption index is defined by

$$C_t = \left[(1-\alpha)^{\frac{1}{\varpi}} C_{H,t}^{\frac{\varpi-1}{\varpi}} + \alpha^{\frac{1}{\varpi}} C_{F,t}^{\frac{\varpi-1}{\varpi}} \right]^{\frac{\varpi}{\varpi-1}}, \tag{7}$$

6

with

$$C_{H,t} = \left[\int_0^1 C_{H,t}(i)^{\frac{\epsilon-1}{\epsilon}} \, di \right]^{\frac{\epsilon}{\epsilon-1}} \quad \text{and} \quad C_{F,t} = \left[\int_0^1 C_{F,t}(i)^{\frac{\epsilon-1}{\epsilon}} \, di \right]^{\frac{\epsilon}{\epsilon-1}}, \qquad (8)$$

where $C_{H,t}$ and $C_{F,t}$ denote consumption of home (H) and foreign (F) goods. $\epsilon > 1$ stands for the home and foreign elasticities of substitution between differentiated goods, respectively. ϖ_t stands for the Armington elasticity of substitution between home and foreign goods. Coefficient $1 - \alpha$ can be interpreted as the degree of home bias in consumption. The consumption index is thus a weighted average of consumption of home goods and foreign goods, where the weight is given by α. Households consume differentiated goods, where consumption of home and foreign goods can be expressed by Dixit-Stiglitz aggregator. With symmetric equilibrium, households choose domestic and foreign tradable goods to minimize expenditure leading to:

$$C_{H,t} = (1 - \alpha) \left(\frac{P_{H,t}}{P_t} \right)^{-\varpi} C_t, \quad C_{F,t} = \alpha \left(\frac{P_{F,t}}{P_t} \right)^{-\varpi} C_t. \qquad (9)$$

The consumer price index (CPI) is defined as

$$P_t = \left[(1 - \alpha) P_{H,t}^{1-\varpi} + \alpha P_{F,t}^{1-\varpi} \right]^{\frac{1}{1-\varpi}}. \qquad (10)$$

Each household chooses C_t, D_t and B_t. The corresponding FOCs are given by

$$\frac{\partial J_0^H(i)}{\partial C_t} \Rightarrow \lambda_t = \epsilon_t^P (C_t - \omega C_{t-1})^{-\sigma}, \qquad (11)$$

$$\frac{\partial J_0^H(i)}{\partial D_t} \Rightarrow \frac{\lambda_t}{P_t} = \frac{\lambda_{t+1}}{P_{t+1}} (1 + R_t) \beta, \qquad (12)$$

and

$$\frac{\partial J_0^H(i)}{\partial B_t} \Rightarrow \frac{\lambda_t e_t}{P_t} = \frac{\lambda_{t+1} e_{t+1}}{P_{t+1}} (1 + R_t^*) \phi_t \beta. \qquad (13)$$

These optimality conditions provide the Euler equation

$$\epsilon_t^P (C_t - \omega C_{t-1})^{-\sigma} = \beta \frac{(1 + R_t)}{\pi_{t+1}} \epsilon_{t+1}^P (C_{t+1} - \omega C_t)^{-\sigma} \qquad (14)$$

as well as the UIP condition

$$(1 + R_t) = (1 + R_t^*)\phi_t \frac{e_{t+1}}{e_t}. \tag{15}$$

3.3 Firms

Firms operate in monopolisticaly competitive markets as they produce differentiated goods and produce using only labor with a diminishing returns production function:

$$Y_t(i) = A_t(N_t(i)H_t(i))^\upsilon, \tag{16}$$

where υ governs the degree of diminishing returns to labor and A_t a technology process that follows an autoregressive law of motion: $log(A_t) = \rho_a log(A_{t-1}) + \epsilon_t^A$.

Firms can sell their output for consumption at home ($C_{H,t}$) or abroad ($C_{H,t}^*$). We assume producer currency pricing such that $P_{H,t} = e_t P_{H,t}^*$. We account for price stickiness by assuming that firms are subject to quadratic price adjustment costs *à la* Rotemberg (1982). Firms maximize real discounted future profits:

$$\begin{aligned}
J_0^F(i) = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t/\chi_t}{\lambda_0/\chi_0} &\left[\left(\frac{P_{H,t}(i)}{P_{H,t}} \right)^{1-\epsilon} C_{w,t} \right. \\
&- \chi_t W_t(i) N_t(i) H_t(i) - \kappa V_t(i) \\
&\left. - \frac{\psi}{2} \left(\frac{P_{H,t}(i)}{P_{H,t-1}(i)} - 1 \right)^2 Y_t(i) \right],
\end{aligned} \tag{17}$$

where ψ is the price adjustment cost coefficient. Since firms take only domestic prices into account, we correct the discount factor by $\chi_t = \frac{P_t}{P_{H,t}}$, which can be interpreted as a proxy for the terms of trade (see Campolmi and Faia (2011)). Hence, the stochastic discount factor discounts future profits taking only domestic prices into account. It provides today's (period t=0) value of future profits in terms of marginal utility of consumption adjusted by home prices. Parameter κ denotes the hiring costs and $C_{w,t} = C_{H,t} + C_{H,t}^*$ world consumption of the home good. Firms maximize (17) subject to the law of motion for employment

$$N_t(i) = (1 - \rho)N_{t-1}(i) + q(\theta_t)V(i)_t, \tag{18}$$

and that supply equals demand (from (16))

$$A_t(N_t(i)H_t(i))^\upsilon = \left(\frac{P_{H,t}(i)}{P_{H,t}} \right)^{-\epsilon} C_{w,t}. \tag{19}$$

8

Firms choose $P_{H,t}(i)$, $N_t(i)$, $V_t(i)$ and bargain for $W_t(i)$ and $H_t(i)$. We interpret the Lagrange multiplier of (19) as marginal costs (mc_t) and the multiplier related to (18) as the marginal value of one worker (μ_t). First order conditions are given by:

$$
\begin{aligned}
\frac{\partial J_0^F(i)}{\partial P_{H,t}(i)} \Rightarrow 0 = & \; (1-\epsilon)\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon}\left(\frac{C_{w,t}}{P_{H,t}}\right) \\
& + mc_t\epsilon\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-1-\epsilon}\left(\frac{C_{w,t}}{P_{H,t}}\right) \\
& - \psi\left(\frac{P_{H,t}(i)}{P_{H,t-1}(i)}-1\right)\left(\frac{Y_t}{P_{H,t-1}(i)}\right) \\
& + \beta\psi\frac{\lambda_{t+1}/\chi_{t+1}}{\lambda_t/\chi_t}\left(\frac{P_{H,t+1}(i)}{P_{H,t}(i)}-1\right)\left(\frac{P_{H,t+1}(i)Y_{t+1}}{P_{H,t}^2(i)}\right) \quad (20)
\end{aligned}
$$

$$
\frac{\partial J_0^F(i)}{\partial N_t(i)} \Rightarrow \mu_t = \beta\frac{\lambda_{t+1}/\chi_{t+1}}{\lambda_t/\chi_t}\mu_{t+1}(1-\rho) + mc_t A_t \upsilon N_t^{\upsilon-1} H_t^\upsilon - \chi_t W_t H_t \quad (21)
$$

$$
\frac{\partial J_0^F(i)}{\partial V_t(i)} \Rightarrow \mu_t = \frac{\kappa}{q(\theta_t)} \quad (22)
$$

Since all firms set the same price in equilibrium (i.e. $P_{H,t}(i) = P_{H,t}$), we may rewrite $\frac{\partial J_0^F(i)}{\partial P_{H,t}(i)}$, which yields (after multiplying by $\left(\frac{P_{H,t}}{Y_t}\right)$)

$$
\psi(\pi_{H,t}-1)\pi_{H,t} = \frac{C_{w,t}}{Y_t}(1-\epsilon+mc_t\epsilon) + \beta\psi\frac{\lambda_{t+1}/\chi_{t+1}}{\lambda_t/\chi_t}(\pi_{H,t+1}-1)\pi_{H,t+1}\left(\frac{Y_{t+1}}{Y_t}\right), \quad (23)
$$

where $\pi_{H,t} = \frac{P_{H,t}}{P_{H,t-1}}$.

3.4   Wage bargaining

Firms and workers negotiate wages according to a Nash bargaining process, such that the wage is determined by solving the problem

$$
\max_{W_t, H_t}\left(\frac{1}{\lambda_t}\frac{\partial J_t^H(N_t)}{\partial N_t}\right)^{\eta_t}\left(\frac{\partial J_t^F(N_t)}{\partial N_t}\right)^{1-\eta_t}, \quad (24)
$$

where $\frac{\partial J_t^H(N_t)}{\partial N_t}$ denotes the households' marginal utility of supplying an additional unit of labor, whereas $\frac{\partial J_t^F(N_t)}{\partial N_t}$ denotes the firms' marginal utility of hiring an additional unit of labor. The parameter η_t can be interpreted as the bargaining power of households.

We assume that $log(\eta_t) = (1 - \rho_\eta)log(\eta^{SS}) + \rho_\eta log(\eta_{t-1}) + \varepsilon_t^\eta$ (in logs) with $0 \geq \eta_t \leq 1$. This is the key shock we will be focusing on. A negative shock to η_t gives the households' marginal utility of supplying an additional unit of labor a lower weight in the Nash bargaining problem, which is equivalent to a lower bargaining power of labor unions. As discussed above, in Germany, this happened mainly through a shift from collective bargaining to concession bargaining and the introduction of opening clauses (see Section (2)).

The first order conditions are given by:

$$
\begin{aligned}
\frac{\partial J_t^H(N_t)}{\partial N_t} \Rightarrow \zeta_t &= \lambda_t(W_t H_t - b) - \epsilon_t^L \epsilon_t^P \frac{H_t^{1+\varphi}}{1+\varphi} && (25)\\
&\quad + \beta\zeta_{t+1}(1-\rho)(1-\theta_{t+1}q(\theta_{t+1}))\\
&= \lambda_t(W_t H_t - b) - \epsilon_t^L \epsilon_t^P \frac{H_t^{1+\varphi}}{1+\varphi} && (26)\\
&\quad + \beta\frac{\partial J_t^H(N_t)}{\partial N_t}(1-\rho)(1-\theta_{t+1}q(\theta_{t+1}))
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial J_t^F(N_t)}{\partial N_t} \Rightarrow \mu_t &= \beta\frac{\lambda_{t+1}/\chi_{t+1}}{\lambda_t/\chi_t}\mu_{t+1}(1-\rho) + mc_t A_t \upsilon N_t^{\upsilon-1} H_t^\upsilon - \chi_t W_t H_t && (27)\\
&= \beta\frac{\lambda_{t+1}\chi_{t+1}}{\lambda_t/\chi_t}\frac{\partial J_t^F(N_{t+1})}{\partial N_{t+1}}(1-\rho) && (28)\\
&\quad + mc_t A_t \upsilon N_t^{\upsilon-1} H_t^\upsilon - \chi_t W_t H_t
\end{aligned}
$$

We derive the equations for wages and hours in Appendix B. For wages, we obtain

$$
W_t H_t = \delta_t + b + \frac{1}{\lambda_t}\epsilon_t^L \epsilon_t^P \frac{H_t^{1+\varphi}}{1+\varphi} - E_t\left[\beta(1-\rho)(1-\theta_{t+1}q(\theta_{t+1}))\delta_{t+1}\right], \qquad (29)
$$

where

$$
\delta_t = \frac{\eta_t}{(1-\eta_t)}\frac{1}{\chi_t}\frac{\kappa}{q(\theta_t)}. \qquad (30)
$$

Hours are determined by

10

$$H_t = \left(\frac{mc_t A_t \upsilon^2 N_t^{\upsilon-1}}{\chi_t \epsilon_t^L \epsilon_t^P} \lambda_t \right)^{\frac{1}{1+\varphi-\upsilon}}. \tag{31}$$

3.5   Market clearing

The market clearing condition is given by

$$Y_t = C_{H,t} + C_{H,t}^* + \kappa V_t + \frac{\psi}{2} \left(\frac{P_{H,t}}{P_{H,t-1}} - 1 \right)^2 Y_t. \tag{32}$$

Production is used to for home and foreign consumption, spending on vacancy costs, and the cost of the quadratic price adjustment.

3.6   The current account and the real exchange rate

The current account is derived from

$$\frac{e_t B_t}{P_t} - \frac{e_t R_{t-1}^* \phi_{t-1} B_{t-1}}{P_t} = NX_t, \tag{33}$$

where net exports are defined as

$$NX_t = \frac{P_{H,t}}{P_t} \left(Y_t - \kappa V_t - \frac{\psi}{2} \left(\frac{P_{H,t}}{P_{H,t-1}} - 1 \right)^2 Y_t \right) - C_t. \tag{34}$$

The current account is defined as

$$CA_t = \frac{e_t B_t}{P_t} - \frac{e_t B_{t-1}}{P_t}. \tag{35}$$

As mentioned above, we assume that the *law of one price* (LOP) holds, implying that $P_{H,t} = e_t P_{H_t}^*$ and $P_{F,t} = e_t P_{F_t}^*$. In our SOE model, we also assume that $P_{F,t}^* = P_t^*$, meaning that the home economy is too small to affect prices in the rest of the world, which are therefore exogenously determined. We define the real exchange rate as

$$\mathcal{Q}_t = \frac{e_t P_t^*}{P_t}, \tag{36}$$

which implies that an increase in $\mathcal{Q}_t$ is a depreciation.

3.7 Monetary policy and fiscal policy

Monetary policy makers follow a Taylor rule

$$\left(\frac{R_t}{R^{SS}}\right) = \left(\frac{R_{t-1}}{R^{SS}}\right)^{\tau_r} \left[\left(\frac{\pi_t}{\pi^{SS}}\right)^{\tau_\pi} \left(\frac{Y_t}{Y^{SS}}\right)^{\tau_y}\right]^{1-\tau_r} \epsilon_t^R. \tag{37}$$

The central bank targets the deviations of inflation and output from their steady-states according to the policy weights τ_π and τ_y. Moreover, the monetary authorities smooth the law of motion of the nominal interest rate according to the τ_r.

Fiscal policy faces the constraint

$$\frac{D_t}{P_t} = R_{t-1}\frac{D_{t-1}}{P_t} + (1 - N_t)b + T_t, \tag{38}$$

implying that the government finances spending on unemployment benefits and net transfers by issuing bonds domestically.

3.8 The foreign economy

Since we focus on the SOE case, we model the rest of the world (RoW) as a set of exogenous processes. All variables below with a superscript "SS" denote steady state variables. The foreign economy is modeled as follows. Foreign consumption deviation from its' steady state follows an AR(1) process

$$\left(\frac{C_t^*}{C^{*SS}}\right) = \left(\frac{C_{t-1}^*}{C^{*SS}}\right)^{\rho_{C^*}} \epsilon_t^{C^*}, \tag{39}$$

where $\epsilon_t^{C^*}$ denotes a shock to foreign consumption and $0 < \rho_{C^*} < 1$. Foreign consumption of home goods is given by

$$C_{H,t}^* = \alpha \left(\frac{P_{H,t}^*}{P_t^*}\right)^{-\varpi} C_t^* = \alpha \left(\frac{P_{H,t}}{P_t^* e_t}\right)^{-\varpi} C_t^*. \tag{40}$$

Inflation is defined as $\pi_t^* = \frac{P_t^*}{P_{t-1}^*}$, which is also assumed to follow an AR(1) process with persistence $0 < \rho_{\pi^*} < 1$:

$$\left(\frac{\pi_t^*}{\pi^{*SS}}\right) = \left(\frac{\pi_{t-1}^*}{\pi^{*SS}}\right)^{\rho_{\pi^*}} \epsilon_t^{\pi^*}, \tag{41}$$

where $\epsilon_t^{\pi^*}$ denotes an error term. We assume that the foreign monetary authority follows a Taylor rule:

$$\left(\frac{R_t^*}{R^{*SS}}\right) = \left(\frac{R_{t-1}^*}{R^{*SS}}\right)^{\tau_r} \left[\left(\frac{\pi_t^*}{\pi^{*SS}}\right)^{\tau_\pi} \left(\frac{Y_t^*}{Y^{*SS}}\right)^{\tau_y}\right]^{1-\tau_r} \epsilon_t^{R^*}, \tag{42}$$

where $\epsilon_t^{R^*}$ is a foreign monetary policy shock.

Finally, the SOE assumption implies that

$$Y_t^* = C_t^*. \tag{43}$$

3.9 The case of a currency union

We now consider the currency union version of the model to account for the establishment of the EMU in 1999. We use this version to ensure that our sign restrictions to identify the wage bargaining shock hold under both a flexible exchange rate regime and a monetary union.

Our EMU model differs from the previous one in the way that the nominal exchange rate e_t is normalized to 1 (i.e. all countries share the same currency) and that there is a single central bank setting the nominal interest rate R_t^* according to the union wide inflation and output gap. We also assume that the Home economy is too small to affect union-wide inflation and output gaps (see (42)). However, the domestic interest rate is foreign debt elastic, meaning that interest rates across the region may differ according to their positions in net foreign assets:

$$(1 + R_t) = (1 + R_t^*)\phi_t \tag{44}$$

Consequently, as a net borrower (lender), the nominal interest rate rises (falls) above (below) the union wide nominal interest rate, which discourages (encourages) consumption. The real exchange rate reflects the price differential between foreign and domestic goods $\mathcal{Q}_t = \frac{P_t^*}{P_t}$.

3.10 Calibration and derivation of sign restrictions

We follow the procedure outlined in Canova and Paustian (2011) to derive robust sign restrictions. The procedure seriously takes into account parameter uncertainty in order to derive robust responses that can then be imposed as sign restrictions on VARs. First, we define a reasonable parameter space for each parameter. Second, we randomly draw from the parameter space 10,000 times and obtain impulse responses for each draw. We use a uniform distribution for the parameter space so we do not impose any strong prior about the value of parameters. Third, we collect the generated impulse responses and observe the signs as well as the periods over which the shocks produce positive or negative responses. This information then enables us to derive sign restrictions from those responses that are robust in terms of the sign of the response.

Table (1) shows the range of values considered for every parameter. The range

for the degree of openness α corresponds to the import share of Germany[4] during the observed period. The discount factor β is set to 0.99, which corresponds to an annual interest rate of 4%. The literature generally considers bargaining power parameters between 0.5 and 0.7 (see Weber (2000)). However, we also want to consider the case of lower bargaining power of households and let η therefore vary between 0.3 and 0.7. The debt elasticity is fixed to 0.01, which implies that an increase in the net foreign asset position by 10% translates into a decline in the borrowing rate by 1% (see Justiniano and Preston (2010)).[5] The degree of risk aversion ranges from 1 (log utility) to 2.5, which corresponds to an elasticity of substitution in consumption of 0.4. Hence, we consider a wide range of estimates by Vissing-Jorgensen (2002). The elasticity of labor supply ranges between 1 and 4, implying a Frisch elasticity between 0.25 and 1. These values are supported by Smets and Wouters (2007) and Cho and Cooley (1994). We allow the price stickiness parameter to vary between values used in Campolmi and Faia (2011) (20) and Krause, Lopez-Salido, and Lubik (2008) (100), which are in the lower and upper range of the literature. Moreover, the habit persistence coefficient takes values between 0.5 and 0.9, which are common in the literature (for example see Smets and Wouters (2007)). With matching efficiency parameter values between 0.5 and 0.9, we cover the main range of estimates (see Pissarides and Petrongolo (2001) for a survey). Elasticities of demand between 5 and 8 imply mark-up ratios of prices over marginal costs between 1.14 and 1.25. This is in line with the estimates in Martins, Scarpetta, and Pilat (2003). We rely on vacancy costs between 0.05 and 0.15 (see for example Krause, Lopez-Salido, and Lubik (2008) and Yashiv (2000)). The parameter space for the separation rate is based on estimates by Hobijn and Sahin (2009). Pissarides and Petrongolo (2001) show that estimates for matching efficiency generally vary between 0.5 and 0.8. According to estimates for the vacancy duration by ECB (2002) and Weber (2000), we take the probability of finding a worker between 0.4 and 0.8. With values for υ between 0.5 and 1, we allow for constant and diminishing returns of labor. Additionally, we consider values between 1 and 3 for the elasticity of substitution between home and foreign goods, which is in line with estimates by Feenstra, Luck, Obstfeld, and Russ (2014). The ranges for the Taylor rule parameters relate to estimates by Orphanides (2001). For the autoregressive coefficients, we employ values between 0.5 and 0.9.

Figures (2) and (3) display the 10% to 90% range of impulse responses for the 10,000 draws following a negative 1 SD shock to the bargaining power of households (i.e. a positive shock to the bargaining power of firms) for both the pre-EMU and EMU model respectively. The response of the current account is expressed as relative to output. The rest of the impulse responses are reported

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[4]Source: World Bank database.

[5]Changing the debt elasticity only affects the persistence of the current account. Results, available on request, show that changing this parameter has no consequence for the identification of shocks.
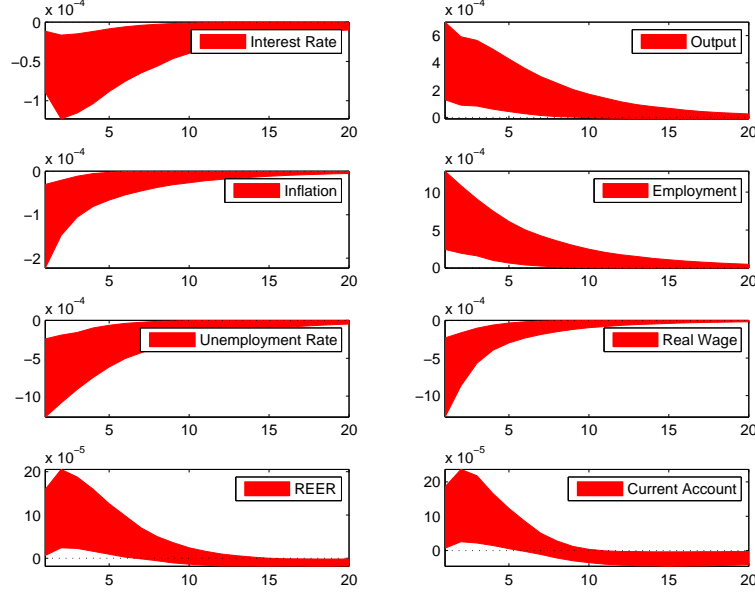
Table 1: Parameter uncertainty

Parameter	Name	Range
α	degree of openess	[0.2, 0.4]
β	discount factor	$[1.04^{-0.25}]$
η	bargaining power of households	[0.3, 0.7]
γ	debt elasticity	0.01
σ	risk aversion	[1, 2.5]
φ	elast. of labor supply	[1, 4]
ψ	price stickiness	[20, 100]
ω	habits	[0.5, 0.9]
$\bar{m}$	matching efficiency	[0.5, 0.9]
ϵ	elast. of demand	[5, 8]
κ	vacancy costs	[0.05, 0.15]
ρ	separation rate	[0.05, 0.1]
ν	elasticity matching function	[0.5, 0.8]
$q(\theta_t)$	probability of finding a worker	[0.4, 0.8]
υ	labor share	[0.5, 1]
μ	elast. of sub. between (H) and (F) goods	(1, 3]
ρ_a	technology shock (AR coef.)	[0.5, 0.9]
ρ_η	bargaining power shock (AR coef.)	[0.5, 0.9]
ρ_P	preference shock (AR coef.)	[0.5, 0.9]
ρ_L	labor supply shock (AR coef.)	[0.5, 0.9]
ρ_{c*}	foreign output gap (AR coef.)	[0.5, 0.9]
$\rho_{\pi*}$	foreign inflation (AR coef.)	[0.5, 0.9]
τ_r	interest rate smoothing	[0.5, 0.9]
τ_y	output gap coef.	[0.1, 0.5]
τ_π	inflation coef.	[1.25, 3]

in Appendix D.

Overall, we find that the shock to bargaining power leads to a decline in marginal costs, which translates into a lower inflation rate. Firms produce more output and demand more labor, which causes a decline in the unemployment rate. In the pre-EMU model, the nominal interest rate falls according to the Taylor rule, since more flexible labor markets reduce inflationary pressure. In the EMU model, the SOE is too small to affect area-wide inflation, hence, the central bank does not respond to the lower inflation. However, the interest rate falls, because it is foreign debt elastic. The higher net foreign asset position reduces the debt elastic risk premium and thus the interest rate. Since UIP and LOP hold, the nominal exchange rate appreciates, while the real exchange rate depreciates. In that way, the nominal exchange rate absorbs part of the shock, because foreign prices in local currency fall. Consequently, the effect on the terms of trade and the real exchange rate in the pre-EMU model is slightly lower than

in the EMU model where the nominal exchange rate is absent.

Figure 2: Shock to bargaining power under parameter uncertainty (pre-EMU)

Note: 10% to 90% range of impulse responses for the 10,000 draws.

The robust responses obtained from the simulation of the model with parameter uncertainty then provide us with a method to identify shocks in the GVAR. This is a more agnostic way of identifying shocks than imposing the strong structure of a DSGE model on the data. The GVAR contains data on output (y), interest rates (r), real wages (wp), inflation (Dp), unemployment rate (u), real exchange rate $(reer)$, and the current account balance as a percentage of GDP (ca). Thus, we look at the robust impulse-response signs obtained from the model for these variables. We summarize the information in Tables (2) and (3). The tables show the signs of the impulse responses on impact for the pre-EMU and the EMU models. A "?" symbol denotes that the response is not robustly positive or negative, and framed values indicate the variables on which we imposed sign restrictions in the GVAR. The shock to bargaining power can thus be identified as follows. The bargaining power shock is the only one which simultaneously increases output and reduces real wages, inflation, and unemployment for both the pre-EMU and the EMU models. Since we have five fundamental shocks driving the seven variables in the GVAR, these four restrictions are sufficient to identify the bargaining power shock in Germany. For output (+), inflation (-), real wages (-) and the unemployment rate (-), we impose restrictions over lags 0-4 on the impulse response functions of the German model in the GVAR. Given the fast reversion of inflation following the shock in the EMU model, we set the

Figure 3: Shock to bargaining power under parameter uncertainty (EMU)
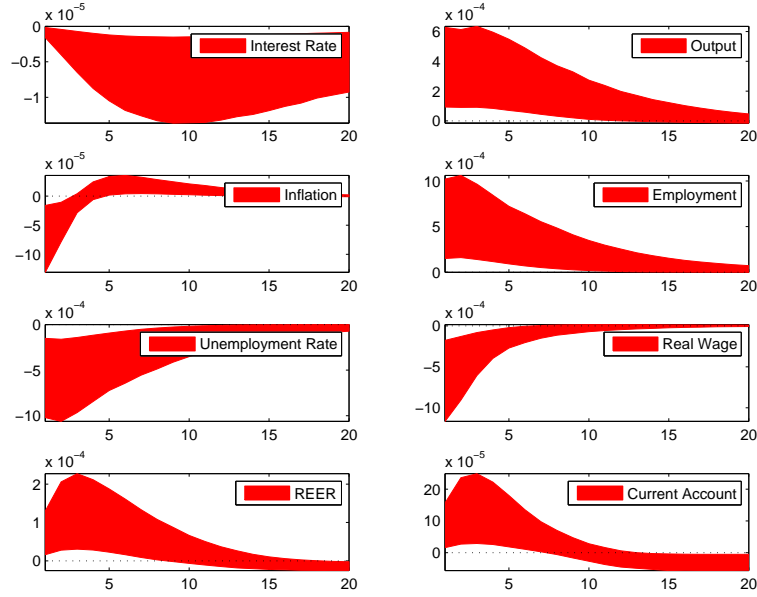
Note: 10% to 90% range of impulse responses for the 10,000 draws.

Table 2: Shock profiles (Pre EMU model)

	Y	R	W	$\mathcal{Q}$	π	U	CA
Technology	+	-	?	+	-	+	+
Bargaining power	+	-	-	+	-	-	+
Preference	?	+	+	-	+	-	-
Monetary policy	+	-	+	+	+	-	+
Labor supply	+	-	-	+	-	+	+

Note: The frames denote the restricted variables.

restriction on inflation only over the lags 0-1. Specifically, the sign restrictions must satisfy the condition $>= 0$ and $<= 0$.

4 The GVAR model

The GVAR model, introduced in the literature by Pesaran, Schuermann, and Weiner (2004), links country-specific VAR models using appropriate weights that allow tracing a country-specific shock into foreign economies. This is especially well suited to our purpose as we want to analyze the effect of a shock to the German labor market on the current account of other EMU members.

Table 3: Shock profiles (EMU model)

	Y	R	W	$\mathcal{Q}$	π	U	CA
Technology	+	-	?	+	-	+	+
Bargaining power	+	-	-	+	-	-	+
Preference	?	+	+	-	+	-	-
Monetary policy	?	-	+	-	+	-	-
Labor supply	+	-	-	+	-	+	+

Note: The frames denote the restricted variables.

4.1 Model set-up

We estimate a GVAR model covering a set of 9 EMU countries using a sample of 61 observations ranging from 1992Q1 to 2007Q2. The sample choice is such that estimates are not subject to the potential biases arising from the German reunification or the 2008 financial crisis. We consider the log levels of all variables involved (except for the current account).[6]

The variables entering the VAR for each economy $i = 1, \ldots, 9$ are real GDP (y), inflation rate (Dp), real wage (rw), unemployment rate (u), real effective exchange rate ($reer$), and the current account balance as ratio of GDP (ca). The interest rate (r) enters as an endogenous variable for Germany but exogenous for the rest of the countries. Table 4 presents the variable names and the corresponding data transformations. Note here that, for the empirical counterpart of the real exchange rate ($reer$), the definition is such that an increase corresponds to an appreciation. Details on data construction can be found in Appendix A.

Table 4: Variable transformations

Variable	Name	Transformation
Real GDP	y	$ln(RGDP_t)$
Inflation Rate	Dp	$\Delta ln(CPI_t)$
Real Wage	wp	$ln(Compens.\ per\ empl./CPI_t)$
Unemployment Rate	u	$ln(Unemployment\ Rate_t.)$
REER	$reer$	$ln(REER_t)$
Current Account Balance	ca	$CA_t/NGDP_t$
Interest Rate	r	$0.25 * ln(1 + R_t/100)$

Table 5 presents detail about how different variables enter the model. Variables with a superscript * are foreign trade-weighted variables as we will discuss below. Variables x_{it} represent the endogenous variables for each country model and x_{it}^* represent variables that enter exogenously. All variables, except the interest rate, are treated as endogenous in all country models. Since the German

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[6]For model estimation we use a modified version of the GVAR Toolbox by Smith and Galesi (2011).

Mark served as anchor currency for the European Exchange Rate Mechanism (ERM), Germany plays the dominant role in our model. Thus, we employ the German interest rate as an endogenous variable in the German model, but as an exogenous in all other country models.[7] Note that the index "2" in the interest rate row refers to the second country in our model, which is Germany.

Table 5: Model specification

Variables	Germany		Others	
	x_{it}	x_{it}^*	x_{it}	x_{it}^*
Real GDP	y_{it}	y_{it}^*	y_{it}	y_{it}^*
Inflation Rate	Dp_{it}	Dp_{it}^*	Dp_{it}	Dp_{it}^*
Real Wage	rw_{it}	rw_{it}^*	rw_{it}	rw_{it}^*
Unemployment Rate	u_{it}	u_{it}^*	u_{it}	u_{it}^*
Real Effective Exchange Rate	$reer_{it}$	-	$reer_{it}$	-
Current Account Balance	ca_{it}	-	ca_{it}	-
Interest Rate	r_{2t}	-	-	r_{2t}

Table 6: Trade Weight Matrix

Country	aut	deu	esp	fin	fra	gre	ita	nld	prt
aut	0.00	0.14	0.02	0.03	0.02	0.03	0.06	0.03	0.01
deu	0.68	0.00	0.27	0.45	0.40	0.31	0.37	0.55	0.22
esp	0.03	0.11	0.00	0.07	0.19	0.09	0.14	0.08	0.45
fin	0.01	0.03	0.01	0.00	0.01	0.02	0.01	0.03	0.01
fra	0.07	0.27	0.32	0.12	0.00	0.14	0.27	0.19	0.17
gre	0.01	0.02	0.01	0.01	0.01	0.00	0.03	0.01	0.00
ita	0.14	0.19	0.17	0.11	0.20	0.29	0.00	0.11	0.08
nld	0.05	0.22	0.08	0.19	0.12	0.11	0.10	0.00	0.07
prt	0.01	0.02	0.11	0.02	0.03	0.01	0.02	0.02	0.00

We employ fixed trade weights (reported in Table 6) for the construction of foreign variables.[8] The weights (ω_{ij}) represent the average total trade between

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[7]We also tested a specification with a dominant unit as described by Chudik and Pesaran (2013). We let the interest rate be exogenous in all countries. In the single-equation dominant unit model the nominal interest rate is regressed on its own lag as well as lags of PPP-GDP weighted aggregates of output and inflation. This specification is similar to a mixed cross-section GVAR that models the ECB policy rule explicitly (see Georgiadis (2015)). The results were similar to those obtained from the benchmark model.

[8]We also estimated the model with two other alternative weight matrices derived from the IMF Coordinated Portfolio Investment Survey. We used the total portfolio investment asset positions of equity and debt instruments. As Eickmeier and Ng (2015), we reversed the direction of assignment by country in order to get matrices for outward and inward portfolio investment. The different weights (averages over the years 2004-2007) had only a very limited effect on our results. FDI and banking claims data are not available for our sample period.

country i and j relative to the total trade of country i with all countries in the sample over the years 1992 to 2007. Foreign variables (except the nominal interest rate) are thus defined as:

$$y_{it}^* = \sum_{j=1}^{N} \omega_{ij} y_{jt} \qquad Dp_{it}^* = \sum_{j=1}^{N} \omega_{ij} Dp_{jt}$$

$$u_{it}^* = \sum_{j=1}^{N} \omega_{ij} u_{jt} \qquad rw_{it}^* = \sum_{j=1}^{N} \omega_{ij} rw_{jt}$$

We now describe the specification and identification method used for the GVAR estimates.

4.2 The single-country models

Due to the small sample size, each economy i is represented by the VARX*(1,1) model

$$x_{it} = a_{i0} + a_{i1}t + \Phi_{i1}x_{i,t-1} + \Lambda_{i0}x_{it}^* + \Lambda_{i1}x_{i,t-1}^* + u_{it}, \tag{45}$$

where x_{it} denotes the vector of domestic variables and x_{it}^* the vector of foreign exogenous variables. a_{i0} and a_{i1} are column vectors of $k_i \times 1$ dimension denoting coefficients of constants and time trends, respectively. The coefficient matricies Φ_{il} and Λ_{il} are of $k_i \times k_i$ dimension. u_{it} is a $k_i \times 1$ vector and assumed to be IID with zero mean and covariance matrix Σ_{ii}.

After further transformations, we get

$$A_{i0}z_{it} = a_{i0} + a_{i1}t + A_{i1}z_{it-1} + u_{it}, \tag{46}$$

where

$$z_{it} = (x_{it}, x_{it}^*)', \quad A_{i0} = (I_{k_i}, -\Lambda_{i0}), \quad A_{i1} = (\Phi_{i1}, \Lambda_{i1}).$$

In order to solve the GVAR, we define the vector z_{it} in terms of the global vector $x_t = (x_{0t}', x_{1t}', ..., x_{9t}')$ as

$$z_{it} = W_i x_t,$$

where W_i denotes a weight matrix. It follows that

$$A_{i0}W_i x_t = a_{i0} + a_{i1}t + A_{i1}W_i x_{t-1} + u_t. \tag{47}$$

By stacking all models, we obtain

$$G_0 x_t = b_0 + b_1 t + G_1 x_{t-1} + c_t, \tag{48}$$

where

$$b_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ \vdots \\ a_{N0} \end{pmatrix}, \quad b_1 = \begin{pmatrix} a_{01} \\ a_{11} \\ \vdots \\ a_{N1} \end{pmatrix}, \quad c_t = \begin{pmatrix} u_{0t} \\ u_{1t} \\ \vdots \\ u_{Nt} \end{pmatrix}$$

and

$$G_0 = \begin{pmatrix} A_{00} W_0 \\ A_{10} W_1 \\ \vdots \\ A_{N0} W_N \end{pmatrix}, \quad G_1 = \begin{pmatrix} A_{01} W_0 \\ A_{11} W_1 \\ \vdots \\ A_{N1} W_N \end{pmatrix}.$$

Premultiplying (48) by G_0 yields

$$x_t = f_0 + f_1 + F_1 x_{t-1} + \epsilon_t, \tag{49}$$

where

$$f_0 = G_0^{-1} b_0, f_1 = G_0^{-1} b_1, F_1 = G_0^{-1} G_1, \epsilon_t = G_0^{-1} c_t.$$

The final equation (49) represents our GVAR model, which we obtain from the estimated single country models.

4.3   Shock identification

We apply our agnostic sign restriction approach, as proposed by Eickmeier and Ng (2015), in order to identify the bargaining power shock in Germany.[9] The advantage of this procedure is that identified shocks are not correlated within countries and only weakly correlated across countries. This enables us to interpret a particular shock as country-specific.

We impose sign restrictions using the algorithms outlined in Rubio-Ramirez,

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[9]The literature on sign restrictions was initiated by Faust (1998), Canova and Nicolo (2002) and Uhlig (2005).

Waggoner, and Zha (2011) and Fry and Pagan (2007). Given the residuals from each estimated country i model, we compute lower triangular Cholesky matrices P_i and create a matrix

$$
P = \begin{pmatrix}
P_0 & 0 & \dots & \dots & 0 \\
0 & \ddots & & & \vdots \\
\vdots & & P_i & & \vdots \\
\vdots & & & \ddots & 0 \\
0 & \dots & \dots & 0 & P_N
\end{pmatrix},
$$

which gives us the impulse responses $\psi^h = \phi^h G_0^{-1} P$, where ϕ^h denotes the hth matrix of the vector moving average representation of the GVAR having a $K \times K$ dimension. We draw random $k_2 \times k_2$ orthonormal matrices[10] and perform QR-decompositions, which provide unique matrices (Q_2) that satisfy $Q_2 Q_2' = I$. We rotate Q_2 in order to obtain 100 impulse responses (given by $\Psi_i^h = (\psi_i^h Q_i')'$), which satisfy our sign restrictions. Since inflation reverts faster than other variables, we impose the restriction on inflation only over the quarters 0-1, whereas other restrictions must hold for quarters 0-4. Since we identify only one shock in a country with 7 variables, we also impose restrictions on the other variables to ensure that the identified shock only appears in the first equation. This strategy enables us to circumvent the multiple shocks problem discussed by Fry and Pagan (2007). The design of the P matrix, however, requires the assumption that there is no correlation between the shocks across countries. Within the GVAR, this is accounted for by matrix G_0, which captures the contemporaneous spillovers across countries.

The 100 draws obtained produce impulse responses which satisfy our sign restrictions according to Tables 2 and 3. However, not all draws are necessarily related to the same data generating process (DGP). Reporting measures like certain percentiles from the distribution of these impulse responses as confidence bands may thus be a malpractice (see Fry and Pagan (2007)). Following Fry and Pagan (2007), we deal with the multiple model problem by selecting the model which produces the impulse responses having the smallest total deviation from the medians of all impulse responses. In the case of the GVAR, we only take German variables into account, because we are focusing on a country-specific shock. The rest of our analysis proceeds by discussing the bootstrap (of 200 draws) of this median target model. We are thus able to identify a country-specific shock in Germany and the GVAR model enables us to trace this shock into foreign countries and to quantify its effect on foreign variables.

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[10]The index 2 refers to country 2, which is Germany ($k_2 = 7$).

5 Results

We now discuss the impulse responses following a bargaining power shock in Germany and analyze the importance of the shock as a driver of current account balances by decomposing its forecast error variance. It is important to note that the imbalances may be seen as a highly persistent process. Therefore, we could expect that a bargaining power shock led to permanent effects on EMU current accounts. Arguably, then, a transitory shock as the one we identify might not be able to explain the observed pattern of imbalances. Our theoretical prior coming from the intertemporal budget constraint, however, implies that the current account to GDP ratio is a stationary variable. Therefore, and along the same lines as Kollmann, Ratto, Roeger, in't Veld, and Vogel (forthcoming), we proceed by considering a shock with transitory effects on the current account.

5.1 A German bargaining power shock

In Figure (4), we report the German impulse responses following a 1 standard deviation bargaining power shock. The light blue area represents the 90% confidence bands, the dark blue area the 66% confidence bands and the red line the median. Following a negative one standard deviation bargaining power shock, real wages, inflation and the unemployment rate fall by definition, while output improves.

We find that the interest rate increases slightly by approximately 0.03%. This results from the large and persistent output increase following the shock while inflation falls only by a small amount and quickly returns to equilibrium within a quarter. The real effective exchange rate appreciates by 0.4%. This is at odds with theoretical priors. However, the appreciation following a supply shock is a common finding in the literature and often referred to as perverse supply side effect. Farrant and Peersman (2006), for example, find this effect for the Euro Area. One possible explanation is the existence of Balassa-Samuelson effects through the expansion of output or real wealth effects that cause an upward shift in demand (see Farrant and Peersman (2006)). Importantly, and in line with the DSGE model, we find a very significant improvement of the German current account balance by almost 0.3%.

Following Canova and Paustian (2011), we analyze the difference between the impulse responses derived directly from the rotation matrices and the Fry and Pagan (2007) median target model. We report all the impulse responses computed using the 100 accepted rotation matrices in Figure 5. The Figure indicates that the difference between both approaches is very small. However, a comparison of both procedures is difficult, because they measure very different objects. The distribution of impulse responses derived from the rotation matrices is closer to a measure of model uncertainty. The Fry and Pagan (2007) approach, on the other hand, is a measure of estimation uncertainty as it involves a bootstrap (re-

Figure 4: Domestic effects of a German bargaining power shock
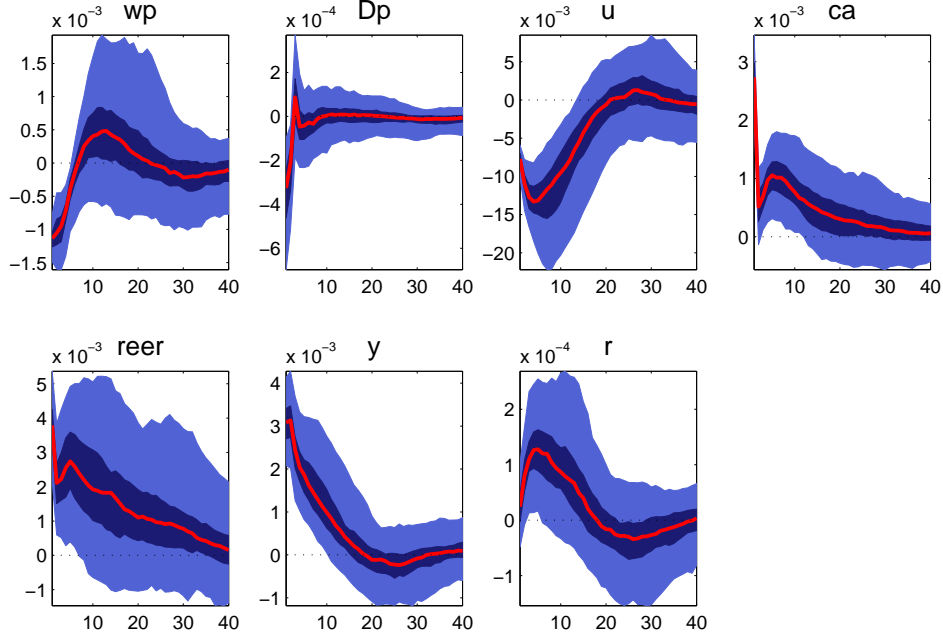

sampling of residuals) of the target model. We observe that the results for the REER and the interest rate vary, meaning that the results of the median target model may not necessarily be significant when considering all possible models. However, the current account response is robustly positive after two quarters.

We now look at the response of the current accounts of the other countries following the German labor market shock. Figure 6 shows that the response of other European current account balances is very heterogeneous. We report the corresponding 90% as well as 66% error bands in Figure 7. The Figure unveils significant deteriorations in Greece and the Netherlands, but significantly positive responses in Spain, Finland and France. The responses of the Austrian, Italian and Portuguese current accounts are insignificant.

5.2 Forecast Error Variance Decomposition

We now present the forecast error variances (FEV) of European current account balances explained by a German bargaining power shocks. This measures the importance of these shocks to explain the variability of current accounts. As stated earlier, German shocks are orthogonal, whereas foreign shocks are weakly correlated. Therefore, we rely on Generalized FEV decompositions and focus on

Figure 5: Model uncertainty
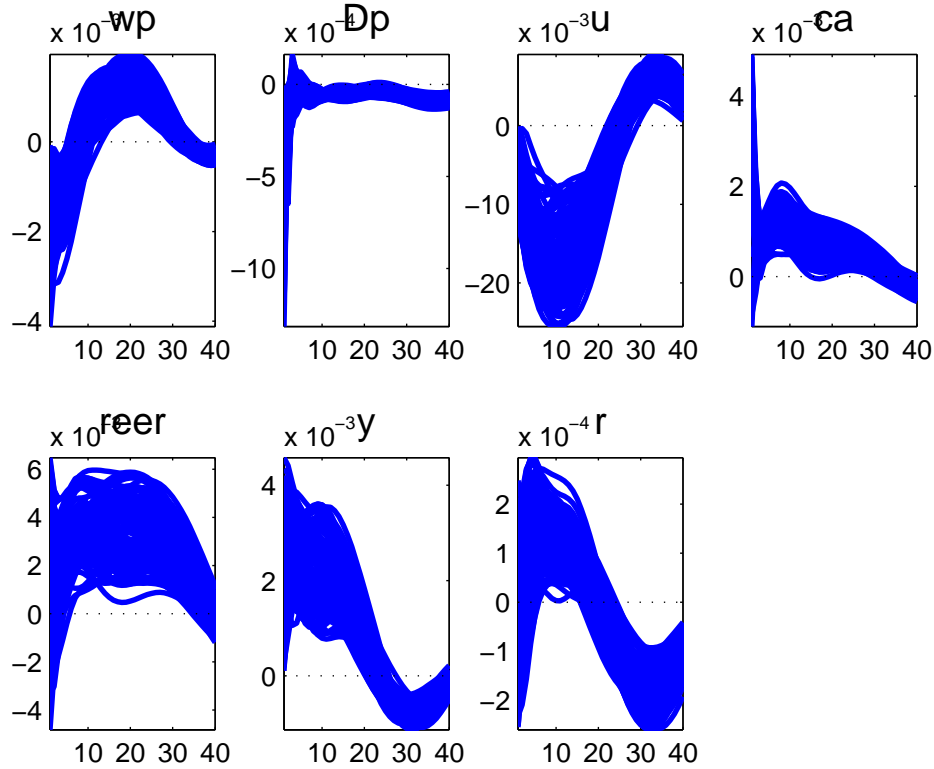
the ranking of explained shares.[11]

Table 7 presents the FEV decomposition for the wage bargaining shock using the median target model and for different horizons. Not surprisingly, the German shock explains more of the domestic current account balance forecast error variance on impact. For the other EMU countries, only for France and Italy we observe a relatively important effect of these shocks but only after 5 years. The general picture, however, is that the German wage bargaining shock explains a much smaller fraction of the forecast error of the current account for other EMU countries indicating that the shock is not a very important driver of European current account balances.

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[11]With sign restrictions, it is important that the restricted shock contributes substantially to explain the forecast error variance of the variables entering the VAR. This is the case in our GVAR. The bargaining power shock explains, for instance, 24%, 16% and 22% of the forecast error variance of German unemployment, real exchange rate, and output respectively on impact. These contributions increase for the 1 year FEV horizon.

Figure 6: Median responses of European current account balances. German bargaining power shock.
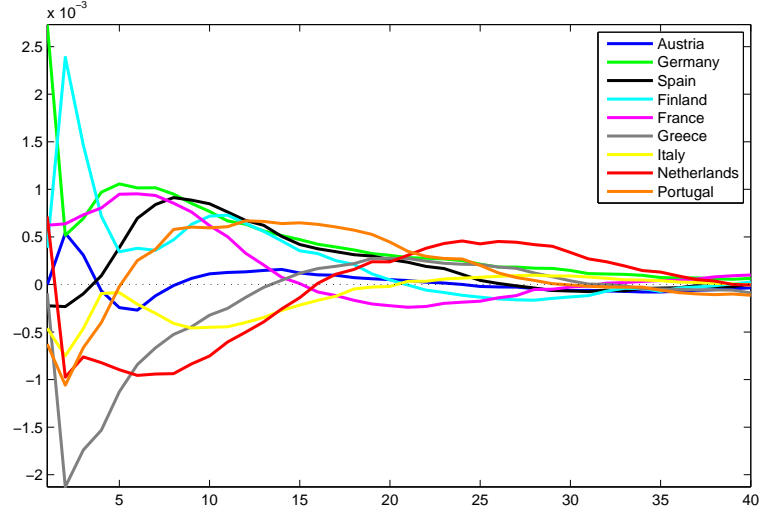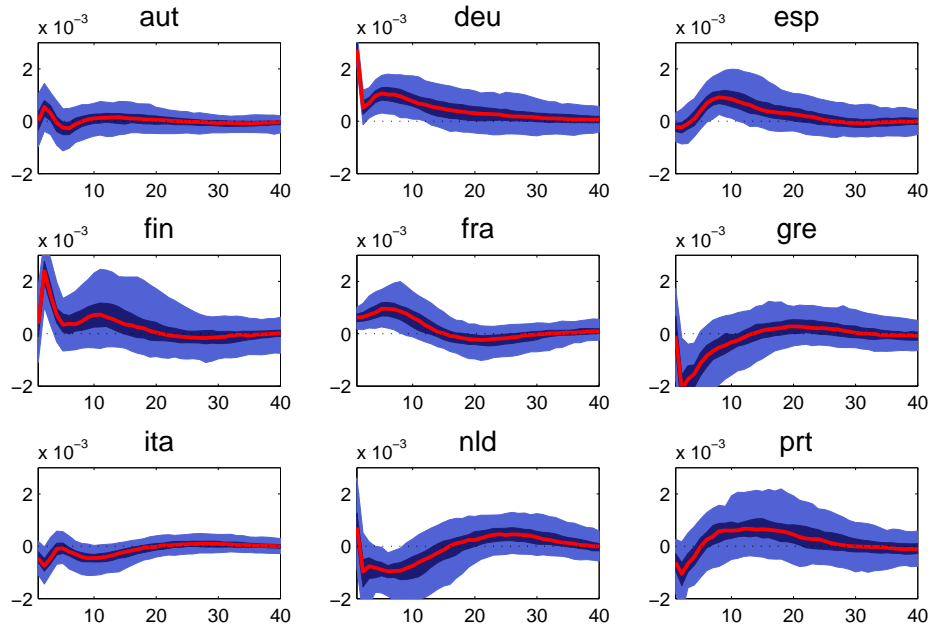

Figure 7: Confidence intervals for European current account balances.

6 Counterfactual analysis

The next step in our analysis is to quantify the contribution of the German labor market shock to the *levels* of both the German and other EMU countries' current

Table 7: Forecast error variance of current account balances explained by a German bargaining power shock

Country	Impact	Year 1	Year 5
aut	0.01	0.05	0.06
deu	0.04	0.13	0.17
esp	0.00	0.02	0.04
fin	0.01	0.03	0.05
fra	0.02	0.05	0.08
gre	0.01	0.04	0.05
ita	0.01	0.04	0.09
nld	0.01	0.02	0.05
prt	0.00	0.02	0.05

accounts. To do so, we perform a counterfactual analysis where we set the German bargaining power innovations to zero. As the GVAR methodology explicitly allows for international linkages, we are able to trace the effects of changing the errors of domestic or foreign equations on the evolution of specific variables. This can be achieved by choosing a specific base point (B) in our sample from which we forecast $B + 1, B + 2, ..., B + h$ conditional on the information available until (B). It is important to note that $B + h$ is part of the sample.

By adding the contributions of all (known) future shocks to the forecast for every point in time $(B + 1, B + 2, ..., B + h)$, we automatically recreate the dataset. However, if we assume that the errors of a specific equation (j) are zero and remove their contribution from the base projection for every point in time, we obtain a counterfactual time series showing what would have happened if that specific shock is canceled out.

This method is best explained using the following notation

$$y_{B+h} = \sum_{i=0}^{h-1} \phi_i \epsilon_{B+h-i} + \phi_h y_B, \tag{50}$$

where ϕ_i denotes the i-th moving average parameter as shown by Lütkepohl (2005).

Plugging the manipulated innovations back to the model provides us with new data representing a world without German bargaining power shocks. For this exercise, we use the model corresponding to the Fry and Pagan (2007) median target. To derive the counterfactual current account balance, we proceed as follows. To obtain a dataset excluding negative German bargaining power shocks from time B onwards, we keep the (known) future errors of all equations and set the (structural) bargaining power shocks in ϵ_t to zero. Then we perform a h-step ahead forecast starting at time B for all k endogenous variables in our

system. Finally, we compute the contributions of the known errors for every observation from B to $B + h$ and add them to the base projection. Given the actual data and the counterfactual series, we may draw conclusions about the historical importance of the bargaining power shock.

Figure 8: Original and counterfactual data of the German CA/GDP ratio (1992Q3-2007Q2)
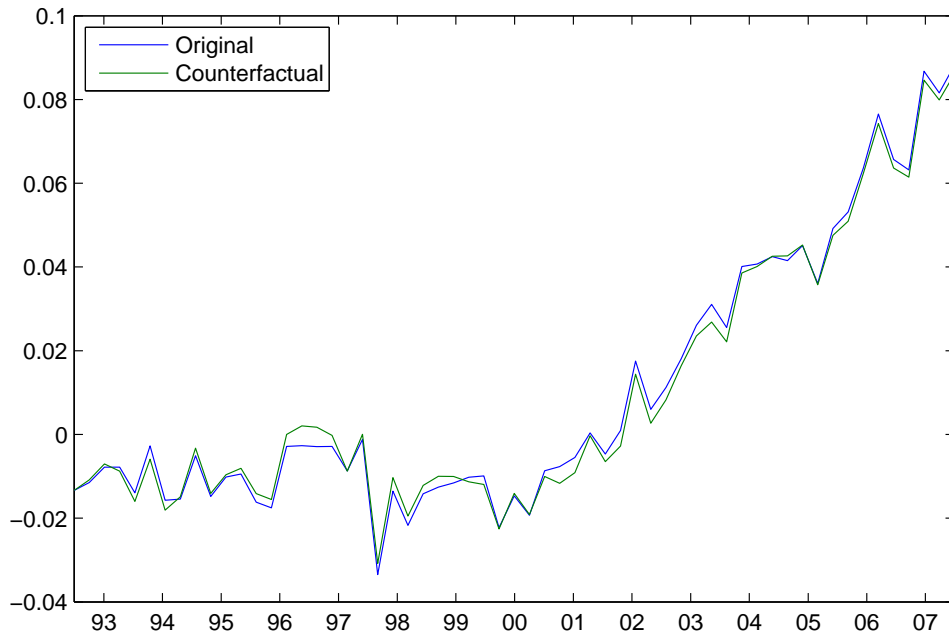

Figure 8 displays both, the original data and the counterfactual data of the German current account as ratio of GDP. We observe that, in the 2000s, the German current account balance would have been lower, if bargaining power shocks were absent. This finding reflects the labor market reforms in the 2000s, which we discussed in Section 2. However, the effect of the shock on the current account balance is very small.

We also compute the contribution of the shock to the dispersion of current account balances for all the countries. We calculate the sum of the absolute deviation (AD_t) of current account to GDP ratios as a measure of dispersion:

$$AD_t = \sum_{i=1}^{N} |ca_{it}|, \tag{51}$$

for $i = 1, \ldots, N$ and $N = 9$. We then compute AD_t for the counterfactual current account series setting the German bargaining power shocks to zero and

compare both series.

Figure 9: Original and counterfactual dispersion of all CA/GDP ratios (1992Q3-2007Q2)
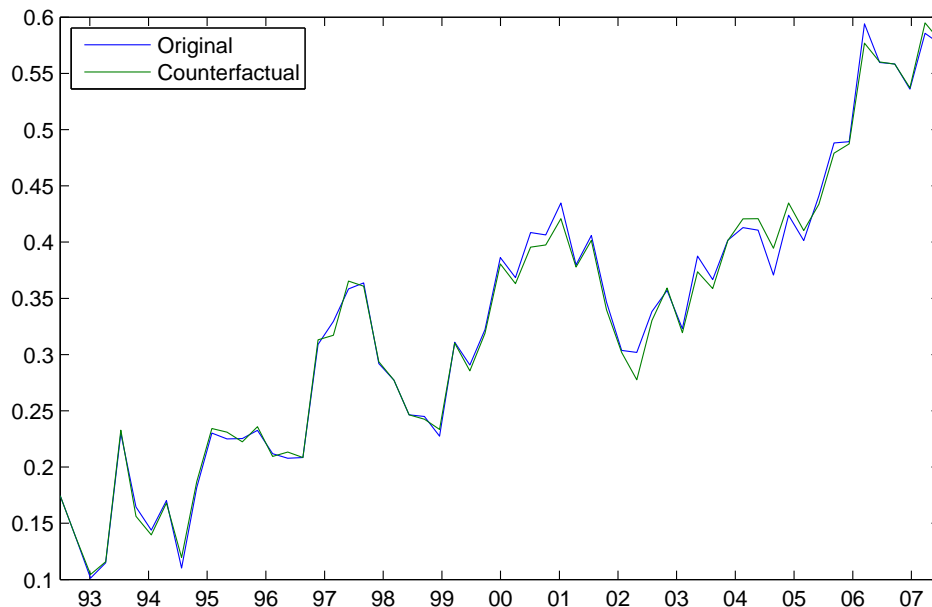

Figure 9 shows that the absolute deviation increases substantially over the whole sample period, which is a measure of the well known increase in European external imbalances. While the total absolute deviation of current account to GDP ratios was only 10% in 1993, it reached almost 60% in 2006. The difference between the original and counterfactual series, however, indicates that the identified German wage bargaining shocks play a very minor role for European Imbalances. The maximum difference between the original and counterfactual series is approximately 2.25% in 2002. Between the years 2000 and 2003 and 2005 and 2007, the divergence would have been slightly lower without German bargaining power shocks. However, this difference is quantitatively small.

7 Conclusion

A popular explanation of the increase in the dispersion of current account positions in the Eurozone states that they originate from gains in German competitiveness resulting from labor market reforms during the late 1990s and early 2000s. A crucial element of these reforms was the reduction in wage setting bargaining power of unions and union coverage. We analyze quantitatively the

effect of shocks to bargaining power in Germany on the current account positions of 9 Eurozone countries.

We develop an open economy New Keynesian DSGE model with search and matching frictions from which we derive robust sign restrictions to identify a wage bargaining shock. The shock robustly reduces wages, inflation, and unemployment and increases output. We then impose these sign restrictions to identify German wage bargaining shocks in a Global VAR (GVAR) including Germany and 8 other EMU countries. The GVAR allows us to trace the shock spillovers originating in Germany on the rest of the countries in the system. This method is more model-agnostic and imposes less structure than estimated DSGE models.

The results from the estimated GVAR show that German wage bargaining shocks were important drivers of output, unemployment, wages and the current account in Germany. After a shock that reduces the bargaining power of unions, the German current account improves significantly. However, the effect of the shock on other European economies is very small. Responses to the shock are generally heterogeneous and the importance of the shock to explain the variance of current account positions in EMU countries is very limited. Counterfactual analysis indicates that, had these shocks been absent, the dispersion of current account positions would have looked very similar to what it was. Consequently, the reduction in bargaining power of German unions after the labor market reforms cannot be the lone driver of European current account imbalances.

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Appendix

A Data

We test every series for seasonality using the testing procedure outlined in Smith and Galesi (2011) and adjust all series with a seasonal component by employing the X12-ARIMA method. We allow the software to correct for additive outliers. All series are obtained in quarterly frequency. Exceptions are explicitly mentioned in this section. When necessary, we interpolate data using the Boots, Feibes, and Lisman (1967) methodology.

- **Real GDP**

  We employ real GDP series from the OECD (Ecowin: oe:(country code)_gdpvq).

- **CPI/Inflation**

  All CPI series are obtained from the OECD database (Ecowin: oecd:(country code)_cpaltt01_ixobq).

- **Real Wage**

  We use compensation of employees data (Ecowin: oe:aut_wsssq) and the total number of employees data (Ecowin: oecd:(country code)_emeytths_stsaq) from the OECD database to compute the compensation per employee. Exceptions are compensation series for Greece, Netherlands and Portugal (Ecowin: oe:(country code)_wsssa) as well as number of employees data for Greece and the Netherlands (ana:(country code)_eem_per) where we extend the quarterly series with interpolated annual data. We deflate these series with the CPI to get a measure of real wages.

- **Unemployment Rate**

  Unemployment rate data (Ecowin: oecd:(country code)_unrtsutt_stsaq) comes from the OECD database. We complete the Greek series with interpolated annual data (Ecowin: oecd:(country code)_unrtsutt_stsaa).

- **REER**

  We use the real effective exchange rate series from the IMF IFS database. (Ecowin: ifs:s(country code)00reczfq)

- **Current Account Balance**

  We use the current account balance from the OECD online database and the nominal GDP (Ecowin: oe:(country code)_gdpq) from the OECD database (Ecowin) to construct the current account balance to GDP ratio.

- **Interest Rate**

  The source for the German nominal short-term interest rate (money market rate) is the IMF IFS database (Ecowin: ifs:s(country code)60b00zfq).

- **Trade Data**

  We use the Directions of Trade statistics from the IMF in annual frequency to compute the trade weight matrix.

B   Solution of the bargaining problem

B.1   Wages

Taking logs of the Nash product

$$\left(\frac{\zeta_t}{\lambda_t}\right)^{\eta_t} \mu_t^{1-\eta_t} \tag{B1}$$

yields

$$\eta_t \ln\left(\frac{\zeta_t}{\lambda_t}\right) + (1-\eta_t)\ln\mu_t. \tag{B2}$$

Differentiating with respect to W_t gives

$$\eta_t \frac{1}{\left(\frac{\zeta_t}{\lambda_t}\right)}\frac{\partial\left(\frac{\zeta_t}{\lambda_t}\right)}{\partial W_t} + \frac{1}{\mu_t}\frac{\partial\mu_t}{\partial W_t} = 0. \tag{B3}$$

or

$$\eta_t\mu_t\frac{\partial\left(\frac{\zeta_t}{\lambda_t}\right)}{\partial W_t} = -(1-\eta_t)\left(\frac{\zeta_t}{\lambda_t}\right)\frac{\partial\mu_t}{\partial W_t}. \tag{B4}$$

First order conditions with respect to W_t and H_t are thus given by

$$\frac{\partial\mu_t}{\partial W_t} = -\chi_t H_t \tag{B5}$$

$$\frac{\partial(\frac{\zeta_t}{\lambda_t})}{\partial W_t} = H_t \tag{B6}$$

$$\frac{\partial\mu_t}{\partial H_t} = -W_t\chi_t + mc_t A_t v^2 N_t^{v-1} H_t^{v-1} \tag{B7}$$

$$\frac{\partial(\frac{\zeta_t}{\lambda_t})}{\partial H_t} = W_t - \frac{1}{\lambda_t}\epsilon_t^L \epsilon_t^P H_t^\varphi \tag{B8}$$

$$\tag{B9}$$

Since $\frac{\partial\mu_t}{\partial W_t} = -\chi_t H_t$ and $\frac{\partial\left(\frac{\zeta_t}{\lambda_t}\right)}{\partial W_t} = H_t$, we get the sharing rule

$$\eta_t\mu_t = (1-\eta_t)\chi_t\left(\frac{\zeta_t}{\lambda_t}\right). \tag{B10}$$

Plugging in the equations for μ_t and ζ_t yields

$$\eta_t \frac{\kappa}{q(\theta_t)} = (1 - \eta_t)\chi_t \Bigg(W_t H_t - b - \frac{1}{\lambda_t}\epsilon_t^L \epsilon_t^P \frac{H_t^{1+\varphi}}{1+\varphi} \tag{B11}$$
$$+ E_t \Big[\beta(1-\rho)(1 - \theta_{t+1}q(\theta_{t+1}))\frac{\zeta_{t+1}}{\lambda_{t+1}} \Big] \Bigg)$$

As the sharing rule must also hold in the future, we get

$$\eta_{t+1}\mu_{t+1} = (1 - \eta_{t+1})\chi_{t+1}\frac{\zeta_{t+1}}{\lambda_{t+1}}, \tag{B12}$$

or

$$\frac{\eta_{t+1}}{(1-\eta_{t+1})} \frac{1}{\chi_{t+1}}\mu_{t+1} = \frac{\eta_{t+1}}{(1-\eta_{t+1})} \frac{1}{\chi_{t+1}}\frac{\kappa}{q(\theta_{t+1})} = \frac{\zeta_{t+1}}{\lambda_{t+1}}. \tag{B13}$$

Plugging (B13) into (B11) yields

$$\eta_t \frac{\kappa}{q(\theta_t)} = (1 - \eta_t)\chi_t \Bigg(W_t H_t - b - \frac{1}{\lambda_t}\epsilon_t^L \epsilon_t^P \frac{H_t^{1+\varphi}}{1+\varphi} \tag{B14}$$
$$+ E_t \Big[\beta(1-\rho)(1 - \theta_{t+1}q(\theta_{t+1}))\frac{\eta_{t+1}}{(1-\eta_{t+1})} \frac{1}{\chi_{t+1}}\frac{\kappa}{q(\theta_{t+1})} \Big] \Bigg)$$

Rearranging gives

$$\frac{\eta_t}{(1-\eta_t)} \frac{1}{\chi_t}\frac{\kappa}{q(\theta_t)} = W_t H_t - b - \frac{1}{\lambda_t}\epsilon_t^L \epsilon_t^P \frac{H_t^{1+\varphi}}{1+\varphi} \tag{B15}$$
$$+ E_t \Big[\beta(1-\rho)(1 - \theta_{t+1}q(\theta_{t+1}))\frac{\eta_{t+1}}{(1-\eta_{t+1})} \frac{1}{\chi_{t+1}}\frac{\kappa}{q(\theta_{t+1})} \Big].$$

Solving for the wage yields

$$W_t H_t = \delta_t + b + \frac{1}{\lambda_t}\epsilon_t^L \epsilon_t^P \frac{H_t^{1+\varphi}}{1+\varphi} - E_t \Big[\beta(1-\rho)(1 - \theta_{t+1}q(\theta_{t+1}))\delta_{t+1} \Big], \tag{B16}$$

where

$$\delta_t = \frac{\eta_t}{(1-\eta_t)} \frac{1}{\chi_t}\frac{\kappa}{q(\theta_t)}. \tag{B17}$$

B.2   Hours

As before, we take logs of the Nash product and differentiate now with respect to H_t:

$$\eta_t \mu_t \frac{\partial \left(\frac{\zeta_t}{\lambda_t} \right)}{\partial H_t} = -(1 - \eta_t) \left(\frac{\zeta_t}{\lambda_t} \right) \frac{\partial \mu_t}{\partial H_t}. \tag{B18}$$

Multiplying both sides by $-\chi_t$ yields

$$-\chi_t \eta_t \mu_t \frac{\partial \left(\frac{\zeta_t}{\lambda_t} \right)}{\partial H_t} = (1 - \eta_t) \chi_t \left(\frac{\zeta_t}{\lambda_t} \right) \frac{\partial \mu_t}{\partial H_t}. \tag{B19}$$

Using equation (B10), we get

$$-\chi_t \frac{\partial \left(\frac{\zeta_t}{\lambda_t} \right)}{\partial H_t} = \frac{\partial \mu_t}{\partial H_t}. \tag{B20}$$

We now plug in the values and get

$$-\chi_t W_t + \chi_t \frac{1}{\lambda_t} \epsilon_t^L \epsilon_t^P H_t^\varphi = -\chi_t W_t + mc_t A_t \upsilon^2 N_t^{\upsilon-1} H_t^{\upsilon-1}. \tag{B21}$$

Rearranging yields our final equation for hours

$$H_t = \left(\frac{mc_t A_t \upsilon^2 N_t^{\upsilon-1}}{\chi_t \epsilon_t^L \epsilon_t^P} \lambda_t \right)^{\frac{1}{1+\varphi-\upsilon}}, \tag{B22}$$

which differs from the one obtained by Krause, Lopez-Salido, and Lubik (2008), because hours do in our open economy model depend on χ_t.

C Steady State

We assume that in steady state $\pi = 1$, $pi^* = 1$, $B = 0$, $e = 1$, $q = 1$ and $C_w = C$.

$$\lambda = (1 - \omega)^{-\sigma} C^{-\sigma} \tag{C1}$$

$$\beta = \frac{1}{R} \tag{C2}$$

$$Y = (NH)^v \tag{C3}$$

$$mc = \frac{\epsilon - 1}{\epsilon} \tag{C4}$$

$$M = \bar{m} S^\nu V^{1-\nu} \tag{C5}$$

$$S = 1 - (1 - \rho)N \tag{C6}$$

$$N = (1 - \rho)N + M \tag{C7}$$

$$\theta = V/S; \tag{C8}$$

$$q(\theta) = M/V \tag{C9}$$

$$\frac{\kappa}{q(\theta)} = \beta \frac{\kappa}{q(\theta)}(1 - \rho) + \text{mc}\nu N^{(\nu-1)} H^\nu - WH \tag{C10}$$

$$WH = \delta + b + \frac{1}{\lambda}\frac{H^{(1+\varphi)}}{(1 + \varphi)} - \beta(1 - \rho)(1 - \theta q(\theta))\delta \tag{C11}$$

$$\delta = \frac{\eta}{(1 - \eta)}\frac{1}{\chi}\frac{\kappa}{q(\theta)} \tag{C12}$$

$$H = (\text{mc}v^2 N^{(v-1)}\lambda)^{(1/(1+\varphi-v))} \tag{C13}$$

$$Y = C + \kappa V \tag{C14}$$

D   IRFs in the DSGE model with parameter un-certainty

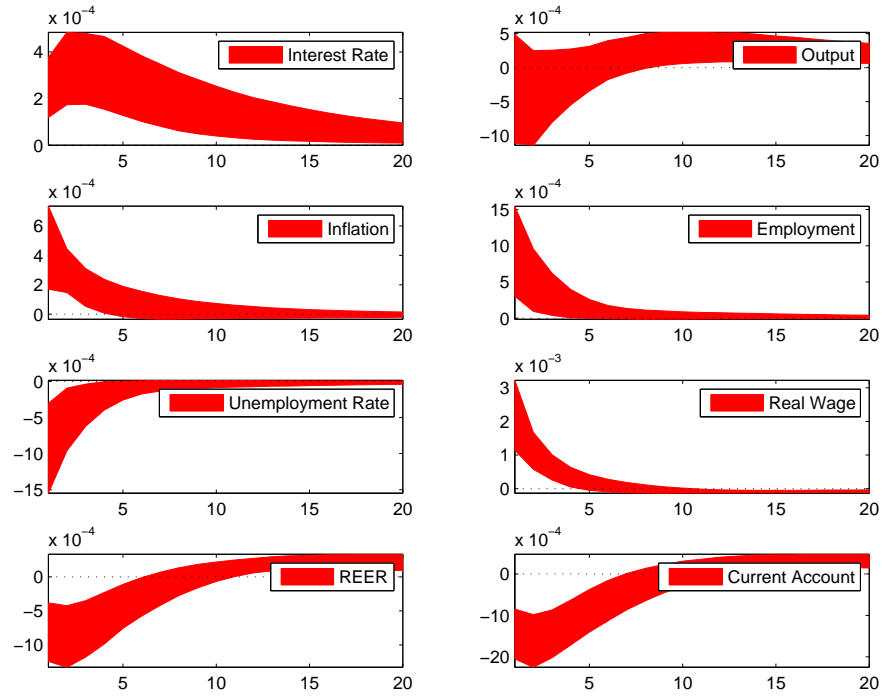Figure 10: Technology shock under parameter uncertainty (pre-EMU model)
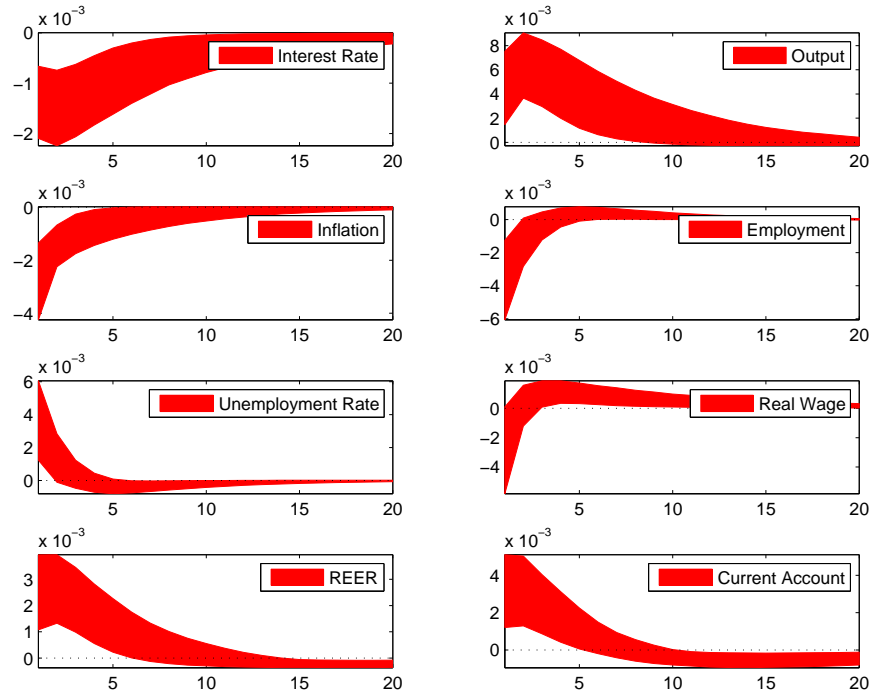
Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

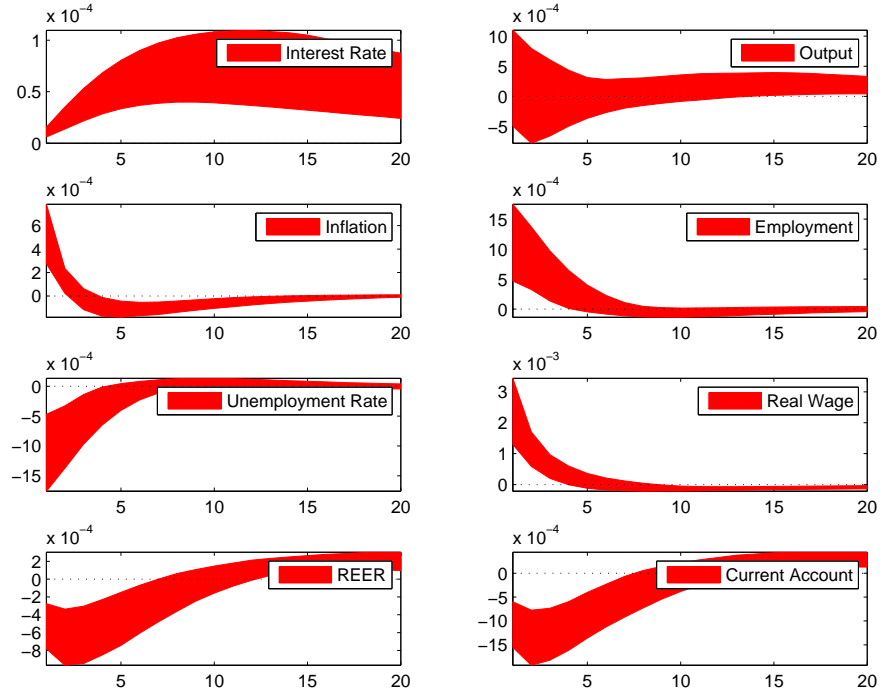Figure 11: Technology shock under parameter uncertainty (EMU model)
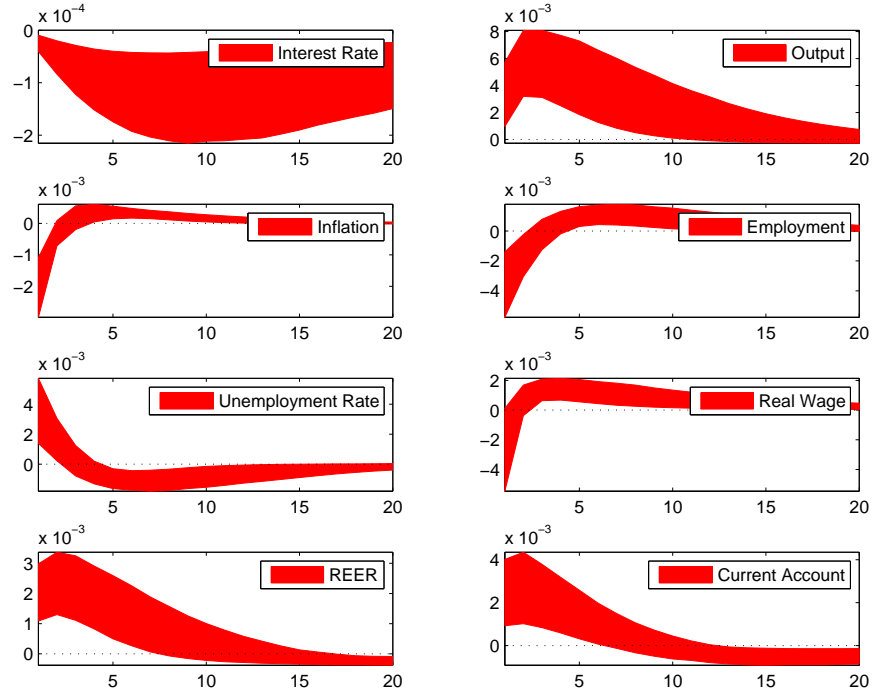
Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

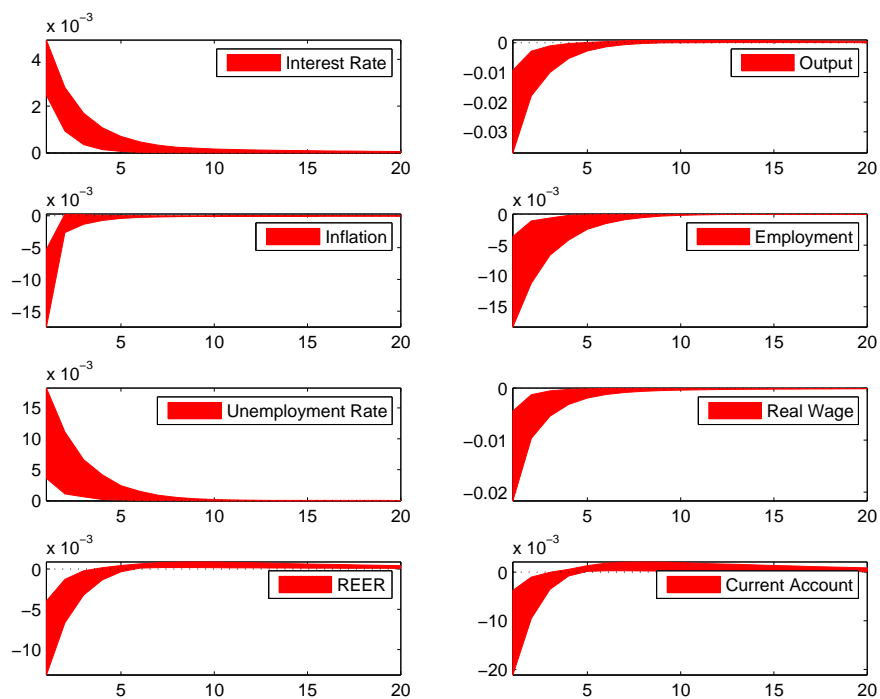Figure 12: Preference shock under parameter uncertainty (pre-EMU model)

Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

Figure 13: Preference shock under parameter uncertainty (EMU model)

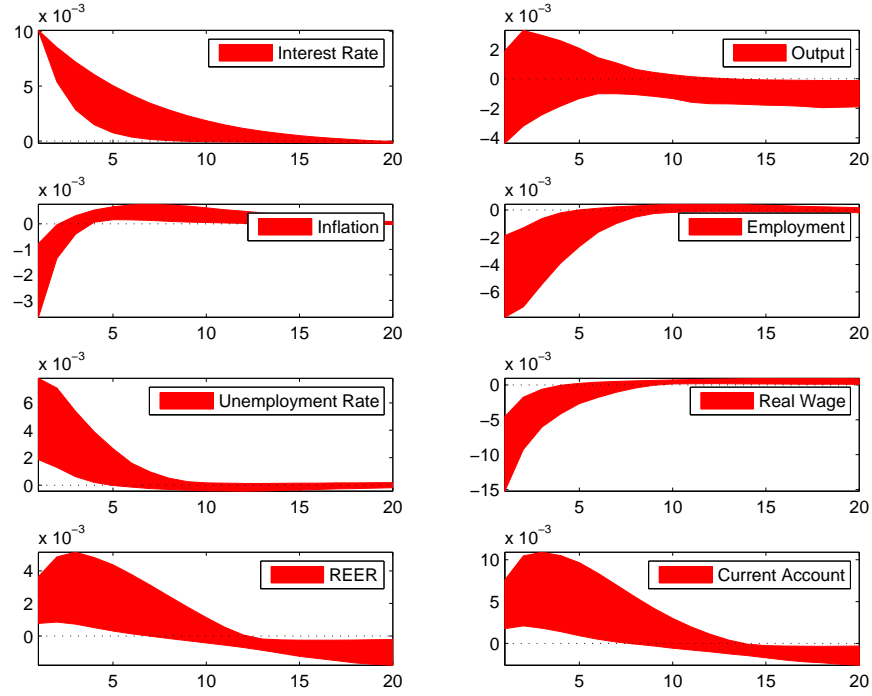Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

Figure 14: Monetary policy shock under parameter uncertainty (pre-EMU model)

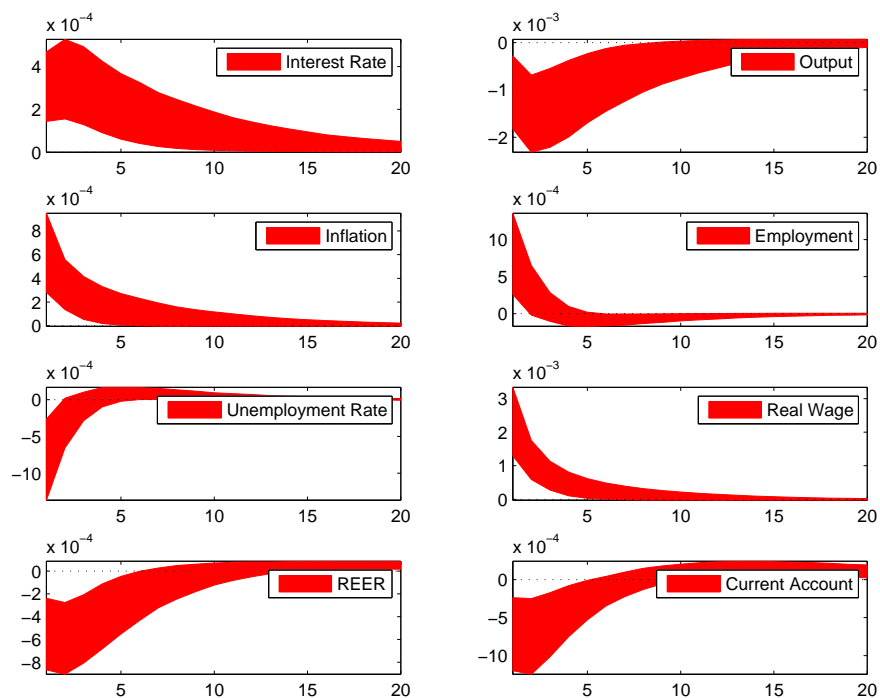Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

Figure 15: Monetary policy shock under parameter uncertainty (EMU model)

Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

Figure 16: Labor supply shock under parameter uncertainty (pre-EMU model)

Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

Figure 17: Labor supply shock under parameter uncertainty (EMU model)
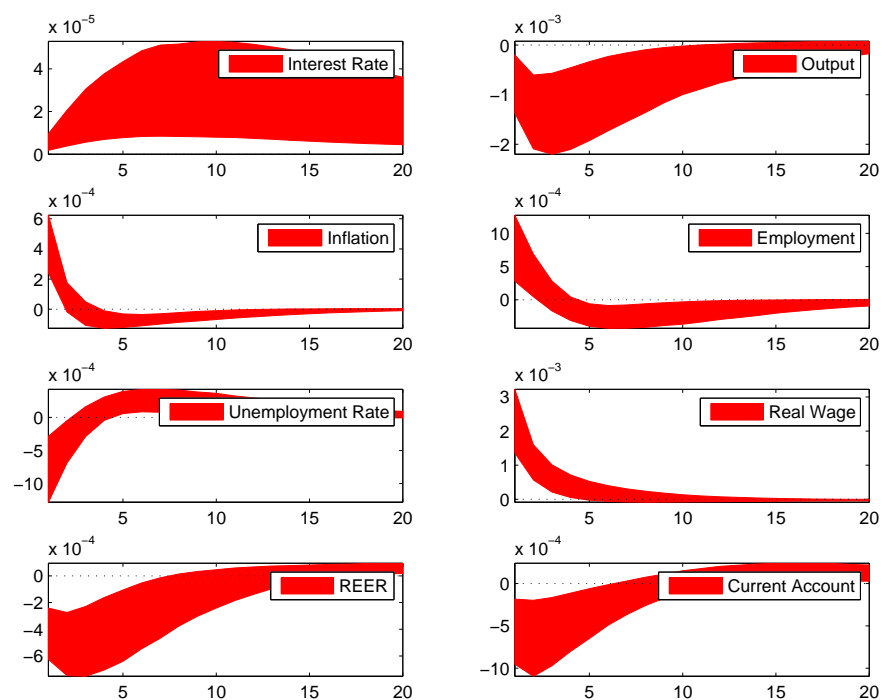
Note: The shaded area denotes the 10% to 90% range of impulse responses for the 10,000 draws.

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