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Abstract

This paper investigates the development of external imbalances from an international perspective by estimating a Global VAR model for the period 1981Q1-2009Q4 with a setup close to that of an international real business cycle model. The model considers 28 countries of which 10 are aggregated as the Eurozone. We compute generalized impulse response functions, as well as generalized forecast error variance decompositions, in order to measure the effects of shocks on international trade balances. The United States, Eurozone and China are considered as the sources of those shocks. We account for imbalances using real GDP, real effective exchange rates (REER) and real interest rates (RIR) as well as the oil price. Overall, we find evidence for the joint dynamics of our variables as drivers of the imbalances and relate our findings to theories of Global Imbalances. We show that real GDP is a relatively unimportant variable compared to the REER, RIR and the oil price. Moreover, we provide a counterfactual analysis of the US trade balance.

JEL Classification: F10, F32, F41.
Keywords: Global Imbalances, Global VAR, International Trade, Open Economy Macroeconomics.

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1 Introduction

In the early 1990s, external balances of several major economies began to widen considerably. The increased divergence of current account balances is known as Global Imbalances (GI). The economic analysis of this phenomenon has led to the question of how these imbalances could evolve. The objective of this research is to investigate drivers of trade balances from an international perspective by estimating a global vector autoregressive (GVAR) model, which allows us to measure the effects of country-specific shocks on international trade balances. Since the trade balance is an essential component of the current account, our research is related closely to the phenomenon of GI.

In this context, we let the data speak for itself and provide generalized impulse response functions (GIRFs) of shocks to real GDP of the United States (US), Eurozone and China on international trade balances. Additionally, we consider shocks to the US real effective exchange rate (REER) as well as the US real interest rate (RIR). Moreover, we measure the effect of a shock to the oil price on international trade balances. Additionally, we provide Generalized Forecast Error Variance Decompositions (GFEVDs) for the trade balances of the United States, the Eurozone and China. These empirical findings may help to illuminate the relevance of certain theories on GI.

Only a few authors have considered the multinational perspective of this phenomenon so far. We follow the ideas of Bussière, Chudik, and Sesteri (2009), but contribute in several ways to existing literature. First, we model trade balances rather than flows in order to measure the effects on exports and imports simultaneously. This links our research closer to the issue of GI, although we are still modeling trade balances, rather than current account balances. Secondly, we introduce the real interest rate (RIR) as a possible driver of trade balances. The new variable allows us to unveil the domestic and international effects of the real interest rate in the context of GI. Thirdly, we provide a disaggregated analysis of shocks to the oil price on international trade balances. Fourthly, we expand the dataset by the years of crisis 2008-2009 and focus on 28 countries, which are important in the context of GI. To the best of our knowledge, these achievements make this paper to the first comprehensive approach that provides statistical facts for the joint dynamics of the variables involved.

In our GVAR model, 10 countries are aggregated to a region, the Eurozone (EURO), so that we model effectively 19 countries (see Table (1)). Given this framework, we find that a positive shock to real GDP tends to worsen the domestic trade balance, while foreign trade balances tend to improve. A positive shock to the REER (depreciation) causes a trade deficit. At the same time, foreign countries experience trade surpluses. The responses to an oil price shock are not uniform from country to country. This reflects the role of oil as an imported good or exported good. Moreover, we find that a positive shock to the RIR translates into a trade surplus. The GFEVDs do generally support our findings. However, we find that shocks to real GDP are less important drivers of the trade balance than shocks to the REER, RIR or the oil price.

This paper is organized as follows. Section (2) provides a literature review covering the theories of GI and related empirical studies. In Section (3), we discuss the data and methodology. We perform an analysis of our data and present the results in Section (4). We show robustness checks in Section (5) and present our conclusions in Section (6).

2 Literature Review

Bracke, Bussière, Fidora, and Straub (2008) define GI as *"external positions of systemically important economies that reflect distortions or entail risks for the global economy"* (p.12). The authors point out that during the period of the gold standard, global imbalances in current accounts had already occurred. Now, for the first time in history, the creditors are emerging market countries, while the debtors are mainly advanced countries. Hence, the situation is a new one, as money is flowing "uphill".

These imbalances appear currently between advanced countries like the USA or the UK and Asia as well as oil-exporting countries like China or Saudi Arabia. First, we present theories which attempt to explain GI. We shall then discuss empirical studies which analyze specific theories.

2.1 Global Imbalances

Several authors have proposed different theories to explain GI. What most theories have in common is their focus on high US consumption rates and the high saving rates of Asian or oil-exporting countries.

Engel and Rogers (2006) propose an intertemporal model in order to explain GI. They find that the intertemporal model does not explain the current account deficit very well. According to their model, the US current account position is unsustainable. However, using survey data of future GDP growth, the fit of the model improves significantly. Hoffmann, Krause, and Laubach (2011) use growth expectations based on observed changes in productivity. It turns out that this approach leads to a model that fits the data very well.

Another theory, refers to the currency pegs of Asian economies to the US-Dollar. Dooley, Folkerts-Landau, and Garber (2003, 2004, 2009) argue that these currency pegs keep the relative prices of Asian goods at a low level and thus improve the region's trade balances. The literature calls this theory the Bretton-Woods II system because, after World War II, the Bretton-Woods system of fixed exchange rates kept the prices of European goods relatively low. This circumstance led Europe into prosperity.

By contrast, Bernanke (2005) argues that Asian countries increased their savings in the early 1990s. These savings flooded international capital markets and this led to a decrease in world interest rates. These low interest rates then stimulated US consumption and discouraged households savings. Consequently, the current account balance deteriorated. Moreover, high oil prices increased revenues in oil-exporting countries so that these countries became lenders on international financial markets. Hence, their current account positions improved remarkably.

However, the IMF (2005) points out that global saving rates have declined, rather than increased. Furthermore, investment rates of East Asian countries which were affected by the 1997 Asian Crisis dropped sharply to levels far below the saving rates. The theory of a global saving glut hypothesis is thus turned into an investment drought hypothesis.

Caballero, Farhi, and Gourinchas (2008) and Mendoza, Quadrini, and Ríos-Rull (2009) argue that financial integration, in combination with differences in the degree of financial market development, has led to GI. Both studies state that safe assets are scarce. Since the US is the biggest supplier of safe assets, savings from countries with less developed financial markets have been invested in the US. This led to low interest rates and thus low saving rates. Consequently, the US current account deteriorated.

Taylor (2008) argues that low interest rates are the result of a loose monetary policy rather than a global saving glut. During the 1990s, the FED kept the funds rate at levels far below what would have been suggested by the Taylor-Rule. According to Bems, Dedola, and Smets (1995), the low interest rates led to a decline in savings and thus, a trade deficit.

Laibson and Mollerstrom (2010) state that a global saving glut would have led to an increase in investment rather than consumption. Their model shows that global imbalances might be driven by asset bubbles. According to their theory, the appearance of an asset bubble affects household savings negatively and consumption positively. This model is in line with the findings of Case, Quigley, and Shiller (2005), who conclude that an increase of stock and house prices leads to an increase in private consumption.

2.2 Empirical Studies

Several authors have applied a structural VAR (SVAR) model with long-run restrictions following Blanchard and Quah (1989) for testing intertemporal models. Lee and Chinn (2006) estimate bivariate SVAR models using real exchange rate and current account data from the G7 countries. They find that temporary (i.e. monetary) shocks explain more of the current account variation than permanent (i.e. productivity) shocks and lead to an improvement of the current account. However, permanent shocks explain much less of the current account variation. Moreover, they lead (with the exceptions of Italy and the UK) to an improvement of a nation's current account. The latter finding violates the theoretical implication of many models. Karadimitropoulou and León-Ledesma (2009) provide a more comprehensive setup by distinguishing between temporary and permanent shocks to domestic net output, preference shocks and external supply shocks. With the exception of France, the authors find empirical evidence for the intertemporal model in the G6 countries (G7 minus the US). Moreover, they conclude that preference shocks and external supply shocks explain most of the current account fluctuations in their system.

Bracke and Fidora (2008) use a more general model for testing the theories of a loose monetary policy, a saving glut and an investment drought. They apply a SVAR model with sign-restrictions on the impulse response functions to identify different shocks. The authors account for monetary, preference and investment shocks which they relate to monetary policy, saving glut and investment drought hypotheses. The authors find that monetary shocks seem to be more important than preference or investment shocks. However, the disadvantage of their approach is that they only consider the United States and a huge aggregate representing the Emerging Markets. This approach does not allow us to draw any conclusions about the importance of specific countries in the Emerging Markets. Southeast Asia is for example an extremely heterogeneous region, meaning that one would expect different countries in the region to respond differently to specific shocks. Moreover, Bracke and Fidora do not account for other advanced economies like the UK or European countries.

Holinski and Vermeulen (2009) apply the GVAR model to find evidence for international wealth effects. Their hypothesis is that an increase of real equity prices affects domestic consumption positively, which again leads to a deterioration of the trade balance. They find evidence for their hypothesis in the cases of the United States, the United Kingdom and France. The authors show that real equity prices are at least as important as the REER for explaining trade balance movements. No evidence was found in the cases of Germany and Japan.

The IMF (2006) postulated a GVAR model to analyze the role of oil prices in the context of GI. The model consists of the United States, China and three large aggregates, namely other advanced countries, other developing countries and oil exporters. The IMF finds that oil price shocks have a positive effect on the external balances of oil exporters and a negative effect on the US trade balance in particular. However, the aggregation of advanced, developing and oil exporting countries does most likely overshadow important aspects of GI, because aggregates do not account for country-specific differences, so that the heterogeneity across the countries in these aggregates is not accounted for. A disaggregated perception of the world may be more helpful in this context as we are interested in identifying countries where an oil price shock has particularly strong effects on the current account (or trade balance).

Bussière, Chudik, and Sesteri (2009) use the GVAR framework for modeling global trade flows. They model real exports and real imports jointly, in combination with real GDP and the REER. Their dynamic analysis shows that a shock to US real output primarily affects the exports of neighboring countries (Canada and Mexico) as well as the European and Asian economies. Moreover, the authors show that an appreciation of the US REER would increase the exports of Japan and several European countries in particular. The impact of a shock to German GDP has positive effects mainly on exports of European countries, but also on those of the US. The authors' findings concerning a shock to Chinese imports on GDP and exports from other countries are only significant in the case of a few Asian countries.

3 The GVAR model

The GVAR modeling approach is relatively new and has been proposed by Pesaran, Schuermann, and Weiner (2004). It allows exploring international linkages of variables by linking country-specific VARX*(p_i,q_i) models of $i = 1, 2, ..., N$ countries with each other, where the X* denotes a vector of foreign variables which enter the country-specific VAR models. These models account for p lags of the domestic and q lags of the foreign variables. Hence, it is possible to explore international linkages between different variables and to trace shocks through a worldwide system of single country models. Pesaran and Smith (2006) show that the VARX*(p_i,q_i) models can be derived as solutions of dynamic stochastic general equilibrium (DSGE) models. Moreover, they demonstrate in this context that short-run and long-run restrictions can be imposed. Dees, Holly, Pesaran, and Smith (2007) build a GVAR on these findings and impose restrictions on the long-run relationships of several variables by identifying the cointegrating vectors of the country-specific vector error-correction models (VECM). An approximation of the GVAR model to a common factor model has been derived by Dees, di Mauro, Pesaran, and Smith (2007).

The estimation of our GVAR model follows a two-step approach. While country-specific VARX*(p_i,q_i) models are estimated separately in the first step, these models are then simultaneously linked with each other using trade weights in the second step. After an explanation of the variables, this methodology will be explained, as it is applied in the GVAR Toolkit (Smith and Galesi (2011)) which we use for the estimation.

3.1 Data and variables

We use data from different sources for the time period between 1981Q1 and 2009Q4. A detailed explanation of the data is provided in Appendix (A). The dataset contains 28 countries of which 10 are aggregated to a region, the Eurozone. Hence, 19 individual countries are effectively modeled.

The variables for the GVAR model are closely related to those of international real business cycle (IRBC) models such as Mendoza (1991). We include real GDP (y_{it}), the real interest rate (rr_{it}), the real effective exchange rate ($reer_{it}$), the trade balance (tb_{it}) and the oil price ($poil_t$). Additionally, the foreign real GDP (y^*_{it}) and the foreign real interest rate (rr^*_{it}) are included as exogenous variables into the system. These are defined as

$$y^*_{it} = \sum_{j=1}^{N} \omega_{ij} y_{jt} \qquad rr^*_{it} = \sum_{j=1}^{N} \omega_{ij} rr_{jt}$$

where ω_{ij} denotes the trade-weight of country i with j. Our trade-weights are fixed and represent the average total trade between country i and j over the years 2005-2007. Table (7) displays the trade shares for all countries.

Variable transformations are given by:

$$\begin{aligned} y_{it} &= ln(GDP_{it}) - ln(CPI_{it}) \\ rr_{it} &= 0.25 * ln(1 + R_{it}/100) - (ln(CPI_{it}) - ln(CPI_{it-1})) \\ tb_{it} &= ln(Exports_{it}) - ln(Imports_{it}) \end{aligned}$$

where R_t represents the annualized nominal interest rate. The REER is constructed as proposed by Dees, Holly, Pesaran, and Smith (2007). First, the nominal exchange rate of United States to the US-Dollar is normalized to 1. Afterwards, the country-specific real effective exchange rates ($reer_{it}$) can easily be computed using the domestic (e_{it}) and foreign (e^*_{it}) logs of the nominal exchange rates to the US-Dollar as well as consumer price indices (p_{it} and p^*_{it}):

$$\begin{aligned} reer_{it} &= \sum_{j=0}^{N} \omega_{ij}(e_{it} - e_{jt}) + p^*_{it} - p_{it} \\ &= e_{it} - e^*_{it} + p^*_{it} - p_{it} \end{aligned}$$

Note here that in the case of the United States, the log nominal exchange rate (e_t) is 0. The Eurozone countries are aggregated using PPP-GDP weights based on the average value of the years 2005-2007. The regional variables are computed as

$$y_{it} = \sum_{l=1}^{N_i} \omega^0_{il} y_{ilt} \qquad rr_{it} = \sum_{l=1}^{N_i} \omega^0_{il} rr_{ilt},$$

$$reer_{it} = \sum_{l=1}^{N_i} \omega^0_{il} reer_{ilt} \qquad tb_{it} = ln\left(\sum_{l=1}^{N_i} Exports_{lt}\right) - ln\left(\sum_{l=1}^{N_i} Imports_{lt}\right)$$

where the GDP-PPP weight ω^0_{il} defines the weight of each country l within region i. The trade balance is modeled differently, because the standard method would place weights (according to the PPP-GDP of the single country) on the different surpluses or deficits. A surplus in Germany would for example be more important than a surplus in the Netherlands. The different weights would thus lead to a major bias, as the trade balance of each country is modeled as the log ratio of exports over imports. Therefore, we compute the Eurozone trade balance as log of the total exports minus the log of total imports. These variables enter the country-specific models, which consist of a vector of domestic variables (x_{it}) as well as a vector of foreign variables (x^*_{it}).

Table (2) explains the specification of the vectors of our model. The only exception from the table is Saudi Arabia, where no data of the nominal interest rate was available. Moreover, it is important to note that the oil price is treated as endogenous in the US model. This is justified by the large share of demand for oil coming from the United States. In all other countries, the oil price enters the model as an exogenous variable. Foreign trade balances are not included as exogenous variables into the model, as the computation of a trade weighted aggregates of our foreign trade balances would not reflect the foreign trade balances, but a mismatch of those. Moreover, we avoid any sort of double deliberation.

3.2 Step one: Estimating the single-country models

We use a lag order of $p = 2$ and $q = 1$ for our VARX*(p_i,q_i) models in order to keep the model parsimonious, while reducing serial correlations as much as possible. The VARX*(2,1) models can be written as

$$x_{it} = a_{i0} + a_{i1}t + \Phi_{i1}x_{i,t-1} + \Phi_{i2}x_{i,t-2} + \Lambda_{i0}x^*_{it} + \Lambda_{i1}x^*_{i,t-1} + u_{it}, \tag{1}$$

where a_{i0} denotes the coefficients of constants and a_{i1} the coefficients of time trends.[1] Φ_{il} and Λ_{il} are $k_i \times k_i$ coefficient matrices for the vectors of domestic and foreign variables. The error-term $u_{i,}$ is a $k_i \times 1$ vector and assumed to be IID and have a zero mean with a covariance matrix Σ_{ii}.

We now define $z_{i,t}$ as a $(k_i + k^*_i) \times 1$ vector of the domestic and foreign variables as

$$z_{i,} = \begin{pmatrix} x_{i,} \\ x^*_{i,} \end{pmatrix}.$$

Substituting it into (1) yields

$$A_{i0}z_{i,t} = a_{i0} + a_{i1}t + A_{i1}z_{i,t-1} + A_{i2}z_{i,t-2} + u_{i,t}, \tag{2}$$

where

$$A_{i0} = (I_{k_i}, -\Lambda_{i0}), \quad A_{i1} = (\Phi_{i1}, \Lambda_{i1}), \quad A_{i2} = (\Phi_{i2}, 0_{k^*_i}).$$

In order to allow for cointegration relationships, we derive the VECMX* representation of our VARX*(2,1) model, which is given by

$$\Delta x_{i,t} = a_{i0} + a_{i1}t - (I - \Phi_1 - \Phi_2)x_{i,t-1} - \Phi_2\Delta x_{i,t-1} + \Lambda_0 x^*_1 + \Lambda_1 x^*_{t-1} + u_{i,t}.$$

This simplifies to

$$\Delta x_{i,t} = a_{i0} + a_{i1}t - \Pi_i z_{i,t-1} - \Gamma_1\Delta z_{i,t-1} + \Gamma_0 z_{i,t} + u_{i,t},$$

[1] Although economic theory suggests that rr, $reer$ are stationary, we include a linear trend in all models. Our sample starts in 1981. From then on, real interest rates for example follow a downward trend. Without using a trend, the coefficients of the VECM would catch it up and produce misleading impulse responses. Estimates without a trend demonstrate exactly this behavior, meaning that the trend is found to be atheoretic, but empirically necessary.

where

$$\Pi = (I_{k_i} - \Phi_1 - \Phi_2, \Lambda_1), \quad \Gamma_0 = (0_{k_i}, \Gamma_0), \quad \Gamma_1 = (\Phi_2, 0_{k_i^*}).$$

The rank (r_i) of the matrix Π_i denotes the number of cointegration relationships in country i. Assuming that the rank is smaller than $k_i + k_i^*$, the matrix may be defined as $\Pi_i = \alpha_i \beta_i'$. Then, α_i denotes a $(k_i + k_i^*) \times r_i$ adjustment matrix, whereas β_i denotes a cointegration matrix of similar dimension. In order to take the trend into the cointegration space, we define a_{i1} as $\Pi_i \Upsilon_i$, which yields the final VECMX* equation

$$\Delta x_{i,t} = c_{i0} - \alpha_i \beta_i'(z_{i,t-1} - \Upsilon_i(t-1)) + \Gamma_1 \Delta z_{i,t-1} + \Gamma_0 z_{i,t} + u_{i,t},$$

where $c_{i0} = a_{i0} + \Pi_i \Upsilon_i$. Table (3) displays the number of cointegration relationships for each country model. Since a VECM can be mapped back into a VAR representation, this paper continues with the representation given by equation (2).

3.3 Step two: Solving the GVAR

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 matrix of identity matrices, zeros and trade weights with a dimension of $(k_i + k_i^*) \times k$ (here: $k = \sum_{i=0}^{N} k_i = 76$). Given the global vector x_t, W_i yields exactly the same vector z_{it}, which we defined earlier. The vector x_t has a dimension of 76×1 and contains the domestic variables of all countries. It is important to recall at this point that the oil price is endogenous only in the US model, but exogenous in all the other models and that rr is omitted in the Saudi Arabian model. Hence, we get the expression

$$A_{i0} W_i x_t = a_{i0} + a_{i1} t - A_{i1} W_i x_{t-1} - A_{i2} W_i x_{t-2} + u_t. \tag{3}$$

When stacking all the country models, we obtain the equation

$$G_0 x_t = b_0 + b_1 t + G_1 x_{t-1} + G_2 x_{t-2} + c_t, \tag{4}$$

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

$$G_0 = \begin{pmatrix} A_{00}W_0 \\ A_{10}W_1 \\ \vdots \\ A_{N0}W_N \end{pmatrix}, \quad G_1 = \begin{pmatrix} A_{01}W_0 \\ A_{11}W_1 \\ \vdots \\ A_{N1}W_N \end{pmatrix}, \quad G_2 = \begin{pmatrix} A_{02}W_0 \\ A_{12}W_1 \\ \vdots \\ A_{N2}W_N \end{pmatrix}$$

Now, we divide equation (4) by G_0, which yields

$$x_t = f_0 + f_1 + F_1 x_{t-1} + F_2 x_{t-2} + \epsilon_t, \tag{5}$$

where

$$f_0 = G_0^{-1} b_0, f_1 = G_0^{-1} b_1, F_1 = G_0^{-1} G_1, F_2 = G_0^{-1} G_2, \epsilon_t = G_0^{-1} c_t.$$

Equation (5) represents our final GVAR model.

3.4 Generalized Impulse Responses and Generalized Forecast Error Variance Decompositions

A common approach for the estimation of impulse responses in structural VAR models is to follow Sims (1980) and to impose $k(k-1)/2$ restrictions in the form of a Cholesky decomposition on the variance covariance matrix (see for example Sims (1986)). Others impose long-run restrictions (see for example Blanchard and Quah (1989)), or directly restrict the impulse responses (see for example Uhlig (2005)). These restrictions give the shocks an economic interpretation and thus have implications for policy makers.

We employ generalized impulse response functions (GIRFs), in order to investigate the effects of shocks. These GIRFs were introduced for nonlinear models by Koop, Pesaran, and Potter (1996) and for linear multivariate models by Pesaran and Shin (1998). The advantage of this method is that the impulse responses are invariant to the ordering of the equations. However, shocks are not orthogonalized, so that they cannot be interpreted in the same way as for example structural shocks. The GIRFs show us what is most likely to happen after a shock to the l^{th} equation in country i. Hence, no direct policy implication result from these responses. However, they are still informative in the manner that they demonstrate the most likely effects of certain shocks.

In order to analyze the proportion of forecast error variance of the trade balance that is explained by shocks to variables in our system, we perform a generalized forecast error variance decomposition (GFEVD). The philosophy of the GFEVD is related to the GIRFs. Shocks are not orthogonalized, meaning that the output is invariant to the ordering of the equations. Since we are allowing for correlations between different shocks by using a non-diagonal covariance matrix, the GFEVDs do not sum to 1. Hence, they cannot be interpreted as the relative contribution of a shock to the forecast error variance. We refer to Dees, Holly, Pesaran, and Smith (2007) for a detailed explanation of the GFEVD.

4 Data Analysis

We now analyze our results. First of all, the country weights and thus the importance of specific countries within the model will be discussed in order to gain an understanding of the model dynamics. Moreover, we test possible cointegration relationships. Additionally, we perform tests for weak exogeneity. Afterwards, structural instabilities will be identified so that possible biases are known and can be accounted for. Thereafter, a dynamic analysis of shocks to variables of the system may be performed.

4.1 Trade and Aggregation Weights

As explained earlier, the core of the GVAR model is a trade weight matrix which has a dimension of 19×19, as the Eurozone is treated as a single country (see Table (7)). Not surprisingly, the Eurozone and the United States, followed by China, the United Kingdom and Japan are the key economies or our system.

The matrix exhibits that the linkages between these economies are particularly strong, as the trade shares are relatively high. Moreover, the table unveils strong border effects. China's column displays particularly high trade shares with other countries of the Asia-Pacific region. Consequently, the main dynamics in our model are expected to occur between these economies.

4.2 Long-Run Relationships, Persistence Profiles and model stability

The VECM representation of the VARX*(2,1) country models allows for cointegration relationships between the variables. As shown in Table (3), we changed the rank suggested by the Johansen trace test in four cases, in order to maintain model stability and to account for economic theory. The persistence profiles show that all considered vectors are cointegrating vectors, as the values of the persistence profiles are converging towards zero (see Figure (2)). GIRFs are stabilizing quickly, which is a desirable property in terms of model stability (see Figures (3)-(8)).

As we have exactly 55 eigenvalues lying on the unit-circle and 97 with moduli smaller than 1, we conclude that our model is stable. For the estimated model, economic theory suggests several possible long-run relations. First, domestic and foreign output may converge, which would imply that a linear combination of both variables may be stationary. Second, Purchasing Power Parity may hold, which implies stationarity of the REER. Third, the real interest rate might be stationary following the Fisher equation. Fourth, stationarity might apply to the trade balance. However, the latter case is questionable as the trade balance is not given as ratio of GDP. As explained in section (3.2), we found it necessary to have an atheoretical linear trend in the cointegration relationships. As this atheoretical trend would lead to atheoretical cointegration vectors, we have not imposed restrictions on the

β-vectors/matrices.

4.3 Weak Exogeneity

Since the VARX*(p_i,q_i) models include foreign variables as exogenous, an assumption is that domestic variables have no impact on their foreign equivalents. The validity of this assumption has been tested following Johansen (1992) and Harbo, Johansen, Nielsen, and Rahbek (1998). Overall, two cases in which the foreign variables seem to be endogenous have been identified (see Table(4)). However, as there is no reason to believe that world income is endogenous in South Korea or that world real interest rate is endogenous in Mexico, it is appropriate to assume that these results are biased by the small size of the sample. No statistics are provided for Norway, Saudi Arabia, and South Africa, because we have no cointegration relationships in these country models. Consequently, the test for weak exogeneity could not be performed. As those economies do not play a major role in the world economy, it is reasonable to assume exogeneity of their foreign variables.

4.4 Structural Stability

In macroeconomic modeling, structural stability is an important issue. Economic crises or policy changes appear with a relatively high frequency and lead generally to significant changes of a time series' history. Dees, di Mauro, Pesaran, and Smith (2007) emphasize that the GVAR model does not overcome this problem. However, the fact that foreign variables enter the VARX*(p_i,q_i) models makes this methodology more resistant to structural breaks than reduced-form single-equation models. The reason for this desirable behavior is that the VARX*(p_i,q_i) models accommodate for co-breaking which is described in Hendry and Mizon (1998). The intuition behind this phenomenon is that if a structural break is transmitted into foreign countries, then the information about the break is already included in the foreign exogenous variable. This is because the GVAR model allows for a contemporaneous effect from foreign variables on domestic ones.

As there is no consensus on how to test for the stability of model parameters, this research follows Dees, di Mauro, Pesaran, and Smith (2007) by performing several stability tests. We test for the time-varying stability of the model parameters using the maximal OLS cumulative sum (CUSUM) statistic (PK_{sup}) by Ploberger and Krämer (2006) as well as the mean square variant (PK_{msq}). Moreover, we consider a test for parameter consistency by Nyblom (1989), which accounts for a non-stationary alternative parameter evolution, in the form of a martingale process. Additionally, we identify structural changes by computing the Wald form of the likelihood ratio statistic (QLR) by Quandt (1960). Furthermore, the mean Wald statistic (MW) is reported, as described in Hansen (1992) and Andrews and Ploberger (1994). Finally, we provide the Wald statistic (APW) by Andrews and Ploberger (1994), which is based on the exponential average. For all statistics, but Ploberger and Krämer (2006), robust versions which allow for heteroscedasticity are reported supplementary. The statistics in Table (5) show how often structural stability could not be verified.

The results are quite heterogeneous and show that in particular, Nyblom, QLR, MW and APW report relatively high rejection rates. While PK_{sup} and PK_{msq} seem to be very stable with about 13% and 11%, all other tests show total rates above 24%. However, when allowing for heteroscedasticity, the results improve substantially. Inspite of the robust Nyblom test, all other rates fall below 25%. Consequently, a huge proportion of the identified breaks reflect breaks in the error variance, rather than the coefficients. Since most of the breaks appear in the GDP series, the pattern might be caused by the Great Moderation. Hence, it is reasonable to follow Dees, di Mauro, Pesaran, and Smith (2007) by using bootstrapped values and confidence bands for the interpretation of the GIRFs. In the given case of structural instability, an interpretation of the point estimates would yield misleading results.

4.5 Dynamic Analysis

In this section, we perform a dynamic analysis of our model. Given the large size of our model, we focus on a smaller set of countries and shocks which we find to be important in the context of GI. First, we estimate GIRFs of shocks to specific variables. Secondly, we perform GFEVDs for quantifying the amount of forecast error variance, which is explained by shocks to variables of our system. We focus in particular upon the effects of shocks to the US, European and Chinese real GDP. Moreover, we simulate a shock to the US REER, in order to investigate its effects on the international trade balances. Additionally, we discuss the role of the RIR on the domestic and international level. Generalized forecast error variance decompositions (GFEVD) for the US, Chinese and Eurozone trade balances are also provided. Additionally, we provide a counterfactual simulation of the US trade balance. The presented GVAR was estimated using time series by Abeysinghe and Rajaguru (2004) for the Chinese, Thai and Malaysian real GDP instead of the interpolated series, as well.[2] However, the impulse responses had a very similar pattern, while the error bands were wider in several cases. Using only the entirely interpolated data from Smith and Galesi (2011) led to a much more pronounced output. Therefore, we analyze the model with interpolated data. The error bands represent the 90% confidence intervals (1000 draws). Additionally, we show a counterfactual simulation of the US trade balance.

4.5.1 A positive shock to United States real GDP

Following an 1SD shock, the US real GDP increases by 0,5%. Figure (3) illustrates that the shock to real GDP leads to a deterioration of the US trade balance. However, the shock does not affect the trade balance contemporaneously. We observe an insignificant temporary decrease of approximately 0,6%. Corresponding significant increases of foreign trade balances can be found in China, the Eurozone, Japan and Thailand. In China, the trade balance increases by about 1,9%, while the confidence bands are relatively wide. In

[2]Results are available on request.

the Eurozone the pattern is different. The shock is significant only in the short-run, having its largest impact (+0,3%) in the second quarter after its occurrance. Moreover, significance is given only contemporaneously, and during the first two quarters following the shock. A similar, but more pronounced pattern can be observed in Japan, where the trade balance increases significantly over the first two quarters. The impact reaches its maximum in the second quarter with an increase of approximatly 0,8%. The Thai trade balance responds in a significantly positive manner only during the first quarter, while the effect shows its highest impact (+0,8%) contemporaneously to the shock. South Korea is another country which clearly shows a positive reaction to the shock. However, it is not significant.

International Real Business Cycle (IRBC) models, which allow not only for intertemporal utility maximization of households, but also for investment decisions of firms, can explain this pattern. Baxter (1995) for example provides a theoretical model which is able to explain this behavior. Additionally, Baxter (1995) provides stylized facts of business cycles in several countries. She demonstrates that savings and investments are supposed to be procyclical. But if the decrease in investments dominates the decrease in savings, the trade balance becomes countercyclical and this is commonly the case. Other authors like Mendoza (1991) or Correiaa, Neves, and Rebelo (1995) present similar findings. Bussière, Chudik, and Sesteri (2009) provide empirical evidence for a significant increase in US imports by approximately 2% after one year, but not for the effect on exports. Hence, we cannot draw any conclusions about the trade balance. However, Bussière, Chudik, and Sesteri (2009) find no evidence for a significant effect on Asian exports, apart from Singapore. This is suprising, as in our model China and Japan belong to the group of countries which are affected the most.

Overall, we find that the effects of shocks to the US real GDP have only a short-lived impact on trade balances. In the cases of China and the Eurozone, we observe a similar behavior (see sections (4.5.2) and (4.5.3)).

4.5.2 A positive 1SD shock to Chinese real GDP

The 1SD shock to real GDP corresponds to an increase of 0,9%. Although the effect of a shock in China does not have a significant effect on the domestic trade balance, Table (4) shows that the median GIRF is similar to the corresponding shock in the United States. The trade balance deteriorates during the first two quarters and starts to improve again after the second. Significant reactions can be observed in Japan, South Korea and the Eurozone. While the balance of the Eurozone (+0,2%) responds only contemporaneously, Japan (+0,8%) shows a significant improvement which lasts for the first 2 quarters following the shock. The effect in South Korea (+0,5%) is significant only in the quarter which follows the shock. Hence, it can be observed that the proximity to China appears to play a certain role when discussing the impact of income shocks on trade balances. Other countries which are worth mentioning in this context are New Zealand and Thailand, countries whose trade balances do not improve significantly, but which show a clearly positive reaction to the

Chinese shock. This finding is interesting because the trade linkages between China and its developed neighbor countries Japan and South Korea seem to be particularly strong. New Zealand and Thailand belong to the Asia-Pacific region as well, which provides further evidence for the existence of intraregional trade linkages in Asia. The reason for this is the increasing integration of trade among Asian economies, which is mainly caused by the creation of intraregional supply chains by multinationals (see for example Sally (2010)). Evidence for a positive effect on the United States cannot be found.

4.5.3 A positive 1SD shock to Eurozone real GDP

Due to an 1SD shock to the Eurozone, real GDP increases by 0.3%. Before analyzing the effects of this increase, it is important to recall that not all member countries of the Eurozone are part of this aggregate. Nevertheless, the largest economies are included, meaning that our results are not seriously biased. Figure (5) demonstrates that the positive shock does not have a significant effect on the European trade balance. However, the trade balance becomes negative after 2 quarters and then stabilizes. Positive effects can be observed in China, India, Japan, South Korea, the United Kingdom and United States. However, the trade balances respond insignificantly to the shock.

4.5.4 A positive oil price shock

Our results demonstrate that the oil price increases by 9,7% due to a positive 1SD shock. As argued earlier, the effect of a positive shock to the oil price on the trade balance is expected to depend upon a countrie's economic structure. The trade balance of oil-exporting countries are supposed to increase with a price rise, while those of oil importing countries deteriorate. Oil-neutral countries, e.g. economies which do not depend on foreign oil resources, should not be affected by a shock. However, this effect might be overshadowed by exchange rate movements, as the oil price is usually denominated in US-Dollar.

Our results (see Figure (6)) show that a positive oil price shock affects the balances of the UK (+0,5%), Norway (+1,3%) positively. The trade balances react contemporaneously to the shock. In Japan (-2,0%), South Korea (-2,3%), Thailand (-2,2%) and the United States (-1,0%), the effect on the trade balances is relatively strong. Significant short-run effects can be observed in the Eurozone, India, Singapore and the United States. The trade balance of the Eurozone deteriorates significantly during the first 2 quarters after the shock by approximately 0,3%. In India, this effect is significant only contemporaneously, while it can also be observed in Singapore during the first and second quarter following the shock.

The GIRF show that the effect of an oil price shock on the trade balance is extremely heterogeneous and that aggregating specific groups of countries would cause misleading results. Even among oil-exporting countries, the effects are heterogeneous. The IMF (2006) finds similar results for the current account of the United States, China and an aggregate of oil-exporting countries. For the aggregates with other advanced and developing countries, the current account deteriorates. Moreover, the IMF argues that the effect is relatively short-lived. We observe this behavior only in a few cases. The reason for this could be the 95% confidence level of the error-bands used by the IMF.

4.5.5 A positive 1SD shock to United States REER

The positive 1SD shock corresponds to a 1,5% depreciation of the REER. Unsurprisingly, the depreciation of the US REER leads to a significant trade balance surplus in the United States, while the foreign balances tend to deteriorate (see Figure (7)). The US balance reacts contemporaneously to the shock and increases in total by approximately 2,2% after 15 quarters. After 4 years, the trade balance starts to decrease slowly. In this situation, however, the uncertainty represented by the confidence bands is very large and the persistence relatively high. Hence, we do not find any evidence for the so called J-curve effect (see Magee (1973)). Holinski and Vermeulen (2009) measure a similarly strong and persistent effect on the trade balance, while Fratzscher, Juvenal, and Sarno (2010) find evidence for a much less pronounced effect with a lower persistence. The differing results may be explained by the fact that the latter study measures the trade balance as a ratio of GDP, rather than exports as ratio of imports. Elsewhere, we find significant deteriorations in Australia, Japan and Thailand. The effect seems to impact the Australian trade balance only in the short-run (quarter 1). In this quarter, the median response indicates a deterioration of about 0,4%. In Japan, the decline becomes significant 1 year after the shock and tends to have a long-run impact of about 1,3%. In Thailand, the effect is slightly larger (1,4%) than in Japan. This result becomes signficant in the first quarter following the shock. In all the other countries, the shock does not have a significant impact on trade balances. However, their balances tend to deteriorate, generally.

4.5.6 A positive shock to the United States Real Interest Rate

Following an 1SD shock, the US RIR increases by 0,3%. Figure (8) shows that the positive shock to the US RIR leads to a significant trade surplus in the US (+1.5%). This finding implies that an increase of the RIR translates into a decrease in investments and thus a trade surplus. Taylor (2008) argues in this context, that the US should then have experienced an investment boom, rather than a consumption boom, which was not the case. However, the RIR can also be interpreted as an asset price. If the RIR is low, the price of an asset is high (*et vice versa*). This interpretation is closely linked to Taylor's theory of a loose monetary policy. However, Shiller (2007) argues that this relationship is tenous, as asset prices do not necessarily reflect their fundamentals. Nevertheless, in this case, the so called international wealth-channel, which is found to be particularly strong in the United States (see for example Fratzscher and Straub (2010) and Holinski and Vermeulen (2009)), may explain trade balance's response. The positive shock to the RIR corresponds to a negative asset price shock, which reduces household wealth and consumption, while improving the trade balance. However, as we cannot control for these other variables, our interpretation should not be taken as unequivocal.

Elsewhere, we find significant positive responses in South Korea (+0,7%) as well as Singapore (+0,4%). Since we do not identify the shocks, we cannot specify the causes of these responses. They could either be caused by capital outflows to the United States, or by asset price spillovers from the United States. The trade balance of New Zealand is the only one which shows a significant negative response (-0,6%) in accordance to the US deficit.

The literature finds no clear evidence for the international effects of the RIR. Mendoza (1991) for example presents a model which predicts that shocks to the world real interest rate have almost neutral effects on a small open economy. However, he also states that the effect might be stronger in highly indebted small open economies. Kose, Blankenau, and Yi (1999), however, present evidence that shocks to the world real interest may have strong effects on the domestic trade balance. They argue that there is no unique proxy for the real interest rate, meaning that these results cannot be treated with certainty.

4.6 Generalized Forecast Error Variance Decomposition

In this section, we discuss the GFEVDs of different trade balances. We shall focus on the United States, Eurozone and China, because these countries are the world's largest economies and of major importance in the context of external imbalances. Our model consists of 76 equations, meaning that we obtain the same number of possible determinants for each trade balance. In order to minimize the output, without losing important information, we report the 10 most important determinants, ordered by their contribution to the forecast variance 10 years after the shock. The Tables (8)-(10) display these 10 variables in the corresponding country. We find in all three cases relatively high percentages for the domestic trade balances, which implies that the trade balance itself explains a lot of its own forecast error variance. Hence, the effect of other variables on the trade balances in our systems might not be very high. Bussière, Chudik, and Sesteri (2009) find a similar high persistence in the case of the US real imports. However Holinski and Vermeulen (2009) find a much lower persistence in the US.

Nevertheless, the statistics show that shocks to the domestic REER and RIR are important determinants of the US trade balance in the long-run. In the short-run, the oil price and output play an important role, as well. Important foreign determinants are the Saudi Arabian and Malaysian REER. This finding is not surprising, because both currencies are pegged to the US-Dollar. However, the explanatory power of other variables is relatively low. In the case of China, we find that the domestic REER and RIR are almost unimportant in the short-run. After 2 years, the explanatory power of several variables increases significantly. Besides the REER and RIR, the statistics indicate the relatively high importance of US output and REER. The oil price plays a role in this, as well. In the Eurozone, we find slightly different results. Here, the domestic RIR is an important determinant of the trade balance in the short-run and long-run. Other variables with a relatively high explanatory power in the short-run are the oil price and the US domestic output. Interestingly, domestic REER does not account for much of the trade balance. This finding might reflect the high percentage of intraregional trade in the Eurozone.

4.7 Counterfactual Simulation: Historical Decomposition

As the GVAR methodology explicitly allows for international linkages, we are able to analyze the effects of changes in errors of domestic or foreign equations on the motion of a specific time series. This can be achieved by choosing a specific base point (B) in our sample, from which on 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 only the errors of a specific equation (j) are known and add their contribution to the base projection for every point in time, then we obtain a time series which shows what would have happened, if the series under investigation was entirely driven by shocks to equation j.

This method is best explained using the Wold Decomposition of a VAR process

$$y_{B+h} = \sum_{i=0}^{h-1} \phi_i \epsilon_{t+h-i} + \phi_{h-1} y_B, \tag{6}$$

where ϕ_i denotes the i-th moving average parameter as shown by Lütkepohl (2005). This methodology is often applied in the context of SVAR models, where a manipulation of structural errors allows us to create data which might, for example, only be driven by monetary policy shocks. This is, however, not possible in our GVAR framework, where the errors are non-orthogonal and correlated. Hence, we not only need to know the future shocks, but also their cross-correlations. Consequently, an interpretation of the shocks as let's say monetary policy shocks is, as in the case of GIRFs, not possible. Nevertheless, this exercise may provide interesting facts regarding the importance of certain errors.

Since each series is driven by 76 shocks, we limit our analysis to the contribution of the US REER errors to the US trade balance. According to the GFEVD, the US REER are errors the most important drivers after the own shocks. We derive the new time series as follows. First, we manipulate the estimated error terms of the country-models. For obtaining a dataset, which is from time B onwards entirely driven by shocks to the US REER, we keep the future errors of this equation and set all the other errors in c_t to zero. Secondly, we allow for cross-correlations of the errors by computing $\epsilon_t = c_t G_0^{-1}$. Thirdly, we perform a h-step ahead forecast starting at time B for all k endogenous variables in our system. Fourthly, we compute the contributions of the known errors for every observation from B to $B+h$ and add them to the base projections. Given the actual data, the base projection and the counterfactual series, we may draw conclusions about the historical importance of certain shocks.

Figure (1) shows the deviation of the actual data as well as the counterfactual series from the base projection. The residuals of the US REER equation seem to be very informative in the context of the US trade balance. They explain much of the trade balance's fluctuations around the base projection, but do not capture the low in 2006. Hence, our results provide additional support for the hypothesis that the US REER was an important driver of the trade deficit. However, it seems as if the exchange rate became less important after 2003. This result is in line with the findings by Lane and Milesi-Feretti (2011), who argue that the adjustment of GI has mainly been caused by demand and output, rather than real exchange rate adjustments.

5 Robustness Checks

In order to investigate the robustness of our results, we perform different analyses. First, we exclude the financial crisis from our sample and reestimate the model for the period 1981Q1-2007Q2. This exercise may show us if the recent crisis has any impact on our findings. Overall, we do not observe a significant change of the results.[3] Secondly, we check if the application of a time-varying weighting scheme would lead to different results. Since there is no trade flows data available for all countries in the sample, we compute foreign aggregates with time-varying weights for a small selection of countries. Table (6) shows that foreign variables computed by time-varying weights and fixed weights are highly correlated. We find no evidence for a serious bias in our series, therefore.

6 Conclusion

This paper has sought to identify the international drivers of trade balances by estimating a Global VAR model for 19 countries. We have considered shocks to real GDP, REER, RIR and oil price as possible determinants of international trade balance fluctuations. Our results reveal the joint dynamics of the variables involved, which can illuminate the relevance of certain channels in the emergence of GI.

First, we have shown that a positive shock to real GDP causes a deterioration of the trade balance. Besides this, the GFEVDs imply that shocks to real GDP are relatively unimportant determinants of the trade balance forecast error variance. Our findings support the hypothesis that the trade balance is a countercyclical variable. This finding is at odds with the literature which finds evidence for the intertemporal model. Nevertheless, in this context, it is important to consider the different time-profiles of the shocks, as we are working with data in levels.

[3] Results for the shorter sample are available on request.

Secondly, we have provided evidence for the importance of shocks to the exchange rate for trade balance fluctuations in the United States and China, but not in the Eurozone. The GIRFs show that the US and Chinese trade balances respond markedly to exchange rate movements. The counterfactual analysis of the US trade balance shows that shocks to the US REER explain a lot of the trade balances' history. These facts offer support for the Bretton-Woods II theory by Dooley, Folkerts-Landau, and Garber (2003, 2004, 2009) and do not deviate substantially from other studies such as Holinski and Vermeulen (2009). However, we have noted that trade balances respond slightly more strongly. This could be explained by the different computation of the REER.

We have also shown the RIR to be another important determinant of the trade balance. Our results demonstrate that a positive shock to the US RIR causes the domestic trade balance to respond positively. A plausible explanation of this behavior is provided by the asset-bubble theory of Laibson and Mollerstrom (2010), with the provision that we interpret the RIR as an asset price. Thus far, several authors have found strong evidence for the importance of asset prices as a driver of trade balances. However, our interpretation of the RIR as an asset price indicates that the (low) interest rate itself is another important variable in this context, as it has been proposed by Taylor (2008).

Finally, our results demonstrate the importance of oil price shocks for trade balance fluctuations in the US, Eurozone and China. Our results are keeping with those of the IMF (2006) and support the hypothesis postulated by Bernanke (2005). Additionally, we have demonstrated that the responses are not only heterogeneous in sign across countries, but also heterogeneous in size.

Given these findings, we can conclude that there is probably not one lone theory of GI, but rather a whole set of theories which may explain the imbalances. Each economy has its own characteristics and responds differently to certain shocks. Since the theories are partly interrelated, it would be incorrect to posit one theory as being *the* theory of GI.

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A Data Appendix

For the construction of the dataset, it was necessary to use different sources. Data with a seasonal component has been adjusted using the TRAMO/SEATS method. The series have been automatically corrected for outliers using the TERROR method, while treating all outliers as additive outliers or transitory changes. This procedure preserves the level of the series which is important when working with cointegration relationships. For this purpose, the TSW software from the Banco de España has been used.

- **Nominal and Real GDP**

  The main data source is the IMF. The Ecowin codes of the series are *ifs:s(ICC)99boczfq* and *ifs:s(ICC)99b00zfq* where (ICC) denotes the IMF country code. Exceptions are Greece (*oe:grc_gdpq*), Ireland (*oe:irl_gdpq*), Mexico (*oe:mex_gdpq*), New Zealand (*oe:-nzl_gdpq*) and Sweden (*oe:swe_gdpq*) where data from the OECD is used. The series for Singapore (*ew:sgd01250*) comes from Statistics Singapore.
  Since quarterly GDP data is not available for all countries, previous applications of the GVAR model used interpolations of series with annual frequency. Instead of performing interpolations, a first model has been estimated using real GDP estimates performed by Abeysinghe and Rajaguru (2004) in the cases of China, Malaysia and Thailand. Those estimates have then been extrapolated as soon as data was available (China: (*ew:chn01005* deflated with *oecd:chn_cpaltt01_ixobq*, 1993Q1), Malaysia: (*ifs:s54899bipzfq*, 1991Q1), Thailand: (*ew:thb01583*, 1993Q1)). In the case of India, real GDP was estimated using the disaggregation method by Chow and Lin (1971). The annual GDP growth (wdi:ind_1421386577) was disaggregated by taking the seasonal differences of the log domestic expenditure (*oe:ind_tddvq*) as an explanatory variable. The series was extrapolated from 1996Q2 on (*oecd:ind_naexkp01_ixobsaq*). Saudi Arabian real GDP was taken from the GVAR Toolkit (Smith and Galesi (2011)). Unfortunately, the application of these estimated series has led to an unsatisfying outcome as described in Section (4.5). The interpolated series from Smith and Galesi (2011) are therefore used in all cases.

- **Consumer Price Index (CPI)**

  The main source of the CPI is again the IMF. The *ifs:s(ICC)64000zfq* series is used except in the cases of Germany (*oecd:deu_cpaltt01_ixobq*) and China (GVAR Toolkit (Smith and Galesi (2011))).

- **Nominal Interest Rate**

  The 3-month T-Bill rate (*ifs:s(ICC)60c00zfq*) is used whenever available. That is, in the cases of Canada, France, UK, Italy, Malaysia, Mexico, New Zealand, Singapore, Sweden, USA and South Africa. Due to the unavailability of the T-Bill rate for all countries, the Money Market rates (*ifs:s(ICC)60b00zfq*) of Australia, Denmark, Spain, Finland, Germany, India, Ireland, Japan, South Korea, Norway and Thailand are used as a proxy. The short-term interest rate from the OECD (*oe:(OCC)_irsq*) is used for Austria, Greece, the Netherlands and Portugal. The deposit rate is used in the case of China (*ifs:s92460l00zfq*). There is no data available for Saudi Arabia.

- **Nominal Exchange Rate**

  The data of the nominal exchange rate comes mainly from the IMF. Here, the series *ifs:s(ICC)00rf0zfq* is modeled. The data for the member countries of the Eurozone comes from the OECD (*oecd:(OCC)_ccusma02_stq*, where (OCC) denotes the OECD country code).

- **Exports and Imports**

  The time series for the Exports (*dots:s(ICC)70d001q*) and Imports (*dots:s(ICC)-71d001q*) do all come from the IMF Directions of Trade Statistics.

- **Trade Statistics**

  The IMF Directions of Trade Statistics with annual frequency are used for the computation of the trade matrix. The Ecowin codes are *dots:s(ICCA)70d(ICCB)y* for the exports from country A to country B where (ICCA) represents the IMF country code of country A and (ICCB) the code of country B respectively. The Ecowin code for the Imports of country A from country B is *dots:s(ICCA)70d(ICCB)y*.
  The only exception to this rule is the trade of Mexico with South Africa. Since IMF data is not available for the years 2005-2007, data for the exports (ew:mxp17310) and imports (ew:mxp17510) from the Banco de Mexico is used.

B Tables and Figures

Table 1: Countries in the GVAR

Model		EURO
AUSTRALIA	NORWAY	AUSTRIA
CANADA	SAUDI ARABIA	FINLAND
CHINA	SINGAPORE	FRANCE
DENMARK	SOUTH AFRICA	GERMANY
EURO	SOUTH KOREA	GREECE
INDIA	SWEDEN	IRELAND
JAPAN	THAILAND	ITALY
MALAYSIA	UNITED KINGDOM	NETHERLANDS
MEXICO	UNITED STATES	PORTUGAL
NEW ZEALAND		SPAIN

Table 2: Model Specification

Variables	US		Others	
	x_{it}	x^*_{it}	x_{it}	x^*_{it}
Real GDP	y_{it}	y^*_{it}	y_{it}	y^*_{it}
Real Interest Rate	rr_{it}	rr^*_{it}	rr_{it}	rr^*_{it}
REER	$reer_{it}$	-	$reer_{it}$	-
Trade Balance	tb_{it}	-	tb_{it}	-
Oil Price	$poil_t$	-	-	$poil_t$

Table 3: Lag Orders and Cointegration Relationships

Country	Lag Length		# of CR
	p	q	
AUSTRALIA	2	1	1
CANADA	2	1	1
CHINA	2	1	2*
DENMARK	2	1	1
EURO	2	1	1
UNITED KINGDOM	2	1	1
INDIA	2	1	1*
JAPAN	2	1	2*
SOUTH KOREA	2	1	2
MALAYSIA	2	1	1
MEXICO	2	1	1
NORWAY	2	1	0
NEW ZEALAND	2	1	1
SAUDI ARABIA	2	1	0*
SINGAPORE	2	1	2
SWEDEN	2	1	1
THAILAND	2	1	2
UNITED STATES	2	1	1
SOUTH AFRICA	2	1	0

*Note: * denotes a change of the # of cointegration relationships suggested by the Johansen trace test.*

Table 4: Tests for Weak Exogeneity

Country	F test	ys	rrs	poil
AUSTRALIA	F(1,100)	0.06	1.24	0.17
CANADA	F(1,100)	1.68	0.31	2.85
CHINA	F(2,99)	0.75	1.12	1.45
DENMARK	F(1,100)	2.49	0.68	0.30
EURO	F(1,100)	0.01	2.04	0.06
UNITED KINGDOM	F(1,100)	0.24	1.23	0.04
INDIA	F(1,100)	0.42	2.54	1.27
JAPAN	F(2,99)	0.15	0.08	2.13
SOUTH KOREA	F(2,99)	4.58*	0.62	1.48
MALAYSIA	F(1,100)	1.15	0.28	0.10
MEXICO	F(1,100)	0.38	6.51*	0.54
NORWAY	F(0,101)	-	-	-
NEW ZEALAND	F(1,100)	1.75	0.34	1.29
SAUDI ARABIA	F(0,103)	-	-	-
SINGAPORE	F(2,99)	0.17	0.08	0.20
SWEDEN	F(1,100)	0.14	0.28	1.20
THAILAND	F(2,99)	0.03	0.26	0.26
UNITED STATES	F(1,99)	0.69	3.69	-
SOUTH AFRICA	F(0,101)	-	-	-

*Note: * denotes significance on the 5% level.*

Table 5: Structural Stability

Test	y	tb	reer	rr	Total
PK_{sup}	5 (0.26)	0 (0)	1 (0.05)	4 (0.21)	10 (0.13)
PK_{msq}	4 (0.21)	0 (0)	1 (0.05)	3 (0.16)	8 (0.11)
Nyblom	8 (0.42)	6 (0.32)	3 (0.16)	7 (0.37)	24 (0.32)
Robust Nyblom	4 (0.21)	5 (0.26)	2 (0.11)	7 (0.37)	18 (0.24)
QLR	8 (0.42)	3 (0.16)	2 (0.11)	5 (0.26)	18 (0.24)
Robust QLR	4 (0.21)	2 (0.11)	1 (0.05)	4 (0.21)	11 (0.14)
MW	10 (0.54)	5 (0.27)	1 (0.06)	7 (0.38)	23 (0.31)
Robust MW	4 (0.22)	4 (0.22)	1 (0.06)	6 (0.33)	15 (0.21)
APW	8 (0.42)	4 (0.21)	1 (0.05)	5 (0.26)	18 (0.24)
Robust APW	3 (0.16)	4 (0.21)	1 (0.05)	6 (0.32)	14 (0.18)

The table displays the number of rejections of the null hypothesis.
Percentages are reported in parenthesis.

Table 6: Correlation between foreign variables derived by fixed and time-varying weights

Country	y*		rr*	
	log-level	Δ	log-level	Δ
Australia	1.00	0.92	0.92	0.92
Denmark	1.00	1.00	1.00	0.99
Eurozone	1.00	0.95	0.96	0.95
Japan	1.00	0.88	0.92	0.90
New Zealand	1.00	0.96	0.97	0.97
United Kingdom	1.00	0.94	0.99	0.99
United States	1.00	0.96	0.86	0.92

Table 7: Trade Weight Matrix

Country	aus	can	chn	dnk	eur	gbr	ind	jpn	kor	mal
aus	0.0000	0.0045	0.0317	0.0059	0.0153	0.0120	0.0430	0.0468	0.0355	0.0337
can	0.0141	0.0000	0.0222	0.0083	0.0192	0.0212	0.0153	0.0220	0.0146	0.0069
chn	0.1692	0.0571	0.0000	0.0388	0.1357	0.0542	0.1495	0.2429	0.2712	0.1245
dnk	0.0045	0.0024	0.0047	0.0000	0.0410	0.0157	0.0052	0.0034	0.0027	0.0019
eur	0.1316	0.0581	0.1859	0.5092	0.0000	0.5663	0.2025	0.1243	0.1250	0.1175
gbr	0.0504	0.0279	0.0289	0.0856	0.2499	0.0000	0.0585	0.0258	0.0206	0.0207
ind	0.0347	0.0045	0.0252	0.0064	0.0203	0.0157	0.0000	0.0098	0.0202	0.0287
jpn	0.1751	0.0322	0.1916	0.0178	0.0610	0.0314	0.0458	0.0000	0.1742	0.1425
kor	0.0664	0.0113	0.1240	0.0085	0.0323	0.0123	0.0429	0.0879	0.0000	0.0550
mal	0.0363	0.0045	0.0349	0.0030	0.0152	0.0074	0.0348	0.0338	0.0278	0.0000
mex	0.0067	0.0271	0.0104	0.0020	0.0178	0.0036	0.0066	0.0133	0.0148	0.0050
nor	0.0016	0.0106	0.0028	0.0714	0.0397	0.0425	0.0057	0.0030	0.0037	0.0008
nzl	0.0546	0.0012	0.0028	0.0017	0.0026	0.0026	0.0031	0.0056	0.0038	0.0046
sau	0.0116	0.0031	0.0188	0.0024	0.0233	0.0077	0.0746	0.0445	0.0499	0.0112
sgp	0.0535	0.0025	0.0370	0.0042	0.0187	0.0158	0.0670	0.0309	0.0350	0.1744
swe	0.0102	0.0037	0.0064	0.1712	0.0647	0.0255	0.0122	0.0047	0.0044	0.0042
tha	0.0398	0.0037	0.0257	0.0037	0.0112	0.0067	0.0179	0.0465	0.0163	0.0677
usa	0.1262	0.7435	0.2376	0.0569	0.2136	0.1432	0.1873	0.2426	0.1736	0.1958
zaf	0.0137	0.0020	0.0095	0.0031	0.0185	0.0163	0.0283	0.0122	0.0068	0.0049

Country	mex	nor	nzl	sau	sgp	swe	tha	usa	zaf
aus	0.0029	0.0021	0.2564	0.0135	0.0387	0.0099	0.0435	0.0115	0.0288
can	0.0278	0.0379	0.0187	0.0107	0.0060	0.0090	0.0097	0.2378	0.0243
chn	0.0589	0.0329	0.1106	0.0987	0.1512	0.0363	0.1409	0.1580	0.1044
dnk	0.0008	0.0539	0.0065	0.0019	0.0020	0.1043	0.0030	0.0036	0.0043
eur	0.0755	0.4397	0.1208	0.1954	0.1150	0.4916	0.1079	0.1663	0.3402
gbr	0.0075	0.2245	0.0454	0.0274	0.0339	0.0908	0.0254	0.0443	0.0899
ind	0.0042	0.0039	0.0093	0.0589	0.0375	0.0081	0.0201	0.0153	0.0286
jpn	0.0381	0.0182	0.1210	0.1825	0.1001	0.0223	0.2382	0.0919	0.1154
kor	0.0241	0.0104	0.0394	0.1038	0.0579	0.0094	0.0408	0.0351	0.0291
mal	0.0102	0.0023	0.0280	0.0120	0.1928	0.0041	0.0834	0.0208	0.0134
mex	0.0000	0.0012	0.0104	0.0033	0.0044	0.0037	0.0049	0.1445	0.0048
nor	0.0007	0.0000	0.0017	0.0007	0.0027	0.1097	0.0018	0.0044	0.0022
nzl	0.0010	0.0003	0.0000	0.0031	0.0051	0.0010	0.0049	0.0027	0.0025
sau	0.0013	0.0009	0.0145	0.0000	0.0284	0.0050	0.0302	0.0184	0.0427
sgp	0.0055	0.0052	0.0370	0.0443	0.0000	0.0041	0.0787	0.0183	0.0126
swe	0.0023	0.0954	0.0069	0.0060	0.0033	0.0000	0.0048	0.0080	0.0144
tha	0.0045	0.0026	0.0243	0.0260	0.0565	0.0039	0.0000	0.0137	0.0179
usa	0.7348	0.0672	0.1431	0.1978	0.1610	0.0810	0.1535	0.0000	0.1242
zaf	0.0001	0.0015	0.0061	0.0139	0.0036	0.0060	0.0083	0.0055	0.0000

Table 8: GFEVD of the United States trade balance

Country	Variable	Impact	Year 1	Year 2	Year 5	Year 10
UNITED STATES	tb	0.98 (0.66)	0.71 (0.47)	0.60 (0.40)	0.52 (0.35)	0.49 (0.33)
UNITED STATES	reer	0.03 (0.02)	0.18 (0.12)	0.26 (0.17)	0.33 (0.22)	0.36 (0.24)
UNITED STATES	rr	0.07 (0.05)	0.13 (0.09)	0.17 (0.11)	0.18 (0.12)	0.18 (0.12)
UNITED STATES	poil	0.06 (0.04)	0.10 (0.06)	0.09 (0.06)	0.08 (0.06)	0.08 (0.05)
SAUDI ARABIA	reer	0.00 (0.00)	0.03 (0.02)	0.04 (0.03)	0.05 (0.03)	0.05 (0.04)
MALAYSIA	reer	0.01 (0.01)	0.02 (0.01)	0.03 (0.02)	0.03 (0.02)	0.03 (0.02)
UNITED STATES	y	0.01 (0.01)	0.04 (0.03)	0.04 (0.02)	0.03 (0.02)	0.03 (0.02)
SOUTH AFRICA	reer	0.01 (0.01)	0.02 (0.01)	0.02 (0.01)	0.02 (0.02)	0.02 (0.02)
SOUTH KOREA	rr	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.01)	0.02 (0.01)
CHINA	reer	0.00 (0.00)	0.01 (0.00)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)

Note: The table displays bootstrapped medians. Contribution relative to the sum over all variables in brackets.

Table 9: GFEVD the Chinese trade balance

Country	Variable	Impact	Year 1	Year 2	Year 5	Year 10
CHINA	tb	0.94 (0.74)	0.76 (0.60)	0.56 (0.42)	0.42 (0.33)	0.38 (0.31)
CHINA	reer	0.00 (0.00)	0.05 (0.04)	0.12 (0.09)	0.13 (0.10)	0.12 (0.10)
CHINA	rr	0.01 (0.01)	0.03 (0.02)	0.06 (0.05)	0.09 (0.07)	0.09 (0.08)
UNITED STATES	y	0.01 (0.00)	0.01 (0.01)	0.04 (0.03)	0.06 (0.05)	0.06 (0.05)
UNITED STATES	reer	0.00 (0.00)	0.01 (0.01)	0.02 (0.01)	0.04 (0.03)	0.05 (0.04)
UNITED STATES	poil	0.01 (0.00)	0.02 (0.02)	0.04 (0.03)	0.04 (0.03)	0.04 (0.03)
SAUDI ARABIA	reer	0.00 (0.00)	0.01 (0.00)	0.02 (0.01)	0.02 (0.02)	0.02 (0.03)
UNITED STATES	rr	0.00 (0.00)	0.02 (0.01)	0.02 (0.01)	0.02 (0.02)	0.02 (0.02)
JAPAN	y	0.01 (0.00)	0.01 (0.01)	0.02 (0.01)	0.02 (0.02)	0.02 (0.02)
CHINA	y	0.01 (0.00)	0.02 (0.00)	0.02 (0.01)	0.02 (0.01)	0.02 (0.02)

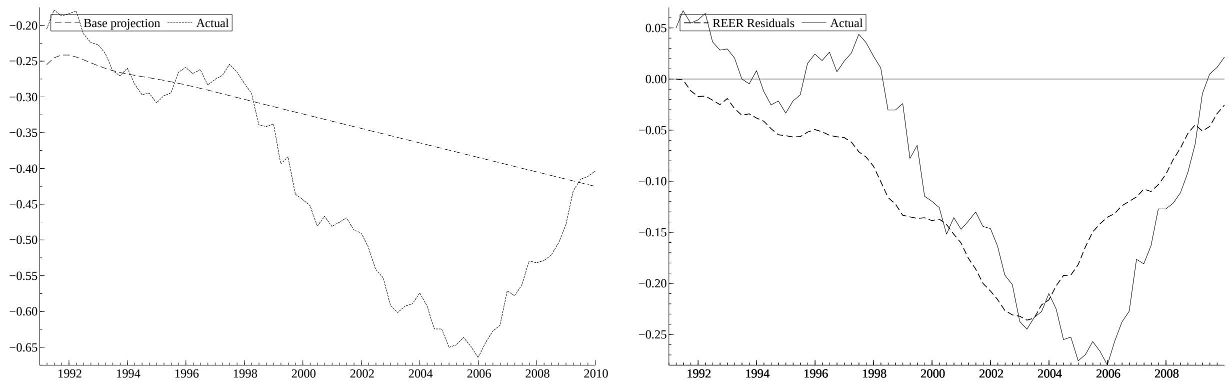
Note: The table displays bootstrapped medians. Contribution relative to the sum over all variables in brackets.

Table 10: GFEVD the Eurozone trade balance

Country	Variable	Impact	Year 1	Year 2	Year 5	Year 10
EURO	tb	0.94 (0.68)	0.77 (0.56)	0.66 (0.48)	0.53 (0.38)	0.47 (0.34)
EURO	rr	0.04 (0.03)	0.15 (0.11)	0.19 (0.13)	0.20 (0.15)	0.21 (0.15)
EURO	y	0.01 (0.01)	0.02 (0.01)	0.03 (0.02)	0.04 (0.03)	0.05 (0.03)
UNITED STATES	poil	0.02 (0.02)	0.05 (0.04)	0.04 (0.03)	0.04 (0.03)	0.04 (0.03)
CANADA	y	0.01 (0.01)	0.02 (0.01)	0.02 (0.02)	0.03 (0.02)	0.03 (0.02)
CHINA	reer	0.00 (0.00)	0.01 (0.00)	0.01 (0.01)	0.02 (0.02)	0.03 (0.02)
THAILAND	y	0.00 (0.00)	0.01 (0.01)	0.01 (0.01)	0.02 (0.01)	0.02 (0.02)
EURO	reer	0.00 (0.00)	0.01 (0.01)	0.02 (0.01)	0.02 (0.01)	0.02 (0.02)
MEXICO	y	0.01 (0.01)	0.02 (0.01)	0.02 (0.02)	0.02 (0.02)	0.02 (0.01)
UNITED STATES	reer	0.00 (0.00)	0.01 (0.01)	0.01 (0.01)	0.02 (0.01)	0.02 (0.01)

Note: The table displays bootstrapped medians. Contribution relative to the sum over all variables in brackets.

Figure 1: Historical Decomposition of the US Trade Balance



(a) Base Projection

(b) Contribution of US REER residuals

Figure 2: Persistence Profiles for our cointegration relationships (bootstrapped median)

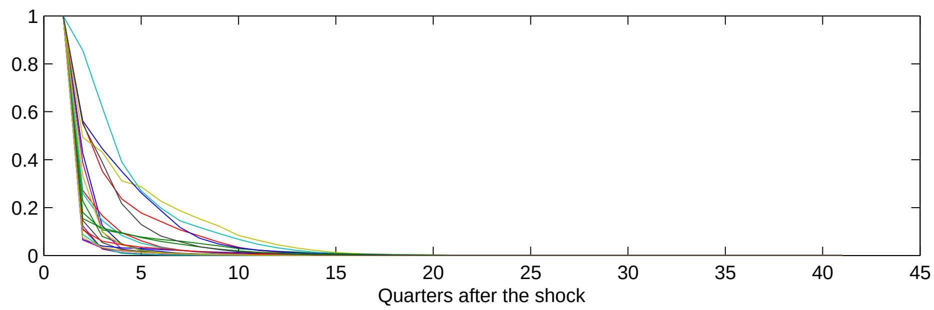


Figure 3: Effects of a 1SD shock to US real GDP on international trade balances

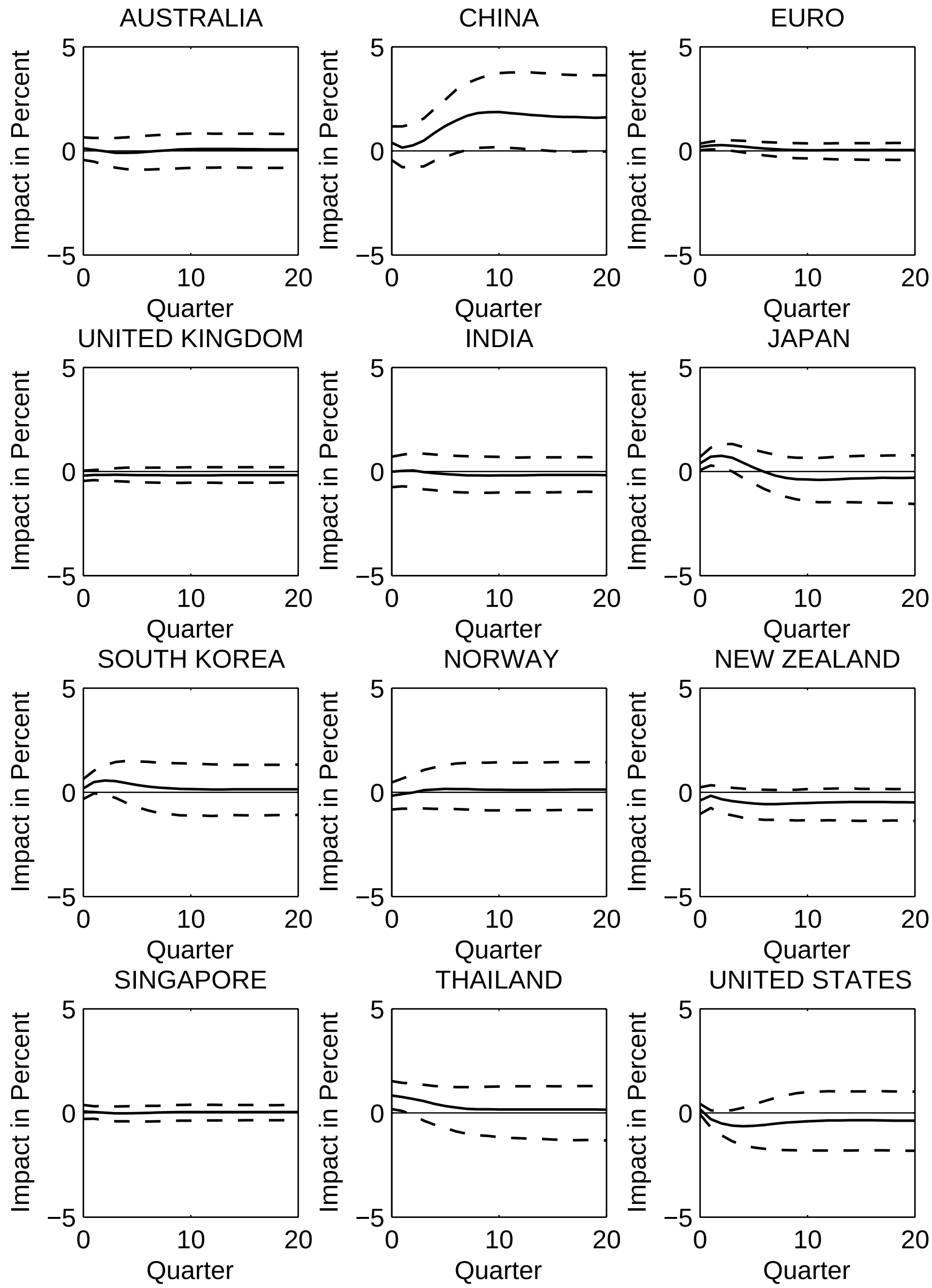


Figure 4: Effects of a 1SD shock to Chinese real GDP on international trade balances

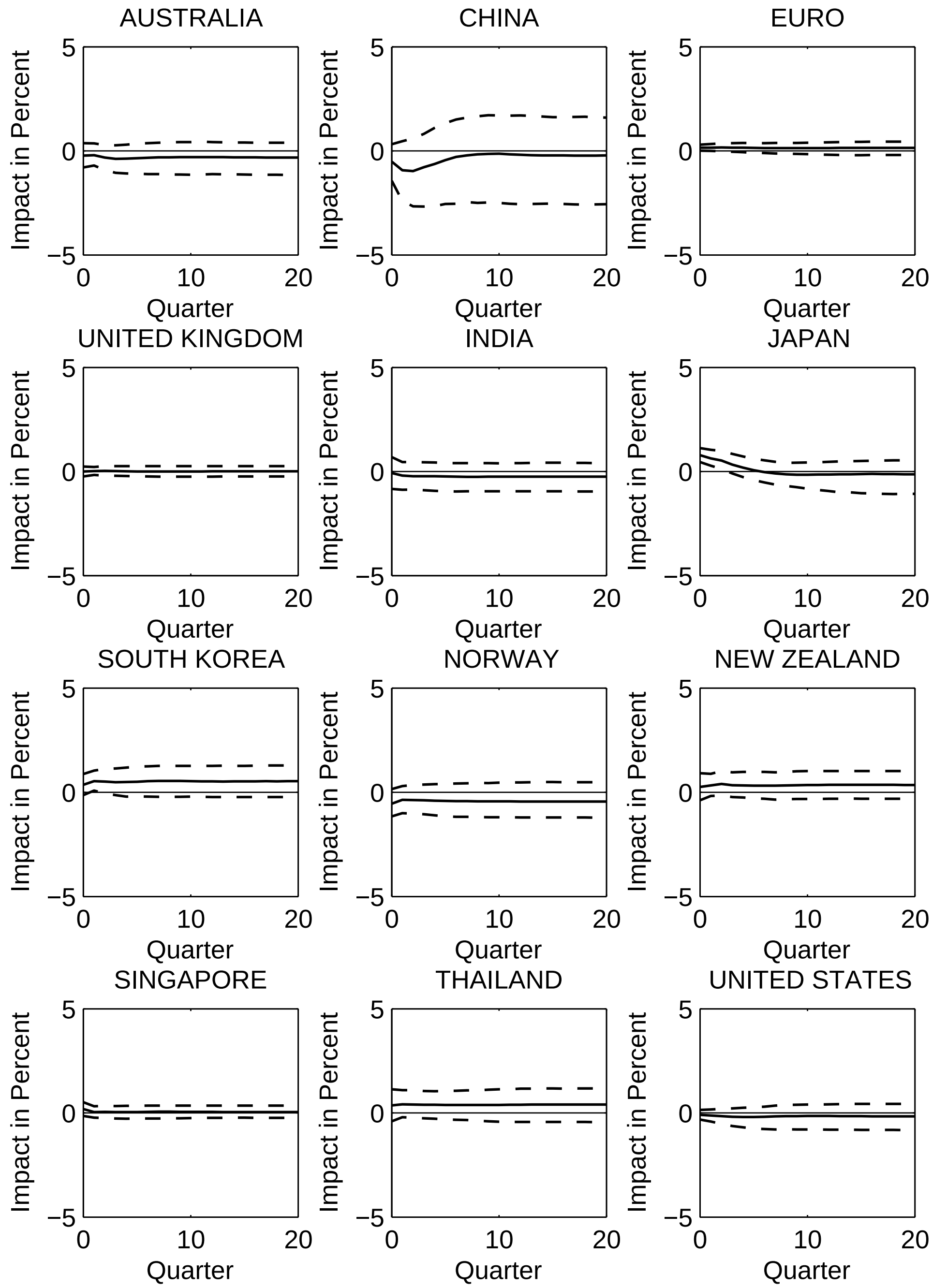


Figure 5: Effects of a 1SD shock to Eurozone real GDP on international trade balances

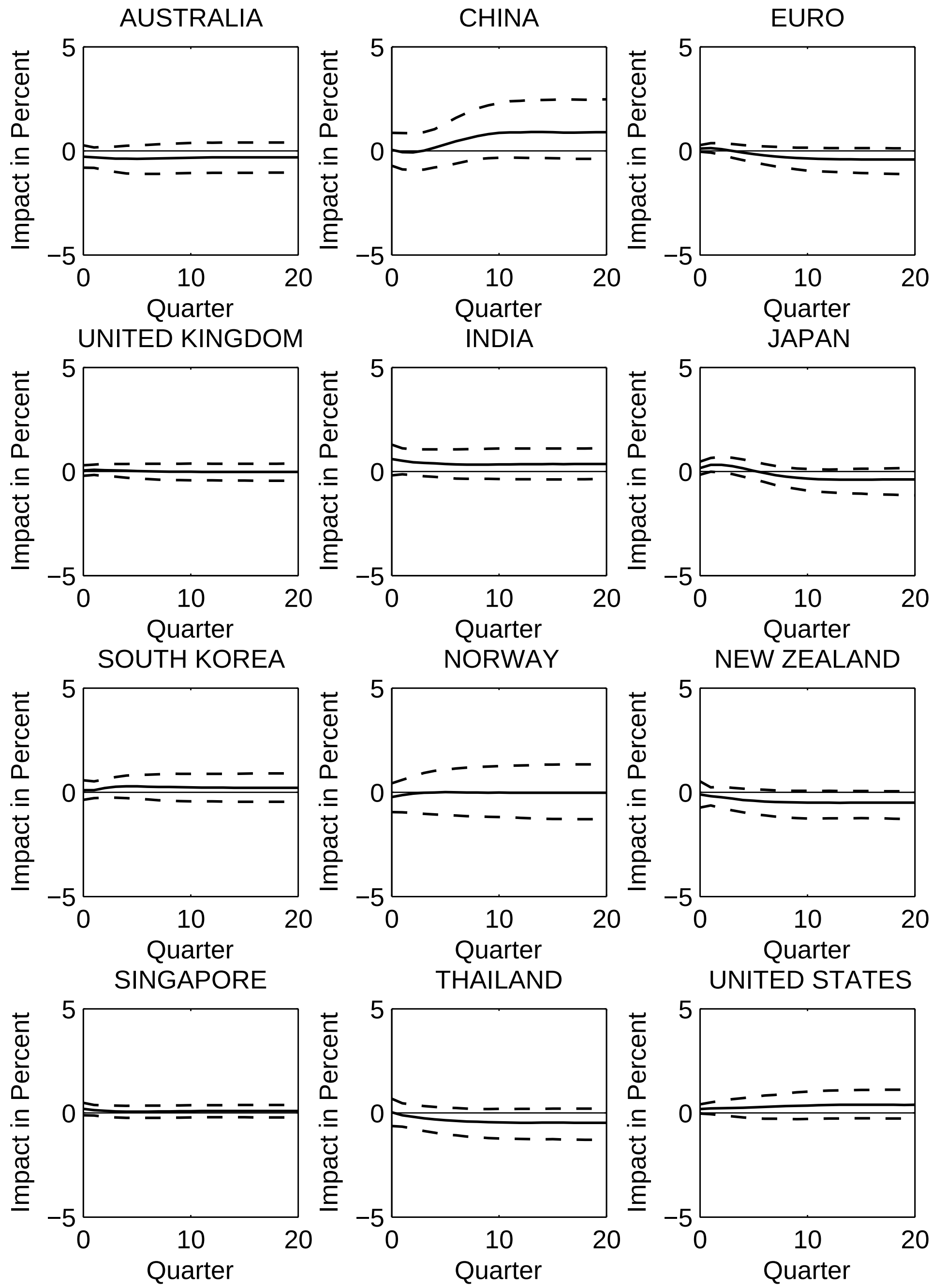


Figure 6: Effects of a 1SD shock to the oil price on international trade balances

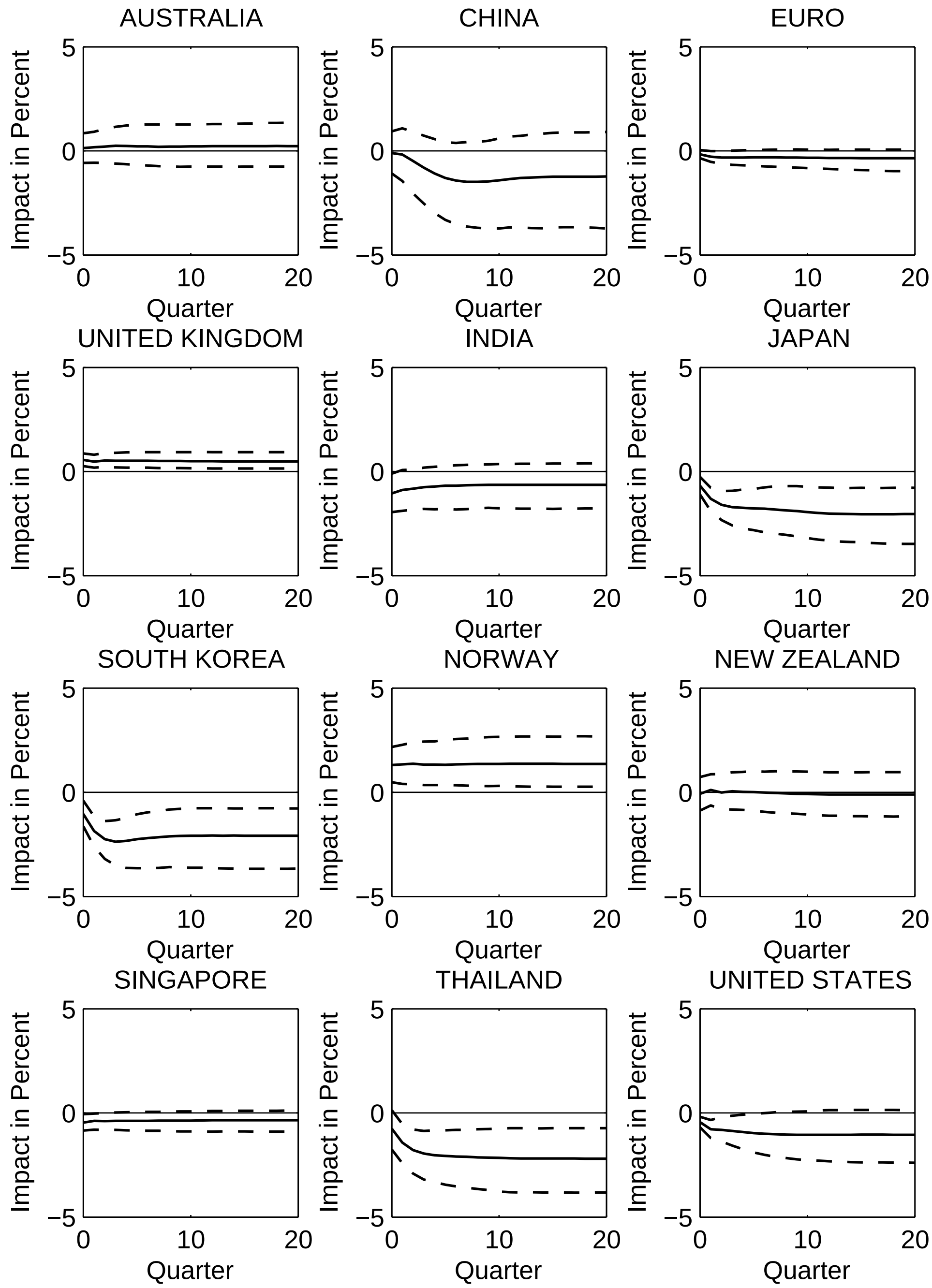


Figure 7: Effects of a 1SD shock to the US REER on international trade balances

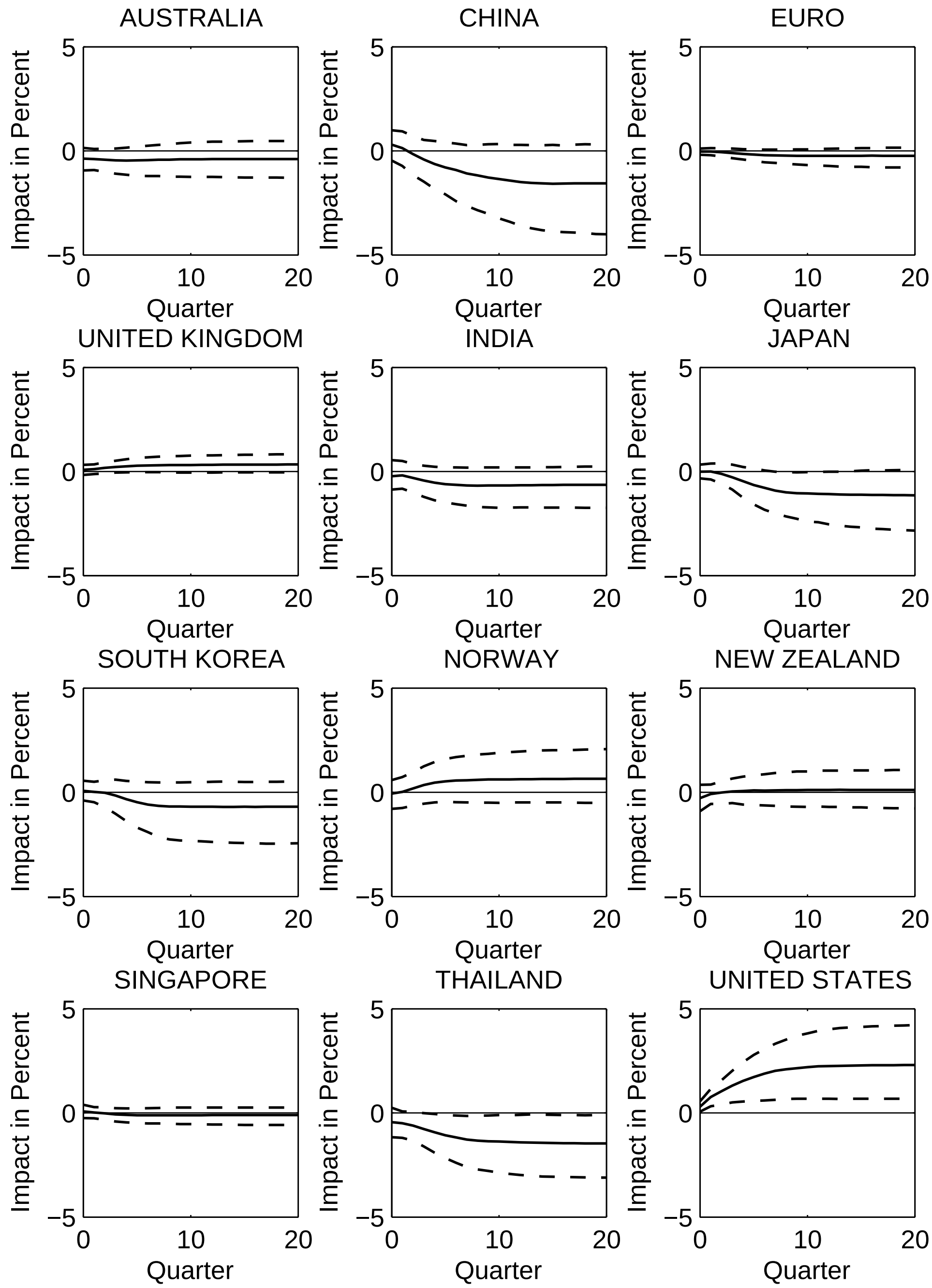


Figure 8: Effects of a 1SD shock to the US RIR on international trade balances