Feeding the Global VAR with theory: Is German wage moderation to blame for European imbalances?

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Abstract

This paper analyses the importance of German wage moderation in the context of European imbalances. Using information from a New Keynesian small open economy model with labor market frictions, we derive sign restrictions for a wage markup shock. This information enables us to identify a German wage markup shock by imposing restrictions on the impulse response functions of German variables in a Global VAR model.

We find that negative German wage markup shocks do generally cause an improvement of the domestic trade balance and a deterioration of foreign trade balances in the Euro Area. However, they account only for a limited proportion of trade balance forecast error variances. Hence, German wage moderation cannot be the lone driver of European imbalances.

Keywords: european imbalances, global var, sign restrictions, wage markups
JEL classifications: F10, F32, F41.

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1 Introduction

The recent EMU experience demonstrates that trade imbalances may not be neutral in affecting economic performance, since those countries that experienced larger current account deficits are currently experiencing deep macroeconomic distress. The IMF (2012) and ILO (2012) mention the increase in German competitiveness during the 1990s as an important determinant of these imbalances. Particularly, the decline in the German real wages, relative to the Euro Area partners, is mentioned as a striking event. We, therefore, employ the Global VAR (GVAR) methodology for 9 EA countries[1], in order to measure the international effects of a negative German wage markup shock.

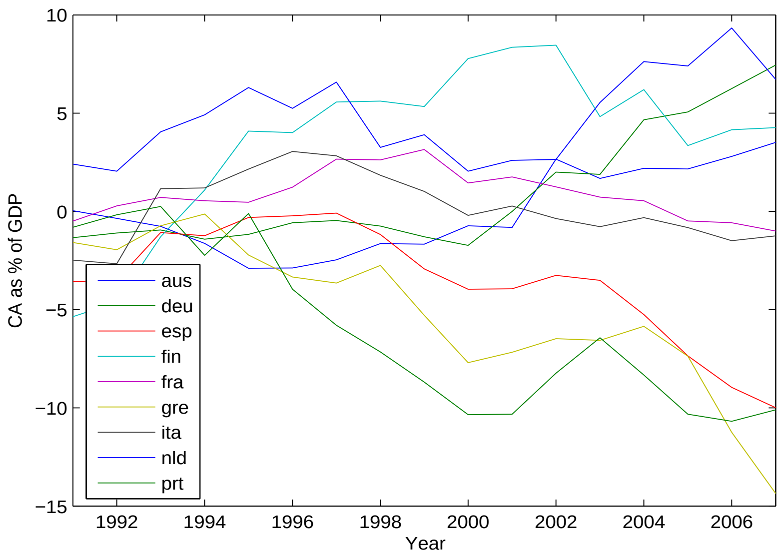
For identifying a wage markup shock, we impose sign restrictions on the impulse response functions of the GVAR model. By employing the bootstrap method outlined in Fry and Pagan (2007), we compute well interpretable point estimates and error bands of international trade balances following a German wage markup shock.

Our paper contributes to the literature by providing an important insight into the international propagation of wage markup shocks, which is an essential question in the European imbalances discussion. We show that negative German wage markups do generally cause an improvement of the domestic trade balance and a deterioration of foreign trade balances in the Euro Area. However, they account only for a limited proportion of trade balance forecast error variances. Hence, German wage moderation cannot be the lone driver of European imbalances.

In the following section, we motivate the study of German wage markup shocks and present related literature. The next section explains the GVAR model and shows how the German wage markup shock is identified. Afterwards, we derive sign restrictions from a New Keynesian SOE DSGE model with labor market frictions, which we impose on the impulse response functions of our GVAR model. We present our results and robustness checks in the following sections. Finally, we conclude.

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

Figure 1: European imbalances



2 Literature review

The literature on European imbalances covers a large amount of determinants. Although wage moderation has been heavily discussed by institutions and policy makers (see IMF (2012) and ILO (2012)), the literature on its international effects is scarce. The IMF and ILO point out that the German wage moderation after the reunification has increased German competitiveness and thus translated into a high current account surplus, while the trade balances of many other European countries deteriorated. Moreover, they mention productivity gains as an alternative driver of unit labor costs.

Vogel (2011) employs a three-region version of QUEST for investigating possible strategies for rebalancing the Euro Area. Among other strategies, he investigates the theoretical outcome of wage moderation. His results indicate that wage moderation should generally help to rebalance current accounts, as it affects marginal cost of firms, which leads to a loss in competitiveness.

Sabbatini and Zollino (2010) investigate the effects of German labor market reforms and come to a similar conclusion as the IMF (2012) and ILO (2012).

3 The German trade surplus: Labor productivity versus real wages

The literature discusses productivity gains as well as wage moderation as drivers of German unit labor costs and competitiveness. We, therefore, analyse the relationships between labor productivity growth, real wage growth and the trade balance in Germany. We proxy labor productivity by real GDP / employment.

Figure 2: German productivity, real wages and the trade balance (1991Q2-2007Q4)

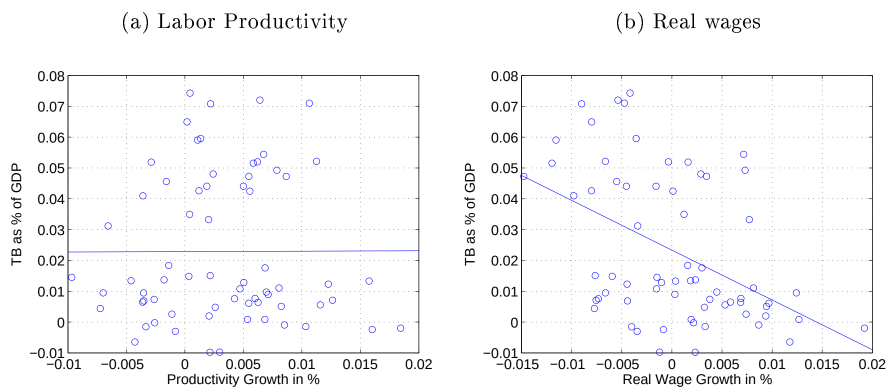


Figure 2 (a) displays no distinct relationship between labor productivity growth and the trade balance. However, Figure 2 (b) reveals a negative relationship between real wage growth and the trade balance. High real wage growth rates coincide with low trade balance to GDP ratios *et vice versa*. This finding underlines the importance of real wages in the context of trade and encourages the analysis of wage markup shocks representing wage moderation in the context of labor market reforms.

In the following section, we present the model, which we employ in order to analysis of the relationship between German wage moderation and European imbalances.

4 The GVAR model

4.1 Model setup

The GVAR model got introduced by Pesaran, Schuermann, and Weiner (2004). Dees, Holly, Pesaran, and Smith (2007) improve the model by allowing for long-run restrictions in the form of cointegration relationships. Dees, di Mauro, Pesaran, and Smith (2007) introduce global variables into the GVAR framework, which act like an approximation to a common factor model. Pesaran and Smith (2006) show that every country specific VARX model can be derived as a solution of a DSGE model.

We estimate a GVAR model covering a set of 9 EA countries using a data sample ranging from 1991Q1 to 2007Q4. The sample size assures that the estimates are not subject to biases induced by the German reunification or the 2008 financial crisis. For the model estimation, we employ a modified version of the GVAR Toolbox (Smith and Galesi (2011)).

Following the structure of DSGE models by Gali, Smets, and Wouters (2011) and Marcellino and Rychalovska (2012), we employ for each economy i the real GDP (y), inflation rate (Dp), employment (e), real wage (rw), unemployment rate (u), real effective exchange rate ($reer$), and trade balance (tb) as variables. Table 1 displays the variable names and the corresponding data transformations.

All variables, except the interest rate, are treated as endogenous in all models. Since the German mark used to be the anchor currency for the European exchange rate mechanism (ERM), which later became the Euro, Germany is playing a dominant role in our model. Given that the German short-term interest rate used to be an important factor even before the introduction of the common currency, we employ the German rate as an endogenous variable in the German model, but as an exogenous one in all other models. Table 2 shows that the real effective exchange rate as well as the trade balance are entirely treated as endogenous.[2] Given that the real effective

[2] Note that the index "2" in the interest rate row refers to the second country in our model, which is Germany.

Table 1: Variable transformations

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

exchange rate is a measure which already incorporates foreign dynamics, it would be misleading to incorporate the same dynamics again as an exogenous variable. A variable capturing a weighted sum of foreign trade balances would be subject to the same criticism.

Table 2: 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}^*
Employment	e_{it}	e_{it}^*	e_{it}	e_{it}^*
Real Wage	rw_{it}	rw_{it}^*	rw_{it}	rw_{it}^*
Unemployment Rate	u_{it}	u_{it}^*	u_{it}	u_{it}^*
Real Exchange Effective Rate	$reer_{it}$	-	$reer_{it}$	-
Trade Balance	tb_{it}	-	tb_{it}	-
Interest Rate	r_{2t}	-	-	r_{2t}

4.2 Step one: Estimating the single-country models

Each economy i is represented by the VARX*(1,1) model

$$x_{it} = a_{i0} + a_{i1}t + \Phi_{i1}x_{i,t-1} + \Lambda_{i0}x^*_{it} + \Lambda_{i1}x^*_{i,t-1} + u_{it}, \quad (1)$$

where a_{i0} and a_{i1} are $k_i \times 1$ column vectors denoting coefficients of constants and time trends, respectively. The coefficient matricies Φ_{il} and Λ_{il} are of $k_i \times k_i$ dimension. $u_{i,}$ 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

$$A_{i0}z_{i,t} = a_{i0} + a_{i1}t + A_{i1}z_{i,t-1} + u_{i,t}, \quad (2)$$

where

$$z_{i,t} = (x_{i,t}, x^*_{i,t}), \quad A_{i0} = (I_{k_i}, -\Lambda_{i0}), \quad A_{i1} = (\Phi_{i1}, \Lambda_{i1}).$$

In order to solve the GVAR, we now define the vector $z_{i,t}$ in terms of the global vector $x_t = (x'_{0,t}, x'_{1,t}, ..., x'_{18,t})$ as

$$z_{i,t} = W_i x_t,$$

where W_i denotes a weight matrix, which helps transforming x_t into the earlier defined z_{it}. We employ fixed trade weights (see Table 5) for the construction of foreign variables. The weights represent the average total trade between country i and j relative to the total trade of country i with all countries in the sample over the years 1991 to 2007. What follows is the expression

$$A_{i0}W_i x_t = a_{i0} + a_{i1}t + A_{i1}W_i x_{t-1} + u_t. \quad (3)$$

By stacking all models, we get

$$G_0 x_t = b_0 + b_1 t + G_1 x_{t-1} + c_t, \quad (4)$$

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

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

Dividing (4) by G_0 yields

$$x_t = f_0 + f_1 + F_1 x_{t-1} + \epsilon_t, \tag{5}$$

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 represents our GVAR model, which we obtained from the single country models. In fact, we allow for cointegration and estimate VECMX models. Since every VECMX can be mapped back into a VARX representation, we explain only the general VAR case.

4.3 Shock identification

Many GVAR applications like Dees, Holly, Pesaran, and Smith (2007) use generalised impulse response functions. GIRFs have the advantage that they are invariant to the ordering of the variables, while showing the most likely responses of variables following a shock. However, the economic interpretation of those shocks is difficult. One alternative for the identification of structural shocks is the application of a recursive ordering scheme (see Sims (1986)), which is very controversial, particularly in the context of large models as ours, because it requires knowledge about the contemporaneous effects between all variables in the country specific model (see Luetkepohl (2007)).

We, therefore, apply the more agnostic sign restriction approach proposed by Eickmeier and Ng (2011), in order to identify a wage markup shock in Germany. The advantage of their procedure is that identified shocks are not correlated within countries and only weakly correlated across countries. This enables us to interpret a certain shock as country specific.

Following Eickmeier and Ng (2011), we impose sign restrictions using the algorithms outlined in Rubio-Ramirez, Waggoner, and Zha (2011) and Fry and Pagan (2007). Given the residuals from each model i, 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 $\psi^h = \phi^h G_0^{-1} P$. We draw random $k_2 \times k_2$ orthonormal matrices[3] 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. Restrictions are imposed on lags 0-4.

We identify a German wage markup shock by imposing restrictions on output, prices, real wages and the unemployment rate (see Table (3) for the theoretical responses according to models such as Gali, Smets, and Wouters (2011) or Marcellino and Rychalovska (2012)). First, we disentangle supply from demand shocks by assuming contrary responses of output and inflation. Secondly, labor supply and wage markup shocks are causing a decline in real wages, while technology shocks and price markup shocks are causing a higher real wages. Finally, the wage markup shock can be disentangled from a labor supply shock by taking the different responses of the unemployment rate into account.

All 100 obtained draws produce impulse responses, which satisfy our sign restrictions. However, not all draws are necessarily related to the same data generating process (DGR). Reporting measures like certain percentiles from the distribution of

[3] The index 2 refers to country 2, which is Germany ($k_2 = 8$).

Table 3: Shock profiles

Shock	y	Dp	wp	em	u	$reer$	r^*
labor supply	+	-	-	+	+	-	
wage markup	+	-	-	+	-	-	
price markup	+	-	+	+	-	-	
technology	+	-	+	-	+	-	
monetary policy	+	+	+	+	-	-	-
preference	+	+	+	+	-	+	

Note: Shock profile is normalized in the way that output improves. Signs correspond to the response 1 quarter following the shock.

these impulse responses as confidence bands may thus be a malpractice (see Fry and Pagan (2007)). Following Fry and Pagan (2007), we select the model, which produces impulse responses that are as close as possible to the median over all variables and continue our analysis by discussing the bootstrap of this model (1000 runs).

5 Results

In this section, we discuss the impulse response functions following a German wage markup shock and analyse the importance of the shock by decomposing its forecast error variance.

5.1 Analysis of the shock

Eickmeier and Ng (2011) point out that for interpreting a shock as country specific, a low pairwise correlation of residuals across countries is required. We, therefore, compute the correlation between residuals of German equations with the corresponding foreign counterparts.

By design, residuals of the country specific models are not correlated. However, we find correlation between the residuals across countries. The average absolute pairwise correlation across countries is 0.10. The maximum pairwise cross correlation is 0.25.

Overall, we find slightly higher correlation coefficients than Eickmeier and Ng (2011), which is a consequence of the chosen dataset. While we are focusing on the Eurozone, a highly integrated and relatively homogeneous economic area, Eickmeier and Ng (2011) model the whole world in which the Eurozone appears as a single country. Nevertheless, our coefficients are still very low, which allows us to interpret our isolated shock as a country specific shock that originates in Germany.

5.2 Impulse response functions

In Figure 3, we report the domestic impulse responses following a wage markup shock. The blue lines represents the median and the red lines correspond to the 90% confidence bands. Following a negative one standard deviation wage markup shock, real wages, inflation and the unemployment rate fall by definition, while output improves. We observe permanent effects on our variables following the wage markup shock and interpret this pattern as a consequence of the permanent reduction in marginal costs induced by the labor market reforms.

The positive and significant response of employment (approximately 0.3%) is in line with economic theory, as the marginal costs of firms increase.

Moreover, we find that the interest rate increases by 0.05%, which is at odds with the results shown in Gali, Smets, and Wouters (2011) as well as Marcellino and Rychalovska (2012). The reason for the positive response can be explained by taking foreign inflation into account. We find that foreign inflation rates do generally improve following a German wage markup shock.[4] As we are modelling a currency union with a common monetary policy, the positive response of the inflation rate is in line with the assumption that monetary policy is following a Taylor rule.

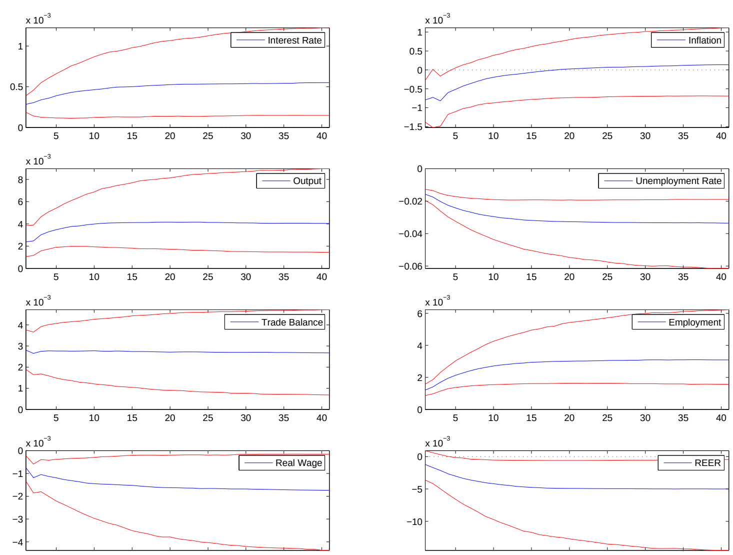
The real effective exchange rate depreciates by 0.5% following the wage markup

[4] Results are available on request.

shock, which is in line with the theoretical models. Note here that a negative response implies a depreciation of the exchange rate.

As the negative wage markup shock improves the competitiveness of Germany, we find a very significant improvement of the trade balance. The wage markup shock has a direct effect on unit labor costs and leads thus to a reduction in prices, which translates into an increase of the trade balance by almost 0.3%. The permanent effect is at odds with economic theory (see Schmitt-Grohe and Uribe (2003)). However, the trade balance to GDP ratio is a highly persistent variable, which explains our findings. Research testing intertemporal budget constraints does often not reject the unit root hypothesis, because of the high persistence in the underlying time series (see for example Liu and Tanna (1996)). Only non-linear or panel approaches such as Christopoulos and Leon-Ledesma (2010) or Wu (2000) find evidence of mean reversion.

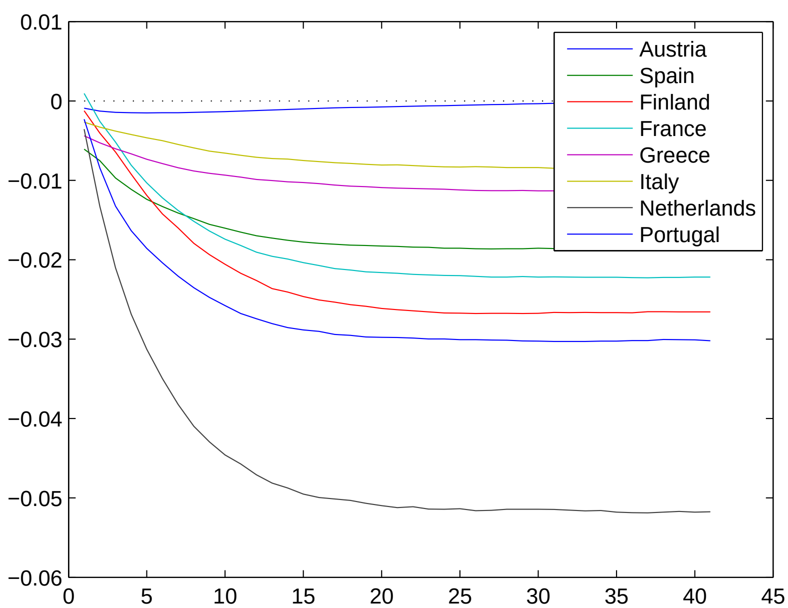
Figure 3: Domestic effects of a German wage markup shock



As we are interested in the effects of a German wage markup shock on European trade balances, we need to investigate the responses of foreign trade balances as well. Figure (4) shows that European trade balances generally deteriorate following the German shock. We report the corresponding 90% error bands in Figure 6. This is an important finding, as it implies that the negative German wage markup does not explain the imbalances shown in Figure (1). It may explain trade balance deteriorations of deficit countries, but it does not cause imbalances in a way that some countries' trade balances deteriorate, while others improve. Hence, German wage moderation cannot be the lone driver of European imbalances, as the responses do not show a pattern that corresponds to Figure 1.

As the impulse responses do not show how much of the trade balance fluctuations is explained by a German wage markup shock, we compute forecast error variance decompositions in the following section.

Figure 4: Responses of European trade balances (ex Germany)



5.3 Forecast Error Variance Decomposition

In this section, we compute the forecast error variances of European trade balances explained by a German wage markup shocks. These statistics show the importance of the German shock as a driver of European external balance fluctuations.

As stated earlier, German shocks are orthogonal, whereas foreign shocks are weakly correlated. Therefore, we focus our analysis on the explained share forecast error variance relative to other countries, rather than the share itself. We order the countries by the explained FEV following 1 year after the shock.

Table 4: Forecast error variance of trade balances explained by a German wage markup shock

Country	Impact	Year 1	Year 2	Year 5
deu	0.1869	0.1350	0.1294	0.1208
nld	0.0162	0.1032	0.0946	0.0872
gre	0.0193	0.0838	0.0962	0.0951
fra	0.0059	0.0706	0.0875	0.0880
esp	0.0303	0.0614	0.0677	0.0690
prt	0.0032	0.0519	0.0600	0.0619
aus	0.0286	0.0410	0.0230	0.0129
fin	0.0053	0.0336	0.0506	0.0600
ita	0.0209	0.0315	0.0420	0.0519

Table 4 displays the shares for all European external balances. Not surprisingly, the German wage markup drives the domestic trade balance the most. The share is particularly high on impact (18.7%), but decays over time. From all foreign trade balances, the Dutch, Greek and French balances are the most affected ones (around 9%). The Netherlands and France are direct neighbours, which can be explained by the proximity to Germany. The finding of a relatively high share for Greece is interesting, because Greece is the country with the lowest trade balance to GDP ratio in the sample. This result is in favour of the statements calling German wage moderation as an important driver of the Greek deficit. Spain, Portugal and Finland are similarly affected by the shock. Interestingly, the shares for Austria, another German neighbour, are relatively low.

Although we find that the German shock affects the domestic trade balance as well as foreign balances, we conclude that it is not of major importance. The shares of explained forecast error variance are relatively low all over the sample.

6 Robustness Checks

As a robustness check, we compare the bootstrapped model (following Fry and Pagan (2007)) with the IRFs obtained directly from the rotation matrices. Canova and Paustian (2011) show that the difference between the Fry and Pagan median and the median obtained directly from the rotation matrices can be large for certain shocks. In their case, the medians of a taste shock even had a different sign.

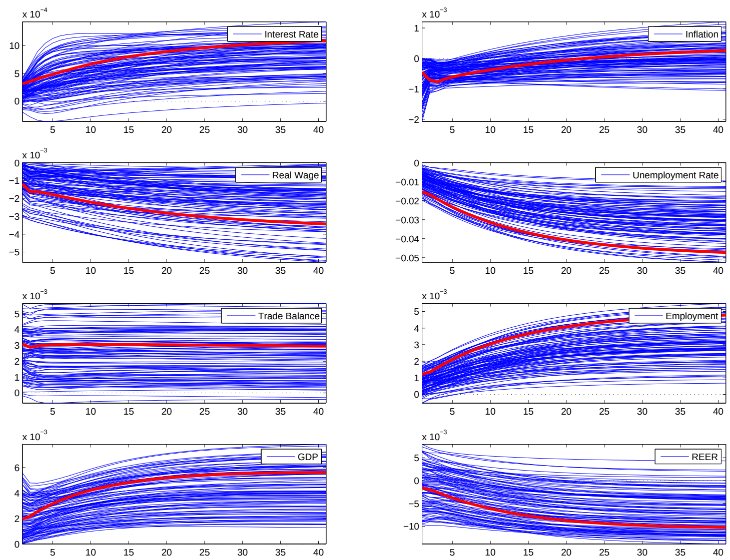
In Figure 5, we present the IRFs from all 100 rotation matrices and the Fry and Pagan median (red). Since the IRFs may result from different DGPs, the Figure is (up to a certain extend) also a measure of model uncertainty, while the error bands in Figure 3 only capture only estimation uncertainty in the selected model. Comparing Figure 5 and Figure 3 shows that the results are relatively similar. Consequently, our results a robust to the choice of both strategies.

7 Conclusion

This paper has sought to analyse the international propagation of a German wage markup shock with a focus on responses of international trade balances. We estimate a Global VAR model for the Euro Area where a German wage markup shock is identified by imposing sign restrictions on the impulse response functions of German variables.

We show that a German wage markup shock leads to an significant improvement

Figure 5: German impulse responses following a German wage markup shock



Note: The impulse responses are obtained directly from the rotation matrices.

of the domestic trade balance, while foreign trade balances deteriorate significantly. Hence, the German wage moderation during the 1990s cannot be the lone driver of the imbalances. Furthermore, forecast error variance decompositions of foreign trade balances, show that the explained variance by the shock is relatively low.

Consequently, positive German wage markups may not be sufficient to rebalance the Euro Area. This is an important finding for policy makers who search for strategies that may rebalance the EMU.

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A Data appendix

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. 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).

- **Employment**

  Data for employment comes from the OECD database (Ecowin: oe:<country code>_et_naq). We complete the Greek series with interpolated annual data (Ecowin: oe:grc_eta).

- **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 complete 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)

- **Trade Balance**

  We use the net exports (Ecowin: oe:<country code>_fbgsq) as well as the nominal GDP (Ecowin: oe:<country code>_gdpq) from the OECD database to construct the trade 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 Tables and Figures

Table 5: Trade-Weight Matrix

Country	aus	deu	esp	fin	fra	gre	ita	nld	prt
aus	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

Figure 6: Foreign trade balance responses following a German wage markup shock