WP/17/241

IMF Working Paper

Fiscal Spillovers in the Euro Area: Letting the Data Speak

by Era Dabla-Norris, Pietro Dallari, and Tigran Poghosyan

INTERNATIONAL MONETARY FUND

 WP/17/241

IMF Working Paper

Fiscal Affairs Department

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November 2017

Abstract

We estimate a panel VAR model that captures cross-country, dynamic interlinkages for 10 euro area countries using quarterly data for the period 1999-2016. Our analysis suggests that fiscal spillovers are significant and tend to be larger for countries with close trade and financial links as well, as for fiscal shocks originating from larger countries. The current account appears to be the main channel of transmission, although strong trade integration among countries in the euro area and spillback effects tend to zero-out the net trade impact in some cases. A subsample analysis shows that the effects of fiscal policy have changed over time, with larger estimated domestic multipliers and spillovers between 2011 and 2014.

JEL Classification Numbers: C11; C33; E62.

Keywords: Fiscal Spillovers; Bayesian Methods; Fiscal Multipliers, Panel VAR.

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[1] We thank Fabio Canova, who served as an external consultant on the project. Itai Agur, Nathaniel Arnold, Tamim Bayoumi, Patrick Blagrave, Xavier Debrun, Enrica Detragiache, Vitor Gaspar, Borja Gracia, Salifou Issoufou, Phakawa Jeasakul, Ksenia Koloskova, Jesper Linde, Paulo Medas, Carlos Mulas Granados, Jean-Marc Natal, Cathy Pattillo, Joana Pereira, Jiri Podpiera, Adina Popescu, Mehdi Raissi, John Ralyea, Veronique Salins, and Anke Weber provided useful comments and suggestions. Fedor Miryugin provided excellent research assistance. The usual disclaimer applies.

Contents **Page**

Tables

Figures

Appendices

I. INTRODUCTION

Active fiscal policy, in coordination with other policies, has been proposed as a way out from a global environment characterized by slow growth and ultra-low interest rates (see Gaspar and others, 2016; Furman, 2016; OECD, 2016; and G20, 2016). Within the euro area, the debate has centered on the need for fiscal expansion in countries with fiscal space, as most other countries are still experiencing a combination of high debt, negative output gaps, and high unemployment (EC, 2016; EPSC, 2016). The proponents for stimulus measures argue that this could contribute to the region's recovery through fiscal spillovers, as cross-border externalities are likely to be strong with growing interconnectedness, while opponents argue that cross-border spillovers are small.

This paper contributes to the ongoing debate by providing new empirical evidence on the transmission of fiscal policy shocks in the euro area. Our study is motivated by several factors. First, from a policy perspective, it is important to understand the magnitude and impact of domestic fiscal shocks on output and key macroeconomic variables of other member countries. Moreover, allowing for heterogeneous shock transmission is particularly important in the euro area context, since institutional factors, market perceptions, and structural differences can make shocks of the same size have differential effects across countries.

Second, from a theoretical perspective, competing models offer different predictions on the size and sign of fiscal spillovers. In a monetary union, where member countries have a common currency and monetary policy rate, trade links between countries are the main transmission channels for fiscal shocks.[2] In some models, the endogenous increase in domestic interest rates that typically accompanies a fiscal expansion offsets the positive domestic demand effect, resulting in negligible spillovers under fixed exchange rates (Cwik and Wieland, 2010; Kollmann and others, 2015). Alternative assumptions with respect to the shock process, expectations formation, the import content of government spending, financial market imperfections, and the presence of a liquidity trap can reverse this conclusion (see Farhi and Werning, 2012; Clancy and others, 2015; Veld, 2016; Blanchard and others, 2015; Corsetti and others, 2010). Overall, economic theory provides rationale for both large, positive, and even negative fiscal spillovers. Empirical evidence is thus required to clarify the net effect of fiscal policy in one country on output and other key variables in other countries.

Finally, recent empirical research has provided mixed evidence. While there is a vast literature on domestic fiscal multipliers (see Mineshima and others, 2014 for a review), empirical evidence on cross-country fiscal spillovers is relatively scarce.[3] Empirical studies typically find economically significant spillovers as compared to model simulations, although there is mixed evidence on the magnitude and even the sign of spillovers (Beetsma and others, 2006; Auerbach and

[2] Rose and van Wincoop (2001) note that the price elasticity of trade is higher within currency unions.

[3] Existing evidence suggests a broad range of possible values for fiscal multipliers, with values ranging from 0.2 to 1.5 depending on the country sample and empirical model considered (Kilponen and others, 2015).

Gorodnichenko, 2013; Hebous and Zimmerman, 2013; Canova and others, 2013; see next section for details). Accordingly, further empirical work on assessing fiscal spillovers is warranted.

We employ a large-scale panel VAR, in which the size of the shocks and their propagation is heterogeneous. Compared to existing empirical studies, based on single-country models augmented with a foreign block or bilateral (trade-based) models, our approach better captures interlinkages across series and countries as well as dynamic feedback loops from fiscal policy shocks to other variables. Second, we estimate both domestic fiscal multipliers and cross-country spillovers to shocks in individual countries, therefore better capturing country-specific heterogeneous effects that are not accounted for by an average estimated impact that is multiplied by trade weights. The interpretation of the coefficients capturing both multipliers and spillovers is more straightforward than in other studies, as domestic and foreign variables are both included in the system.[4] Finally, we can differentiate between fiscal spillovers originating from shocks in different countries and explore transmission channels through which fiscal spillovers materialize (trade, financial, exchange rate), including over time.

The model is estimated for 10 euro area countries using quarterly data for the period 1999-2016, and includes variables capturing economic and financial links. We rely on sign restrictions to identify fiscal policy shocks, as proposed by Canova and Pappa (2007) in a multi-country setting, and on Mountford and Uhlig (2009), using data for the US. This approach imposes minimal restrictions on the shape of the impulse response functions and is consistent with a large class of macroeconomic models.

We find that fiscal spillovers are positive and non-negligible, but vary across countries originating the fiscal shock. Domestic fiscal multipliers are also positive and country-specific, confirming that average estimates of fiscal multipliers can potentially be misleading. The relative size of the countries originating the fiscal shock, and their integration through trade and financial channels are important determinants of the magnitude of fiscal spillovers. However, strong trade integration among countries in the euro area and spillback effects can zero-out the net impact in some cases. For instance, in small and open economies, the increase in domestic income from inward spillovers can result in higher imports, undoing the initial expansionary effect on the current account. Similarly, in large economies, strong international trade interlinkages throughout the manufacturing value chain can reduce the positive net effect of spillovers on a country's external position. The results are broadly robust to alternative sign restriction approaches and other robustness checks.

A subsample analysis shows that the effects of fiscal policy have changed over time, reflecting different states of the business cycle and changes in policy frameworks. While we detect

[4] See, for example, Auerbach and Gorodnichecnko (2013) and Beetsma and others (2006).

idiosyncrasies in some countries, we typically find larger domestic multipliers and spillovers during the euro area crisis.

The rest of the paper is organized as follows. Section II provides a brief review of the related literature. Section III describes the model, identification assumptions, and estimation approach. Section IV summarizes the dataset. Section V presents the results. Finally, section VI concludes.

II. LITERATURE REVIEW

Empirical studies analyzing fiscal spillovers adopt different empirical methodologies and alternative approaches for the identification of fiscal shocks.

Beetsma and Giuliodori (2004) use a standard VAR model estimated during the pre-EMU period to derive spillovers from fiscal policy, focusing on the change in imports from other countries. They find statistically and economically significant trade spillovers resulting from fiscal impulses in Germany, Italy, and France.[5] Beetsma and others (2006) expand the analysis by considering a homogeneous coefficients panel VAR with both a fiscal and trade block for eleven EU countries over the period 1965-2002, identifying fiscal shocks using structural restrictions as in Blanchard and Perotti (2002). They find that spillovers from a 1 percent increase in German government spending lead to an output response that varies between 0.05 percent of GDP in Greece and 0.4 percent of GDP in Belgium. One drawback of the identification approach used in these empirical studies (i.e., recursive ordering of the VAR endogenous series, with government spending ordered first) is that fiscal shocks are unlikely to be unanticipated. This implies that it may be difficult to distinguish genuine fiscal policy shocks from those driven by business cycle movements.[6] An additional shortcoming is that the approach tends to be less accurate than multilateral models in terms of bias and mean squared error.[7]

Auerbach and Gorodnichenko (2013) adopt the local projections method (LPM) for measuring fiscal spillovers from a weighted average of fiscal shocks emanating from other countries, where the weights reflect bilateral trade flows.[8] Fiscal shocks are defined as the forecast errors of

[5] The importance of the trade channel is also highlighted in model based simulations for the euro area in Attinasi and others (2017), among others.

[6] Blanchard and Perotti (2002) test the existence of anticipated fiscal policy shocks using future values of estimated fiscal shocks at a quarterly frequency. They argue that their approach addresses endogeneity concerns as they find that anticipation effects are not important in the United States. However, Ramey (2011) shows the existence of anticipation effects obtained from VAR models estimated with quarterly data.

[7] Georgiadis (2017) shows that this is more pronounced when bilateral transmission channels become less important compared to indirect higher-order spillovers and spillbacks, which can indeed be the case in highly integrated economies in the EA.

[8] The LPM approach involves computing impulse response functions of exogenous fiscal shocks on output using a univariate regression framework (Jorda, 2005).

government spending in OECD projections. They find a large cross-border effect of government spending, with the output impact (over a 6-year period) of a 1 percent of GDP fiscal consolidation in all trading partners ranging between 1.6 and 2.0 percent, and reaching 3 percent during periods of economic slack. The homogeneity assumption used in their panel specification (and in related literature), however, implies that only the average spillover impact can be estimated.[9] Moreover, estimates for slack periods appear to be sensitive to the assumed length of recession episodes.

Another set of studies uses the narrative measure of fiscal shocks (the external instrument), again focusing on the trade channel. Goujard (2017) employs LPM to examine spillovers in OECD countries using the narrative measure of fiscal consolidations from Devries and others (2011). The estimates of fiscal spillovers are sizeable, with stronger spillovers between countries with limited exchange rate adjustment or within currency unions, than among countries with more flexible exchange rate arrangements. Similarly, Poghosyan (2017) assesses cross-country spillovers from fiscal consolidations in 10 euro area countries using more recent data on fiscal consolidations. The narrative approach, however, may include consolidations that were implemented in response to bad news about the future growth of the economy, which complicates the causal interpretation of the effect (Ramey, 2011).

A number of papers estimate a global autoregressive model (GVAR) with fiscal shocks identified using the orthogonalized impulse response function to isolate the heterogenous impact of fiscal shocks (Hebous and Zimmerman, 2013; Ricci-Risquete and Ramajo-Hernandez, 2015; Belke and Osowski, 2016; Georgiadis and Hollmayr, 2016). In contrast to the above-mentioned papers, this approach allows for quantifying the variation in the magnitude of spillover effects among different source and recipient countries. For instance, Hebous and Zimmermann (2013) find fiscal spillovers of mixed sign, with spillovers from a 1 percent of GDP fiscal shock in Germany ranging from -0.2 percent of GDP in Italy to 0.13 percent of GDP in Luxembourg. While the GVAR approach can capture spillovers from trade as well as other channels (e.g., interest rate and exchange rate channels), it still relies on weights that are exogenously set. Moreover, the identification relies on orthogonalized response functions, which cannot be interpreted in a structural sense.

In this paper, we identify shocks by means of sign restrictions on the response of certain endogenous variables. An advantage of this strategy is that it imposes a minimal set of assumptions on the shape of the impulse response functions. We use two types of sign restrictions on impulse responses typically used in the literature. One approach identifies government spending shocks by imposing a restriction that domestic government spending, the budget deficit, and output increase on impact (see Canova and Pappa, 2007). The spending

[9] The granularity that characterizes our approach also imposes some restrictions such as having to impose specific priors to reduce the constellation of parameters to estimate (see the following sections).

shock in one country may endogenously generate contemporaneous co-movement between government deficit and output across countries. While parsimonious, this set of restrictions helps to distinguish positive spending shocks from other types of shocks.[10] Importantly, the identifying restrictions are imposed only on impact. Therefore, output can either increase or decrease after the first period, and the fiscal impulse can pay out for itself in the longer run (i.e. the deficit falls).

The second approach follows Mountford and Uhlig (2009) by first identifying a business cycle shock, which captures automatic responses of spending and net taxes to changes in output over four quarters. The government spending shock is then defined as a shock where government spending rises for four quarters after the shock, and which is orthogonal to the business cycle shock. This identification strategy is also adopted by Nicar (2015) and Bicu and Lieb (2015). Compared to Nicar (2015), our work extends this identification approach to a model with cross-country and dynamic interlinkages. In comparison to Bicu and Lieb (2015), we do not nest together the panel and factor augmented VAR structures, but instead develop further the cross-sectional dimension of the model and undertake sub-sample analysis.

III. MODEL

To compute domestic fiscal multipliers and measure the international transmission of fiscal shocks (or spillovers), we employ a heterogeneous panel VAR model of the form:

$$y_{it} = D_i(L)Y_{t-1} + F_i(L)W_t + e_{it}$$

where *i = 1, …, N* stands for countries, *t = 1, …, T* for time, and L is the lag operator; y_{it} is a *G x 1* vector of endogenous series for each *i*, and $Y_t = (y'_{1t}, \dots, y'_{Nt})$; $D_{i,j}$ are *G x NG* matrices for each lag *j = 1, …, p*; $F_i = f_{i,1}, \dots, f_{i,q}$ are *G x M* matrices for each lag *j = 1, …, q*; W_t is an *M x 1* vector of common exogenous variables; $e_{it} \sim N(0, \Sigma_i)$ is a *G x 1* vector of disturbances. No constant is included since each variable is deseasonalized, demeaned and standardized.[11]

Models of this type have been used to study the structure of cyclical fluctuations, the contribution of local versus external shocks to the business cycle, time variations in the transmission of shocks, and other issues of interest to macroeconomists and policymakers (see Canova and Ciccarelli, 2012). In this model, both the instantaneous and lagged dynamics are unit-specific. This implies that the size of the shocks and their propagation is potentially heterogeneous (see also the review article by Canova and Ciccarelli, 2013). While it is common to assume cross-country homogeneity and pool cross-sectional information when studying the effects of fiscal policy (see Ball and others, 2013), heterogeneity biases of the type discussed in Pesaran and others (1996) could be present and distort economic inference. In addition,

[10] For instance, it rules out a demand shock which entails a decrease in government spending, or a supply shock which increases output but reduces inflation.

[11] This is needed to correctly estimate the loadings to the factors (see later in this section).

whenever the *NG x NG* matrix *D(L) = [D_1(L), …, D_N(L)]'*, is not block diagonal for some *L*, cross-unit lagged interdependencies matter. Thus, dynamic feedbacks across countries are possible, which expands the type of interactions our empirical model can account for. Bilateral VAR models allow for country-specific coefficients' estimates, but they fall short on the multilateral dimension and ability to account for dynamic lags. Work in the direction of understanding the size and the sign of possible biases (see Chudik and Pesaran, 2011; Chudik and Straub, 2017; and Georgiadis, 2017) suggests that multi-country models that accommodate for some degree of heterogeneity are preferable relative to bilateral VAR models, which may underestimate the size of spillovers.

A. Dimensionality of the Parameter Space

The features of the model discussed above add realism, but also increase the number of parameters to be estimated. We can rewrite the model in regression format as:

$$Y_t = Z_t\delta + E_t$$

where $Z_t = I_{NG} \otimes X_t'$; $X_t' = (Y_{t-1}', \dots, Y_{t-p}', W_{t-1}', \dots, W_{t-q}')$; $\delta = (\delta_1', \dots, \delta_N')$; δ_i are *Gk x 1* vectors containing, stacked, the G rows of the matrix D_i and F_i; and Y_t and E_t and *NG x 1* vectors of endogenous variables and random disturbances, where $E_t \sim N(0, P \otimes \Omega)$. If one considered 10 countries, 5 variables per country, and 2 lags, the dimensionality of δ would be 5000 x 1, and an unrestricted variance covariance matrix would have 1125 free parameters. Thus, the sheer dimensionality of the problem prevents any meaningful unconstrained estimation of the model. We make two assumptions to decrease the dimensionality of the parameter space.

First, as we assume a Kroneker structure for the covariance matrix:

$$E_t \sim N(0, P \otimes \Omega)$$

where *P* is *N x N* and Ω is *G x G*, *P* captures the correlation structure across countries, *G* the correlation structure across variables, and E_t is a vector of stacked disturbances.[12] The Kroneker structure implies that shocks have the same instantaneous correlation structure in different countries. This is not unreasonable given that the macroeconomic series that we consider behave similarly in euro area countries. We center the prior for the matrix *P* at the values of bilateral trade weights, which is consistent with the priors used in many other empirical studies. If *P* is diagonal, there are no contemporaneous spillovers. We leave the off-diagonal elements of *P* unrestricted such that they are determined by the degree of correlation across countries.

Second, we assume that the vector δ is a function of a lower dimensional vector θ, as in:

[12] This assumption allows us to reduce the number of estimated parameters, and therefore better accommodates the degrees of freedom in our sample, which are relatively few given the preference for using post-1999 data that follow the introduction of the single currency.

$$\delta = \Xi\theta + u$$

where Ξ is a selection matrix made of zeros and ones, and u is a vector of disturbances capturing unmodeled features in the coefficient vector δ, and $u \sim N(0, (P \otimes \Omega) \otimes V)$. This factorization of the model's coefficients transforms an over-parametrized panel VAR into a parsimonious SUR model, where the regressors are averages of subsets of right-hand side variables. In particular, the first factor condenses country-specific data; the second and third factors summarize endogenous and exogenous series-specific data, respectively; and the fourth factor reflects lagged series. The specification takes the following form:

$$\Xi\theta = \Xi_1\theta_1 + \Xi_2\theta_2 + \Xi_3\theta_3 + \Xi_4\theta_4$$

where the loading matrices Ξ_j have dimensions *NGk x N*, *NGk x G*, *NGk x M*, *NGk x p* respectively; and θ_j are mutually orthogonal factors capturing the coefficients corresponding to each country, endogenous series and exogenous series, and time lags.

While these assumptions play a similar role to imposing a shrinkage prior (Del Negro and Schorfheide, 2011), this re-parametrization strategy remains preferable to using a collection of VARs or bilateral VARs to estimate spillovers. This is because the random pooling of cross-sectional information helps obtain more accurate parameter estimates and reduces standard errors for any given sample length. Second, if the momentum that the shocks induce across units is the result of a complicated structure of lagged interdependencies, alternative frameworks could mistakenly detect and interpret it as a shock, and not as an endogenous response.

B. Identification and Estimation

As discussed above, we adopt two approaches for identifying shocks using sign restrictions. Following Canova and Pappa (2007), we identify a deficit financed expansionary government expenditure shock imposing three instantaneous sign restrictions: i) government expenditure increases; ii) the deficit increases; and iii) domestic output increases. The second set of restrictions follows Mountford and Uhlig (2009). A business cycle shock is identified as one where output and net taxes increase for four periods (quarters), and the increase in net taxes is larger than the increase in government spending to ensure that output is not increasing due to higher government spending. The underlying assumption is that the positive co-movement between taxes and output is the result of an expansionary business cycle. A government spending shock is then identified by imposing a restriction that government spending increases during four consecutive periods, the increase is larger than the increase in taxes, and that it is orthogonal to the business cycle shock. In contrast to the previous approach, where government spending increases upon impact, in the latter, responses are restricted for a year following the shock, but there is no restriction on output.

For each of the two approaches, economic restrictions are obtained from the endogenous series identifying the domestic block, and rotations satisfying the restrictions are subsequently imposed

on the matrix Ω, which accounts for the general relationship among endogenous variables for the average country.[13] Given the model structure, impulse responses are computed as the difference between two conditional forecasts: one where an orthonormal shock is set to one in $t = 1$ and zero otherwise, and another where the shock is set to zero in all periods. Formally, letting $\mathcal{F}_t^j$ be a conditioning set containing a set of initial conditions, drawn from the posterior distribution of the unknown parameters, and a value for the structural shock, the non-cumulative impulse responses can be defined as:

$$IR_y(t,\tau) = E(y_{t+\tau}|\mathcal{F}_t^1) - E(y_{t+\tau}|\mathcal{F}_t^2)$$

for $\tau = 1, 2, \ldots, 20$ quarters. Since the data are standardized before estimating the model, the impulse responses are rescaled by each series' standard deviation when computing dynamic responses. When plotting impulse responses in the rest of the paper, we show cumulated responses.

Our approach to estimation is Bayesian, primarily because the sample is relatively small (see Appendix 1 for details about the estimation algorithm). Appendix 2 describes the properties of the priors and posterior draws used for inference. As can be seen from the Figures 1-8 in Appendix 2, the prior distributions are diffuse, and their support is much wider than that of the posterior estimates. To increase the efficiency of the estimation algorithm, the priors are centered around the OLS estimated coefficients. Posterior draws appear well behaved, with no clear trends or patterns, and low serial correlation. A number of checks were conducted on the parameters controlling for the properties of the priors' distributions, without appreciable effects on the empirical results.

The model is estimated over the full sample (1999-2016), as well as on recursive windows. This allows us to accommodate any structural breaks that can cause instability in the estimated coefficients (e.g. Global Financial Crisis, ultra-low interest rates). A non-parametric setup to time variation is also convenient because it renders estimation of the model computationally more tractable.

IV. DATASET

Our ten euro area countries are Germany, France, the Netherlands, Belgium, Austria, Italy, Spain, Ireland, Finland, and Portugal. The balanced panel covers the period from 1999 to 2016 at quarterly frequency.[14] By considering a sample starting in 1999, we minimize possible biases

[13] For each country, we draw 10,000 orthonormal matrices rotating the contemporaneous variance-covariance matrix of the shocks and apply the median rotation to each posterior draw of the covariance matrix. Therefore, our approach captures both coefficient uncertainty and, to some extent, identification uncertainty.

[14] Using data at a quarterly frequency expands the length of the series. However, a number of caveats have been identified in the literature related to the use of fiscal series at quarterly frequencies, including interpolation,

arising from the introduction of the euro and other potential structural breaks, such as the unification of Germany and the currency crisis in the run-up to the monetary union. As mentioned in the previous section, we also consider several sub-samples beyond the full sample spanning 1999-2016. The first sample window covers 1999-2009, and subsequent windows are extended by one year until 2016 to assess potential changes in the magnitude of fiscal spillovers following the global financial crisis and with monetary policy at the effective lower bound.[15]

The data include government expenditures (the sum of consumption and investment), government revenues net of transfers, government debt, output, current account balance, real effective exchange rate (REER), and a benchmark interest rate (the yield on 10-year government bonds). Our interest in transmission channels implies that we need to examine intra-area movements in real exchange rates—the price level in a member country relative to a trade-weighted average of the price levels in other members. This can help isolate divergent real exchange rate behavior in response to a fiscal shock in member countries. We include government debt and check ex-post that its path is not explosive to accommodate the results in Favero and Giavazzi (2007).[16] The benchmark interest rate proxies for the monetary policy stance and financial conditions.

Exogenous series are added to control for the conduct of US and EA monetary policy (the federal fund rate and Eonia), global business cycles (world output), and developments in commodity markets (oil prices). Appendix 3 provides a summary of the series used and data sources. The interest rate variable enters the model in levels, while the remaining variables are expressed in real per capita terms and transformed into natural logarithms.[17]

V. RESULTS

This section presents the results. We show the results primarily using impulse response functions and fiscal multipliers. While alternative definitions of multipliers have been used in the literature, we adopt the definition in Owyang and others (2013), where fiscal multipliers and spillovers are obtained as the cumulative response of output (in percent) divided by the cumulative change in government spending (in percent). Unless otherwise mentioned, this is the definition of fiscal

seasonality, and quality of the data. Some of these concerns are less acute in a homogeneous sample of advanced economies, which is our case.

[15] An alternative experiment would be to split the sample into two subsamples, before and after 2008. However, the resulting subsamples are too short and therefore subject to estimation biases.

[16] Favero and Giavazzi (2007) conclude that ignoring the transversality condition on debt-to-GDP ratios could lead to a trajectory of government spending that is implausible in the long-term, and an overestimation of its domestic and foreign impacts.

[17] The current account series has been rescaled by adding a constant value prior to applying the log transformation.

multipliers and spillovers—which could also be interpreted as an elasticity—that we use when reporting results in the rest of the paper. This definition is appropriate in a VAR-type application where the impulse response of government spending can exhibit persistence, and the cumulative size of the shock can be (marginally) higher than the response upon impact.[18]

In what follows, when plotting IRFs, we adopt the convention to mark statistically significant results using triangles. Given the large number of countries considered in our analysis, this avoids cluttering the plots.

A. Multipliers and Spillovers in the Euro Area

Table 1 presents a matrix summarizing point estimates and confidence intervals of short run (one year) domestic fiscal multipliers (diagonal elements) and spillovers (off-diagonal elements) for the 1999-2016 sample, expressed in percent. Fiscal multipliers are positive and below unity, but their size varies across countries. The magnitude is above 0.5 in Germany, France, the Netherlands, Ireland, and Italy and below 0.5 in Belgium, Austria, Spain, and Portugal. Multipliers can also be expressed in euro-to-euro terms (i.e. Keynesian fiscal multipliers), in which case the question of interest is whether one euro of additional government spending injected into the economy leads to an output expansion that is greater or lower than one euro.[19] The euro-to-euro multipliers are below unity in Portugal, Spain, Austria, and Belgium; above one in Germany (the median value is 1.5) and in Ireland; and close to one in other countries.

In some cases, our results show that smaller economies have smaller domestic fiscal multipliers. This is somewhat counterintuitive for countries within a currency union, as one would expect that the centralized monetary authorities systematically react to fiscal expansions in large economies only. However, several of the smaller economies in our sample are also the most open ones. As Figure 1 shows, there appears to be a negative relationship between trade openness and the size of the domestic fiscal multiplier in our limited sample of ten euro-area economies.[20]

Cross-country spillovers are positive, and can be large and significant. Larger economies and countries that are more integrated tend to generate more sizeable fiscal spillovers. To help

[18] By considering the integral below the impulse response, rather than just the point estimate at any given horizon, this approach controls for any persistence in the dynamics of the shock, and allows for better assessing the overall impact of a policy change.

[19] As commonly done in the literature, impulse responses are normalized by the ratio of government spending to GDP to convert the percent changes to euro changes. Owyang and others (2013) advise against relying on the sample average for normalization. However, for a much shorter sample, as is the case in our model, the government spending to GDP ratio is broadly stable and we can use its average.

[20] Our measure of trade openness does not control for the import content of export (ICE), which can be large for some of the countries in our sample. As discussed below, a high ICE can affect the transmission of fiscal policy shocks across countries.

interpret our results, Figure 2 provides a graphical representation of trade flows between the 10 EA countries. As can be seen from the figure, the Netherlands, Belgium, Italy, France and Austria represent the main export markets for Germany. Consistent with this observation, we find that an expansionary spending shock in one of these countries generates large spillovers to Germany (at year one, 0.21, 0.14, 0.11, 0.22, and 0.15 respectively). [21] Another interesting example consists of the Netherlands and Austria, both of which channel more than half of their exports to Germany (see Figure 2). We find that, when Germany implements a fiscal expansion, spillovers to the Netherlands (0.17) and Austria (0.16) are indeed sizeable. Nevertheless, for some countries, spillovers from fiscal expansion in France are larger than those from fiscal expansion in Germany, a result consistent with the findings of Georgiadis and Hollmayr (2016). Italy and Belgium are also important trading partners of Germany and are subject to sizable spillovers (0.13 each) following a German fiscal expansion. Following the same line of thoughts, the comparatively large spillovers observed between Belgium and the Netherlands (0.11 and 0.13, respectively) are also consistent with close trade links between these two countries.

Spillovers are sizable also when the "spillover receiving" economy is small and has a narrow export base. In our sample, Finland, Portugal, and Ireland are relatively smaller countries that are well integrated through trade in goods or services. Finland has three main export partners, namely Germany, France, and the Netherlands, which also correspond to the three largest "spillover sending" economies (0.19, 0.15, and 0.16, respectively). Similarly, Germany and France are important export markets for Portugal, and generate large fiscal spillovers to Portugal (0.12, 0.15, respectively).

Our results indicate that, among the smaller economies, Ireland is subject to large fiscal spillovers from core EA countries. This evidence is hard to interpret based only on trade flows, which are not that large (see Figure 2). We argue that financial linkages and other idiosyncratic factors make Ireland a special case. It is well known that Ireland is an important financial center in Europe, but the country's legislative and economic environment also favor the establishment and operation of multinational companies.[22] As a proxy for the strength of financial linkages across

[21] While we use evidence obtained from the longest sample (1999-2016) as our baseline in the discussion, and we choose to express spillovers in percentages, one set of results can hardly accommodate all cases, and in selected instances, the results obtained from alternative subsamples may be more accurate. As a case in point, the spillover from Belgium to Germany in Table 1 is large and similar to the one from Germany to Belgium. However, in the 1999-2009 sample the spillover from Germany equals 0.27 while the one from Belgium takes the value of 0.18, once rescaled by the share of government spending to GDP. The full set of results are available from the authors upon request.

[22] The importance of multinational companies is exemplified by the recent revision of 2015 output growth in Ireland from 7.8 percent to 26.3 percent. This jump in the growth rate was driven by several one-off factors related to the functioning of multinational companies, such as relocation of aircraft leasing assets, corporate inversion deals, and transfer of international patents, all of which were widely recognized as not reflecting changes to the real economy. The 2015 revision to the national accounts is also the likely cause of the observed

countries, we consider the consolidated foreign claims series maintained by the Bank of International Settlements (BIS). Figure 4 plots the average (between 1999 and 2016) bilateral consolidated foreign claims of reporting banks for the 10 EA countries, Figures 4 and 5 plot total foreign claims by country in 2006, in levels and as a share of GDP, respectively. A comparison of Figures 2, 3, and 5 suggests that the level of financial interconnectedness between Ireland and the EA block, on average, was significantly higher than trade flows during the sample horizon considered.

Finally, while benefiting from expansionary policies undertaken by core EA countries, smaller countries generate small spillovers. In particular, Ireland, Finland, and Portugal represent a small share of the EA overall GDP, and the impact that domestic expansionary policies have on other member countries is small and often not different from zero (see Table 1).

B. Evolution of Spillovers Over Time

The effects of fiscal policy can change over time. Figure 8 plots the values for domestic fiscal multipliers in each country across different sub-samples, starting from the shortest one (i.e. 1999-2009). Figure 9 does the same for the cross-country spillovers of a government spending shock in Germany.[23]

The time pattern of fiscal multipliers tends to be similar across countries, with larger fiscal multipliers obtained for sample windows that end in the years 2011-2014. This period broadly corresponds with the euro area sovereign debt crisis, the launch of the Long-Term Refinancing Operations, and successive rounds of quantitative easing by the ECB amidst concerns that monetary policy was constrained by the zero-lower bound. Estimated multipliers are, however, lower and tend to revert to pre-crisis values in the last two sample windows, which include periods of normalization in economic conditions. Spain, Portugal, and Ireland stand out from the rest of the sample. Interestingly, fiscal multipliers in Spain and Portugal evolve similarly across different samples, which could reflect the exposure to common economic cycle and shocks. In particular, multipliers in these countries are very high in the first sample (i.e. 1999-2009), possibly as a consequence of greater exposure to the 2007 crisis in economies with more profound structural imbalances.[24]

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jump in the domestic fiscal multiplier and spillovers, compared to previous sample windows. Our main results are unaffected if Ireland is dropped from the sample.

[23] In the interest of brevity, we focus on spillovers from a shock in Germany. The evidence is not remarkably different when considering fiscal spillovers from other countries in the sample. The full set of results is available from the authors upon request.

[24] The combination of a short sample period and a clear boom-bust cycle in the latter part of the sample may further explain the large multiplier observed in Spain.

The time profile of fiscal spillovers from Germany follows a hump-shaped pattern, one also observed for the domestic fiscal multiplier.[25] This appears to suggest that both domestic and spillover effects of government spending shocks are influenced by similar factors, and therefore tend to move in tandem. The list of countries where spillovers from Germany are largest (the Netherlands, Finland, Austria, Belgium, and Italy) remains relatively stable across sub-samples, indicating that trade and financial relations take time to evolve. Interestingly, Spain and Portugal were less exposed to spillovers from Germany in earlier samples, but this changed during the euro area crisis.

C. Domestic Transmission Channels

Figure 10 shows the domestic responses of (the level of) government spending, output, the current account, and REER to a one percent increase in government spending, for the 1999-2016 sample. In all countries, after the initial increase, government spending shows some persistence and peaks approximately two years after the shock. The effect on domestic output is always expansionary, and dies out after two years once the positive impulse from government spending ends. Consistent with the results shown in Table 1, the effects are large in Germany, where output jumps on impact (0.7 percent) and expands steadily during the following quarters, plateauing above 0.9 percent. The elasticity of output to a government spending shock is significantly lower in Portugal, Spain and Belgium, where it remains below 0.4.

Standard economic theory predicts that an increase in government spending stimulates domestic demand and imports, leading to a trade deficit with respect to the rest of the world. In line with these theoretical predictions and previous empirical studies based on EA countries (De Castro and Garrote, 2012; Beetsma and others, 2006), we find that the current account turns negative in almost every country, and the results are quantitatively large in some cases. For example, the current account falls by around 3 percent on impact in Germany and stabilizes around 2 percent thereafter. In France, the current account falls by 3.5 percent on impact and deteriorates further to almost 4 percent. In Spain, it falls by approximately 1 percent, however the confidence bands overlap the zero line. In the remainder of countries, the response of the current account is either muted or even slightly positive.

Several factors can weaken the theoretical prediction of "twin deficits". If countries are strongly integrated, higher domestic demand in one can quickly spillover to the others, stimulating imports from abroad. Moreover, in recent decades, Global Value Chains (GVC) have altered production processes and resulted in strong trade interlinkages throughout the value chain, especially in manufacturing. GVCs have also increased the importance of

[25] The only country that clearly stands out from the others is Ireland, but we have already discussed reasons as why this represents an outlier.

regional linkages, given the key role of manufacturing in some of the largest European economies (Amador and others, 2015, and Figures 6 and 7). Both factors apply to EA countries, which have become increasingly integrated through trade and financial channels, and through a higher import content of domestic exports. Overall, we interpret our findings as an indication that increased interconnectedness renders disentangling the net impact of fiscal policy on the current account using only the post-euro experience more challenging. Finally, from a purely methodological standpoint, most existing studies do not account for lagged interdependencies across countries, while our model does. If spillback effects became increasingly important over time, then models that omit them would fail to characterize the true overall impact on the current account.

Changes in a country's domestic demand, economic activity, and external balances can also affect its international competitiveness, as measured by the exchange rate and relative prices. There is no agreement in the theoretical literature on the behavior of the REER in response to government spending shocks. Alternative assumptions on the behavior of the real interest rate (Obstfeld and Rogoff, 1995; Corsetti and others, 2012), home bias in government purchases (Frenkel and Razin, 1996), and households' intertemporal optimization between consumption and labor lead to different predictions. The existing empirical evidence is also mixed. Benetrix and Lane (2009) find opposite effects in EMU countries (real appreciation) compared to other G7 economies (real depreciation), and argue that the reason lies in the different types of exchange rate regimes in the two groups. Beetsma and others (2006) find evidence in support of a real appreciation in European countries following a positive shock to government absorption. Monacelli and Perotti (2010) instead find that higher government spending induces a real exchange rate depreciation, and argue that this can be related to the response of domestic consumption.

Our results reflect some of this uncertainty. Using the baseline set of identifying restrictions, the REER response is either positive or negative, depending on the country.[26] However, using the Mountford and Uhlig (2009) identification restrictions, the results point more consistently toward a real exchange rate appreciation (see the Extensions section for details). Among the IRFs shown in Figure 10, the largest positive response is observed for Germany, which is plausibly the only economy large enough to affect the EA-wide interest and exchange rates. Among the countries were the REER response is negative, the effects are most noticeable for the Netherlands and Ireland (around -0.1 percent).[27]

[26] A positive response of the REER indicates an appreciation.

[27] Institutional reforms can support external competitiveness when fiscal policy is used to stimulate domestic demand. Typically, countries undertake labor and product market reforms in the context of difficult economic conditions marked by high unemployment, a stagnant economy, and pressures on public finances (IMF 2017). In the case of the Netherlands, these reforms were introduced mostly in the aftermath of the 2007 financial crisis. In Ireland, they date back to the late '80s.

Policymakers are typically interested in the dynamics of government debt in response to an increase in government spending. However, the interpretation of these impulse responses deserves some caution. At any point in time, the stock of government debt has different maturities, and rollover effects can be sizable, making it difficult to establish a one-to-one relationship with changes in government outlays. Nonetheless, we find that government debt increases in most countries, although efforts to reduce the buildup of debt leads to a negative response in some sample windows and countries. Interestingly, Germany is the only case where public debt consistently falls across all sub-samples. This likely results from many factors, including strong fiscal discipline.

D. International Transmission Channels

Foreign output always expands in response to higher domestic spending, although the strength of the effect varies by country, as highlighted by the heterogeneity of fiscal spillovers. The current account appears to be the single most important series to capture the transmission of shocks (see Figure 11).[28]

We expect *a priori* that higher domestic demand translates into an expansion of exports from trading partners. Indeed, this pattern is observed between some of the countries in our sample that are connected through strong trade linkages. For example, a fiscal shock in the Netherlands or in Belgium expands the current account in Germany by 0.4 percent, Austria by 0.2 percent, and Italy by 0.1 percent. A fiscal shock in Austria expands the current account in Germany by 0.3 percent and in Italy by approximately 0.1 percent. The current account in Germany also reacts positively to fiscal expansions in France (0.4 percent), Italy (0.25 percent), and Spain (0.1 percent).

However, as observed also in the case of the domestic transmission of shocks, second-round effects can reverse the positive response of the current account. In our sample, the most notable cases occur in response to a fiscal shock in Germany and France. In the case of a fiscal shock in Germany, not only does the domestic current account fall, but it turns negative in the Netherlands and Belgium (approximately 1 percent). Although the response is smaller and not significant, it is also negative in France, Austria, Italy and Spain. In the case of a fiscal expansion in France, the current account in Belgium falls by 1 percent, while it expands or remains broadly stable in the remaining countries. As mentioned in the previous section, strong trade integration and a large import content of exports can weaken the conventional transmission mechanism, and the overall positive effect of fiscal spillovers on net exports.

[28] We do not consider the transmission of fiscal shocks originating from small countries, since the magnitude of spillovers is small. The full set of results is available upon request.

Beyond the current account, the impulse responses for other variables are typically quantitatively small, and the estimated impacts negligible. We have already noted that, with few exceptions, fiscal shocks do not seem to significantly affect domestic competitiveness. Therefore, it is not surprising to see muted or insignificant effects in other countries. Similarly, our results indicate that long-term interest rates tend to increase in response to government spending shocks, but the size of this effect is small. The notion that a less conservative management of fiscal balances systematically leads markets to increase the cost of government financing is not supported by the data. Of course, this does not rule out spending increases at times of strained public finances, or heightened market uncertainty leading to spikes in government borrowing costs.

E. Regression Analysis

To further explore the determinants of fiscal spillovers across countries, we take advantage of the time and cross-sectional variation of the IRFs obtained from our panel VAR, and regress fiscal spillovers on a set of controls. We focus on the role of trade and financial links, controlling for country- and time- fixed effects, and run the following regression:

$$S_{i,j,t} = d_r + d_s + d_t + \beta x_{i,j} + \varepsilon_{i,j,t}$$

where $S_{i,j,t}$ denotes the cumulative fiscal spillover from country i to country j in quarter t, ranging between 1 and 20; d_r, d_s, and d_t represent dummies for spillover receiving countries, countries originating fiscal shocks, and quarters, respectively; $x_{i,j}$ contains bilateral country characteristics; and $\varepsilon_{i,j,t}$ is the i.i.d. residual. In particular, $x_{i,j}$ represents either bilateral trade or bilateral financial flows between any pair of countries.[29] To control for structural changes related to the global financial crisis, or the deepening of trade integration, we consider trade and financial links in 2006, 2016, as well as the average over the whole sample period. We also include country and time dummies to capture country- and time-specific unobserved heterogeneity.

Table 2 presents the results. Stronger bilateral trade links increase fiscal spillovers. Moreover, the regression results also indicate that the importance of the trade channel has increased over time.[30] The effects of bilateral financial flows are also positive and statistically significant, suggesting that greater financial interconnectedness is associated with higher fiscal spillovers. Interestingly, the subsample evidence seems to indicate that the impact of financial links was stronger before the global financial crisis. The estimated coefficients on both bilateral trade and financial variables remain stable and statistically significant when controlling for country and time

[29] Bilateral trade flows are defined as the sum of exports and imports between two countries, rescaled by total trade among all countries in the sample. Bilateral financial flows are defined similarly for consolidated foreign claims.

[30] The null hypothesis of the equality of the coefficients in the 2006 and 2016 regression specifications is rejected by an F-test.

effects (column 2). Overall, our results suggest that both bilateral trade and financial linkages are important determinants of cross-country spillovers.

F. Extensions

The effect on prices

We replace the REER with the Consumer Price Index (CPI) among the endogenous series to examine the impact of an expansionary government spending shock on the domestic and foreign price level. In the euro area, this question bears special relevance as the zero lower bound on the reference monetary policy rate has heightened the debate on using expansionary fiscal policy to stimulate inflation (see Blanchard and others, 2015). Our evidence suggests that both domestic and foreign price levels generally rise in response to fiscal shock (Spain is a notable exception). The observed increase in prices is consistent with the stimulus effect that the increase in government spending has on output (both domestically and abroad), in turn spurring inflationary pressures.

The magnitude of the domestic response is largest in the case of France, where the CPI increases by 0.1 percent on impact, peaking at 0.15 percent in the third year (see Figure 12).[31] The change in the price level is also positive and statistically significant in Italy and Austria, although smaller in size than that in France. In other countries, including Germany, the responses are muted and insignificant. As mentioned, the only exception is the negative response of the price level in Spain, which is likely related to the prolonged deflationary period following the 2007 crisis.

International responses are delayed as the effects of the shock feed through economies. Foreign prices start rising only two to three quarters after the shock. This is interesting since it suggests that the propagation of the shock to foreign prices may work mostly through the demand channel, rather than through expectations, which react immediately to a shock. The magnitude of the responses abroad is also smaller, with the increase in foreign prices typically not exceeding 0.05 percent.

Alternative identification restrictions

We next impose the identification restrictions proposed by Mountford and Uhlig (2009), while leaving unchanged the model structure and the endogenous and exogenous series used in the estimation and analysis.

Fiscal spillovers do not change substantially under this alternative identification approach (see Table 3). The magnitude of the median estimates is in the ballpark of the magnitudes obtained under our baseline identification strategy, falling within the confidence bands of the latter in a number of cases. As previously noted, spillovers tend to be larger among countries that are

[31] The CPI responses are not annualized.

integrated through trade, and for the larger source countries. However, the size of fiscal multipliers obtained using the Mountford and Uhlig (2009) method differs more markedly from our baseline results for some countries, potentially reflecting alternative set of restrictions that characterize each identification scheme.

Fiscal multipliers estimated using the Mountford and Uhlig (2009) method are larger in the case of Belgium, Austria, Italy, Spain and Ireland and smaller for the remaining countries. However, in some cases, differences in estimates obtained under the two approaches are not economically significant. For example, for Italy, Spain, and Ireland, the multipliers estimated under the two approaches are respectively 0.54, 0.27, and 0.71, compared to 0.5, 0.31, and 0.68. Where differences between the two sets of estimates are more marked, the results remain nonetheless well anchored within the upper and lower values commonly found in the literature.

The IRFs also offer some interesting insights. In particular, the dynamic pattern of the REER consistently points to an appreciation in response to the government spending shock (see Figure 13). In earlier sections, we found that the evidence was not conclusive. While using the Mountford and Uhlig (2009) sign restrictions, our results are more in line with other studies that find a real appreciation in response to a government spending shock in EA countries. Government bond yields remain either unchanged, or turn negative and small, confirming that there appears to be no systematic response of financial markets to spending impulses.

Other robustness tests

To check the robustness of our results, we considered a battery of test, including alternative sample size, different endogenous and exogenous series included in the estimation, and changes in prior specifications. The broad thrust of our results and the magnitude of spillovers remains largely unchanged (results available upon request).

As a robustness check on sample size, we estimated a version of the model excluding Ireland, but did not observe any significant differences in the spillover estimates compared to our baseline for other countries. To examine robustness to alternative variables considered in the estimation, we included a REER series with respect to the rest of the world based on a CPI measure of domestic costs and prices instead of capturing intra-area movements in real exchange rates, as in the baseline. We also considered a version of the model in which we replace the REER with the CPI, and the Eonia is used as a proxy for the benchmark interest rate instead of government bond yields. Our results remained broadly unchanged. Finally, we considered a number of sensitivity tests on the prior distributions. However, given the loose priors (see Appendix 2), changing the parameters did not have measurable impacts on the posterior results.

VI. CONCLUSIONS

What are the effects of government spending shocks in the home country and abroad? This paper offers new empirical evidence for a sample of 10 EA countries covering the post-euro

period. We estimate fiscal multipliers for each country in the sample, and fiscal spillovers for each country vis-à-vis the others. To better capture dynamic interlinkages, which can be important in the euro area, we employ a large-scale panel-VAR model with leading and lagged interdependencies covering macroeconomic, monetary, and financial variables. We check the sensitivity of the results across alternative samples, economic series, and to alternative identification assumptions.

We find that domestic fiscal multipliers are positive and heterogeneous across countries, and fiscal spillovers can be significant in some cases. The heterogeneity in estimates of domestic multipliers suggests that the effects of spending increases are different across countries, rendering average estimates of fiscal multipliers misleading. We also observe an inverse relationship between the size of domestic fiscal multipliers and trade openness. Importantly, we find that: fiscal spillovers are larger (i) when the spillover-sending or source economy is large; (ii) among countries that are highly integrated through trade or financial linkages; and (iii) when the spillover-receiving economy is small and has a narrow export base. This evidence seems to align well with proposals advanced recently for expansionary fiscal policies in large economies with fiscal space to be a non-negligible growth driver for other countries in the euro area.

The current account appears to be the main channel of transmission for fiscal shocks both domestically and abroad. However, strong trade integration among countries in the euro area and spillback effects tend to zero-out the net impact when using a sample that only covers the post-euro period. As such, we do not find systematic evidence in favor of the "twin deficit hypothesis", and in a few instances, we observe a decoupling between the (positive) output dynamics and the (negative) response of the current account.

Fiscal policy changes, especially in large countries, can, in principle, impact domestic and foreign interest rates, and the exchange rate vis-à-vis other currencies. However, at least for the countries and the period under consideration, we do not find strong evidence in support of other transmission channels. The real effective exchange rate, which is commonly regarded as a proxy for a country's competitiveness, moves little in response to a government spending shock. This result is not surprising as prices and wages tend to be sticky in the short run. Moreover, the common currency and the centralized conduct of monetary policy likely contributed towards dampening fluctuations of the nominal exchange rate in response to domestic fiscal innovations. Interestingly, Germany, possibly the only economy large enough to affect the external competitiveness of the currency block, is also the only case where we find some evidence of a positive impact of fiscal policy on the real exchange rate. While long-term interest rates do not appear to respond systematically to spending innovations, we find some evidence that both domestic and foreign price levels generally rise in response to fiscal shocks, although the magnitude of the estimated effects is small.

The sub-samples analysis shows that the effects of fiscal policy can change over time, reflecting different states of the business cycle and policy frameworks. In a few cases, sizeable changes in the size of the estimated spillovers across some subsamples could be driven by one-off factors – e.g. the rebasing of GDP in Ireland, or the boom-bust cycle in Spain. However, while we detect idiosyncrasies for some countries, we typically find larger domestic multipliers and spillovers between 2011 and 2014. This period broadly corresponds with the euro area sovereign debt crisis, the launch of the Long-Term Refinancing Operations and of successive rounds of quantitative easing when the monetary policy rate was constrained at the effective lower bound. Finally, in the case of Ireland, we observe very high inward spillovers, but low outward spillovers from domestic fiscal policy shocks. This may suggest that the legislative framework (e.g. taxation of corporate income, repatriation of profits, establishment of a company, etc.) can be a decisive factor in determining how the effects of a fiscal policy shock are transmitted abroad.

Future research could investigate spillovers from alternative fiscal instruments. For instance, spillovers from public consumption and public investment can have different magnitudes. Similarly, tax shocks can have different effects than government spending shocks.

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Table 1. Fiscal Multipliers and Spillovers (1 year)

Recipient country \ Country originating the fiscal shock	Germany	France	the Netherlands	Belgium	Austria	Italy	Spain	Ireland	Finland	Portugal
Germany	0.71 [0.63, 0.82]	0.22 [0.14, 0.31]	0.21 [0.15, 0.26]	0.14 [0.11, 0.19]	0.15 [0.12, 0.2]	0.11 [0.07, 0.15]	0.08 [0.05, 0.11]	0.03 [0.01, 0.04]	0.06 [0.03, 0.09]	0.06 [0.03, 0.08]
France	0.09 [0.06, 0.12]	0.53 [0.45, 0.61]	0.07 [0.05, 0.1]	0.07 [0.05, 0.09]	0.04 [0.02, 0.06]	0.06 [0.04, 0.08]	0.04 [0.02, 0.06]	0.02 [0.01, 0.03]	0.01 [0, 0.03]	0.03 [0.02, 0.04]
the Netherlands	0.17 [0.13, 0.2]	0.14 [0.09, 0.2]	0.52 [0.46, 0.58]	0.11 [0.08, 0.14]	0.06 [0.03, 0.09]	0.07 [0.04, 0.1]	0.05 [0.03, 0.07]	0.02 [0.01, 0.04]	0.04 [0.02, 0.06]	0.03 [0.01, 0.05]
Belgium	0.13 [0.1, 0.16]	0.15 [0.11, 0.2]	0.13 [0.1, 0.16]	0.29 [0.24, 0.34]	0.05 [0.03, 0.07]	0.06 [0.04, 0.08]	0.04 [0.02, 0.06]	0.03 [0.01, 0.03]	0.03 [0.01, 0.05]	0.03 [0.01, 0.05]
Austria	0.16 [0.12, 0.2]	0.13 [0.07, 0.18]	0.09 [0.05, 0.13]	0.06 [0.04, 0.09]	0.44 [0.39, 0.49]	0.07 [0.04, 0.11]	0.04 [0.02, 0.07]	0.02 [0.01, 0.03]	0.03 [0.01, 0.05]	0.03 [0.01, 0.05]
Italy	0.13 [0.09, 0.17]	0.16 [0.11, 0.23]	0.11 [0.07, 0.14]	0.08 [0.05, 0.11]	0.08 [0.05, 0.11]	0.50 [0.46, 0.54]	0.06 [0.04, 0.09]	0.02 [0.01, 0.04]	0.04 [0.02, 0.07]	0.04 [0.02, 0.06]
Spain	0.12 [0.08, 0.16]	0.14 [0.1, 0.2]	0.09 [0.06, 0.13]	0.07 [0.04, 0.09]	0.06 [0.03, 0.09]	0.08 [0.05, 0.11]	0.31 [0.27, 0.35]	0.02 [0.01, 0.03]	0.03 [0.01, 0.05]	0.06 [0.04, 0.08]
Ireland	0.34 [0.22, 0.49]	0.49 [0.27, 0.69]	0.33 [0.21, 0.47]	0.30 [0.21, 0.4]	0.22 [0.13, 0.34]	0.24 [0.13, 0.37]	0.17 [0.09, 0.24]	0.68 [0.6, 0.76]	0.12 [0.05, 0.21]	0.11 [0.04, 0.19]
Finland	0.19 [0.13, 0.26]	0.15 [0.06, 0.23]	0.16 [0.1, 0.22]	0.10 [0.06, 0.15]	0.10 [0.05, 0.14]	0.11 [0.07, 0.16]	0.07 [0.04, 0.1]	0.04 [0.02, 0.06]	0.49 [0.39, 0.59]	0.06 [0.03, 0.09]
Portugal	0.12 [0.08, 0.16]	0.15 [0.09, 0.2]	0.08 [0.04, 0.12]	0.07 [0.04, 0.1]	0.06 [0.03, 0.09]	0.07 [0.03, 0.1]	0.07 [0.05, 0.1]	0.02 [0.01, 0.03]	0.04 [0.02, 0.06]	0.29 [0.25, 0.33]

Note: The table presents fiscal multipliers (diagonal elements) and spillovers (off-diagonal elements) at year one, obtained using the sample 1999-2016. Sending countries are reported along the columns, while recipient countries are stacked along the rows. Multipliers and spillovers are defined as the ratio of the cumulative change of output over the cumulative change of government spending. Numbers in parenthesis indicate 68 percent confidence intervals.

Table 2. Determinants of Fiscal Spillovers

	(1)	(2)
Sample Average		
Bilateral trade	0.014***	0.012***
	[0.001]	[0.001]
Bilateral financial links	0.013***	0.012***
	[0.001]	[0.000]
Observations	1,800	1,800
R-squared	0.825	0.866
2006		
Bilateral trade	0.013***	0.011***
	[0.001]	[0.001]
Bilateral financial links	0.008***	0.009***
	[0.001]	[0.001]
Observations	1,720	1,720
R-squared	0.83	0.88
2016		
Bilateral trade	0.016***	0.014***
	[0.001]	[0.001]
Bilateral financial links	0.003***	0.003***
	[0.001]	[0.001]
Observations	1,800	1,800
R-squared	0.81	0.86
Dummies for receiving countries	Yes	Yes
Dummies for quarters	No	Yes

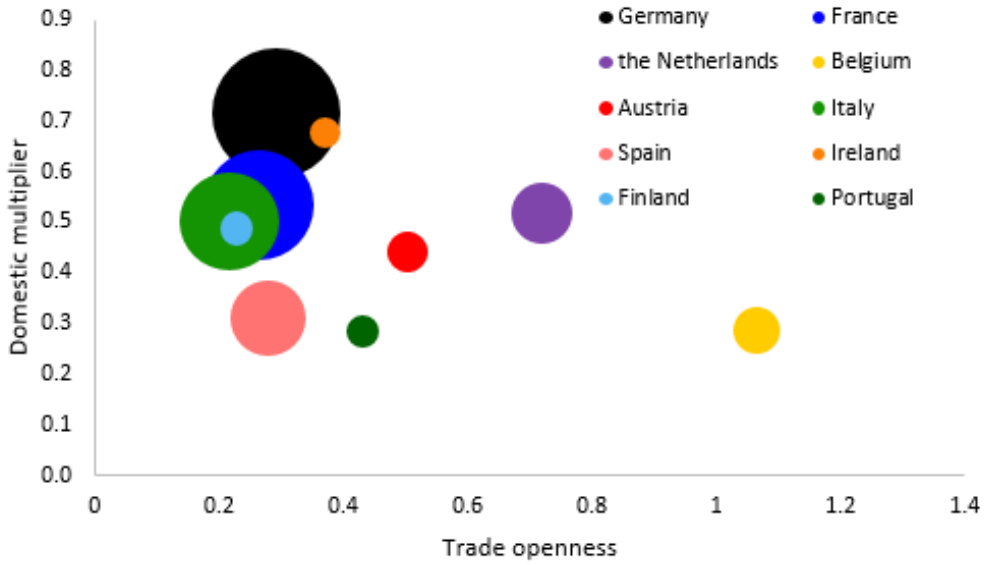
Note: The dependent variable is the bilateral fiscal spillovers as measured by the IRFs. The regression results 'Sample average' (top of the table) use the average between 1999 and 2016 of bilateral trade and financial flows among the regressors; the center and bottom panels use bilateral trade and financial flows in 2006 and 2016 respectively. Estimations are performed using OLS with robust standard errors. Confidence intervals: ***<0.01, **<0.5, and *<0.1.

Table 3. Fiscal Multipliers and Spillovers Under Alternative Identification Restrictions (1 year)

Recipient country \ Country originating the fiscal shock	Germany	France	the Netherlands	Belgium	Austria	Italy	Spain	Ireland	Finland	Portugal
Germany	0.46 [0.4, 0.5]	0.14 [0.08, 0.21]	0.09 [0.06, 0.12]	0.15 [0.09, 0.2]	0.14 [0.1, 0.19]	0.14 [0.07, 0.2]	0.06 [0.02, 0.09]	0.06 [0.03, 0.08]	0.03 [0, 0.06]	0.10 [0.06, 0.14]
France	0.05 [0.03, 0.07]	0.36 [0.32, 0.39]	0.03 [0.02, 0.05]	0.07 [0.04, 0.09]	0.04 [0.01, 0.06]	0.08 [0.05, 0.1]	0.04 [0.02, 0.05]	0.02 [0.01, 0.04]	0.02 [0, 0.03]	0.04 [0.01, 0.05]
the Netherlands	0.10 [0.06, 0.14]	0.11 [0.06, 0.16]	0.26 [0.24, 0.28]	0.14 [0.1, 0.18]	0.06 [0.02, 0.09]	0.09 [0.03, 0.13]	0.05 [0.02, 0.07]	0.04 [0.02, 0.07]	0.03 [0.01, 0.05]	0.06 [0.03, 0.09]
Belgium	0.08 [0.05, 0.11]	0.11 [0.07, 0.16]	0.07 [0.05, 0.09]	0.42 [0.39, 0.44]	0.05 [0.02, 0.08]	0.09 [0.03, 0.13]	0.04 [0.02, 0.06]	0.05 [0.03, 0.07]	0.02 [0, 0.04]	0.05 [0.02, 0.07]
Austria	0.12 [0.09, 0.16]	0.10 [0.03, 0.15]	0.05 [0.02, 0.07]	0.08 [0.03, 0.13]	0.54 [0.5, 0.56]	0.13 [0.07, 0.18]	0.04 [0.01, 0.06]	0.03 [0.01, 0.06]	0.02 [0, 0.05]	0.05 [0.02, 0.09]
Italy	0.08 [0.04, 0.1]	0.11 [0.06, 0.15]	0.04 [0.02, 0.06]	0.08 [0.04, 0.11]	0.07 [0.04, 0.1]	0.54 [0.52, 0.57]	0.04 [0.02, 0.06]	0.03 [0.02, 0.06]	0.02 [0, 0.04]	0.05 [0.02, 0.08]
Spain	0.07 [0.03, 0.09]	0.10 [0.05, 0.14]	0.04 [0.02, 0.06]	0.08 [0.04, 0.11]	0.04 [0, 0.07]	0.08 [0.04, 0.13]	0.27 [0.25, 0.29]	0.04 [0.02, 0.06]	0.02 [0, 0.04]	0.08 [0.05, 0.11]
Ireland	0.19 [0.12, 0.28]	0.21 [0.08, 0.34]	0.13 [0.07, 0.18]	0.28 [0.18, 0.37]	0.12 [0.03, 0.22]	0.24 [0.1, 0.35]	0.12 [0.06, 0.19]	0.71 [0.66, 0.75]	0.06 [0, 0.12]	0.11 [0.03, 0.19]
Finland	0.07 [0.04, 0.11]	0.10 [0.04, 0.15]	0.05 [0.03, 0.07]	0.09 [0.05, 0.13]	0.05 [0.01, 0.09]	0.09 [0.03, 0.14]	0.04 [0.01, 0.06]	0.04 [0.01, 0.06]	0.34 [0.31, 0.36]	0.06 [0.02, 0.09]
Portugal	0.05 [0.03, 0.07]	0.05 [0.02, 0.08]	0.02 [0.01, 0.03]	0.04 [0.02, 0.06]	0.03 [0.01, 0.05]	0.05 [0.02, 0.07]	0.04 [0.02, 0.05]	0.02 [0, 0.03]	0.01 [0, 0.02]	0.20 [0.19, 0.21]

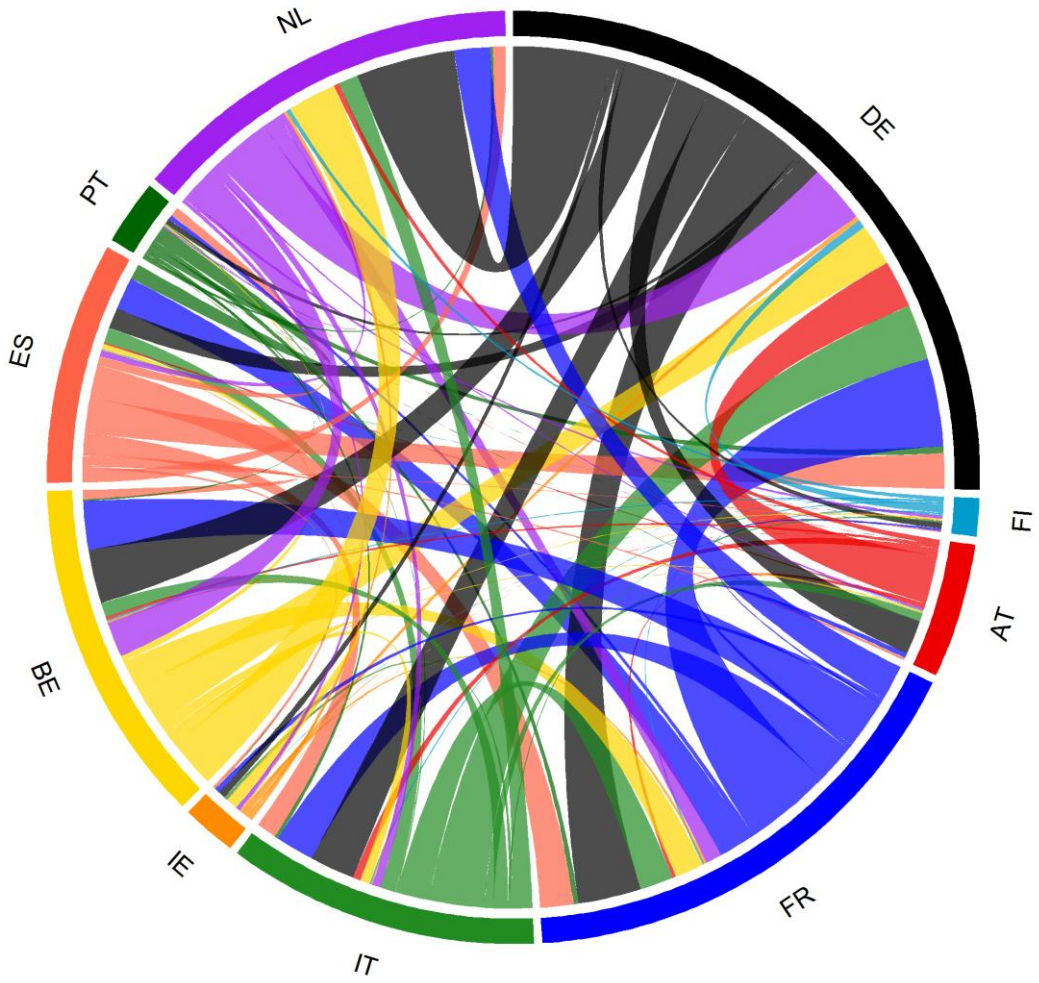
Note: The table reproduces fiscal multipliers (diagonal elements) and spillovers (off-diagonal elements) at year one, obtained using the sample 1999-2016 and the identification restrictions in Mountford and Uhlig (2009). Sending countries are reported along the columns, while recipient countries are stacked along the rows. Multipliers and spillovers are defined as the ratio of the cumulative change of output over the cumulative change of government spending. Numbers in parenthesis indicate 68 percent confidence intervals.

Figure 1. Openness to Trade and Fiscal Multipliers



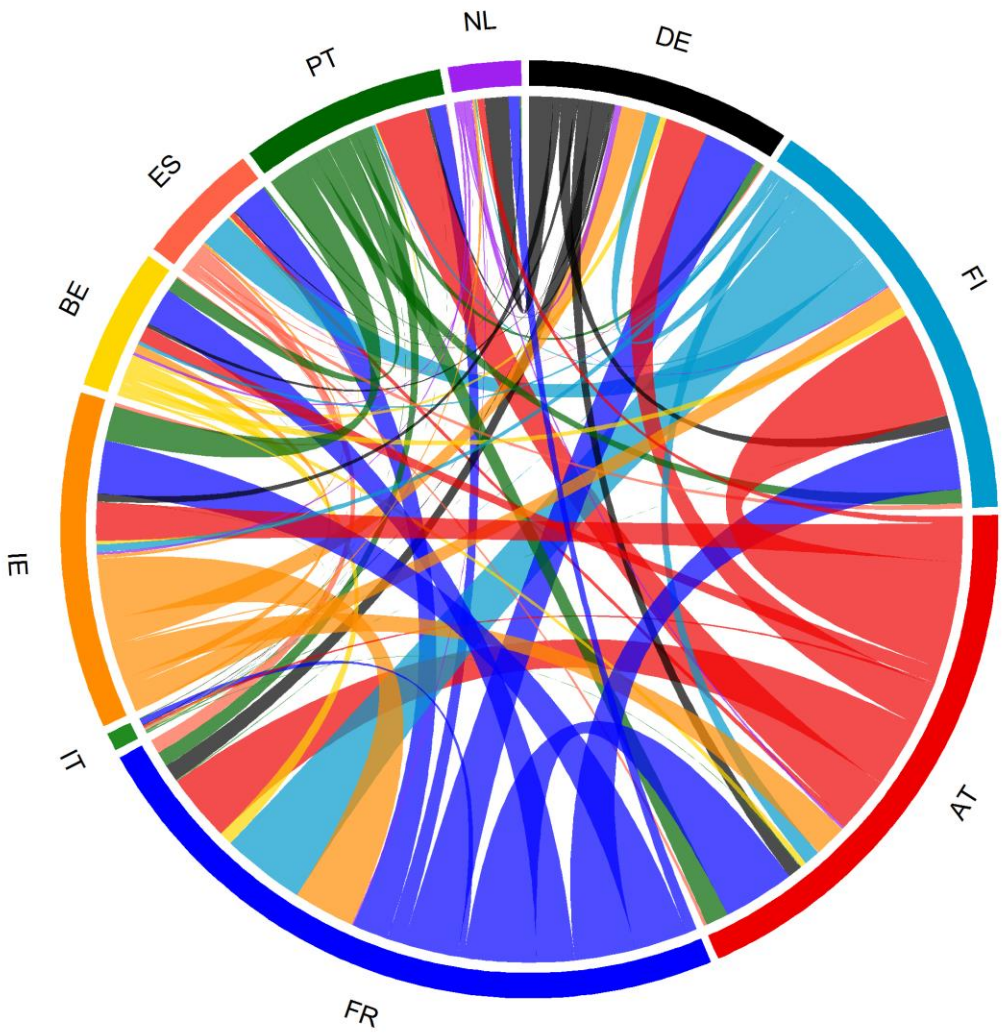
Note: Trade openness is defined as the sum of a country's exports and imports over GDP. Domestic fiscal multipliers correspond to the ones reported along the main diagonal of Table 1 above. The diameter of each bubble is proportional to the size of a country's GDP.

Figure 2. Bilateral Trade Flows



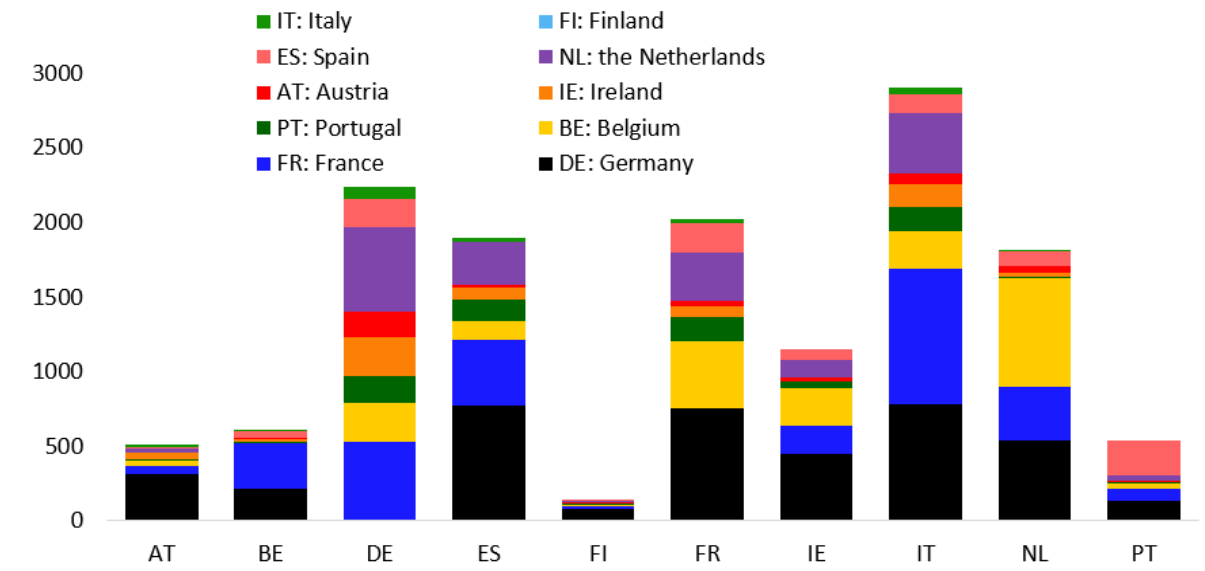
Note: Bilateral trade flows in goods and services. Sample average over 1999-2016. Each segment on the circle corresponds to a country's share of total trade flows (sum of imports and exports) among the 10 countries in our sample. In each segment, chords of the same color of the segment represent exports from the respective country to the others; chords of different colors than the segment show imports from other countries. Thicker chords indicate relatively stronger trade links between country pairs. Countries: Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Italy (IT), Ireland (IE), the Netherlands (NL), Portugal (PT), Spain (ES).

Figure 3. Bilateral Financial Flows



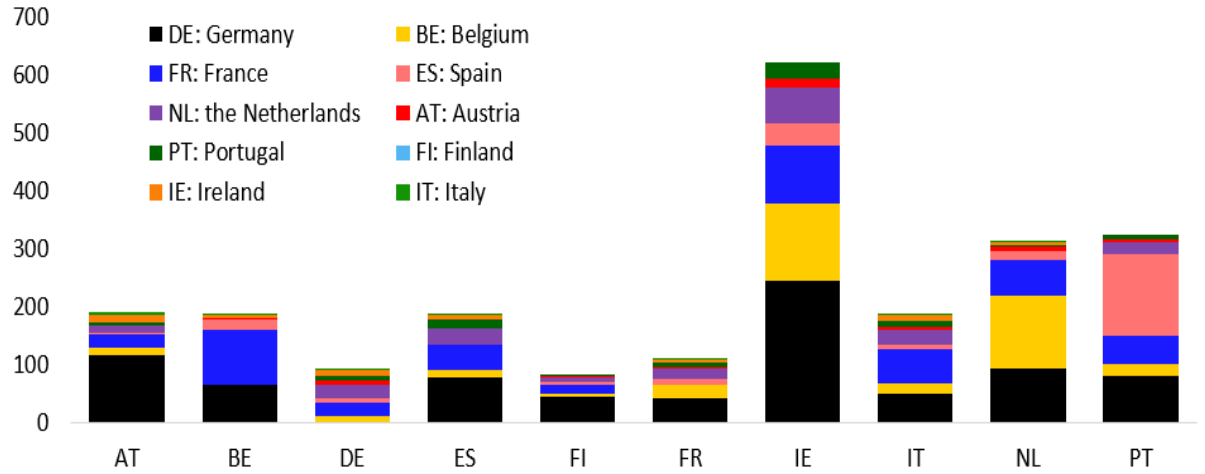
Note: Bilateral consolidated foreign claims of reporting banks, immediate borrower basis. Sample average over 1999-2016. Each segment on the circle corresponds to a country's share of total financial flows (sum of foreign and domestic claims) among the 10 countries in our sample. In each segment, chords of the same color of the segment represent claims of domestic reporting banks to foreign banks; chords of different colors than the segment show foreign banks' claims on domestic banks. Thicker chords indicate relatively stronger financial links between country pairs. Countries: Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Italy (IT), Ireland (IE), the Netherlands (NL), Portugal (PT), Spain (ES).

Figure 4. Foreign Claims by Country in 2006
(US $, billions)



Note: Consolidated foreign claims of reporting banks, immediate borrower basis.

Figure 5. Foreign Claims by Country in 2006
(in percent of GDP)



Note: Consolidated foreign claims of reporting banks, immediate borrower basis, expressed in percent of domestic GDP.

Figure 6. Evolution of Exports by Source and Recipient Country
(in percent of GDP)

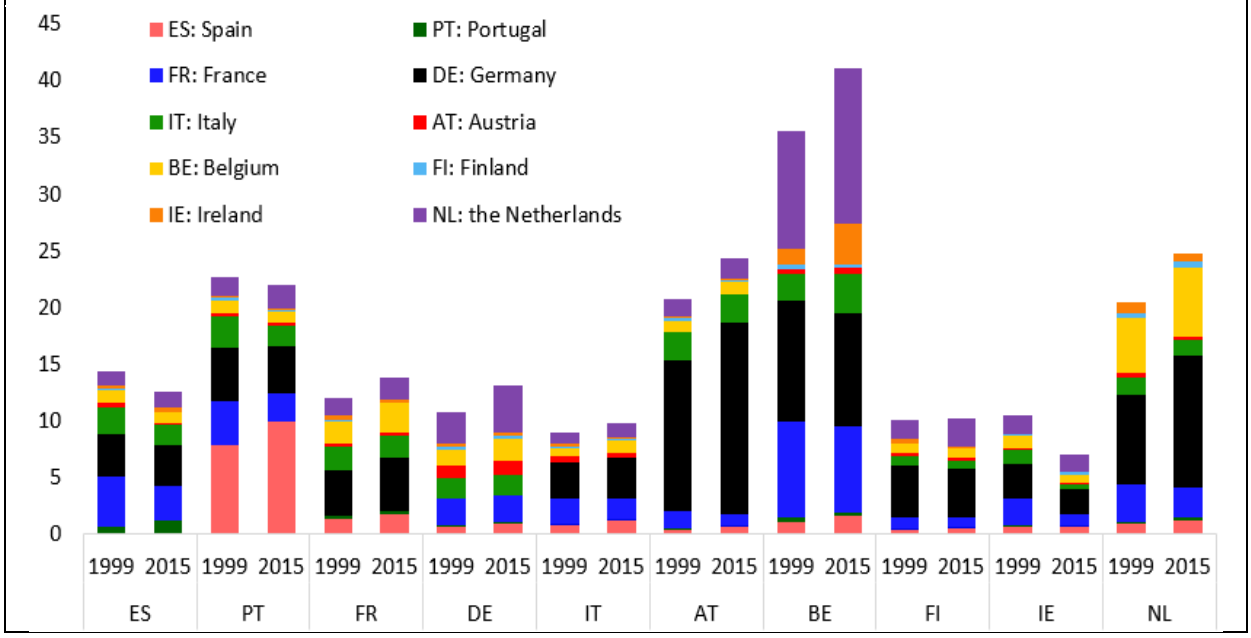


Figure 7. Evolution of Imports by Source and Recipient Country
(in percent of GDP)

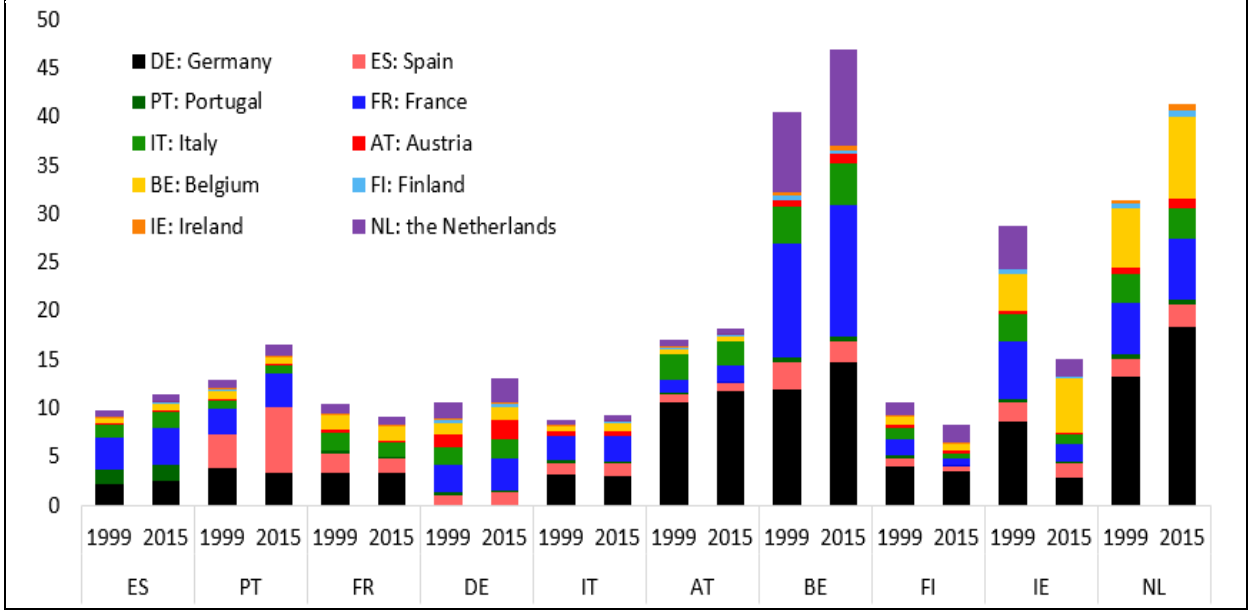
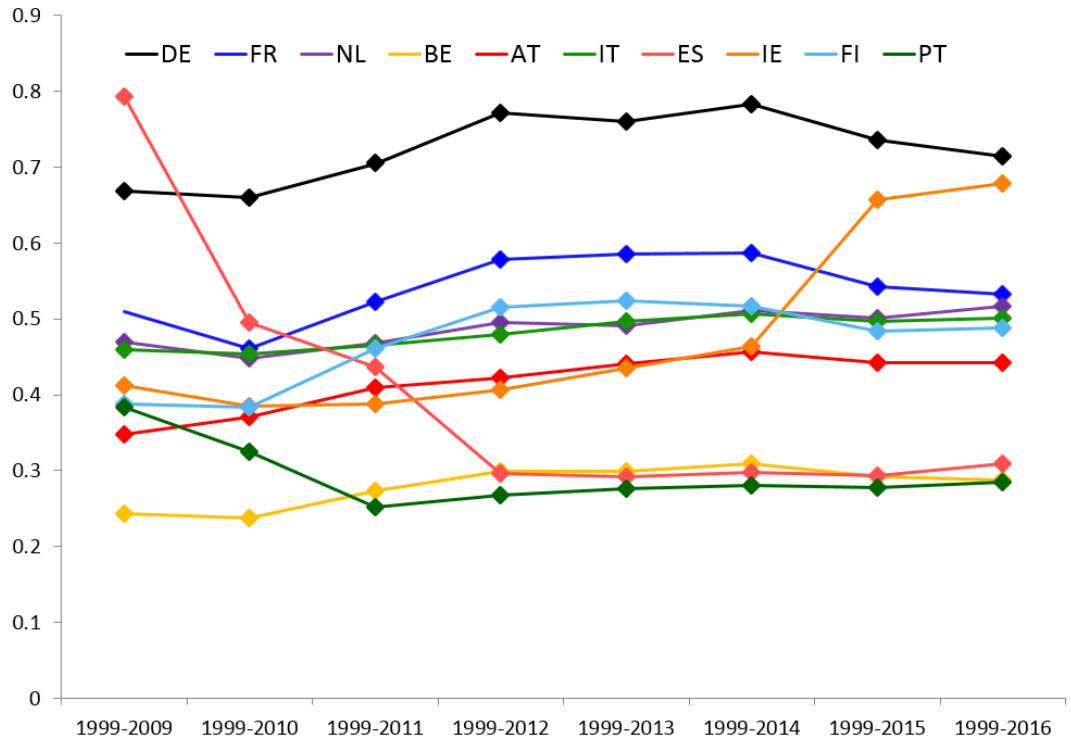
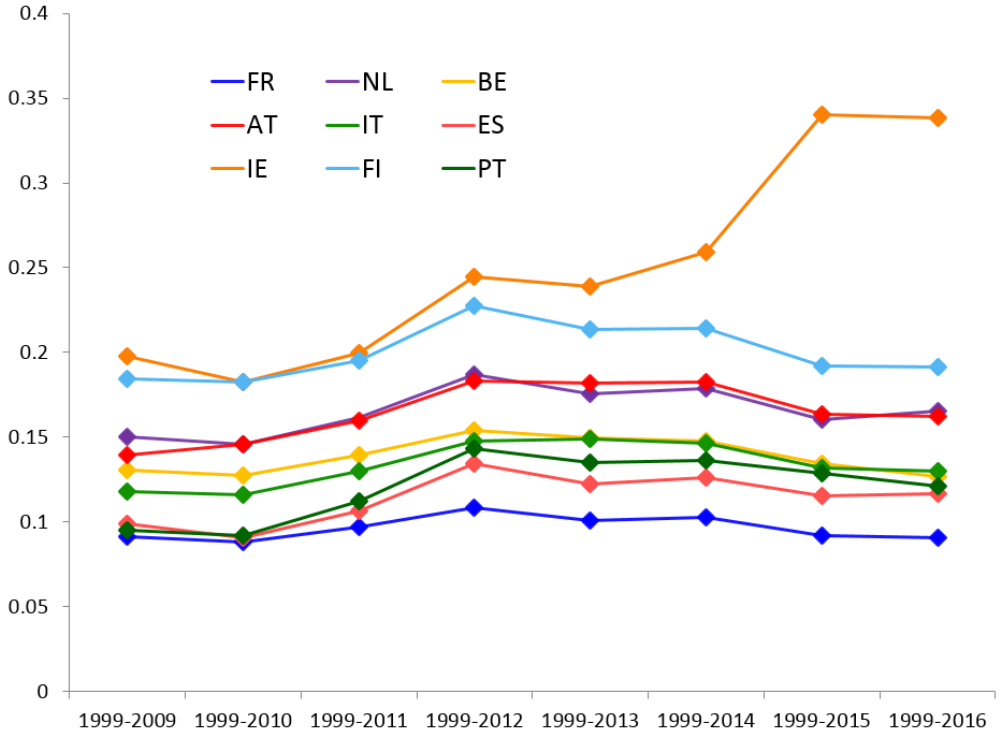


Figure 8. Fiscal Multipliers Across Sub-Samples



Note: The figure plots fiscal multipliers in each of the countries in our sample, across different sub-samples (x-axis). The multiplier is calculated in response to a 1 percent increase in government spending. A marker indicates that the result is statistically significant.

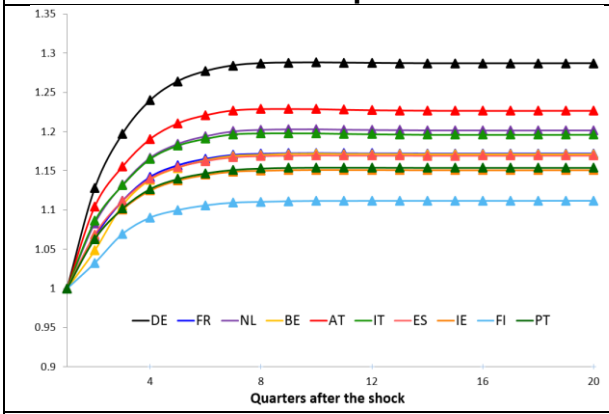
Figure 9. Fiscal Spillovers from Germany Across Sub-Samples



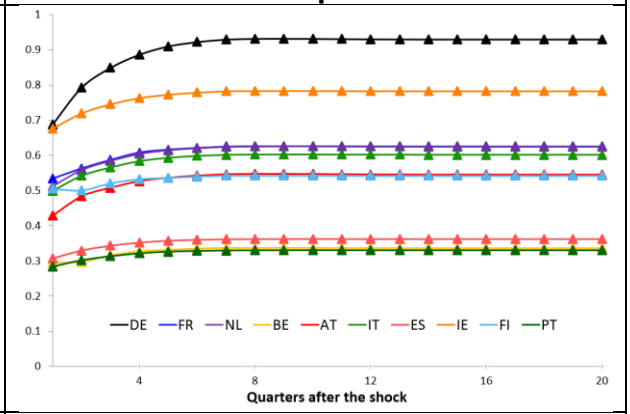
Note: The figure plots fiscal spillovers from Germany in each of the remaining countries in our sample, across different sub-samples (x-axis). The spillover is calculated in response to a 1 percent increase in government spending in Germany. A marker indicates indicate that the result is statistically significant.

Figure 10. Domestic Responses to a Government Spending Shock

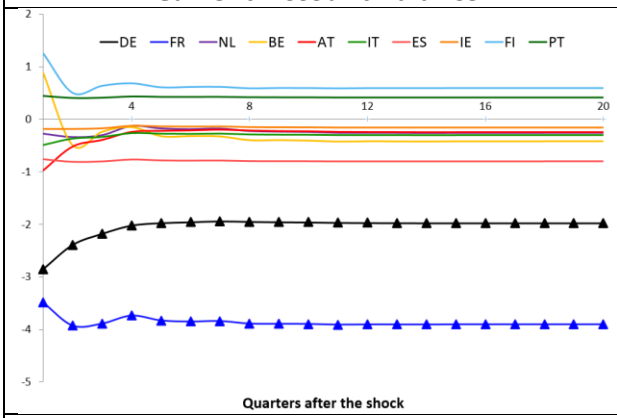
Government Expenditure



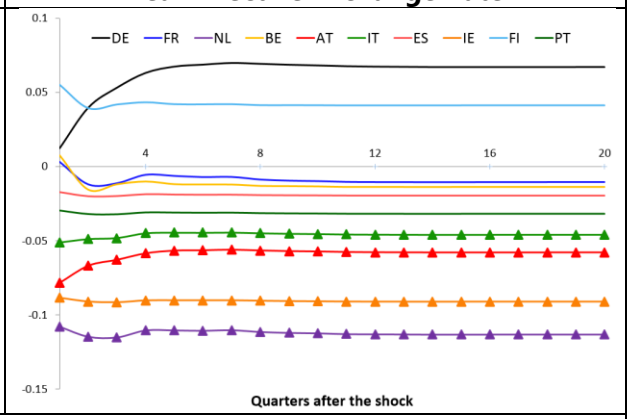
Output



Current Account Balance



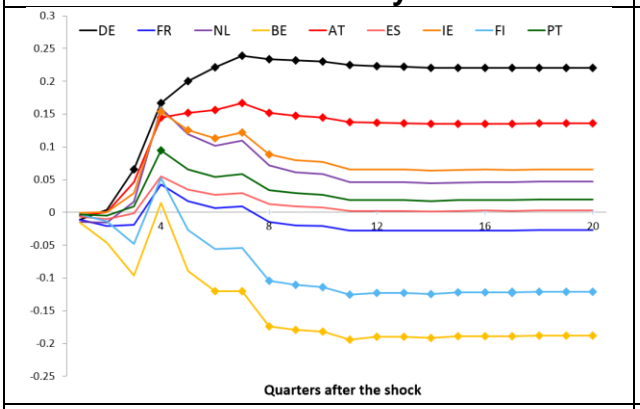
Real Effective Exchange Rate



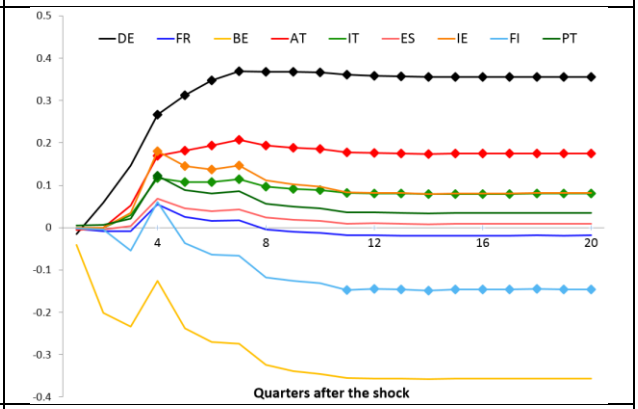
Note: The figure plots the domestic responses of government spending, output, current account, and REER to a government spending shock. The size of the shock on impact is equal to 1 percent. The unit on the x-axis is quarters after the shock, and the unit on the y-axis is percent. A marker indicates that the result is statistically significant.

Figure 11. International Responses of the Current Account to a Government Spending Shock

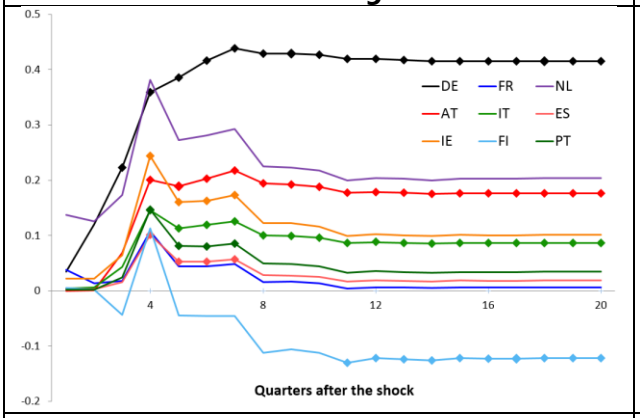
Shock in Italy



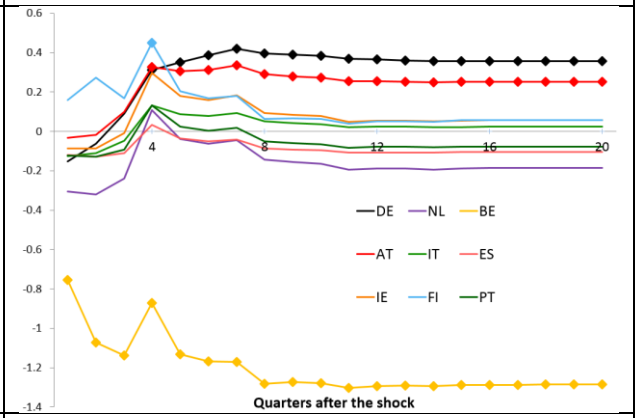
Shock in the Netherlands



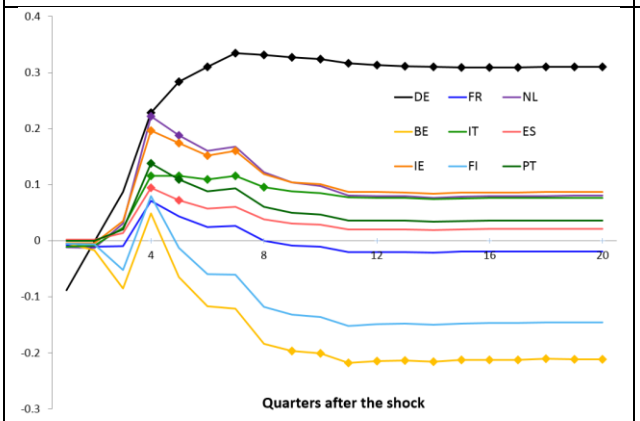
Shock in Belgium



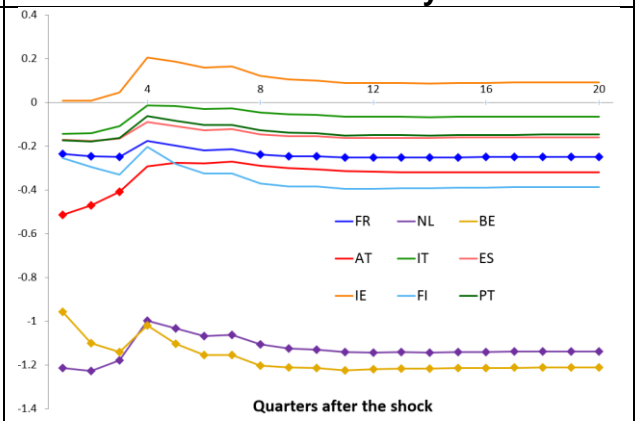
Shock in France



Shock in Austria

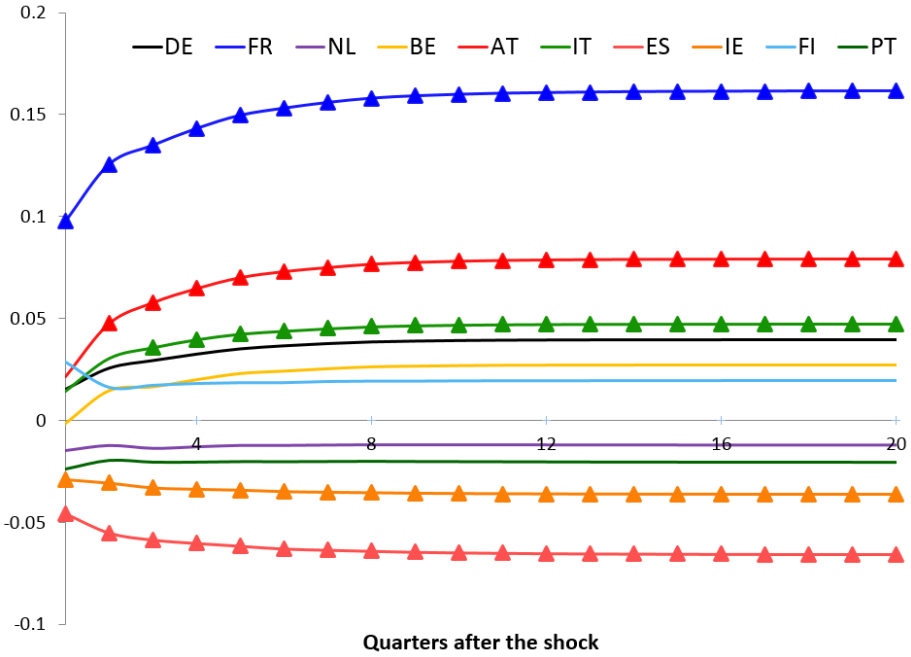


Shock in Germany



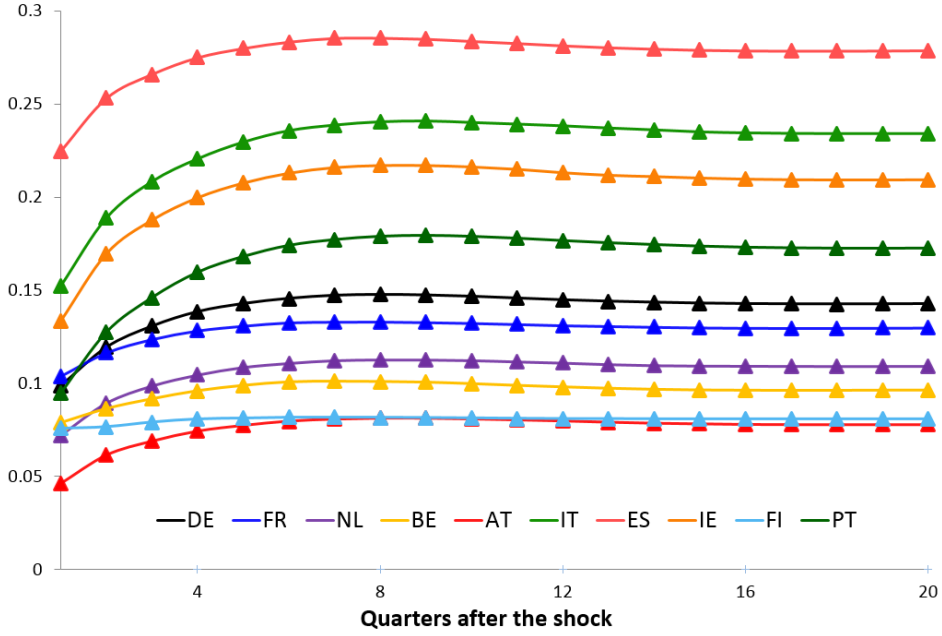
Note: The figure plots the international responses of the current account to a government spending shock. The size of the shock on impact is equal to 1 percent. The unit on the x-axis is quarters after the shock, and the unit on the y-axis is percent. A marker indicates that the result is statistically significant.

Figure 12. Domestic Responses of the CPI



Note: The figure plots the domestic responses of the CPI to a government spending shock. The size of the shock on impact is equal to 1 percent. The unit on the x-axis is quarters after the shock, and on the y-axis is percent. A marker indicates that the result is statistically significant.

Figure 13. Domestic Responses of the REER Under Alternative Identification Restrictions



Note: The figure plots the domestic responses of the REER to a government spending shock identified using the identification restrictions in Mountford and Uhlig (2009). The size of the shock on impact is equal to 1 percent. The unit on the x-axis is quarters after the shock, and the unit on the y-axis is percent. A marker indicates that the result is statistically significant.

Appendix 1. Estimation Approach

We adopt a Bayesian estimation approach. By replacing the assumed law of motion for δ into the model in regression format, we obtain:

$$Y_t = \sum_{j=1}^{p} \mathcal{Z}_{jt}\,\theta_j + v_t$$

where $\mathcal{Z}_{jt} = Z_t \Xi_j$ and $v_t = E_t + Z_t u_t$. Assuming $V = \sigma^2 I$, the error term can be written as $v_t \sim N\big(0, (I + \sigma^2 Z_t' Z_t')(P \otimes \Omega)\big)$. Thus, the unknowns of the model are the vector of factors θ, the scale factor σ^2, and the blocks of the variance covariance matrices of the VAR shocks, *P* and Ω.

We assume an independent prior for the four blocks:

$$\theta \sim N(\theta_0, \Theta)$$

$$P \sim IW(r, Q)$$

$$\Omega \sim IW(o, R)$$

$$\sigma^2 \sim IG(0.5, 0.5 s^2)$$

where the hyper parameters $(\theta_0, \Theta, \mathrm{r}, \mathrm{Q}, \mathrm{o}, \mathrm{R}, s^2)$ are treated as fixed; *IW* stands for the Inverse Wishart distribution, and *IG* for Inverse Gamma distribution. θ_0 is computed as average of cross-sectional data, while Θ is a fixed constant; *Q* is estimated using the residuals of the country specific models and *R* using the residuals of the variable specific models; and s^2 is obtained using the average of the variance of the residuals of *AR(p)* regressions of the *NG* endogenous variables. To obtain the posterior distributions for the model's unknowns, we combine the prior with the likelihood of the data, which is proportional to:

$$L \propto \Big(\prod_t |(I + \sigma^2 Z_t' Z_t')(P \otimes \Omega)|^{-\frac{1}{2}} \exp\Big[-\frac{1}{2}\sum_t (Y_t - \mathcal{Z}_t\theta)'\big((I + \sigma^2 Z_t' Z_t')(P \otimes \Omega)\big)^{-1}(Y_t - \mathcal{Z}_t\theta)\Big]$$

We use Gibbs sampling cycles from the conditional posterior of each block of unknowns. A Metropolis step is used to integrate the conditional posterior of σ^2, which is non-standard given the Jacobian term in the likelihood function. Candidate draws in the Metropolis algorithm are obtained from $\sigma^{2i} = \sigma^{2i-1} + h$, where σ^{2i-1} is the previous draw and *h* is normally distributed with zero mean and variance *l*.[32]

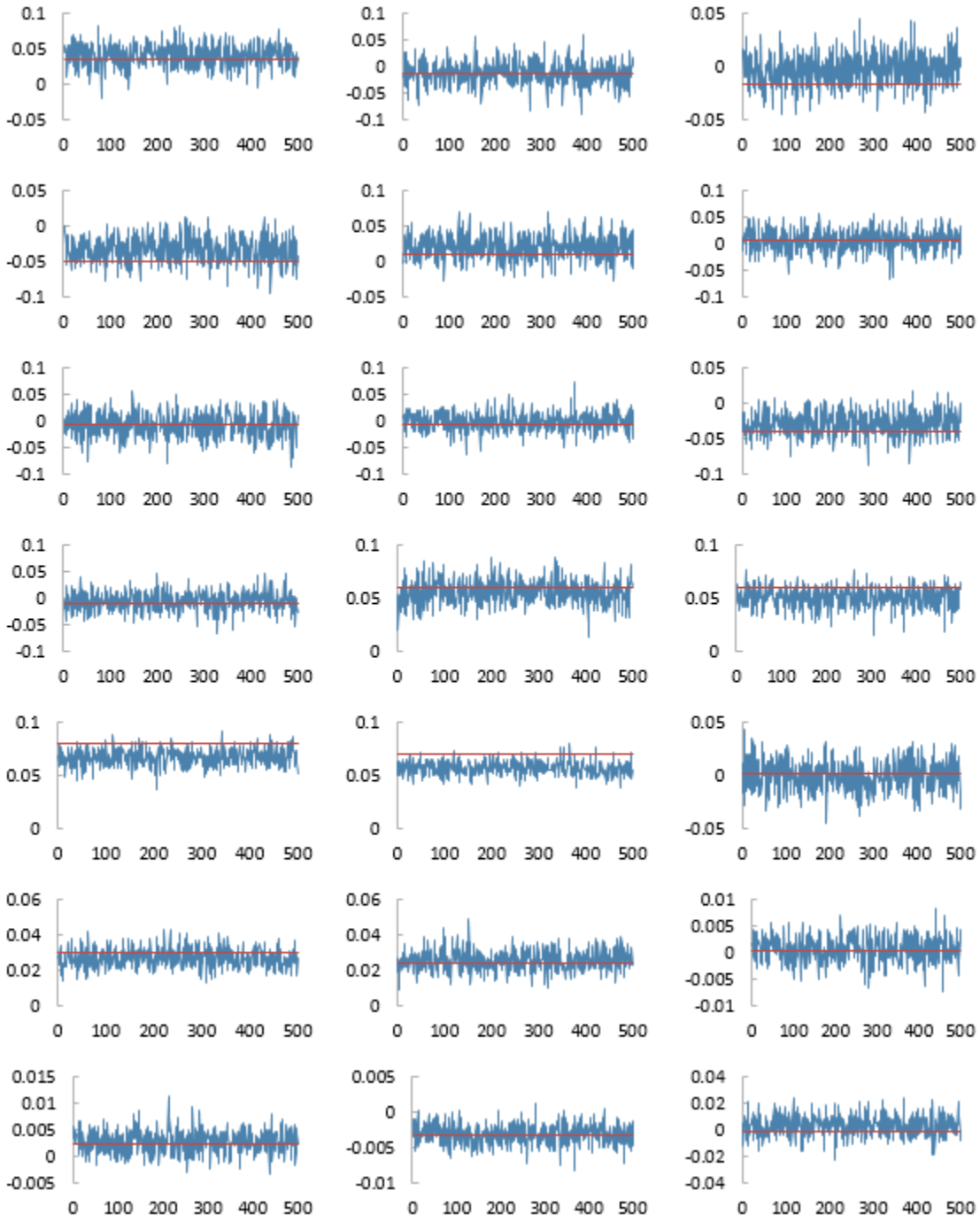
[32] The value of *l* is selected to have an acceptance rate of the order of approximately 33 percent.

Cycling through the conditional distributions produces in the limit draws from the joint posterior of the unknowns. The results we present are based on the last draw of 500 chains of length 1000 all starting in a small random interval of the last draw of a single (burn-in) chain of 100000 draws. The model features a heteroskedastic error term, although the time variation is derived from lags of the endogenous variables rather than an exogenous independent process.

The model has time-invariant parameters and the VAR errors have fixed volatilities. This is a departure from the literature that estimates models where both the VAR coefficients and volatilities are time varying (see the seminal work by Primiceri, 2005). Allowing for time-varying parameters can complicate structural analysis, since the parameter drifting is introduced ad hoc and lacks a genuine structural interpretation.

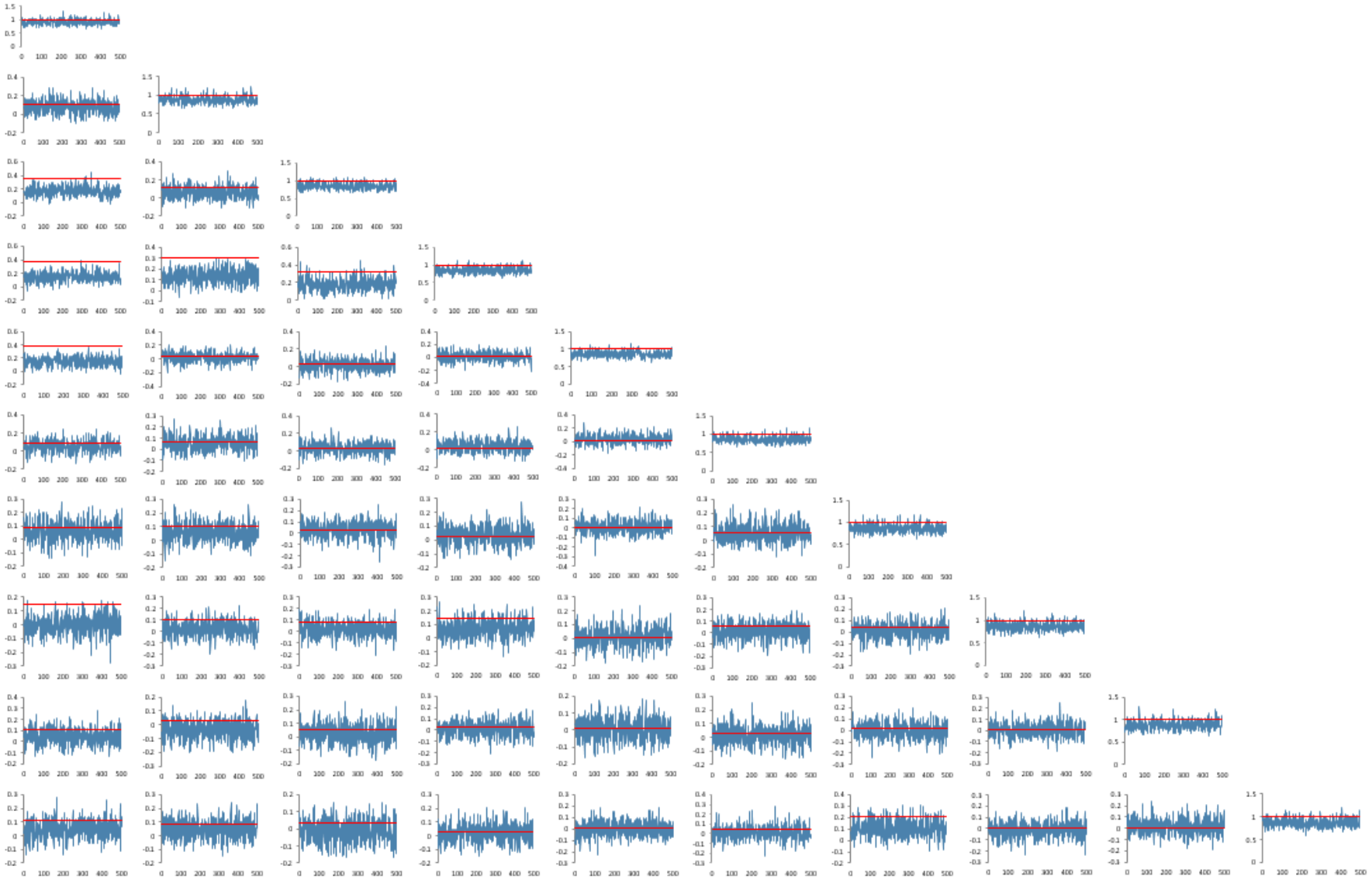
Appendix 2. Gibbs Sampler Output

Appendix Figure 1. Posterior Draws for Vector of VAR Coefficients θ



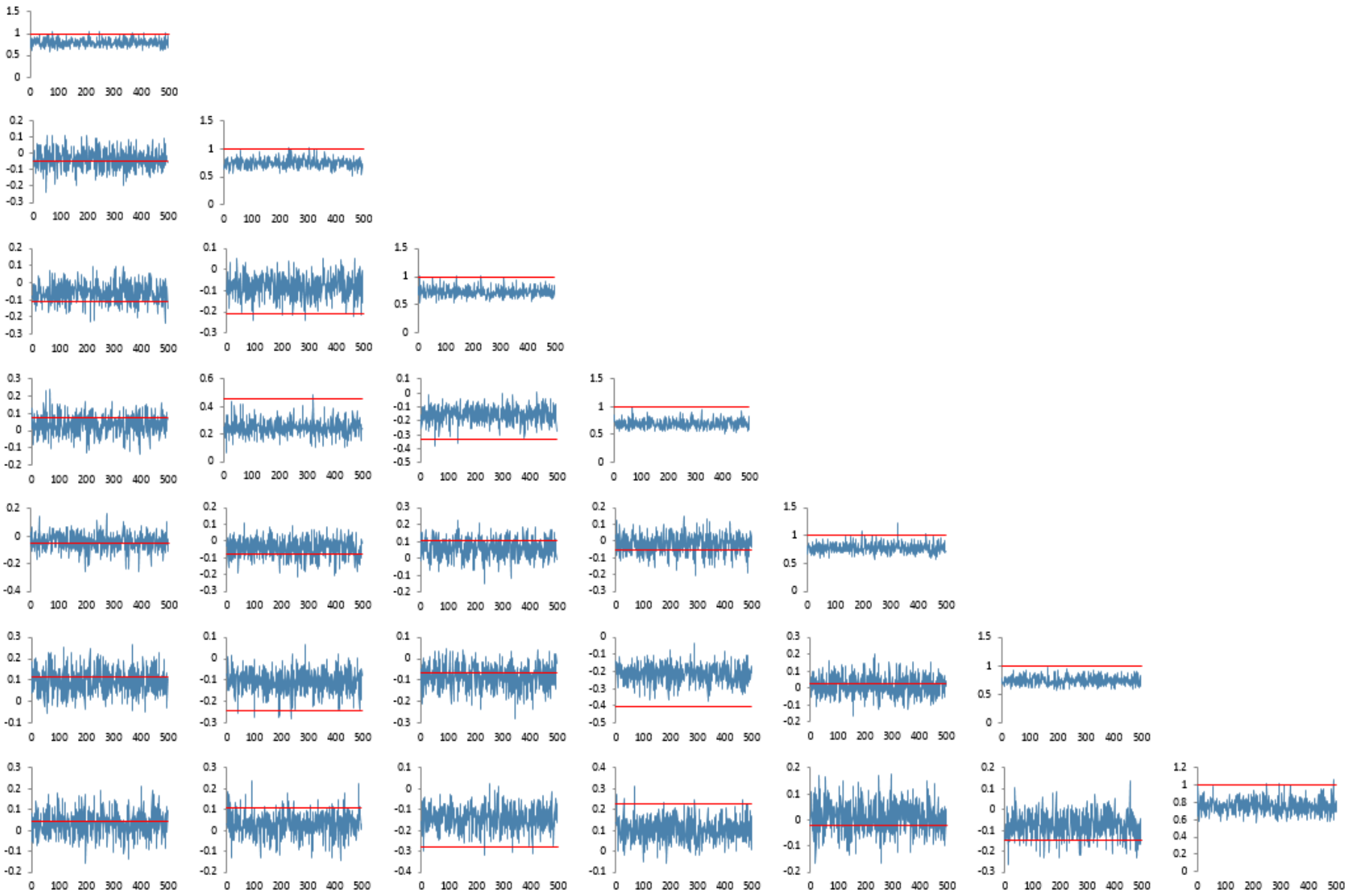
Note: Red line indicates initial value, posterior draws are in blue. The x-axis indicates the total number of posterior draws used for inference, in this case 500.

Appendix Figure 2. Posterior Draws for Country Covariance Matrix P



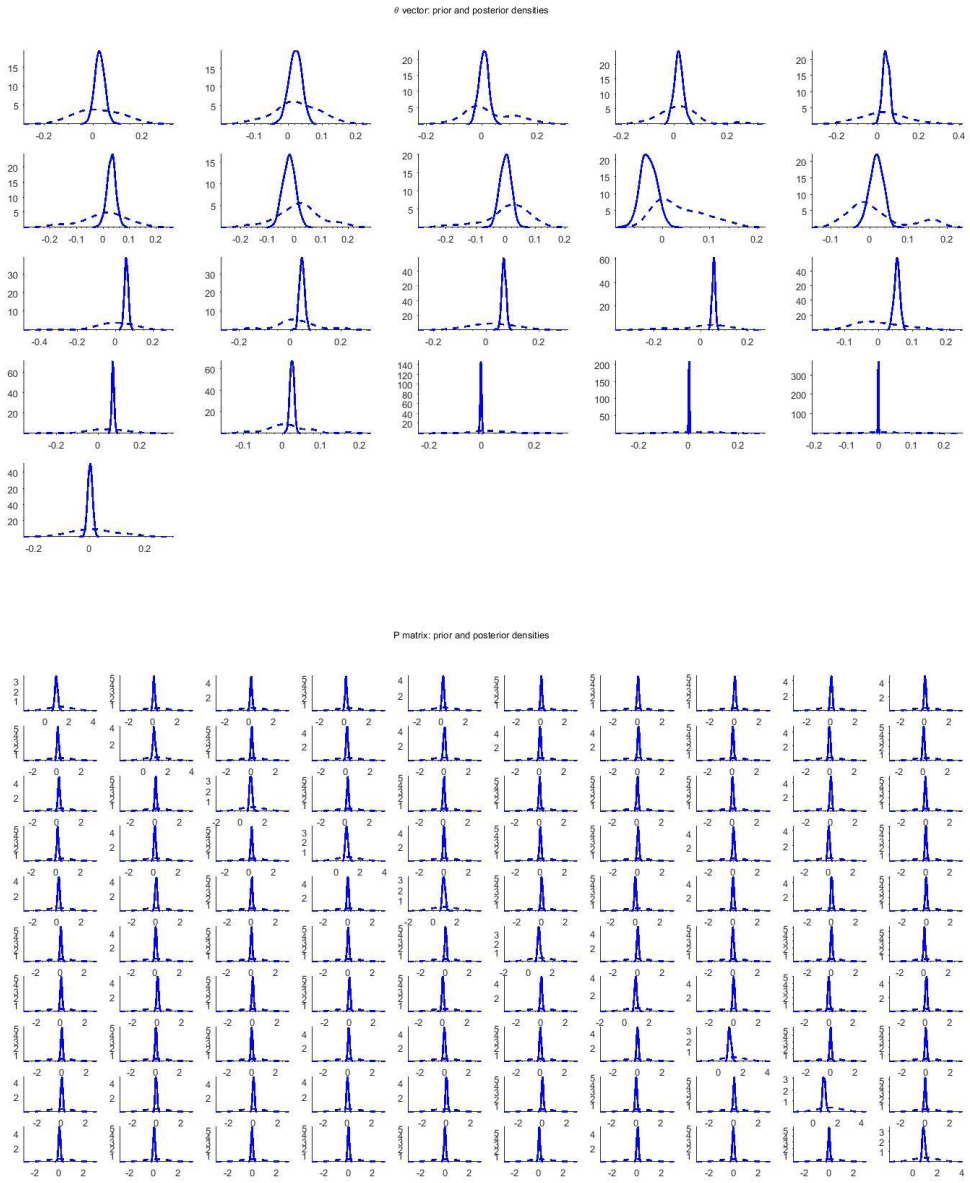
Note: Red line indicates initial value, posterior draws are in blue. The x-axis indicates the total number of posterior draws used for inference, in this case 500.

Appendix Figure 3. Posterior Draws for Series Covariance Matrix Ω



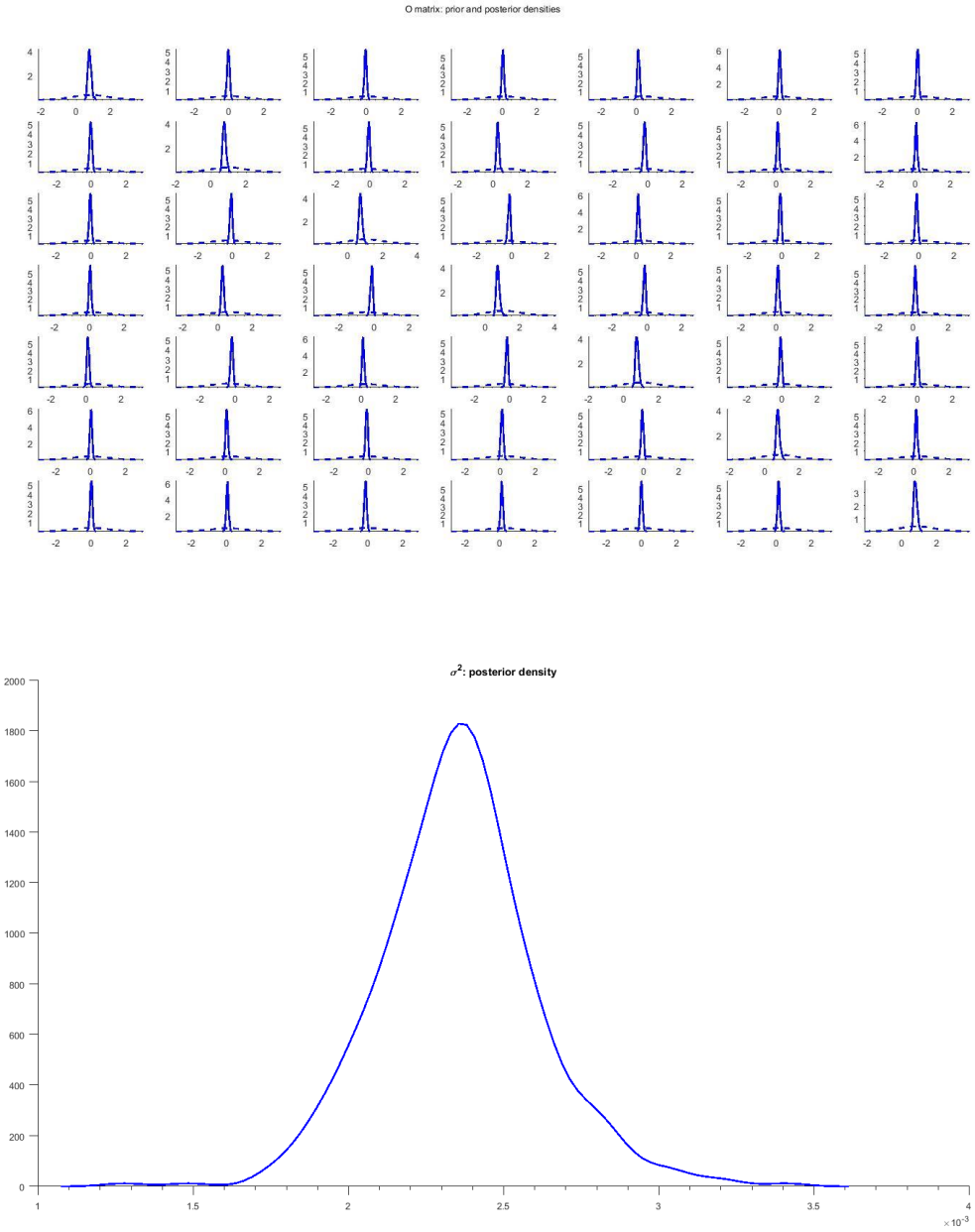
Note: Red line indicates initial value, posterior draws are in blue. The x-axis indicates the total number of posterior draws used for inference, in this case 500

Appendix Figure 4. Posterior Density Distribution for Vector of VAR Coefficients θ and Country Covariance Matrix P



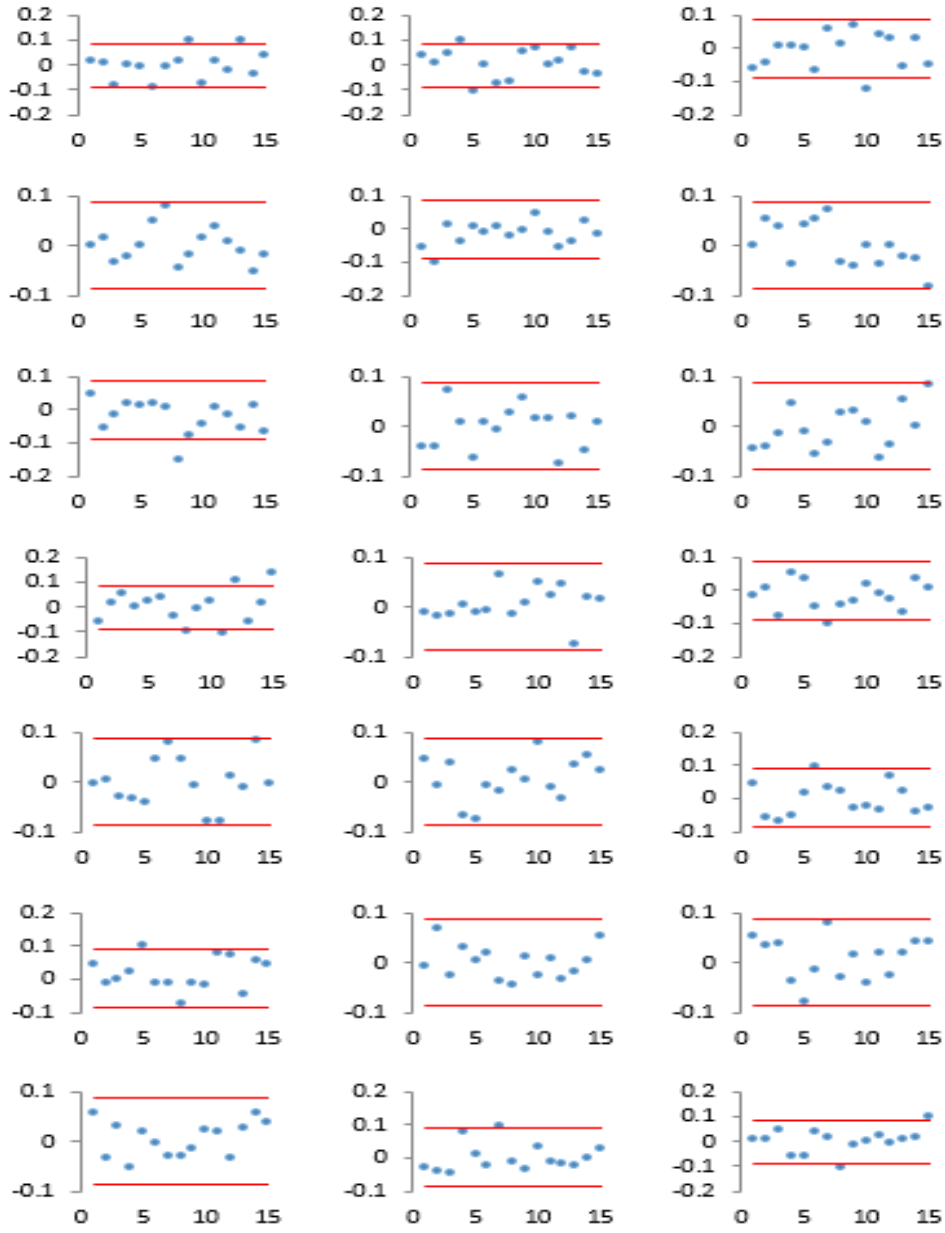
Note: Dashed lines denote the densities of prior distributions, while solid lines the densities of the posteriors.

Appendix Figure 5. Posterior Density Distribution for Series Covariance Matrix Ω and σ^2



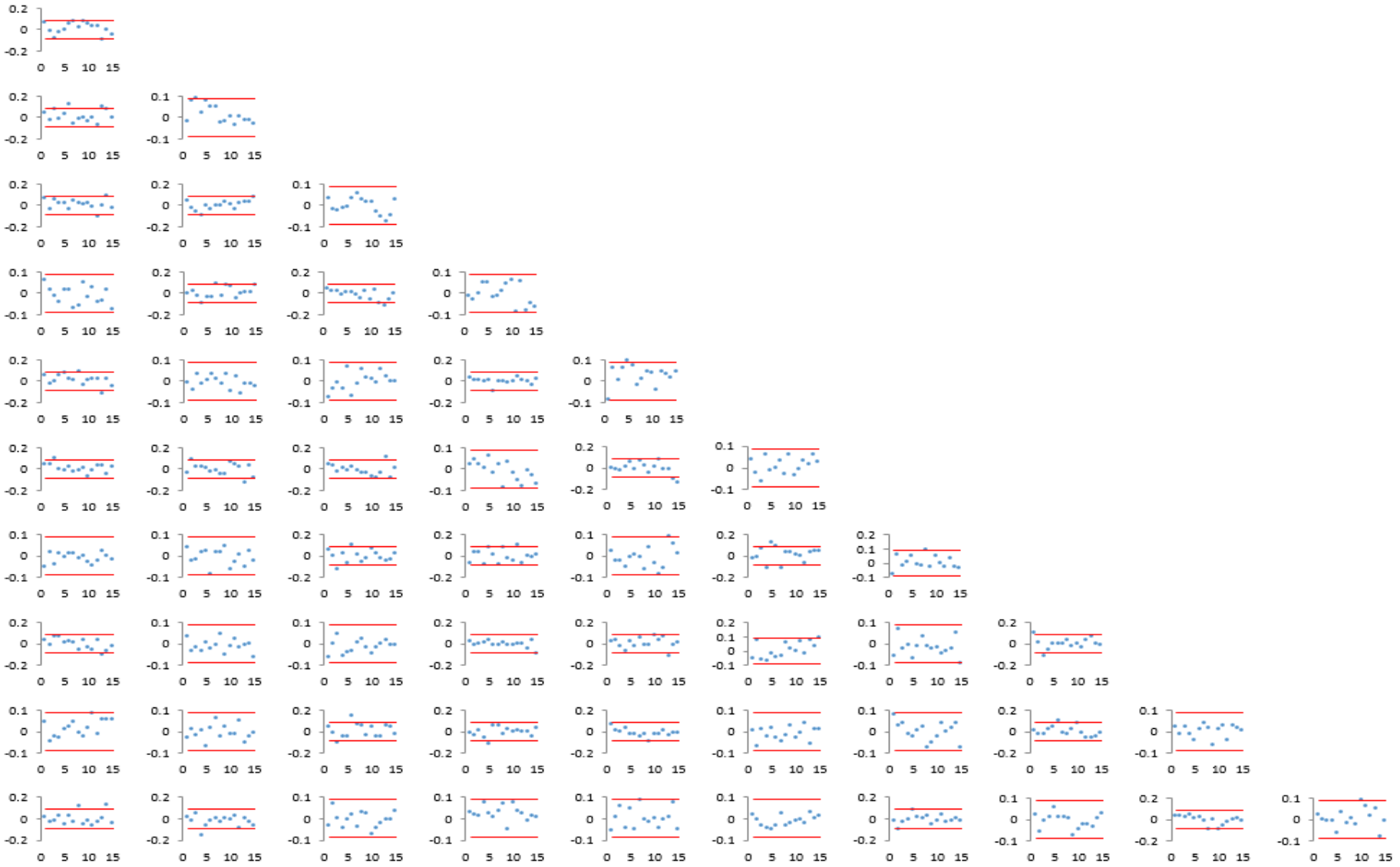
Note: Dashed lines denote the densities of prior distributions, while solid lines denote the densities of the posteriors.

Appendix Figure 6. Autocorrelation of Posterior Draws for Vector of VAR Coefficients θ



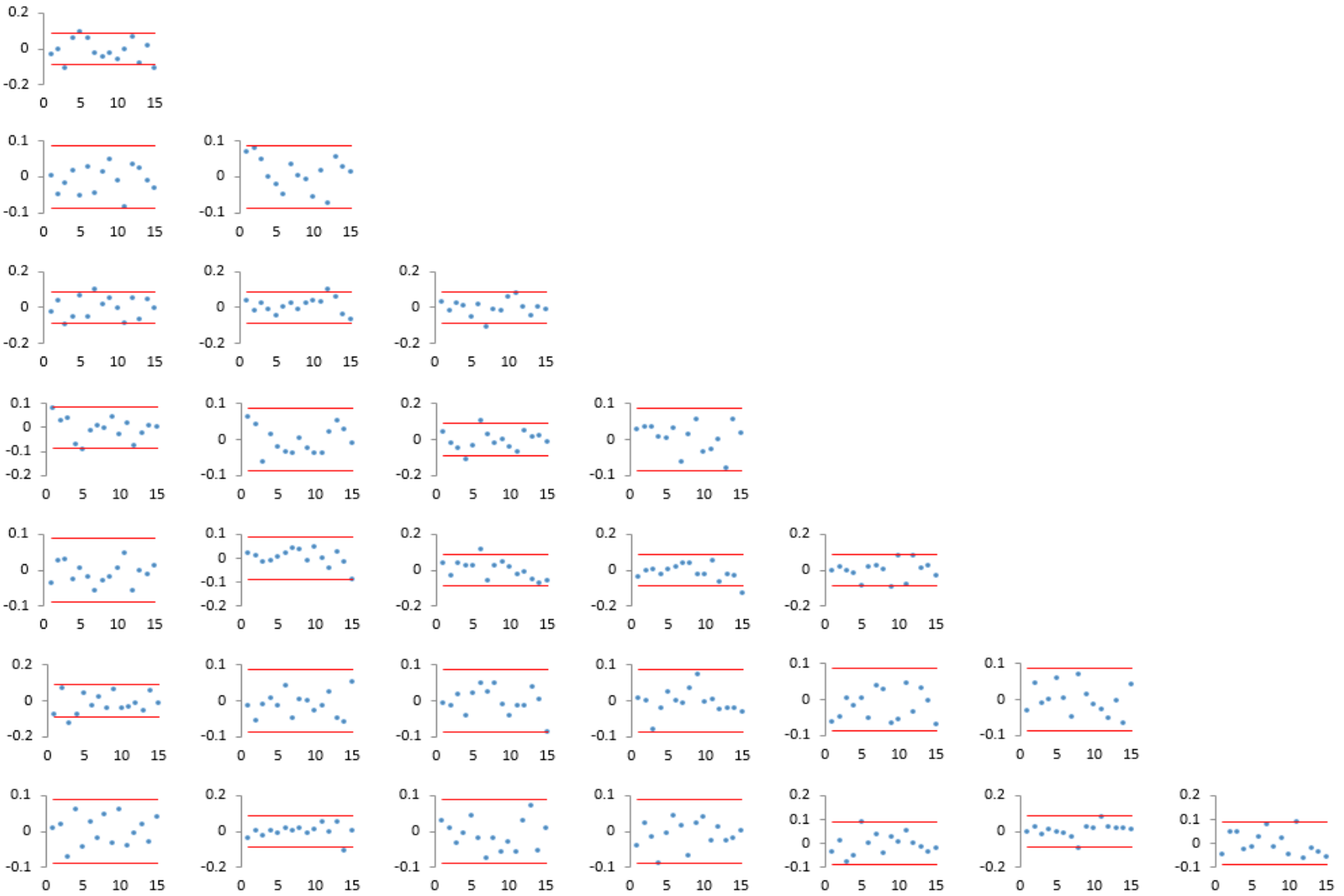
Note: Red lines denote 1.5 SD interval. Dots indicate serial correlation at a given lag (in quarters).

Appendix Figure 7. Autocorrelation of Posterior Draws for Country Covariance Matrix P



Note: Red lines denote 1.5 SD interval. Dots indicate serial correlation at a given lag (in quarters).

Appendix Figure 8. Autocorrelation of Posterior Draws for Series Covariance Matrix Ω



Note: Red lines denote 1.5 SD interval. Dots indicate serial correlation at a given lag (in quarters).

Appendix 3. Data Sources

Series name	Series code	Source
Population	XPOPT.P	Oxford Economics
GDP deflator	XPGDP.E / XPGDP.F	Oxford Economics
CPI	XCPI..E / XCPI..F	Oxford Economics
10-year government bond yield	GBOND.	Datastream
Short-term interest rate	XRSHR.R	Oxford Economics
REER	Q..RECE	IMF - International Financial Statistics
Nominal GDP	XGDP..B / XGDP..E	Oxford Economics
Government revenue	XGREV.A / XGREV.B	Oxford Economics
Government expenditure	XGEXB.A / XGEXB.B	Oxford Economics
Government consumption	XGCN..B	Oxford Economics
Government interest	XGDPI.A / XGDPI.B	Oxford Economics
Government debt	XGGDB.A / XGGDB.B	Oxford Economics
Government transfers	XGCGP.A / XGCGP.B	Oxford Economics
Current AB	XBCU..A / XBCU..B	Oxford Economics
Government investments	XGINV.C / XGINV.D	Oxford Economics
Exports	Q7D0EXA	IMF - Direction of Trade Statistics
Imports	Q7D1EXA	IMF - Direction of Trade Statistics
US FFR	USPRATE.	Reuters
EU short-term interest rate, next 6 month	EXIFIRSTR	World Economic Survey, IFO
OPEC Oil Basket Price U$/Bbl	OILOPEC	OPEC
Crude Oil Average Spot Price	HWWICGE	HWWI
Nominal world GDP	WDXGDP..A	Oxford Economics
World GDP, PPP	WDXGPP..A	Oxford Economics
EUR to USD exchange rate	EUDOLLR	Reuters