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Shafik Hebous
Tom Zimmermann

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Abstract

We estimate spillover effects of a fiscal shock in one member country in the euro area on outputs of the rest of the members, using a Global Vector Autoregression (GVAR) model. We compare the effects of a domestic fiscal shock with those of a similar size area-wide shock expressed as a weighted average of the fiscal shocks across all member countries. According to our estimates, the impact of an area-wide fiscal shock on output of a member country tends to be positive and larger than that of a domestic shock. Since the cost of participating in the area-wide shock is lower than the cost of a similar size domestic shock, our finding indicates the importance of coordinated fiscal actions in the euro area.

JEL-Code: E620, F410, F420, F150, H500, H600.

Keywords: fiscal policy coordination, cross-border spillovers, open economy macroeconomics, European integration, Global VAR.

Shafik Hebous
Goethe University Frankfurt
Frankfurt am Main / Germany
hebous@wiwi.uni-frankfurt.de

Tom Zimmermann
Harvard University
Cambridge MA / USA
tzimmerm@fas.harvard.edu

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1. Introduction

In a speech in June 2011, Jean-Claude Trichet, the former president of the ECB, has provoked envisaging a ministry of finance at the euro area level to exert inter alia "direct responsibility in the surveillance of both fiscal and competiveness policies". In a similar vein, the IMF has emphasised the need for a "collective" fiscal response to the global economic crisis stormed in late 2008 through 2009.[1] Not only the discussion in the policy arena but also economics posits that in a highly integrated world, domestic fiscal actions can affect foreign economies. Domestic effects of a fiscal shift and the associated cross-border externalities are particularly pronounced in the context of a currency union where the exchange rate between member countries is fixed.

In this study, we estimate the effects of coordinated fiscal stimuli in the euro area. Specifically, we build upon the multi-country global vector autoregression (GVAR) approach developed by Pesaran et al. (2004) as follows:

- Estimate an augmented country-specific VAR model for every economy in the euro 12 area. Country-specific VAR models are augmented with foreign variables.
- Estimate the spillover effects of a domestic budget balance shock on the members of the euro area by consistently combining all country-specific VAR models in one multi-country model and treating all variables as endogenous.
- Compare domestic with spillover effects of the area-wide fiscal shock. Following Dees et al. (2007), the area-wide fiscal shock is expressed as a weighted average of the budget deficit shocks across the euro area countries, allowing for inter-linkages between these economies.

In essence, in terms of magnitude, the area-wide shock is not larger than the domestic shock. One may think of the euro-wide shock as a shock that has the magnitude of a domestic shock, but to which each country contributes only a fraction depending on the size of the country. According to our results, the impacts on output of most members following the area-wide shock are larger than those resulting from a domestic shock. Noting that the cost of participating in the area-wide shock is lower than the cost of a similar size domestic shock, our findings indicate the importance of coordinated fiscal stimuli.

[1] See Trichet (2011) and IMF Staff Position Note (2008; 2009).

Perotti (2007) reappraises in detail arguments against the empirical results from VAR estimates of the effects of fiscal shocks. There is an ongoing debate on the identification of a structural fiscal shock that captures only discretionary fiscal actions.[2] However, in the context of cross-border externalities, fiscal spillovers resulting from a (large) budget deficit in one country would occur whether the cause is only discretion or a combination of discretion, automatic responses, and other effects. Therefore, we primarily rely on identifying *generalised* impulse response functions. These impulse responses, although broadly interpretable, are informative and capture overall spillover effects.

This study proceeds as follows. Section 2 provides a brief theoretical background of fiscal spillover effects. Section 3 presents our empirical methodology of modelling fiscal policy externalities in the GVAR framework and interprets the fiscal shocks. Section 4 describes the data and our empirical specifications. Section 5 displays our main findings and the robustness analysis based on various identification strategies and specifications. Finally, section 6 concludes.

2. Theoretical Background

There are three main spillover channels of an expansionary fiscal policy in one member country into the rest of the currency union, as can be demonstrated in a multi-country Mundell-Fleming model with a fixed exchange rate peg between members and perfect capital mobility. (1) Positive spillover effects through trade: A fiscal expansion stimulates domestic activities, pressuring the exchange rate to appreciate and the domestic interest rate to increase. In a currency union, however, the exchange rate between members is fixed and the interest rate is ultimately determined at the union level. Hence, domestic money under circulation increases, further stimulating domestic output. The increase in domestic output leads to an increase in imports, boosting the income of the trading partners. (2) Negative spillover effects through eventually affecting the union interest rate: The initial increase in the domestic interest rate following the fiscal expansion attracts capital flows into the domestic economy out of the rest of the union and elsewhere, putting upward

[2] Various structural identification schemes have been suggested in the literature. Blanchard and Perotti (2002) use a SVAR framework. Ramey (2011) relies on exogenous dates of changes in government defence spending whereas Romer and Romer (2010) apply the idea for legislated tax changes. Mountford and Uhlig (2009) employ the sign restriction approach. Caldara and Kamps (2008) compare the findings obtained from those approaches. Auerbach and Gorodnichenko (2012) employ regime switching models and control for real-time predictions. All these studies provide estimates for the U.S. economy.

pressure on the interest rates of the members of the rest of the union. The final equilibrium of the union-wide interest rate may be at a higher level than before the shock. This interest rate channel may have a contractionary effect on foreign and domestic output. (3) Spillover effects through the real exchange rate: The euro is floating with respect to the rest of the world. If the fiscal expansion in a (large) member economy causes an appreciation of the real exchange rate of the euro, as the Mundell-Fleming model predicts, the expansionary effects will be dampened due to worsening trade balances.

Although the transmission mechanism of an expansionary fiscal shock differs in micro-founded dynamic stochastic general equilibrium (DSGE) models, the standard DSGE model agrees with the Keynesian predications of the positive response of output and the appreciation to the real exchange rate. Contrary to the Keynesian predictions, however, consumption decreases in a standard DSGE model. The forward-looking consumer in a DSGE setup is aware of the increase in the present value of household tax liabilities (negative wealth effect) due to the fiscal expansion. Monacelli and Perotti (2010) stress that consumption increases *and* the real exchange rate *depreciates* following an expansionary fiscal shock.[3] Several recent theoretical DSGE studies focus on fiscal shock spillovers within an international setup or specifically in a currency union. Corsetti et al. (2010) show in a two-country DSGE model that financing a current fiscal stimulus plan with a combination of an increase in medium-run taxes and a decrease in medium-run government spending ("spending reversal") enhances positive cross-border fiscal spillovers. Cwik and Wieland (2011) perform simulation exercises using various versions of a structural DSGE model estimated and calibrated for the euro area. They find no support for positive spillover effects of an increase in government spending.[4] Overall, economic theory provides reasoning to expect positive and negative spillover effects. Empirical evidence is required to clarify the final effect on output and other key variables.

[3] The debate on the reaction of consumption and other variables has stimulated a number of studies to modify a standard DSGE model in order to account for the empirically found increase in consumption and depreciation of the real exchange rate. This is accomplished, for example, by allowing for habit persistence at the good level as in Raven et al. (2007), or for future government spending to decrease in reaction to the stock of public debt as in Corsetti et al. (2012). Some models explain the increase in consumption by incorporating non-Ricardian households, as suggested in Mankiw (2000). Some empirical studies do not support the positive response of consumption. Hebous (2011) provides a survey of the theoretical and empirical literature on the dynamics of key variables following a fiscal shock.

[4] Several theoretical studies on fiscal policy in a currency union focus on the interaction between optimal fiscal and monetary policy rules. Examples are Ferreo (2009) and Galí and Monacelli (2008).

3. Fiscal Policy Externalities in a GVAR Framework

3.1. The GVAR Approach

The GVAR provides an unprecedented coherent approach to estimate spillover effects of a domestic fiscal shock on foreign variables by treating all domestic and foreign variables as endogenous. Strictly, while the terminology ”global” VAR is due to the fact that Pesaran et al. (2004) include most countries in the world, our GVAR is indeed a ”euro area” VAR that models interdependences across the euro area members.[5] Without loss of generality, in this section, we illustrate the GVAR model by considering one lag. This can be easily generalised to the case of multiple lags. We derive in four steps a system in which the variables of all 12 members of the euro area are combined as follows.

Step 1: Estimate an augmented country-specific VAR model:

$$Y_{i,t} = \alpha_{i,0} + \alpha_{i,1}t + \Phi_i Y_{i,t-1} + \Lambda_{i,0} Y^*_{i,t} + \Lambda_{i,1} Y^*_{i,t-1} + \epsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ is a $k_i \times 1$ vector of domestic variables. The subscript $i = 1, 2, \ldots, N$ is a country index while $t = 1, \ldots, T$ denotes time. $Y^*_{i,t}$ is a $k^*_i \times 1$ vector of foreign variables. The residual $\epsilon_{i,t}$ is independently and identically distributed with a zero mean and a variance-covariance matrix Σ_i. A foreign variable of country i is computed as a weighted average of its values for the rest of the members. We allow the weights to differ across variables. Section 4 describes the weights in details. In a standard country-specific VAR model, foreign variables are discarded; that is, the matrices of coefficients $\Lambda_{i,0}$ and $\Lambda_{i,1}$ are set equal to zero. To study interdependence across countries, one may estimate a large VAR model that includes variables of all countries in the vector Y. In such a model, all variables, domestic and foreign, are treated as endogenous. However, due to the large number of variables, and hence of coefficients to be estimated, and the relatively small number of observations, estimating such a large VAR model is intractable. The GVAR offers an alternative approach by treating foreign variables as weakly exogenous in the country-specific VAR model.

Thus, step 1 allows us to obtain estimates for the matrices $\alpha_{i,0}$, $\alpha_{i,1}$, Φ_i, $\Lambda_{i,0}$, $\Lambda_{i,1}$ and the variance-covariance matrix Σ_i.

[5] Pesaran et al. (2004) use the GVAR to examine the effects of global risks on a bank's loan portfolio.

Step 2: Transform the model as follows:

$$\underbrace{(I, -\Lambda_{i,0})}_{:=A_i}\underbrace{\begin{pmatrix} Y_{i,t} \\ Y^*_{i,t} \end{pmatrix}}_{:=Z_{i,t}} = \alpha_{i,0} + \alpha_{i,1}t + \underbrace{(\Phi_i, -\Lambda_{i,1})}_{:=B_i}\underbrace{\begin{pmatrix} Y_{i,t-1} \\ Y^*_{i,t-1} \end{pmatrix}}_{:=Z_{i,t-1}} + \epsilon_{i,t} \tag{2}$$

to obtain the matrices: A_i, B_i, $Z_{i,t}$, and $Z_{i,t-1}$.

Step 3: Rearrange the terms to express $Z_{i,t}$ in terms of Y_t:

$$Z_{i,t} = W_i Y_t \tag{3}$$

The matrix W_i is $(k_i + k_i^*) \times k$, where $k = \sum_{i=1}^{N} k_i$. The elements of the matrix W_i are zeros, ones, and the weights used in computing the foreign variables. The matrix W_i links country-specific variables with all foreign variables in the system. The crucial aspect of equation (3) is that there is no subscript i attached to Y_t, that is, variables of all countries in our system are stacked in Y_t.

Step 4: Plug equation (3) into (2) and rearrange to derive:

$$A_i W_i Y_t = \alpha_{i,0} + \alpha_{i,1}t + B_i W_i Y_{t-1} + \epsilon_{i,t} \tag{4}$$

which yields the "global" solution:

$$GY_t = \alpha_0 + \alpha_1 t + HY_{t-1} + \epsilon_t \tag{5}$$

where: α_0, α_1 , G, H, and ϵ_t contain all country-specific vectors, and $cov(\epsilon_t) = \Sigma$.

Equation (5) combines all variables in one system, enabling us to examine the effects of a shock to one domestic variable in country i on other domestic variables of country i and variables of country j.

3.2. Interpretation of the Fiscal Shock

As in a standard VAR analysis, the impulse response functions summarise the dynamics of the variables following a shock to the system. While reduced form shocks can be broadly interpreted, structural shocks can be directly linked to policy recommendations. Therefore, existing VAR studies endeavour to disentangle the effects of the structural (discretionary) fiscal shock from other effects. Broadly, the identification of a structural fiscal shock can be achieved either by imposing short-run and long-run restrictions or by means of the sign restriction approach. However, as scrutinised in Perotti (2007) and surveyed in Hebous (2010), the appropriate identification of the structural fiscal shock is heavily debatable. For our purpose, we are particularly interested in the sign of the spillover effect, which is per se subject to different theoretical predictions. This makes the implementation of the sign restriction approach not uncontroversial. In the case of relying on exclusion restrictions, the identification of the structural shock requires imposing $\sum_{i=1}^{N} k_i(k_i-1)$ restrictions that entail several assumptions. Moreover, recovering a structural shock, based on exclusion restrictions in a GVAR model, depends on the ordering of the countries in the system. Strictly, there is no theoretical background to guide the order of the countries.

Given the difficulties in identifying structural domestic shocks, identifying structural spillover effects becomes more challenging. Hence, our strategy is to rely on generalised impulse response functions. These shocks contain not only the discretionary component of fiscal policy, but also other automatic responses. Still, these shocks are informative, and are invariant to the ordering of the variables in the system (Pesaran and Shin; 1998). The spillover effects of a budget deficit in one member country on the rest of the union would occur independently of the factors behind the deficit, whether discretionary actions or not. Our focus here is the resulting area-wide (global) dynamics.[6]

Pesaran et al. (2004) show that the GIRF to a one-standard error shock to the jth equation corresponding to the lth variable in country i at time t on expected values of Y at time $t+h$ can be computed as:

$$\psi_{j,l}(h) = \frac{1}{\sqrt{\sigma_{ii,ll}}}(G^{-1}H)^h G^{-1}\Sigma s_j, \;\; h = 0, 1, \ldots \tag{6}$$

where s is a selction vetor that has 1 as its jth element and zeros otherwise.[7]

A central focus of our analysis is impulse responses following an area-wide budget

[6] In a related companion paper, we exploit recent data from the IMF identifying fiscal consolidation episodes based on the narrative records. However, in the companion paper, the estimation focuses on bilateral effects in a panel framework rather than the anaylsing the global dynamics as in this paper.

[7] This is valid for the VAR(1) model discussed in the previous section. See Pesaran and Shin (1998) for a generalisation.

deficit. This area-wide shock (or so-called ”global shock”) is recovered as a weighted average of the variable-specific shocks across all countries. The weights in the area-wide shock are calculated as the ratio of the GDP of a member country to the total GDP of the euro area.[8]

4. Data and Empirical Specification

Our benchmark specification is a VAR(1) model with a 7-dimensional $Y_{i,t} = (x_{i,t}\ bb_{i,t}\ c_{i,t}\ r_{i,t}\ reer_{i,t}\ nx_{i,t}\ d_{i,t})$, where x is real output per capita, bb is the ratio of primary budget balance to GDP or the ratio of cyclically adjusted government primary balance to potential GDP or real government investment spending per capita, c is real consumption per capita, r is the real interest rate, $reer$ is the real effective exchange rate (an increase in $reer$ indicates an appreciation), nx is the ratio of net exports to GDP (trade balance), and d is the ratio of public debt to GDP. As argued in Favero and Giavazzi (2007) and Chung and Leeper (2007), the results of studies that do not take account of the government budget constraint are biased. We consider this by introducing the equation of debt dynamics in country-specific VAR models.[9] All level variables are expressed in natural logarithm. Due to the limited length of the time series, we are restricted to estimate the individual models with only one lag in both domestic and foreign variables. The individual models are then combined to get the GVAR solution of equation (5). Most time series in our analysis are obtained from the OECD Economic Outlook database. The frequency of the data is quarterly, spanning the time period from 1979 to 2009.[10] Our baseline model consists of 12 euro area countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, and Spain. As a robustness check, we re-estimate the model including the UK and the US as additional foreign countries into all country-specific models.

We compute a foreign variable as a weighted average of its values for the rest of the members as follows:

[8] See Dees et al. (2007) for a detailed derivation of the global shock.

[9] Data on debt for Greece, Ireland, Luxembourg, Portugal, and Spain are either not available or the series are short. Therefore, for these countries the country-specific VAR model is 6-dimensional.

[10] Born and Müller (2012) show that the responses of annual and quarterly variables to fiscal shocks are very similar. The data appendix describes in detail the construction of the variables and documents the sources of the data. Some time series are not available for all countries.

$$y^*_{i,t} = \sum_{j=1}^{n} w^y_{ij} y_{i,t},$$

Bilateral flows of trade and capital are important determinants of cross-country linkages. We use two different weighting series to construct foreign variables. In the case of real variables, that is, x, bb, and c, the weights are computed based on the trade share of country j in total trade of country i (trade weights). In the case of financial variables, $r^*_{i,t}$ and $d^*_{i,t}$, we use the share of capital flows from country j to country i in total capital inflows into country i (capital weights). The weights are zero for $i = j$. Trade and capital weights are computed as average values over the period 1980-2007 and 2001-2007, respectively.[11] There is no $reer^*$, since the $reer$ is already computed using the worldwide bilateral trade shares as described in the data appendix. Also, to avoid double counting there is no $nx^*_{i,t}$. The source for the bilateral trade data is the International Monetary Fund Direction of Trade Statistics. Table (A1) in the appendix displays the bilateral average trade and capital weights for the countries in our sample. Germany is the most important trade partner for all euro area countries. For example, the share of trade with Germany in French total trade is 19.1 percent. However, trade with France accounts only for about 9.8 percent of total German trade. Data on capital weights are taken from the Coordinated Portfolio Investment Survey (CPIS) database of the International Monetary Fund. The figures of capital weights show, for example, that 11.1 percent of total French capital inflows are from the Netherlands.

As shown in table (A2) in the appendix, most of the variables are integrated of order one. Tests for cointegration, however, give mixed results. In this case, Enders (2003) and Hamilton (1994) recommend estimating a VAR in terms of levels of variables. This is because a vector error correction model (VECM) might impose invalid restrictions on the coefficients if the assumed cointegrating relations are wrong. A VAR in first differences, however, might be misspecified if variables are actually cointegrated. Hence, estimating a VAR in levels serve as a good compromise since it yields consistent estimates, albeit inefficiency.

[11] Data on bilateral capital portfolio flows are not available before 2001.

5. Empirical Results

5.1. Benchmark Results

We study the effects of three distinct shocks. First, we compute the impulse response functions of output of a member country in the euro area to a *domestic* fiscal shock. Second, we compute the impulse response functions of *overall*, domestic and spillover, effects of an *area-wide* fiscal shock. Third, for the area-wide fiscal shock, we disentangle the spillover effects from the domestic effect on output. For this purpose, we exclude one member country, and derive *pure* spillover effects of an area-wide shock to all other members. The weights in the GVAR are adjusted accordingly. We repeat this process for every member country. Our benchmark fiscal shock is a budget deficit shock. Figure (1) summarises the results. Comparing the dynamics resulting from all these shocks, the area-wide impulse response functions show visibly more pronounced effects on output of many countries. For example, the impact and dynamics of output in Germany following the area-wide shock are clearly positive in comparison with the case of the domestic German shock.

In fact, to be better off, the effects of the area-wide shock do not have to be larger than the domestic effects. For illustration, consider a domestic shock of size x, and replace it by an area-wide shock of size x. From the standpoint of a member country, the difference is also in terms of the cost of the shock. A country pays only a fraction of the area-wide shock depending on the size of the country. The resulting deficit, from the perspective of a country, is lower than that in the case of fully financing a domestic shock of size x. Since a major contribution of our study is to disentangle fiscal spillover effects, in figure (2), we re-plot the impulse response functions of output resulting from this shock, and add the 90 percent confidence bands. We note in some cases significant impacts. The upshot as revealed by figures (1) and (2) is that pure spillover effects are the major contributor to the positive responses of output in member countries.

The reaction of monetary policy to an aggregate area-wide fiscal shock might be a different from that to a country-specific fiscal shock. However, coefficients of correlation between the bb and the r residuals for each country reveal that they tend to be relatively low (the median is 0.03). In addition, the correlation between the interest rate response to a domestic shock and the response to an area-wide fiscal shock tends to be rather high for all member countries reaching above 85 percent in some cases (the median is 0.64).

This documented pattern of correlation does not indicate a different reaction of monetary policy to an area-wide fiscal shock from the reaction to a domestic shock.

To economise on space, we do not report full detailed estimated bilateral spillover effects resulting from domestic shocks. The estimates mostly suggest positive, but depending on the pair of countries in some cases negative, spillover effects of a budget deficit shock on output of other members. However, overall, the bilateral effects resulting from budget deficit shocks are not highly significant. Hebous and Zimmermann (2010) documented detailed results.

As a robustness check, we also consider government spending shocks. Conceptually, a government spending shock is different from the budget balance shock since the latter captures all forms of expansion whether through taxes, transfers or spending. Figure (3) shows that, in general, the pattern of output dynamics following a spending shock is similar to figures (1) and (2). Furthermore, figures (1) and (3) indicate that countries that are characterised with weak effects of the domestic shock, such as Germany and Greece, have incentives to abstain from participating in the area-wide shock. This free-riding possibility – avoiding the cost of the shock and profiting from the expansion in the rest of the area – arises due to the heterogeneous dynamics across member countries.

Our approach gives the net spillover effects without disentangling the contribution of the various channels through which these effects might have occurred. However, existing empirical studies on fiscal policy externalities in the euro area typically concentrate on one spillover channel, ignoring others. For instance, Beetsma et al. (2006) consider fiscal spillover effects through trade and, in contrast to our integrated approach, proceed in two steps. First, they obtain estimates of the effects of a fiscal shock on output, using a European panel VAR. Second, they impose homogeneity restrictions – that is, the magnitude of the response of output in all included countries is identical – and plug the panel VAR estimates into a trade-gravity type model. The results of Beetsma et al. (2006) suggest, for example, that a 1-percent increase in German public spending boosts foreign income by 0.15 percent. Faini (2006) employs a single-equation panel approach to estimate the spillover effects through the interest rate channel and finds that a 1-percent decrease in the primary surplus of a member country raises the interest rate of a typical member by 41 basis points.[12] Some studies, such as Pappa (2009), employ aggregate figures of the

[12] While the above mentioned studies focus on fiscal policy externalities in the EU, Arin and Koray (2009) consider the transmission of fiscal shocks from the U.S. to Canada. They find a negative effect of U.S. government spending shocks on Canadian output.

euro area to estimate the effects of a fiscal shock. Aggregate numbers, while useful, remain silent concerning the economic interdependences of the euro area economies. Beetsma et al. (2006, 2008) use a European panel VAR model. Panel estimates are based on the homogeneity assumption that outputs of all included countries in the panel respond in the same manner to a fiscal expansion. In contrast, one aspect of our area-wide shock is that it is directly derived from the interdependences across the euro area countries, allowing the response of output to differ across countries. It also allows for inter-leakage effects across members.[13]

In a related study for the U.S. economy, Nakamura and Steinsson (2011) exploit variations in the reactions of states' spending to national military buildups. Particularly, they use the interaction term between national defence spending and a state dummy to generate predicted state procurement. The predicted values of states' military procurement are then used in the equation for output regression. According to their results, the magnitude of the spending multiplier in one region relative to another is approximately 1.5. The documented findings in our study are, additionally, linked to several results of VAR studies addressing the impacts of a fiscal shock mainly on the domestic economy. The majority of these studies are particularly interested in the U.S. economy or selected G7 economies; for example, Blanchard and Perotti (2002) and Perotti (2005).

5.2. Global Vector Error Correction Model and Time-Varying Weights

In this section, we reconsider two issues: 1) The specification of the empirical model, and 2) the definition of the fiscal variable. Thus far, we have reported results based on a GVAR specification. The mixed results of cointegration tests, reported previously, might lend support to estimating a Global Vector Error Correction Model (GVECM) instead of a GVAR model in levels. Here, we estimate a GVECM specification while maintaining our benchmark list of variables. We make further adjustments to the model. First, to remove effects of cyclical and automatic components, we use the cyclically adjusted government primary balance as a percentage of potential GDP obtained from the OECD.[14] Second,

[13] Some early studies consider macroeconomic disturbances and the pattern of correlation between business cycles in the euro area. For example, Cheung and Westermann (1999) find evidence for non-synchronised common business cycles of Germany and Austria. Bayoumi and Eichengreen (1992) find that the underlying shocks are significantly more idiosyncratic across EU countries than across the U.S.

[14] The cyclically adjusted data are not available for Luxembourg during the whole sample period.

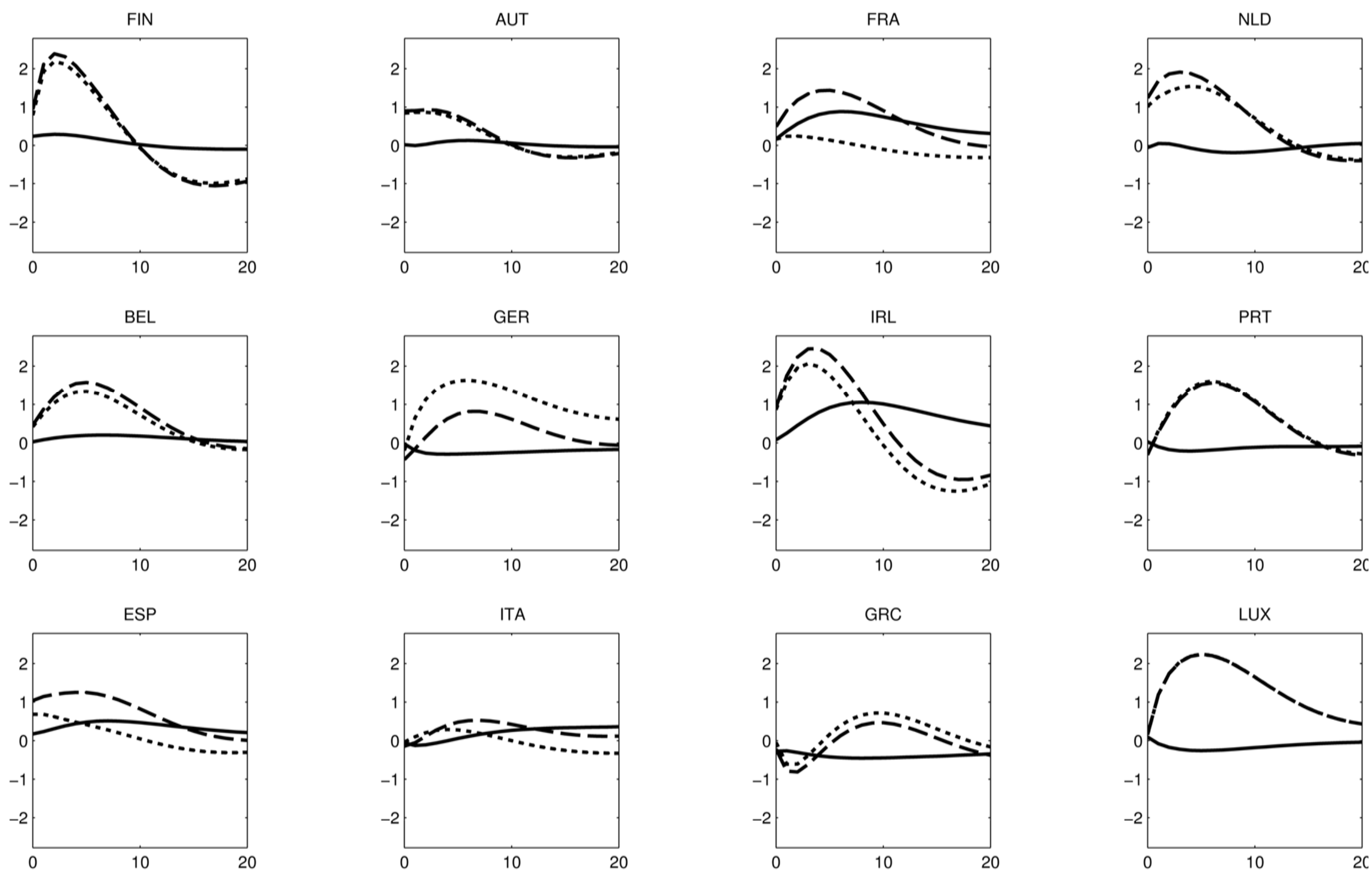
we use time-varying weights for constructing foreign variables and obtaining the global results. Since portfolio data are not available for the entire sample period, we employ quarterly time-varying trade weights. The selection of the model lag length is based on the BIC criterion. Results suggest using one lag of both domestic and foreign variables in each country-specific model. Figure (4) displays the resulting dynamics of outputs for the described GVECM specification. Overall, in line with the GVAR results, the impulse response functions resulting from a 1-percent area-wide cyclically budget balance shock suggest larger effects on output than those obtained from a fully domestic shock supporting our previous results.

Finally, we add two more countries, the UK and the US, to the set of the euro area countries in our model. While the UK and the US are part of the estimation procedure of the model, the area-wide shock is defined as a "regional" shock originating from Euro area countries without the participation of the US or the UK in the fiscal action. Thus, the variables of the UK and the US do not contribute to the area-wide fiscal shock but rather serve as additional global controls that affect the estimated coefficients of all country-specific models and hence also the global model. The construction of the variables for the UK and the US is identical to that for euro area members as described in section (4).[15] Figure (5) presents the impulse response functions following a 1-percent area-wide cyclically budget balance shock. The dynamics of outputs again reveals that the area-wide shock has a higher impact on output than a domestic shock for most countries.

[15] Of course, weights have to be adjusted for the construction of foreign variables.

Figure 1

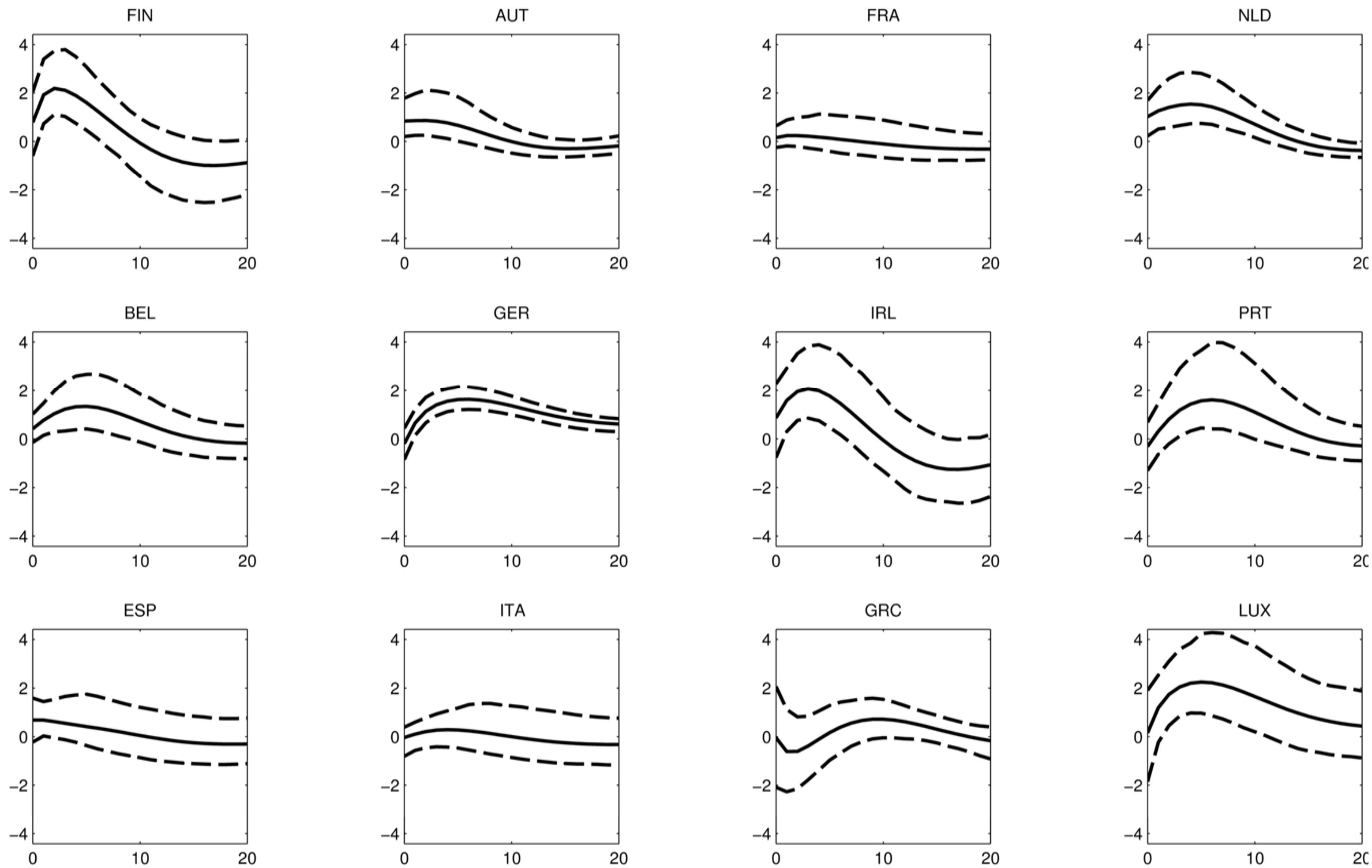
Domestic and Spillover Effects of a 1-Percent Area-Wide Budget Balance Shock on Output vs. Domestic Effects of a Domestic Shock



Note: The bold line presents domestic effects of a domestic shock. The dashed line presents spillover effects including domestic effects of an area-wide shock. The dotted line presents only spillover effects of an area-wide shock excluding the domestic effect.

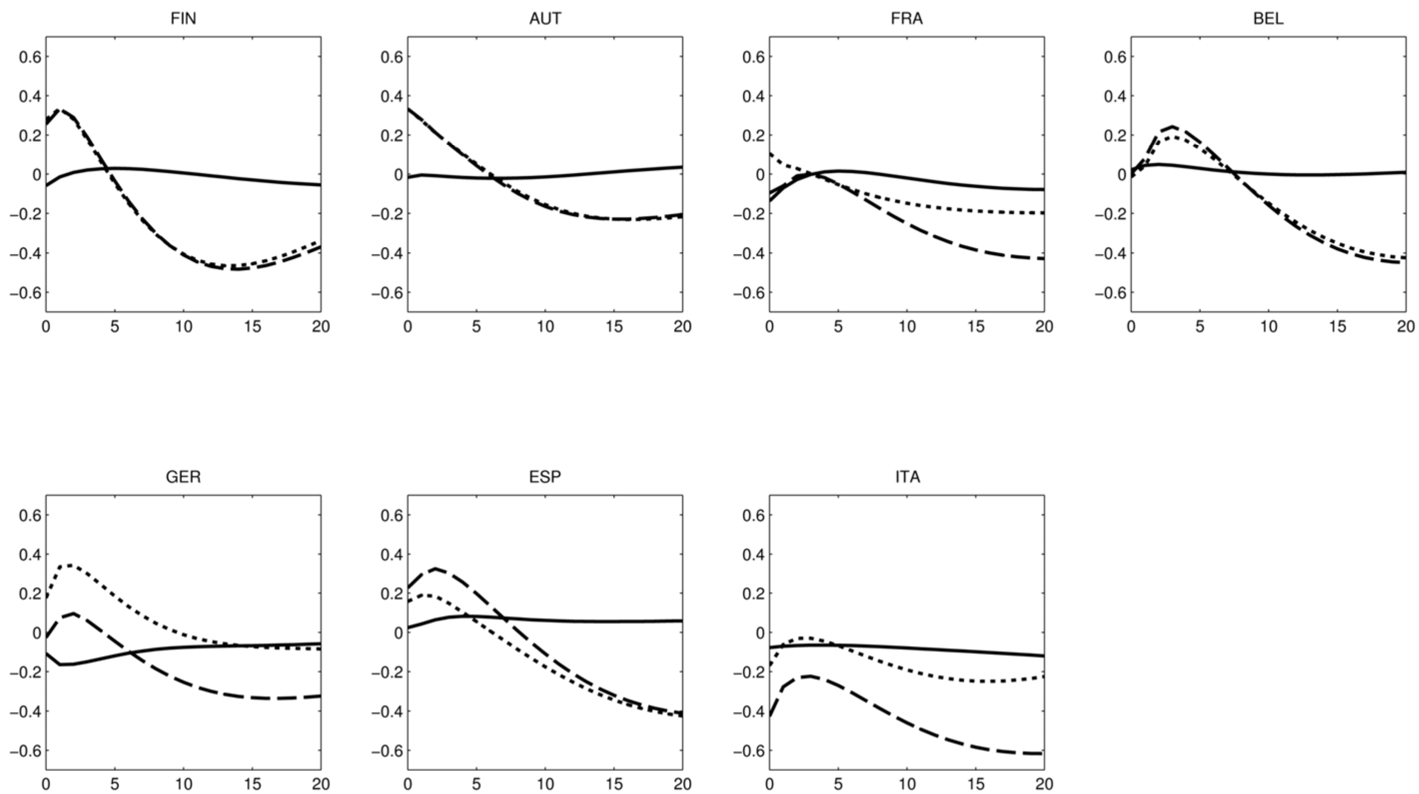
Figure 2

Spillover Effects of a 1-Percent Area-Wide Budget Balance Shock on Output with Confidence Bands and Excluding Domestic Effects



Note: The dashed lines present bootstrap 90 percent confidence intervals.

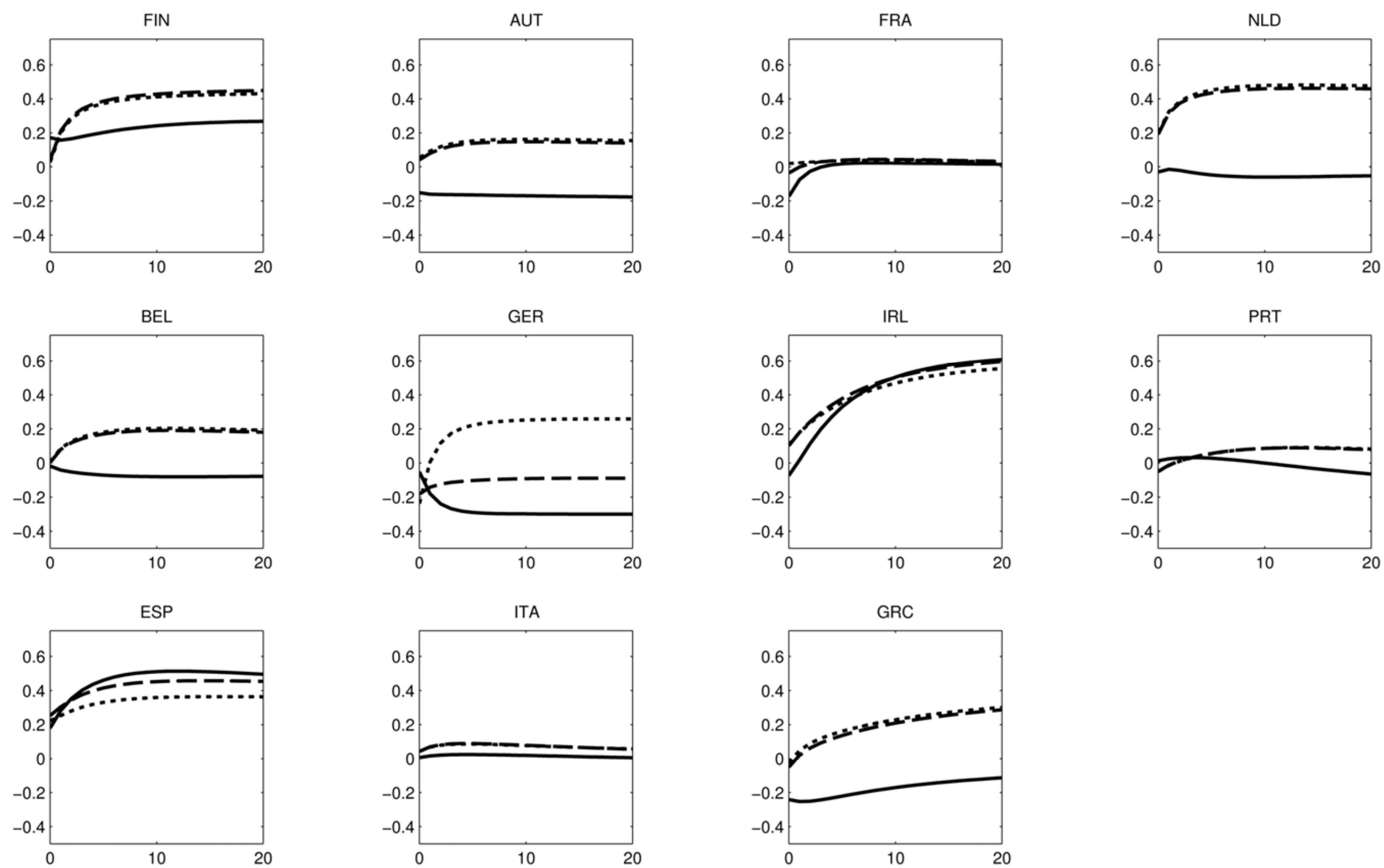
Figure 3
Domestic and Spillover Effects of a 1-Percent Area-Wide Government Spending Shock on Output vs. a Domestic Shock



Note: The bold line presents domestic effects of a domestic shock. The dashed line presents spillover effects including domestic effects of an area-wide shock. The dotted line presents only spillover effects of an area-wide shock excluding the domestic effect.

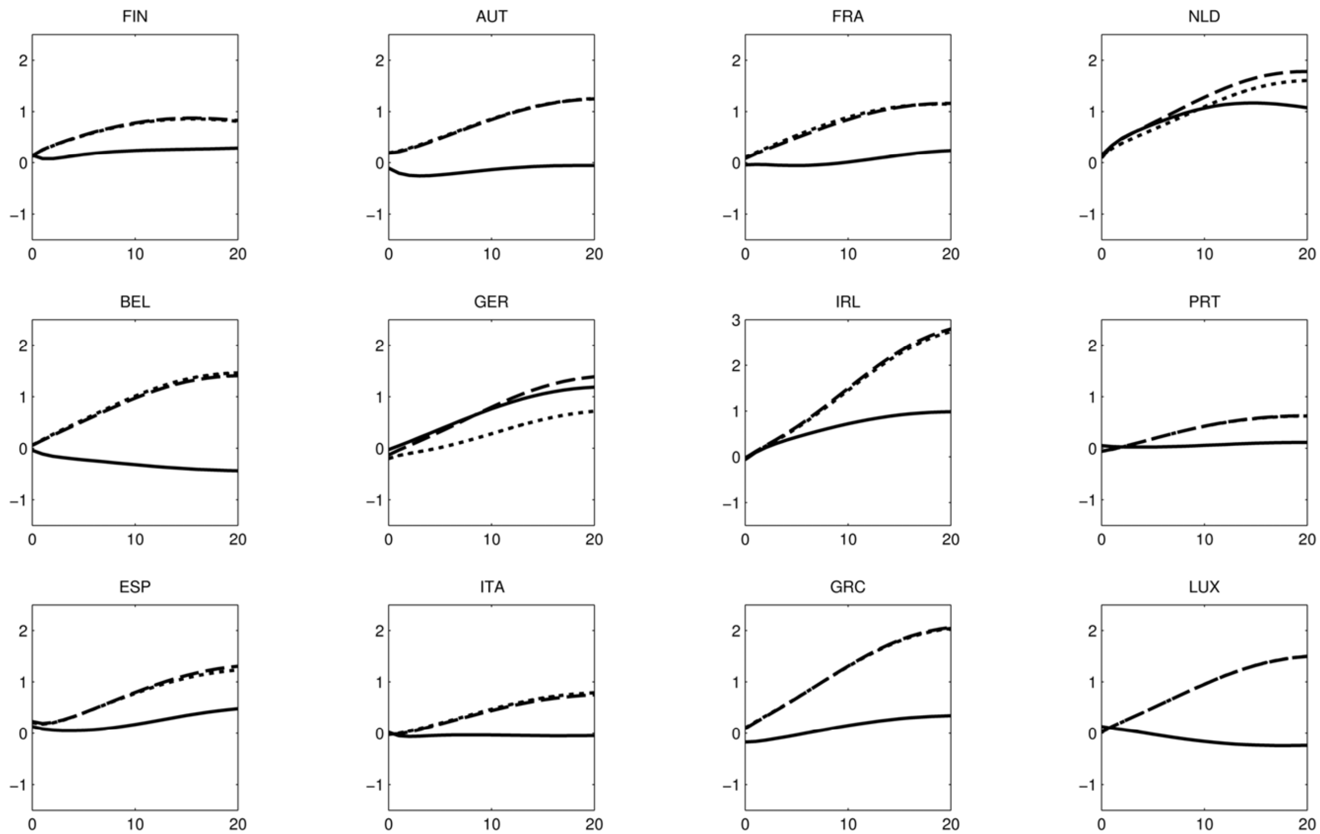
Figure 4

Domestic and Spillover Effects of a 1-Percent Area-Wide Cyclically Adjusted Budget Balance Shock on Output: GVECM



Note: The bold line presents domestic effects of a domestic shock. The dashed line presents spillover effects including domestic effects of an area-wide shock. The dotted line presents only spillover effects of an area-wide shock excluding the domestic effect. Time-varying weights are used.

Figure 5
Effects of a 1-Percent Area-Wide Cyclically Adjusted Budget Balance Shock on Output: GVECM Including the UK and the US



Note: The bold line presents domestic effects of a domestic shock. The dashed line presents spillover effects including domestic effects of an area-wide shock. The dotted line presents only spillover effects of an area-wide shock excluding the domestic effect. Time-varying weights are used.

5.3. Testing Weak Exogeneity of Foreign Variables

The assumption of weak exogeneity of foreign variables does not exclude short-run feedbacks between domestic and foreign variables but implies no long-run feedbacks from domestic variables to foreign variables. That is, in the terminology of time-series analysis, foreign variables are "long-run forcing" for domestic variables. Formally, to test for this assumption, we follow Dees et al. (2007), and apply an F test of the joint null hypothesis that the estimated error correction terms obtained from the country-specific models ($\hat{ecm}_i$) corresponding to M_i cointegrating relationships do not significantly enter the auxiliary regressions of foreign variables. The auxiliary regressions of foreign variables take the form:

$$\Delta Y^*_{i,t} = \alpha_{i,s} + \sum_{k=0}^{M_i} \chi_{i,k,s} \hat{ecm}_{i,k,t-1} + \beta_{i,s} Y^*_{i,t-1} + \gamma_{i,s} Y_{i,s,t-1} + \mathbf{e}_{i,t,s}, \qquad (7)$$

where the subscript s denotes the s^{th} element of the vector $Y^*_{i,t}$. Accordingly, we test:

$$H_0 : \chi_{i,k,s} = 0, k = 1, 2, ..., M_i.$$

Table (1) presents the results obtained from the model with the cyclically adjusted budget balance ratio. Since, as mentioned previously, *reer* and *nx* are not components of the vector of foreign variables, the results of the test are reported for all other variables. The critical values are displayed in the second column. As is apparent from the table, we cannot reject the null hypothesis of weak exogeneity for most variables and countries in our model. Note that no cointegrating relationships for Greece have been found. Luxembourg is not included in table (1) because the series of cyclically adjusted budget balance ratio is not available. However, checking various variants of the reported model in table (1), that is, considering the non-adjusted *bb* and time-varying weights versus fixed weights, yield similar results for Luxembourg and the other countries. Overall, the test results lend support to our model specification.

Table 1
Test for Weak Exogeneity at the 5% Significance Level

Country	Crit-Ftest	$bb*$	$y*$	$c*$	$r*$	$d*$
Austria	3.085	0.520	2.776	1.439	3.234	0.288
Belgium	3.085	0.959	0.980	2.705	0.045	0.309
Finland	3.085	0.173	1.123	1.191	0.721	0.509
France	3.933	0.226	1.889	6.418	0.684	0.740
Germany	3.933	0.096	2.001	0.154	1.333	1.377
Ireland	3.085	0.727	1.197	7.238	2.348	0.040
Italy	3.085	0.014	2.090	6.161	3.549	0.979
Netherlands	2.695	0.716	1.044	1.478	0.677	0.025
Portugal	3.085	0.015	0.266	0.954	0.993	0.544
Spain	2.694	1.087	1.868	3.726	0.683	1.243

Note: The test is based on Dees et al. (2007). See also equation (7).

6. Conclusion

This study contributes to the literature on the effects of fiscal shocks on the economy by (1) estimating the domestic and spillover effects of a domestic fiscal shock on outputs of the euro area members, (2) estimating the effects of a euro area-wide fiscal shock by applying a multi-country VAR framework, the GVAR, to the analysis of fiscal policy.

Our focus has been on the area-wide (global) dynamics. According to our results, an area-wide fiscal shock has higher impacts on output than a similar size domestic shock. When every member country contributes to the euro area-wide shock based on the size of the country, it is less costly from the standpoint of a member country and also more effective (or at least not less effective) than a domestic shock. This indicates the importance of coordinated fiscal actions.

Finally, our results indicate heterogeneity in the dynamics of outputs across the euro-area members following a fiscal shock. The source of this heterogeneity is an important area of further research.

7. Appendix

7.1. Description of the Data

All data, except for the *reer* and the weights in the GVAR, are obtained from the OECD Economic Outlook. *bb* is the ratio of government balance to GDP; (NLGXQ/100). The ratio of cyclically adjusted government primary balance, as a percentage of potential GDP is the series NLGXQA. GDP is the gross domestic product in market prices, value in €. y is the natural logarithm of the real GDP volume per capita. Per capita variables are calculated by dividing the series under consideration by the total labour force. Real variables are computed by filtering the series under consideration by the GDP deflator inflation rate. The GDP deflator is the ratio of GDP to GDPV, where GDPV is the gross domestic product volume. The variable real government investment spending per capita is computed using the series IGV. c is the natural logarithm of private consumption per capita, where private consumption is the series CPV. r is the real long-run interest rate, where the interest rate series is (IRL). *reer* is the natural logarithm of the real exchange rate (2005=100). Specifically, *reer* is calculated as geometric weighted averages of bilateral exchange rates adjusted by relative consumer prices. The weights are derived from manufacturing trade flows and capture direct bilateral trade and third market competition. These series and a detailed description are available online at the Bank for International Settlement; www.bis.org. *nx* is the ratio of net export to GDP. The series of net export is computed as exports of goods and services (XGS, value in €) minus imports of goods and services (MGS, value in €). The resulting series is filtered by GDP. Debt (d) is the ratio of government gross financial liabilities to GDP; GGFLQ/100. In the case of Germany, figures for the period before 1991 correspond to West Germany. We use quarterly series. In case quarterly data are not available, we use interpolated annual data. The trade weights in the GVAR are obtained from the Direction of Trade Statistics (DOTS) of the International Monetary Fund and are computed as average values over the period 1980-2007. Data on capital weights in the GVAR are taken from the Coordinated Portfolio Investment Survey (CPIS) database of the International Monetary Fund and are computed as average values over the period 2001-2007.

Table A1
Bilateral Trade and Capital Shares in the Euro Area

Trade Weights in the Euro Area, averages 1980-2007												
	AUT	BEL	FIN	FRA	GER	GRC	IRL	ITA	LUX	NLD	PRT	ESP
Austria	0	0.009	0.006	0.041	0.385	0.004	0.003	0.086	0.002	0.031	0.003	0.014
Belgium	0.005	0	0.003	0.085	0.095	0.002	0.014	0.027	0.013	0.084	0.003	0.017
Finland	0.012	0.012	0	0.044	0.140	0.004	0.006	0.033	0.001	0.045	0.005	0.016
France	0.009	0.040	0.005	0	0.191	0.005	0.009	0.103	0.007	0.054	0.011	0.060
Germany	0.048	0.026	0.009	0.098	0	0.007	0.007	0.079	0.004	0.090	0.008	0.029
Greece	0.011	0.031	0.008	0.069	0.170	0	0.006	0.128	0.003	0.053	0.003	0.025
Ireland	0.005	0.035	0.006	0.061	0.102	0.003	0	0.033	0.001	0.042	0.003	0.020
Italy	0.023	0.015	0.005	0.126	0.168	0.011	0.005	0	0.003	0.037	0.007	0.039
Luxembourg	0.014	0.262	0.006	0.171	0.277	0.003	0.005	0.049	0	0.056	0.007	0.028
Netherlands	0.010	0.056	0.008	0.080	0.225	0.005	0.010	0.050	0.003	0	0.007	0.022
Portugal	0.010	0.017	0.008	0.127	0.155	0.002	0.005	0.066	0.002	0.043	0	0.174
Spain	0.009	0.016	0.005	0.165	0.142	0.004	0.007	0.084	0.002	0.038	0.042	0
Capital Weights in the Euro Area, averages 2001-2007												
	AUT	BEL	FIN	FRA	GER	GRC	IRL	ITA	LUX	NLD	PRT	ESP
Austria	0	0.0172	0.010	0.066	0.259	0.027	0.032	0.057	0.057	0.074	0.006	0.027
Belgium	0.014	0	0.009	0.134	0.099	0.026	0.027	0.128	0.192	0.097	0.014	0.049
Finland	0.020	0.020	0	0.124	0.129	0.010	0.040	0.054	0.054	0.075	0.006	0.053
France	0.016	0.035	0.013	0	0.121	0.019	0.036	0.121	0.045	0.111	0.018	0.079
Germany	0.039	0.015	0.016	0.097	0	0.019	0.041	0.096	0.151	0.098	0.013	0.077
Greece	0.022	0.003	0.002	0.060	0.079	0	0.013	0.034	0.088	0.035	0.007	0.010
Ireland	0.008	0.009	0.006	0.055	0.078	0.007	0	0.075	0.019	0.036	0.012	0.039
Italy	0.009	0.011	0.005	0.096	0.119	0.013	0.045	0	0.248	0.079	0.007	0.024
Luxembourg	0.014	0.029	0.009	0.084	0.152	0.008	0.021	0.070	0	0.057	0.005	0.034
Netherlands	0.016	0.029	0.009	0.093	0.160	0.014	0.017	0.077	0.029	0	0.005	0.044
Portugal	0.009	0.019	0.004	0.113	0.128	0.010	0.083	0.053	0.071	0.074	0	0.074
Spain	0.006	0.019	0.006	0.127	0.137	0.005	0.027	0.124	0.067	0.100	0.012	0

Notes: These numbers are computed by the authors. An entry presents the share of trade of the column country in total trade of the row country. The data on trade weights are obtained from the Direction of Trade Statistics of the IMF. Data on capital weights are taken from the CPIS database of the IMF.

Table A2
Unit Root Tests

	Unit root tests (levels)											
	FIN	AUT	FRA	NLD	BEL	GER	IRL	PRT	ESP	ITA	GRC	LUX
bb	-1.728	-2.765	-1.785	-2.952	-2.056	-3.607	-1.602	-2.888	-1.916	-2.026	-1.839	-2.255
x	-1.091	-1.363	-1.817	-0.560	-1.370	-1.094	-1.074	-1.444	-1.984	-2.314	0.293	-2.030
c	-4.660	-2.406	-5.318	-0.681	-1.952	-2.368	-3.932	-3.705	-2.861	-3.790	-2.462	-0.800
r	-2.451	-1.351	-1.122	-1.343	-2.606	-3.605	-2.049	-3.345	-1.619	-3.702	-2.597	-2.393
$reer$	-1.675	-2.122	-3.507	-2.801	-3.295	-2.591	-1.249	-1.096	-1.389	-2.148	-0.533	-1.540
nx	-1.448	-1.210	-1.427	-2.996	-2.322	-2.321	-2.610	-3.281	-1.282	-2.490	-2.283	-1.786
d	-1.952	-1.797	-0.268	-1.388	-1.807	-0.183	-	-	-	-1.290	-	-
$rb*$	-2.588	-3.118	-2.105	-2.399	-2.295	-2.194	-2.160	-1.573	-2.146	-2.415	-2.062	-1.962
$x*$	-1.392	-1.367	-1.588	-1.478	-1.294	-1.818	-1.483	-1.615	-1.512	-1.367	-1.664	-1.460
$c*$	-3.905	-3.330	-3.972	-4.016	-4.310	-1.511	-4.303	-4.577	-5.863	-4.532	-4.387	-3.960
$r*$	-2.246	-2.468	-2.273	-2.618	-1.036	-1.027	-2.601	-1.333	-1.139	-1.484	-1.224	-2.679
	Unit root tests (first differences)											
	FIN	AUT	FRA	NLD	BEL	GER	IRL	PRT	ESP	ITA	GRC	LUX
bb	-7.529	-7.519	-6.312	-7.517	-2.304	-7.507	-3.181	-7.520	-2.744	-6.581	-6.554	-7.523
x	-3.596	-6.725	-5.273	-5.817	-3.974	-6.984	-4.723	-5.168	-5.006	-5.815	-4.329	-5.999
c	-4.447	-7.452	-2.417	-4.005	-3.564	-8.700	-4.077	-1.473	-3.516	-3.015	-2.107	-7.006
r	-6.950	-5.807	-8.731	-11.134	-6.190	-6.953	-9.187	-7.863	-8.208	-6.904	-5.389	-6.480
$reer$	-6.404	-5.728	-7.111	-5.298	-4.964	-6.078	-7.241	-3.893	-5.534	-6.698	-7.308	-4.653
nx	-11.689	-8.397	-8.211	-7.843	-7.878	-8.320	-7.833	-4.844	-8.171	-7.933	-3.827	-9.614
d	-2.181	-2.891	-2.593	-3.644	-2.497	-3.564	-	-	-	-3.464	-	-
$rb*$	-7.517	-7.517	-7.517	-7.517	-7.521	-3.291	-7.518	-7.526	-7.519	-7.523	-7.517	-6.256
$x*$	-4.905	-5.814	-4.589	-4.967	-4.257	-3.803	-4.455	-4.115	-4.154	-4.791	-4.577	-4.311
$c*$	-4.628	-7.764	-4.105	-6.666	-3.723	-3.021	-4.048	-3.299	-3.423	-4.491	-3.907	-4.143
$r*$	-7.414	-7.054	-7.272	-7.064	-8.891	-8.634	-7.392	-7.524	-7.476	-9.138	-8.726	-7.493

Notes: Standard Dickey-Fuller tests are computed for all variables. If the absolute value of an entry is greater than 2.89 (Dickey-Fuller test statistic), a unit-root is rejected at the 5% significance level. The optimal number of lagged differences is determined by BIC.

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