Spillover effects of debt and growth in the euro area: Evidence from a GVAR model

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Abstract

This paper employs a global vector autoregression model to analyze two-way spillover effects of public debt and growth between Germany as the largest economy of the Eurozone and its core and periphery groups of countries. Using quarterly data over the period 1991Q1–2014Q4, we find that positive growth shocks originating in any of the three entities spill over to the other regions of the Eurozone, and also lower debt levels at least transitorily in all regions. In contrast, a debt shock occurring in the Eurozone periphery induces a transitory effect on debt levels in the Eurozone core and periphery, but exerts no significant impact on the growth dynamics in either region.

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1. Introduction

Rising public debt levels in the aftermath of the Great Recession and the recent debt crisis in the Eurozone have renewed interest in investigating the causal relationship between government debt and economic growth. In an influential study, Reinhart and Rogoff (2010) focus on the correlation between debt and growth for a large sample of countries, finding no effect at low debt levels, but a significant negative impact of debt on growth for countries with high debt-to-GDP ratios. A subsequent literature using standard growth equations to investigate potential nonlinear effects of debt on growth for different country samples has come up with conflicting results as to the existence or size of any such threshold values (see, e.g., Checherita-Westphal and Rother, 2012, Herndon et al., 2014, Pescatori et al., 2014, Eberhardt and Presbitero, 2015). Rather than focusing on the unidirectional causality of debt on growth, a different strand of recent literature analyzes the potential of two-way causality between debt and growth on the basis of vector-autoregressive models, which have the advantage of allowing debt and GDP to be simultaneously treated as endogenous variables (Lof and Malinen, 2014, Puente-Ajovín and Sanso-Navarro, 2015, Kempa and Khan, 2016). In this literature, hardly any affirmation of the notion that debt causes growth is found, although there is strong evidence of a reverse and negative causality of growth on debt.

One drawback of the literature cited above is the exclusive focus on analyzing the debt-growth nexus within individual countries or country groups without considering potential spillover effects between them. This omission appears to be particularly striking in an increasingly globalized world economy, with countries being more interdependent today than ever before. In fact, a debt or growth shock in one country may have repercussions on the debt and growth dynamics of other countries. Such international transmission effects are likely to be of particular relevance for shocks originating in large countries or in countries with strong trade and financial linkages, such as within the common market of the EU or the currency union of the Eurozone.

This paper analyzes two-way spillover effects of public debt and growth in the Eurozone. To this end we employ the global vector autoregression (GVAR) model pioneered by Pesaran et al. (2004). The GVAR model augments individual country VAR or vector error correction (VECM) models by the corresponding foreign variables, and then combines the individual country models to construct a global model which can be used to analyze national interdependencies by means of impulse response analysis. While the GVAR model is ideally suited to study international shock transmission, it has not yet been widely applied to investigate the debt-growth nexus.

A number of studies use the GVAR methodology to trace the transmission of fiscal policy measures across European countries. These include Hebous and Zimmermann (2013) and Ricci-Risquete and Ramajo-Hernández (2015) who estimate spillover effects of a fiscal shock in one country on outputs of other countries within the Eurozone and EU respectively, and Caporale and Girardi (2013) who investigate the dynamic effects of fiscal imbalances in individual Eurozone member states on the borrowing costs of other members of the euro area. However, none of these papers considers the debt-growth nexus directly. In fact, the only paper we are aware of using a GVAR model in this context is Konstantakis and Michaelides (2014). They study the transmission of growth and debt between the US and an aggregate of 15 European Union (EU15) countries. Their results turn out to be mostly insignificant, with the exception of a US debt shock which causes a short-run increase in the debt level of the EU15.

Rather than using US and EU 15 aggregate data, we study the transmission of debt and growth shocks between Germany as the largest economy of the Eurozone and its core and periphery groups of countries. Apart from evaluating the claim that a growth impulse in

Germany raises the growth prospects and lowers debt levels in the Eurozone periphery, we can also ascertain whether and how the recent debt crisis in the southern periphery has affected the economic performance of Germany and the other Eurozone core countries. Using quarterly data over the period 1991Q1–2014Q4, we find that positive growth shocks originating in any of the three entities spill over to the other regions of the Eurozone, and also lower debt levels at least transitorily in all regions, albeit not always significantly so. Similarly, a debt shock occurring in the Eurozone periphery induces a transitory effect on debt levels in the Eurozone core and periphery, but exerts no significant impact on the growth dynamics in either region.

The remainder of the paper is structured as follows: section 2 describes the GVAR model, section 3 introduces the data and reports on some of their statistical properties which need to be satisfied as a prerequisite to apply the GVAR methodology, section 4 discusses the results by means of impulse response analysis, and section 5 concludes.

2. The GVAR model

The GVAR methodology constitutes a simple yet rigorous way to analyze interdependencies across economies or regions in a multi-country setting. The GVAR model is implemented in two steps. In a first step separate VAR or VECM models are estimated for each individual country or region. These models are augmented by appropriately weighted averages of corresponding weakly exogenous foreign variables, and are referred to as VARX models. In a second step the individual VARX models are combined in a consistent manner by means of a link matrix to build and simultaneously solve the global model.

Let $N+1$ be the number of countries or regions in the model indexed by $i=0,1,\ldots,N$, with $i=0$ as the reference country (Germany in our case), and $t=1,\ldots,T$ denoting time. The individual country or regional VARX (q_i, q_i^*) models are given by

(1) $$\mathbf{x}_{i,t} = \mathbf{a}_{i,0} + \mathbf{a}_{i,1}t + \sum_{m=1}^{q_i} \mathbf{\Phi}_{i,m}\, \mathbf{x}_{i,t-m} + \sum_{n=0}^{q_i^*} \mathbf{\Lambda}_{i,n}\, \mathbf{x}^*_{i,t-n} + \mathbf{u}_{i,t} \;,$$

with $\mathbf{x}_{i,t}$ a $k_i\ x\ 1$ vector of region-*i* endogenous domestic variables and $\mathbf{x}^*_{i,t}$ a $k_i^*\, x\ 1$ vector of the corresponding weakly exogenous foreign variables, where $\mathbf{\Phi}_i$ and $\mathbf{\Lambda}_i$ are $k_i\ x\ k_i$ and $k_i\ x\ k_i^*$ coefficient matrices associated with the domestic and foreign variables respectively. Moreover, $\mathbf{a}_{i,0}$ is a $k_i\ x\ 1$ vector of fixed intercepts, $\mathbf{a}_{i,1}$ is a $k_i\ x\ 1$ vector on the deterministic time trends, and $\mathbf{u}_i$ is a $k_i\ x\ 1$ vector of region-specific shocks, where $\mathbf{u}_i \sim \mathrm{N}(\mathbf{0}, \mathbf{\Sigma}_{ii})$, and $\mathbf{\Sigma}_{ii}$ is a non-singular covariance matrix. Region-specific shocks are assumed to be serially uncorrelated, but cross-regional correlations between entities *i* and *j* among the idiosyncratic shocks are allowed for, so that $E(\mathbf{u}_{i,t}, \mathbf{u}'_{j,s}) = \mathbf{\Sigma}_{ij}$ for $t=s$, and $E(\mathbf{u}_{i,t}, \mathbf{u}'_{j,s}) = \mathbf{0}$ for $t \neq s$.

The vector of foreign region-specific variables, $\mathbf{x}^*_{i,t}$, is obtained from weighted averages of each variable across all other countries of the sample. More specifically, for any $i, j = 0,1,\ldots,N$,

(2) $$\mathbf{x}^*_{i,t} = \sum_{j=0}^{N} w_{i,j}\mathbf{x}_{j,t} \;,$$

where $w_{i,j}$ is a weighting factor that captures the importance of region *j* for region *i*, with $\sum_{j=0}^{N} w_{i,j} = 1$ and $w_{i,i} = 0$. We follow standard practice by using as weights the fixed trade shares between countries.

Setting $p_i = \max(q_i, q_i^*)$, the model of Eq. (1) can be rewritten as

(3) $$\mathbf{A}_{i,0}\mathbf{z}_{i,t} = \mathbf{a}_{i,0} + \mathbf{a}_{i,1}t + \sum_{m=1}^{p_i} \mathbf{A}_{i,m}\mathbf{z}_{i,t-m} + \mathbf{u}_{i,t} \ ,$$

where the $(k_i + k_i^*)x\,1$ vector $\mathbf{z}_{i,t} = \left\{ (\mathbf{x}_{i,t})', (\mathbf{x}_{i,t}^*)' \right\}'$ contains both the domestic and foreign variables, and where the $k_i\, x\left(k_i + k_i^*\right)$ coefficient matrices are given by $\mathbf{A}_{i,0} = \left(\mathbf{I}_{k_i}, -\mathbf{\Lambda}_{i,0}\right)$ and $\mathbf{A}_{i,m} = \left(\mathbf{\Phi}_{i,m}, \mathbf{\Lambda}_{i,m}\right)$, for $m = 1, \ldots p_i$.

In order to allow for co-integrating relationships within and between regions, the individual-region VARX models of can also be estimated in error-correction form:

(4) $$\Delta\mathbf{x}_{i,t} = \mathbf{c}_{i,0} - \boldsymbol{\alpha}_i \boldsymbol{\beta}_i' \left(\mathbf{z}_{i,t-1} - \boldsymbol{\gamma}_i (t-1)\right) + \mathbf{\Lambda}_{i,0}\Delta\mathbf{x}_{i,t}^* + \sum_{m=1}^{p_i - 1} \mathbf{\Gamma}_{i,m}\, \Delta\mathbf{z}_{i,t-m} + \mathbf{u}_{i,t} \ .$$

Here $\boldsymbol{\alpha}_i$ is a $k_i\, x\, r_i$ loading matrix and $\boldsymbol{\beta}_i$ is a $\left(k_i + k_i^*\right) x\, r_i$ matrix of coefficients of the long-run equilibrium, with r_i denoting the co-integration rank between $\mathbf{x}_i$ and $\mathbf{x}_i^*$ for region *i*.

In a second step, the regional-specific variables are stacked in a single $k\,x\,1$ vector $\mathbf{x}_t = \left\{ (\mathbf{x}_{0,t})', (\mathbf{x}_{1,t})', \ldots, (\mathbf{x}_{N,t})' \right\}'$ with $k = \sum_{j=0}^{N} k_j$, and linked by means of region-specific

$(k_i + k_i^*) x\ k$ matrices collecting the individual trade weights $w_{i,j}$. These link matrices are of the form

(5) $$\mathbf{W}_i = \begin{bmatrix} \mathbf{0}_{k_i} & \dots & \mathbf{I}_{k_i} & \dots & \mathbf{0}_{k_i} \\ w_{i,0}\mathbf{I}_{k_i^*} & \dots & w_{i,i}\mathbf{I}_{k_i^*} & \dots & w_{i,N}\mathbf{I}_{k_i^*} \end{bmatrix},$$

and are constructed to yield the identity $\mathbf{z}_{i,t} = \mathbf{W}_i \mathbf{x}_t$. From Eq. (3) it follows that

(6) $$\mathbf{A}_{i,0}\mathbf{W}_i\mathbf{x}_t = \mathbf{a}_{i,0} + \mathbf{a}_{i,1}t + \sum_{m=1}^{p_i} \mathbf{A}_{i,m}\mathbf{W}_i\mathbf{x}_{t-m} + \mathbf{u}_{i,t} \ ,$$

Stacking the $N+1$ systems in Eq. (6) yields the global model

(7) $$\mathbf{G}_0\mathbf{x}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \sum_{m=1}^{p} \mathbf{G}_m\mathbf{x}_{t-m} + \mathbf{u}_t \ ,$$

where

$$\mathbf{G}_0 = \begin{bmatrix} \mathbf{A}_{00}\mathbf{W}_0 \\ \mathbf{A}_{10}\mathbf{W}_1 \\ \vdots \\ \mathbf{A}_{N0}\mathbf{W}_N \end{bmatrix}, \quad \mathbf{G}_m = \begin{bmatrix} \mathbf{A}_{0m}\mathbf{W}_0 \\ \mathbf{A}_{1m}\mathbf{W}_1 \\ \vdots \\ \mathbf{A}_{Nm}\mathbf{W}_N \end{bmatrix} \quad \text{for } m = 1,\dots p, \quad \text{and} \quad p = \max(p_0,\dots,p_N),$$

$$\mathbf{a}_0 = \begin{bmatrix} \mathbf{a}_{00} \\ \mathbf{a}_{10} \\ \vdots \\ \mathbf{a}_{N0} \end{bmatrix}, \quad \mathbf{a}_1 = \begin{bmatrix} \mathbf{a}_{01} \\ \mathbf{a}_{11} \\ \vdots \\ \mathbf{a}_{N1} \end{bmatrix}, \quad \mathbf{u}_t = \begin{bmatrix} \mathbf{u}_{0t} \\ \mathbf{u}_{1t} \\ \vdots \\ \mathbf{u}_{Nt} \end{bmatrix}.$$

With $\mathbf{G}_0$ a non-singular $k\,x\,k$ matrix that depends only on the known trade weights and parameter estimates, the GVAR(p) model is finally obtained after pre-multiplying Eq. (7) by $\mathbf{G}_0^{-1}$:

(8) $$\mathbf{x}_t = \mathbf{b}_0 + \mathbf{b}_1 t + \sum_{m=1}^{p} \mathbf{F}_m \mathbf{x}_{t-m} + \boldsymbol{\varepsilon}_t \ ,$$

with $\mathbf{b}_0 = \mathbf{G}_0^{-1}\mathbf{a}_0$, $\mathbf{b}_1 = \mathbf{G}_0^{-1}\mathbf{a}_1$, $\mathbf{F}_m = \mathbf{G}_0^{-1}\mathbf{G}_m$ for $m = 1,\dots p$, and $\boldsymbol{\varepsilon}_t = \mathbf{G}_0^{-1}\mathbf{u}_t$.

3. Data and model specification

We use quarterly data from 1991Q1 to 2014Q4 for 11 major Eurozone countries, grouped into three entities of roughly equal economic weight: Germany as a stand-alone, a Eurozone core group including Austria, Belgium, Finland, France and the Netherlands, and the Eurozone periphery made up of Greece, Ireland, Italy, Portugal and Spain. The model is estimated with data on public debt and economic growth as well as 5 additional macroeconomic variables (aggregate consumption and investment, the government budget balance, the trade balance as well as a long-term interest rate) which could potentially function as transmission mechanisms between debt and growth.

Data on the GDP growth rate, the trade balance and the long-term interest rate come from OECD Economic Outlook, government debt as a percentage of GDP, the government budget balance and the investment data were collected from Oxford Economics, and the consumption data come from national sources, where all data were collected from Datastream.[1] Whenever seasonally adjusted data were not available, they were adjusted using the census X-12 method. Regional variables for the core and periphery groups were constructed using the aggregator

[1] The long-term interest rate was left out from the country-specific model of Greece due to a lack of reliable data.

(9) $$y_t = \sum_{i=1}^{N} W_i y_{i,t} \ ,$$

where y_t denotes a regional variable, $y_{i,t}$ is the value of that variable for country *i*, and W_i represents the relative importance of country *i* within the region. Following Dees et al. (2007), W_i is computed by dividing the PPP-GDP figure of each country by the total sum across the *N* countries of the region, such that their weights add up to unity.

Stationarity of the data was checked for the region-specific variables and their corresponding foreign variables. We used both the Augmented Dickey Fuller (ADF) test as well as the Weighted-Symmetric Dickey Fuller (WS) test for this purpose. The WS test exploits the time reversibility of stationary autoregressive processes in order to increase their power performance and was originally suggested by Park and Fuller (1995).[2] The lag length was selected according to the Bayesian-Schwartz (BS) criterion. Unit root tests were conducted for all domestic and foreign variables, where we included an intercept and a time trend. The results are shown in Table 1. As expected, there is a mix of stationary and non-stationary variables with most of the data falling into the latter category. All nonstationary data are integrated of order 1. Given that most of the time series are non-stationary, Johansen's cointegration test was conducted in order to determine the number of cointegrating relationships for each region, where a deterministic trend was allowed for in the cointegration space. Based on the trace statistic, we found the number of cointegrating relationships to be 3 for the Eurozone core and 4 for both Germany and the periphery countries.

Table 1 about here

[2] Authors like Leybourne et al. (2005) and Pantula et al. (1995) provide evidence of the superior performance of the WS test compared to ADF test.

Next we set up the VARX models. Although the GVAR approach has the flexibility of handling different specifications for different countries or regions, for reasons of comparability we include all 7 macro variables in each regional model both as endogenous as well as corresponding foreign variables. The order of the region-specific VARX (q_i, q_i^*) models was chosen using the BS criterion, where a VARX (2,1) was selected for each of the 3 regions in the sample.

The GVAR model requires the region-specific foreign variables $\mathbf{x}_{i,t}^*$ to be weakly exogenous. In general, a variable in a VARX model is considered weakly exogenous (or long-run forcing) if there is no long-run feedback from $\mathbf{x}_{i,t}$ to $\mathbf{x}_{i,t}^*$, without necessarily ruling out lagged short run feedback between the two sets of variables. As suggested by Johansen (1992), weak exogeneity can be determined by testing the joint significance of the estimated error correction terms in auxiliary equations of the region-specific foreign variables $\mathbf{x}_{i,t}^*$. To this end we run separate regressions for each l^{th} element of $\mathbf{x}_{i,t}^*$ of the form:

$$(10) \qquad \Delta x_{it,l}^* = a_{i,l} + \sum_{k=1}^{r_i} \delta_{ik,l} E\hat{C}M_{ik,t-1} + \sum_{m=1}^{q_i} \boldsymbol{\varphi}'_{im,l} \Delta \mathbf{x}_{i,t-m} + \sum_{n=1}^{q_i^*} \boldsymbol{\psi}'_{in,l} \Delta \mathbf{x}_{i,t-n}^* + \eta_{it,l} \ ,$$

where the $E\hat{C}M_{i,k,t-1}$ for $k = 1, \ldots, r_i$ are the estimated error correction terms corresponding to the r_i cointegrating relations found for the i^{th} region, and q_i and q_i^* are the orders of the lagged rates of change for the domestic and foreign variables respectively. The weak exogeneity test is an F-test of the joint hypothesis that $\delta_{i,k,l} = 0$ for $k = 1, \ldots, r_i$ in the above equation. The lag orders of q_i and q_i^* are selected using the BS criterion, and are not necessarily the same as those of the underlying region-specific models. The results are reported in Table 2, where all variables for all regions pass the test. Finally, we have checked the dynamic stability of the GVAR model of Eq. (8) by ascertaining that all its eigenvalues lie on or inside the unit circle.

Table 2 about here

4. Results

We follow common practice in the GVAR literature in presenting our results by means of generalized impulse response functions (GIRFs), as originally proposed by Koop et al. (1996). The GIRFs are obtained from the moving-average representation of Eq. (8) given by:

(11) $$\mathbf{x}_t = \mathbf{d}_t + \sum_{s=0}^{\infty} \mathbf{A}_s \boldsymbol{\varepsilon}_{t-s},$$

where $\mathbf{d}_t$ is the deterministic component of $\mathbf{x}_t$, and where $\mathbf{A}_s$ can be derived recursively as

(12) $$\mathbf{A}_s = \mathbf{F}_1\mathbf{A}_{s-1} + \mathbf{F}_2\mathbf{A}_{s-2} + \ldots + \mathbf{F}_p\mathbf{A}_{p-1} \qquad \text{for} \quad s = 1, 2, \ldots,$$

and $$\mathbf{A}_0 = \mathbf{I}_k,\ \mathbf{A}_s = \mathbf{0} \qquad \text{for} \quad s \leq 0 \quad .$$

The GIRF of a one standard-error shock to the l^{th} equation at time t on the j^{th} variable at time $t+h$ is computed as:

(13) $$\psi_{lj}(h) == \frac{s_j' \mathbf{A}_h \mathbf{G}_0^{-1} \boldsymbol{\Sigma}_u s_l}{\sqrt{s_l' \boldsymbol{\Sigma}_u s_l}},$$

where h denotes the forecast horizon, $\mathbf{\Sigma}_u$ is the covariance matrix pertaining to the global model of Eq. (7), and s_l is a $k\, x 1$ selection vector with a unity value for the l^{th} element, and zeros otherwise.

In contrast to the standard impulse response analysis of the traditional VAR literature, GIRFs integrate out the effects of shocks to individual variables on the basis of the observed residual covariance matrix without having to rely on orthogonalization. This makes the GIRFs invariant to the ordering of countries and variables, which is a desirable feature for the GVAR setting in which both the high dimensionality of the model and the presence of cross-country interactions may render a theory-led ordering of the variables problematic.[3]

We report GIRFs for an expansionary one-standard-error shock to regional GDP growth originating in one of the three regions which we define as Germany, the core euro area and the Eurozone periphery. Whereas these are displayed in Figures 1-3, we also consider the international transmission of a debt shock arising in the Eurozone periphery in Figure 4. In all cases, we report the bootstrap median estimates and the associated 90% bootstrap confidence bands computed on the basis of 1000 replications of the GIRFs, where the forecast horizon extends up to 20 quarters and is recorded along the horizontal axis.

Figure 1 about here

Figure 1 shows the dynamic transmission of a positive GDP growth shock originating in Germany. This shock significantly raises the GDP growth rates of both the core and the periphery country groups on impact and throughout the first 4 quarters of the adjustment. The

[3] The fact that GIRFs are obtained on the basis of non-orthogonalized residuals does not allow for an interpretation of the structural nature of the shocks. However, this is not a problem as long the dynamics of the international shock transmission rather than a quantification of the disturbances hitting the economy are the main focus of analysis.

growth reactions are about half the size of the German impulse in the periphery and somewhat lower in the core region. The German growth shock also contributes to lowering the levels of public debt in all three regions, although for both Germany and the core group this effect is significant only in the medium term and is reversed in the longer run. Interestingly, the quantitative reaction of the debt trajectory is much stronger in both the core and the periphery groups relative to Germany. This result may at least in part be explained by the reactions of the real interest rate which is transitorily lowered in all three regions and particularly so in the Eurozone periphery, even though the effect turns out to be only marginally significant at about 8 quarters into the adjustment.

In order to shed more light on the transmission of the German growth shock on the components of aggregate demand across the three regions, Figure 1 also reports the GIRFs for the trade balance (*TB*), the government budget balance (*BB*), as well as for aggregate consumption (*C*) and investment (*I*). It turns out that the German trade balance significantly improves in the short run, but is not affected in the medium and long term. In contrast, both the core and the periphery groups observe a (marginally significant) deterioration in *TB*. The government budget balance is not much affected by the German growth shock. There is a slight improvement within the first year of the adjustment, but it is only significant for the Eurozone periphery at the two-quarter horizon. Finally, the GIRFs for consumption and investment turn out to be mostly insignificant. Whereas both Germany and the core countries experience a decrease in consumption and investment activity in the medium term, there is a positive and (marginally) significant effect in the periphery group. However, these effects are quantitatively rather small.

Figure 2 about here

Figure 2 displays the GIRFs for a positive GDP growth shock originating in the core group of Eurozone countries. The transmission of this shock on the growth rates of the three regions are qualitatively similar to those observed for the German growth shock, with a positive and significant transmission on impact and throughout the first 4 quarters of the adjustment. The quantitative impact on euro area GDP growth is about one-for-one and thus stronger than in the case of the German shock. Although the effect on public debt is qualitatively also rather similar to the GIRFs of Figure 1, it is of smaller size and turns out to be mostly insignificant. This result can again be motivated by the dynamics of the real interest rate which does not react significantly to the core area growth impulse in any of the three regions. Turning to the components of aggregate demand, the trade balance improves for Germany in the short run, stays unchanged in the core area and deteriorates transitorily for the periphery group, whereas the effects on the budget balance, as well as on consumption and investment activity, are again rather small, but generally positive for the euro area periphery.

Figure 3 about here

Figure 3 presents the GIRFs for a positive GDP growth shock in the euro area periphery. The impulse raises the growth performance in both Germany and the core euro area on impact and during the first four quarters of the adjustment. However, the size of the effect is fairly small, reaching 50% of the original impact in Germany and even less in the core group of Eurozone countries. The level of debt is again transitorily lowered in all three regions, but the impact turns out to be comparably small in Germany. Moreover, the debt trajectories revert to their starting levels rather quickly and even tend to increase in the longer run, particularly for Germany and the core euro area. These debt dynamics are mirrored by an increasing real interest rate in all three regions. The reactions of the components of aggregate demand turn out to be similar to the GIRFs of Figures 1 and 2. There is no appreciable effect on the budget balance, whereas the trade balance improves for Germany, deteriorates for the Eurozone periphery, and stays unchanged for the core euro area countries. The effects on consumption and investment are again rather small, but are positive and clearly significant for the peripheral countries.

Figure 4 about here

As a final exercise, Fig. 4 presents the results for an increasing debt level in the Eurozone periphery. This shock leads to transitorily rising debt levels in both Germany and the core countries. Whereas the transmission may be fostered by increasing real interest rates across the euro area in the short to medium term, there is no significant effect on either the GDP growth rates or the government budget balance in any of the three regions. In terms of the other components of aggregate demand, the trade balance shows short- to medium-term improvements for the euro area core and peripheral countries, but deteriorates for Germany. The reactions of consumption and investment are again mostly insignificant with the exception of consumption in Germany with a marginally significant improvement in the short run, and in the Eurozone periphery where the level of consumption recedes on a permanent basis. However, these effects are again very small throughout.

5. Conclusion

This paper employs a global vector autoregression (GVAR) model to analyze two-way spillover effects of public debt and growth across the euro area. We use quarterly data from 1991Q1 to 2014Q4 for 11 major Eurozone countries, which are combined into three entities of roughly equal economic weight: Germany as the single largest economy of the euro area, a

Eurozone core group including Austria, Belgium, Finland, France and the Netherlands, and the Eurozone periphery made up of Greece, Ireland, Italy, Portugal and Spain. The model is estimated with data on public debt and economic growth as well as 5 additional macroeconomic variables which may function as potential transmission mechanisms between debt and growth. These are aggregate consumption and investment, the government budget balance, the trade balance and a long-term interest rate.

We find that an increase in GDP growth in any of the three entities is transmitted into higher growth rates in the other regions of the Eurozone. Growth shocks also transitorily lower debt levels in all regions, but these effects turn out to be mostly insignificant. The only exception is a growth impulse originating in Germany which lowers debt levels significantly across all regions of the Eurozone. We associate these differential debt effects with the reaction of the real interest rate. Whereas the German growth shock leads to a transitorily lower real interest rate in all three regions, and particularly so in the Eurozone periphery, growth shocks in the core euro area leave the real interest rate unaffected, whereas a peripheral growth impulse even raises the real interest rate, although not significantly so. Similarly, a debt shock emanating from the Eurozone periphery raises the real interest rate across the euro area and leads to transitorily rising debt levels in both Germany and the group of core countries, but exerts no significant impact on the growth dynamics in either region. In all cases, the reactions of the other macro variables appear to be rather weak and frequently insignificant.

We interpret this evidence as being supportive of the notion that policy measures designed to raise the aggregate euro area growth rate may best be coordinated as the impulse originating in any of the three regions spills over into the rest of the Eurozone. At the same time, the German growth impulse has the strongest impact on debt and can thus be considered essential if the aim is to reduce public debt levels across the euro area. We also conclude that the recent sovereign debt crisis affecting the Eurozone periphery does not appear to have dampened the growth prospects of the euro area economies, although it may have directly contributed to higher debt levels by raising real interest rates across the Eurozone.

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Figures and tables

Figure 1: Impulse response functions for an expansionary shock to German GDP growth

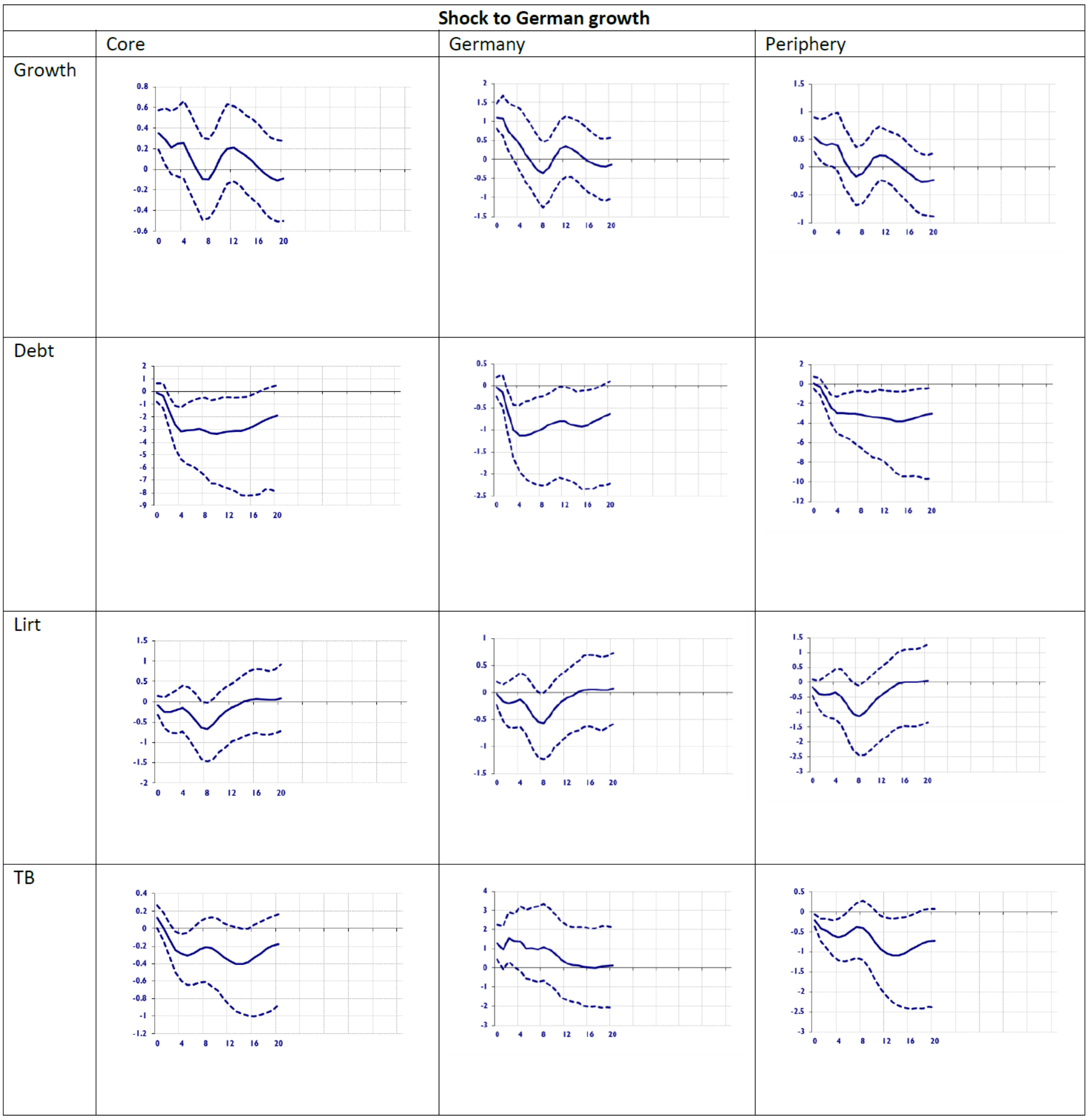
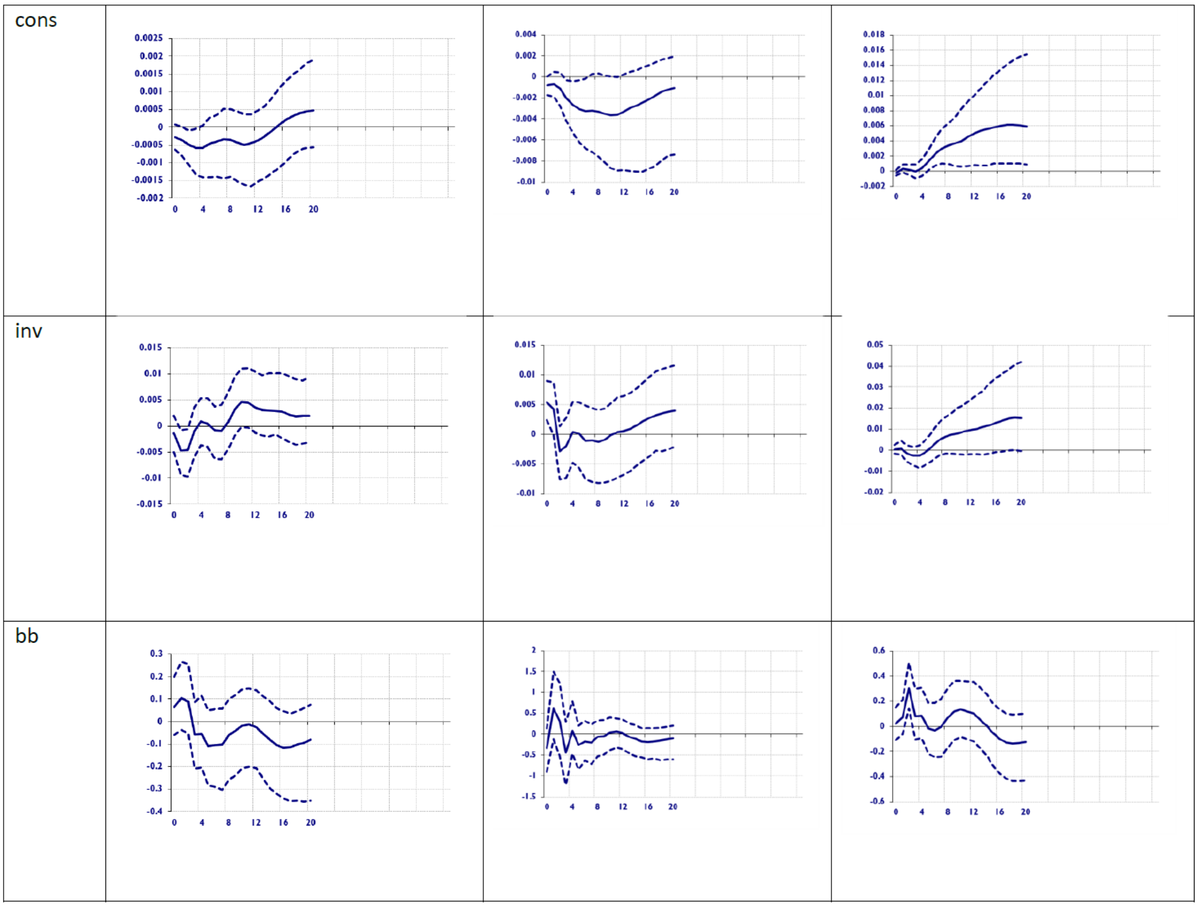


Figure 1 (continued)



Notes: The Figure reports general impulse response functions (GIRFs) following a one-standard-deviation growth shock in Germany on the GDP growth rate (GR), the trade balance (TB), public debt (PD), the budget balance (BB), consumption (C) and investment (I) for Germany as well as the core and periphery groups of euro area countries.

The graphs show bootstrap median estimates with the associated 90% bootstrap confidence bands computed on the basis of 1000 replications of the GIRFs, where the forecast horizon extends up to 20 quarters and is recorded along the horizontal axis.

Figure 2: Impulse response functions for an expansionary shock to GDP growth in the euro area core group

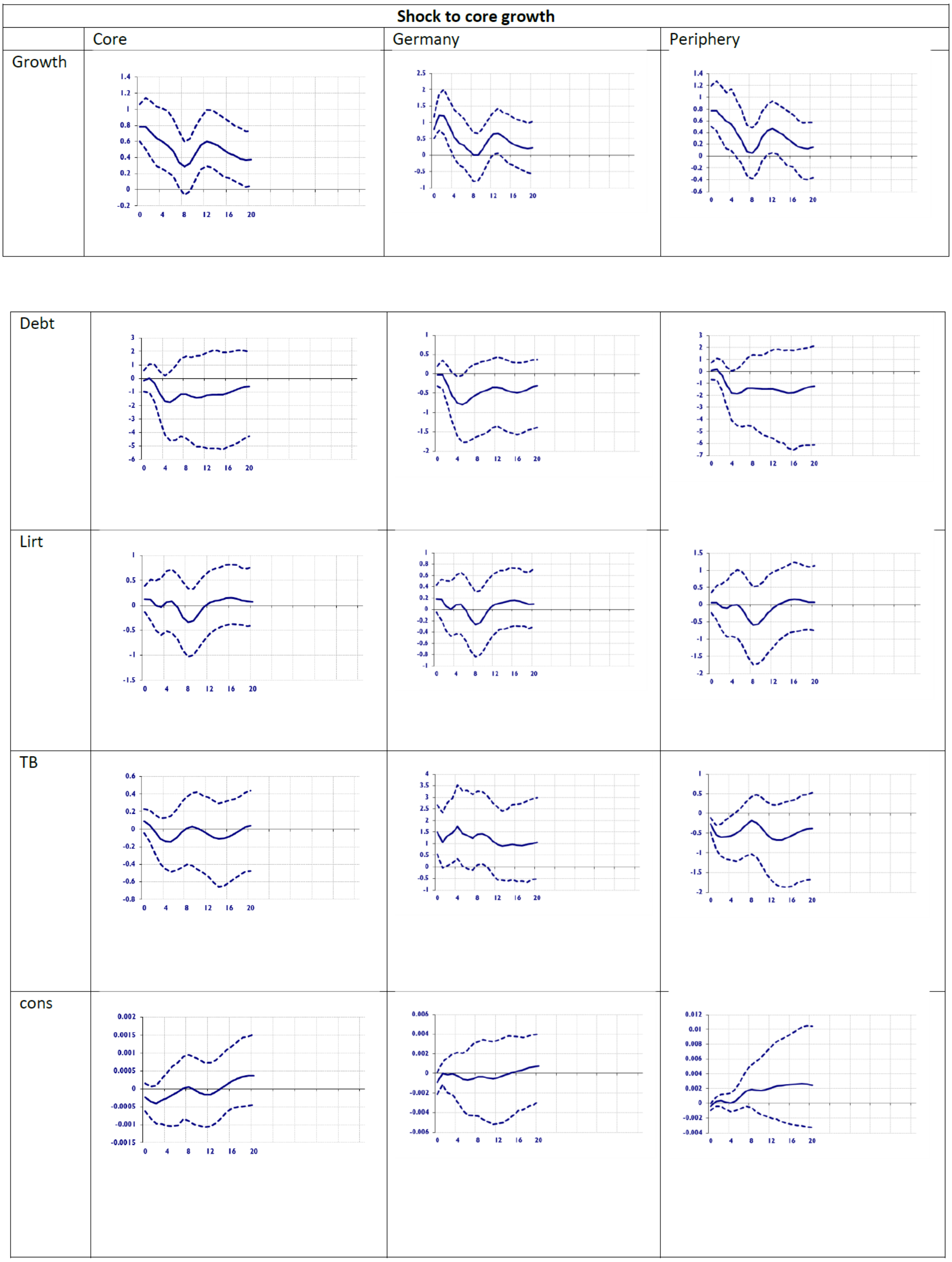
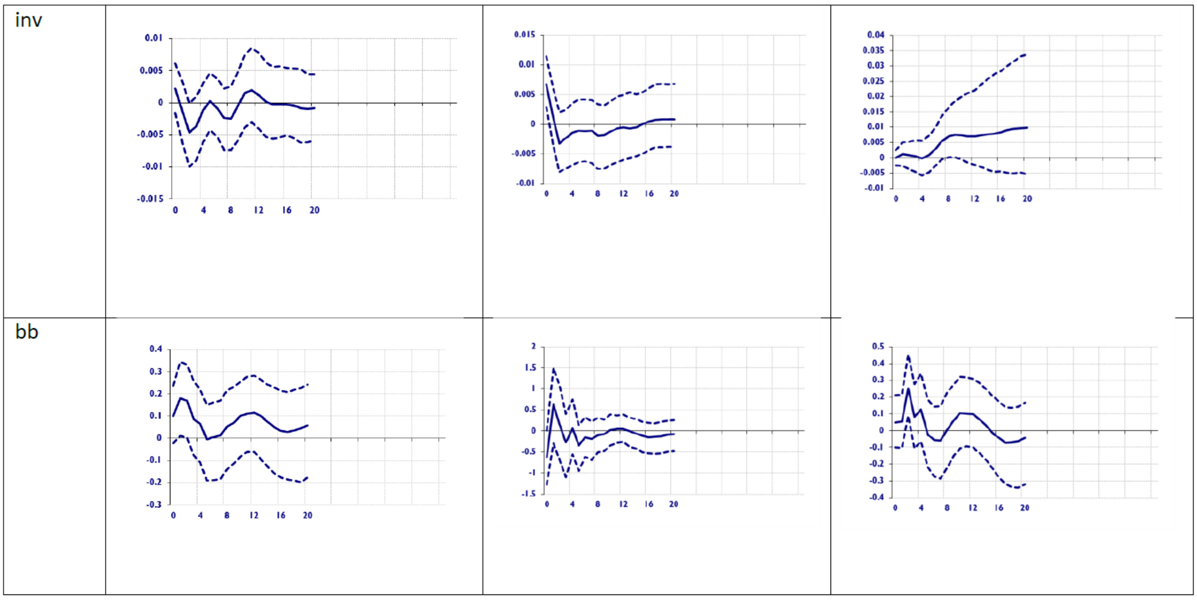


Figure 2 (continued)



Notes: See Figure 1

Figure 3: Impulse response functions for an expansionary shock to GDP growth in the euro area periphery group

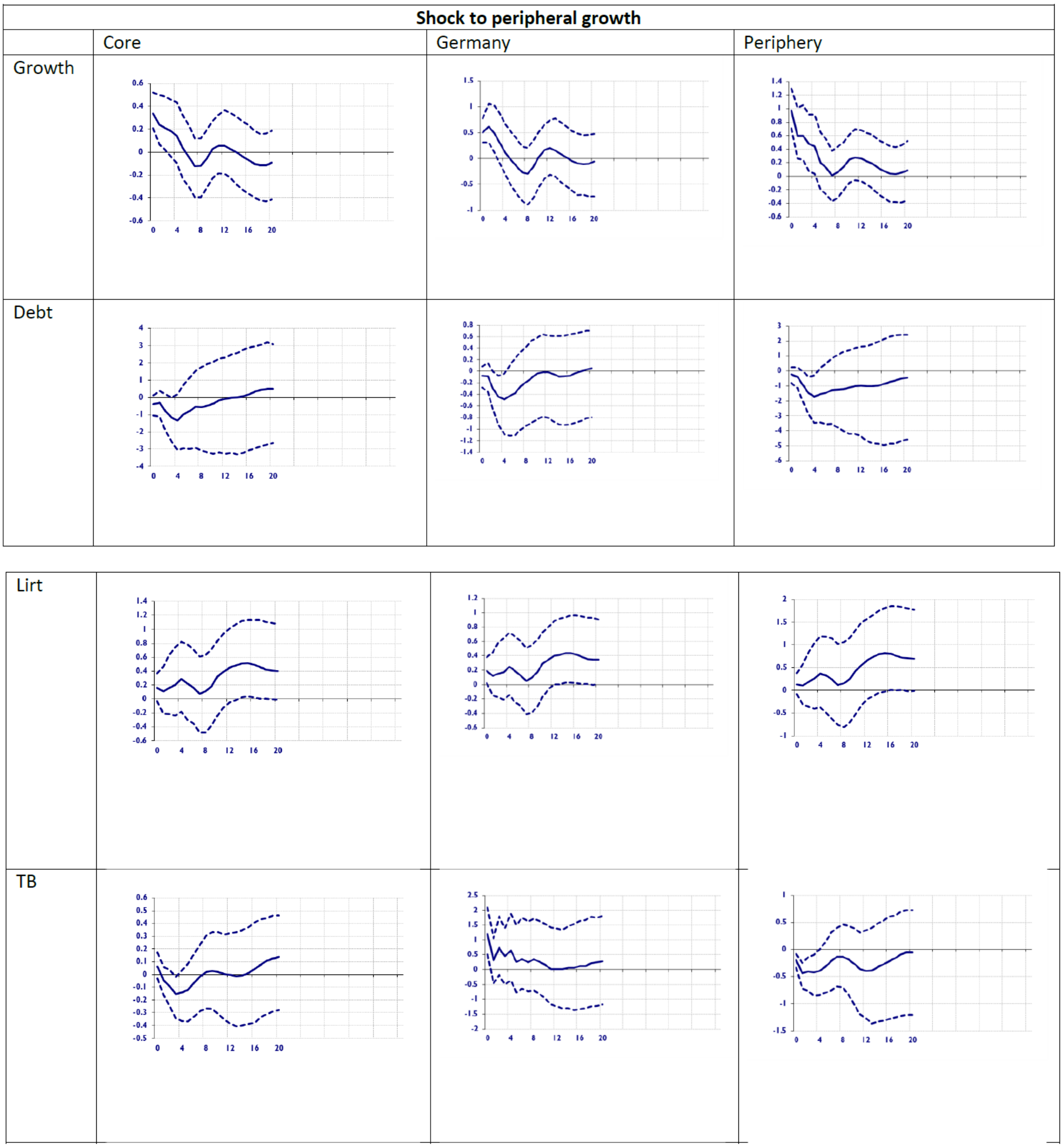
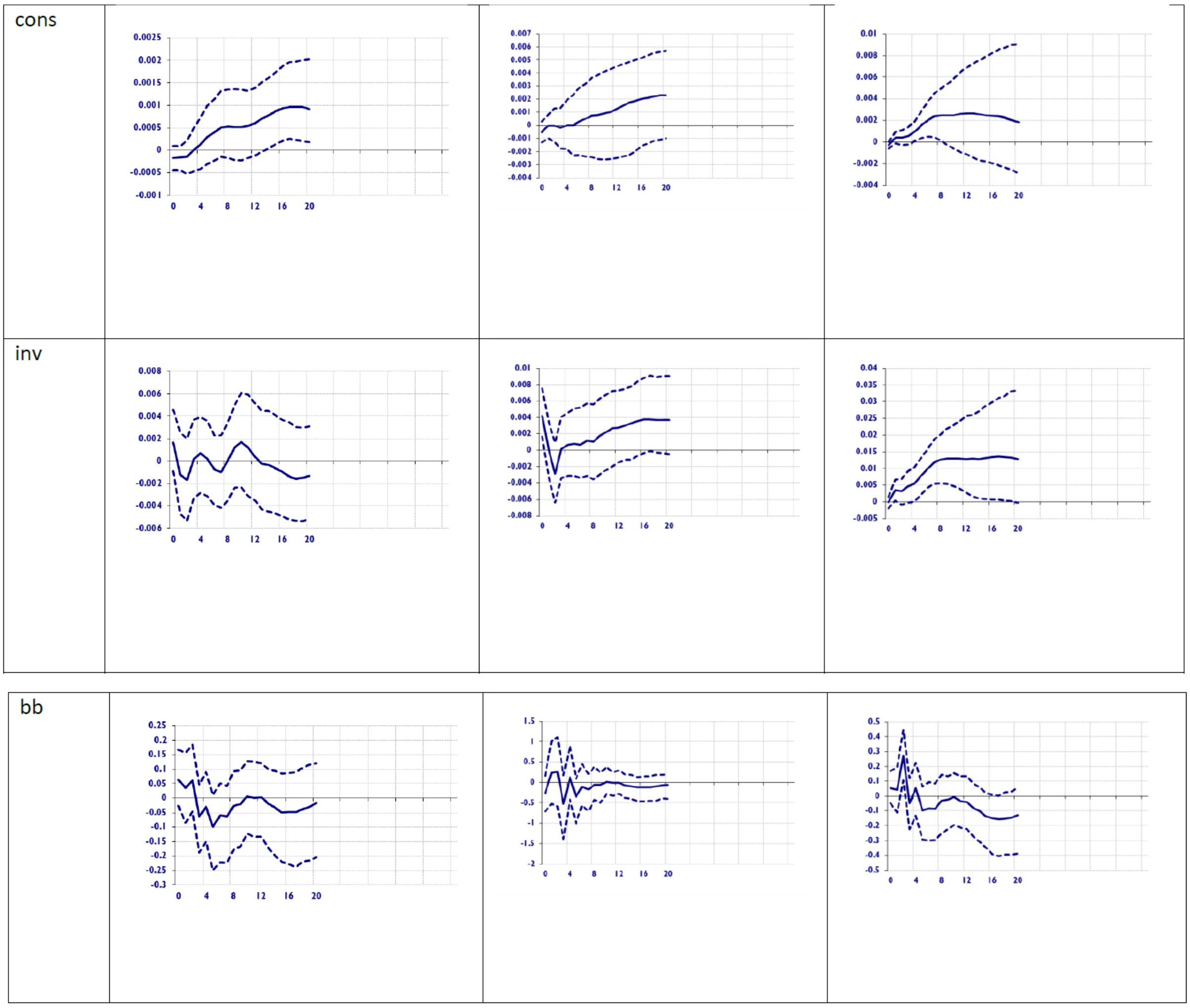


Figure 3 (continued)



Notes: See Figure 1

Figure 4: Impulse response functions for an expansionary debt shock in the euro area periphery group

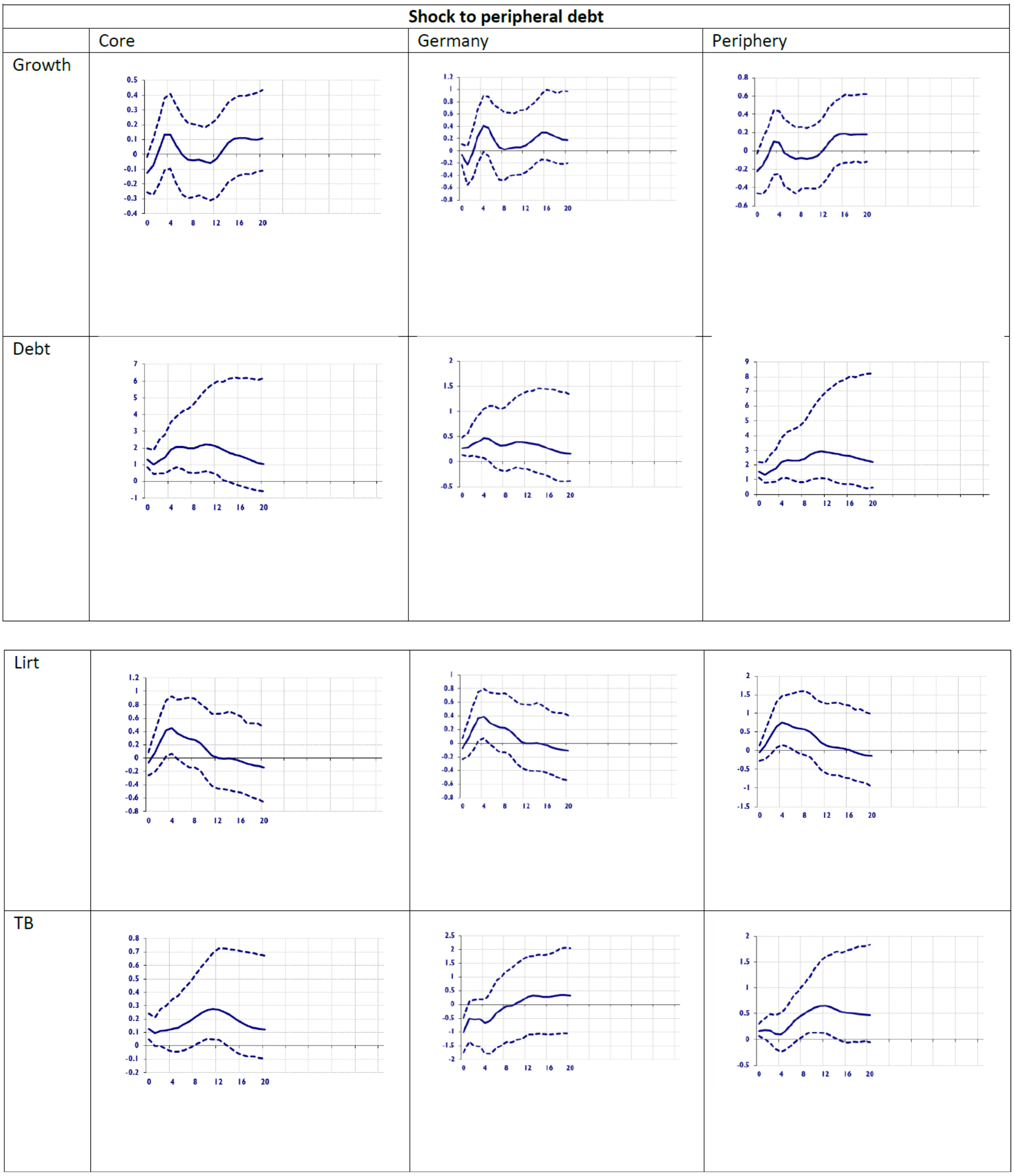
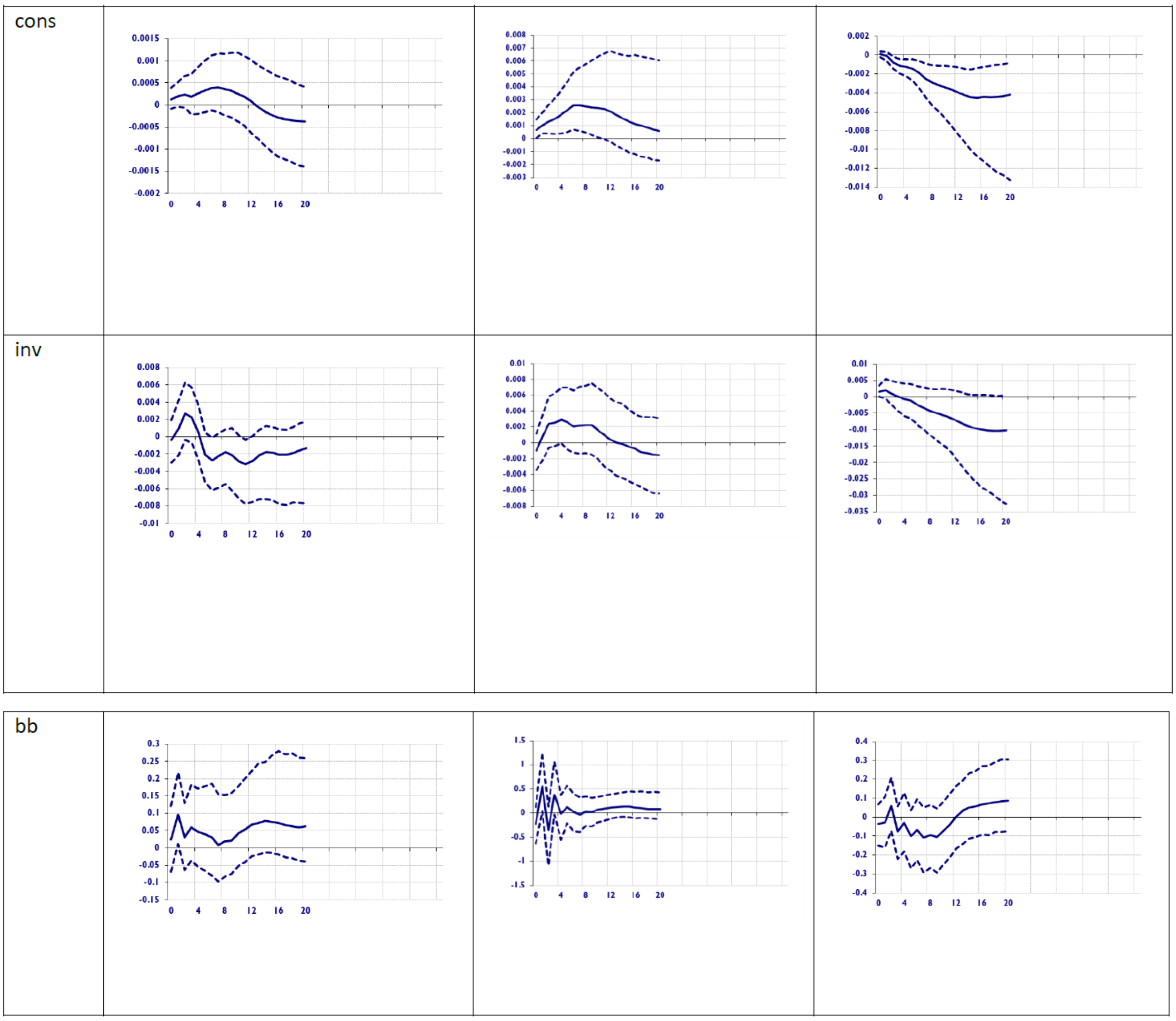


Figure 4 (continued)



Notes: See Figure 1

Table 1: Unit root tests

	Statistic	Critical value	GERMANY	CORE	PERIPHERY
Domestic Variables					
GROWTH	ADF	-3.45	-4.20	-2.67	-2.33
	WS	-3.24	-3.78	-2.88	-2.31
DEBT	ADF	-3.45	-2.68	-2.31	-2.42
	WS	-3.24	-2.40	-2.66	-2.66
LIRT	ADF	-3.45	-3.55	-3.20	-1.99
	WS	-3.24	-3.28	-2.43	-1.16
TB	WS	-3.24	-3.03	-1.35	-1.38
	ADF	-2.89	-0.71	-1.54	-1.31
C	ADF	-3.45	-2.60	0.57	-0.19
	WS	-3.24	-0.98	0.10	-0.82
I	ADF	-3.45	-1.70	-2.33	-1.43
	WS	-3.24	-1.73	-2.64	-2.02
BB	ADF	-3.45	-6.15	-4.32	-2.94
	WS	-3.24	-6.39	-4.37	-2.86
Foreign Variables					
GROWTH	ADF	-3.45	-3.48	-2.51	-3.54
	WS	-3.24	-3.61	-2.62	-3.69
DEBT	ADF	-3.45	-2.79	-2.64	-2.94
	WS	-3.24	-2.92	-2.92	-3.18
LIRT	ADF	-3.45	-2.91	-2.87	-3.28
	WS	-3.24	-2.00	-2.01	-2.55
TB	ADF	-3.45	-2.87	-1.63	-2.70
	WS	-3.24	-3.09	-1.15	-2.81
C	ADF	-3.45	-0.90	0.98	-1.93
	WS	-3.24	-1.31	-0.11	-1.50
I	ADF	-3.45	-1.77	-0.47	-2.31
	WS	-3.24	-2.00	-1.21	-2.38
BB	ADF	-3.45	-3.18	-3.59	-3.41
	WS	-3.24	-3.40	-3.65	-3.53

Notes: GROWTH, DEBT, LIRT, TB, C, I and BB denote the output growth rate, public debt, the long-run interest rate, the trade balance, consumption, investment and the budget balance respectively.

Table 2: Weak exogeneity tests

Country	Critical value	GROWTH	DEBT	LIRT	TB	C	I	BB
GERMANY	2.49	0.67	0.18	0.41	0.63	0.12	2.18	1.14
CORE	2.86	1.50	0.10	0.96	0.33	1.68	1.12	0.68
PERIPHERY	2.63	1.27	0.49	1.63	0.82	0.37	0.21	1.16

Notes: Tests for weak exogeneity at the 5% significance level