How would a fiscal shock in Germany affect other European countries? Evidence from a Bayesian GVAR model with sign restrictions

Markus Eller, Martin Feldkircher, Florian Huber¹ In this paper we analyze the international effects of a fiscal policy shock in Germany on other European countries. To that end we use a flexible version of a Bayesian global vector autoregression (GVAR) model and a dataset with broad country coverage comprising a wide range of macroeconomic and financial variables. Our results suggest a comparatively strong response in a majority of European economies to such a shock. In particular, we provide evidence that a deficit-financed expansionary government spending shock in Germany generates longlasting positive cross-border output spillovers. In the case of the euro area periphery and Central, Eastern and Southeastern (CESEE) economies, these effects may be transmitted via the financial channel since financial variables such as equity prices and private sector credit significantly increase in response to the assumed fiscal shock in Germany. Upward effects on consumer prices, by contrast, are limited to core euro area countries. When looking at the effects of an expansionary tax cut shock instead of those of a spending-driven fiscal shock, we identify cross-border output spillovers of a similar magnitude but with a lower degree of persistence; in the case of CESEE economies, these results are also characterized by more estimation uncertainty. Finally, we also provide evidence for considerable cross-country heterogeneity in fiscal spillovers; for instance within CESEE, output responses to a fiscal shock in Germany are strongest in Croatia, Hungary and Slovenia.

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The main intention of this paper is studying the transmission of fiscal shocks generated in key euro area countries to other euro area countries as well as countries located in Central, Eastern and Southeastern Europe (CESEE). Given the room for maneuver available for decentralized, discretionary fiscal policy actions in the euro area (despite some coordination of fiscal policies), we are not going to simulate a coordinated euro area-wide fiscal shock (as, for instance, Hebous and Zimmermann, 2013) but, instead, we will focus on Germany as it is the only country among the largest euro area members that is perceived as having some fiscal space at the moment (in line with the IMF, 2014, which does not see leeway for fiscal easing in other large euro area countries such as France, Italy or Spain). Given the size of the German economy and its pivotal role in Europe in terms of trade, FDI, cross-border banking and supply chains, we presume that any considerable discretionary fiscal expansion or contraction generated in Germany would have a non-negligible impact not only on other euro area countries but also on CESEE countries located outside the euro area.

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Several policy papers have recently commented that Germany could use the budgetary room of maneuver available under its fiscal rules, arising from buoyant government revenues among other factors, to finance additional public investment and growth-friendly structural reforms (IMF, 2016; OECD, 2016). Other European countries could potentially benefit from such a fiscal expansion in Germany if cross-country output spillovers were considerably positive. In our paper we do not want to give a recommendation whether Germany should eventually implement a fiscal stimulus or not. Still, considering the hypothetical situation of a fiscal shock in a large euro area economy with fiscal space, we are interested in studying the related cross-border spillovers using a flexible modeling approach that allows us to incorporate bilateral economic links and to take into account feedback loops in addition to spillover effects. More specifically, this paper presents a global vector autoregression (GVAR) model we have designed to cover nearly 30 countries worldwide over the period 1995–2015; based on this model, we study the impact of a fiscal shock generated in Germany on key macroeconomic variables in Germany itself and related spillovers to the other economies considered. As for the fiscal shock, we are going to distinguish two different policy scenarios: on the one hand, a deficit-financed expansionary government spending shock and, on the other hand, a deficit-financed expansionary tax cut shock. In the presentation of cross-border spillovers we will focus on cross-regional differences between euro area core countries, euro area periphery countries and CESEE economies. In addition, cross-country differences in the spillovers to CESEE economies are examined in detail.

The structure of this paper is as follows: Section 1 puts our approach into the context of the existing literature on international fiscal policy spillovers in Europe. In section 2, we introduce the key characteristics of our Bayesian GVAR model, including shock identification assumptions. Section 3 discusses the preparation of the data series. In section 4, we use impulse response analysis to investigate the impact of fiscal easing on a variety of macrofinancial variables at national and international level; section 5 concludes.

1 What do we know about the extent of international fiscal spillovers in Europe?

Up to the 2008 global financial crisis (GFC) there had been only rare empirical attempts to examine the transmission of a foreign fiscal shock to domestic macroeconomic variables in Europe (e.g., Beetsma et al., 2006). However, after the GFC, particularly at the peak of the European sovereign debt crisis of 2010–2012, the literature on cross-country fiscal spillovers in Europe began to grow rapidly.

Among the literature contributions that have come closest to addressing our research question are papers that have already examined fiscal policy spillovers from Germany to other euro area and/or CESEE economies. Existing simulations based on structural multi-country models suggest that cross-border spillovers of a fiscal shock generated in Germany are indeed non-negligible, but their extent varies across the chosen methodological frameworks and assumptions. For instance, the ECB (2014) provides evidence for comparatively small cross-border output spillovers within the euro area stemming from a fiscal consolidation shock generated in Germany: three years after the shock, totaling 1% of GDP, the cumulative negative spillover effect on the GDP of other euro area countries

reaches a maximum of 0.06% (namely for small euro area economies). Notably, if the shock were generated in another large euro area economy, the resulting spillovers would be smaller than in the case of Germany as the shock-originating country. Simulations based on a New Keynesian DSGE model by the European Commission (in 't Veld, 2013) point to more sizable spillover effects: a two-year increase in government investment in Germany totaling 1% of GDP increases real GDP in other euro area countries by between 0.2% and 0.3%. In a more recent paper, in 't Veld (2016) shows that an investment-based fiscal stimulus in euro area countries with current account surpluses would cause significantly positive GDP spillovers to the rest of the euro area; here, the type of monetary policy response is apparently decisive: spillovers are the largest when nominal interest rates are constrained at the zero interest rate floor. Blanchard et al. (2015), moreover, show that, if policy rates remain low for a prolonged period in the euro area, a fiscal expansion in euro area core economies would have a large and positive impact on GDP in euro area periphery countries. In a similar vein, Elekdag and Muir (2014) show that accommodative monetary policy would strengthen the expansionary impact of higher German public investment, both at the national level and in the rest of the euro area. Simulation results of the Deutsche Bundesbank (2016) also indicate that a deficit-financed expansion of public investment in Germany would stimulate output in other European economies, with larger spillovers for small euro area core and CESEE countries than for euro area periphery countries.²

Spillovers from a fiscal shock in Germany to CESEE countries have rarely been addressed so far. Besides the mentioned paper of the Deutsche Bundesbank (2016), to the best of our knowledge, only two more papers have done so: Crespo Cuaresma et al. (2011) study the transmission of a fiscal policy shock generated in Germany to key macroeconomic variables in five CESEE economies. They estimate an open-economy structural vector autoregressive model identified by imposing restrictions on contemporaneous responses. They find that an easing of the German fiscal balance yields positive output effects in Hungary and Poland, but negative ones in the Czech Republic, Slovakia and Slovenia (the latter apparently due to a stronger weight of the negative interest rate channel in comparison to the potentially positive trade and exchange rate channels). Elekdag and Muir (2013) use a DSGE framework to simulate fiscal spillovers from Germany to other euro area countries and four CESEE economies (Czech Republic, Hungary, Poland and Slovakia). According to their results, a debt-financed two-year increase in government consumption yields rather small, though positive, cross-border output spillovers. Notably, these spillovers have increased over time (as a reflection of strengthening trade linkages) and are larger for CESEE than for euro area economies.

In our paper, we add value to this CESEE-specific literature by employing a global VAR model for mainly two reasons. First, it allows us to incorporate bilateral economic links to study the worldwide propagation of a fiscal shock generated in Germany and to take into account related spillbacks and second-round effects. Modeling feedback loops in addition to spillovers seems essential since CESEE

² Nevertheless, this report is quite critical with regard to the implementation of a short-term fiscal stimulus in Germany, as such a stimulus would have a procyclical impact in the current situation of GDP growing close to its potential.

economies are not only strongly integrated with the euro area but also share strong economic ties among themselves (see also Fadejeva et al., 2017, who recently demonstrated the importance of second-round effects for CESEE regarding the propagation of international shocks). Second, the GVAR framework offers a compact representation of the world economy with a minimum of assumptions, while still offering the possibility for structural and economic analysis. This is in contrast to the structural multi-country models mentioned before, as these typically come along with a wide set of assumptions for which it is often not clear whether they equally hold for all countries considered.

So far, there are only a few papers that have already used a GVAR model to study fiscal cross-border spillovers in Europe. Caporale and Girardi (2013) investigate the response of long-term government bond yields in a given euro area country following a shock to the public debt-to-GDP ratio in another euro area member country. Their analysis is based on a sample of eleven euro area members over the period 1999–2010. They find that increasing public debt in Germany and France alleviates sovereign borrowing costs in the other euro area countries (via positive liquidity effects), while the opposite holds if government debt rises in euro area periphery countries (as in this case, apparently, country risk considerations are more important than liquidity effects). Similarly, Nickel and Vansteenkiste (2013) study the spillover of a government consumption shock to financial variables in the four largest euro area economies plus Sweden, the U.K., Japan and the U.S.A. over the period 1980–2008. In contrast to Caporale and Girardi (2013), they show that a fiscal expansion generated in Germany (or the U.S.A.) raises government bond yields elsewhere. Hebous and Zimmermann (2013) compare the output effects of national versus coordinated euro area-wide fiscal shocks (stemming from the budget balance or government investment spending) for twelve euro area economies in the years 1979-2009. According to their results, a euro area-wide fiscal shock has a larger impact on output than a national shock of similar size, pointing to the importance of coordinated fiscal measures within the euro area. A similar case for improved fiscal policy coordination at the level of the European Union (EU) is made by Ricci-Risquete and Ramajo-Hernández (2015), who distinguish between government spending and government revenue shocks. In a recent paper, Dragomirescu-Gaina and Philippas (2015) investigate the issue of fiscal policy discretion versus international fiscal policy coordination based on a sample of twelve EU countries for the period 1978–2013; they show that private international capital flows make domestic fiscal policies more responsive to foreign shocks.

With this study, we add to the existing fiscal GVAR literature in four ways: First, by means of sign restrictions we use a coherent identification strategy to pin down two different variants of deficit-driven fiscal shocks proposed in the literature (e.g., see Canova and Pappa, 2011, and Mountford and Uhlig, 2009). Second, we use a Bayesian version of the GVAR framework that features modern shrinkage priors and stochastic volatility, two features that are of great importance for modeling macro-time series (see, e.g., Huber and Feldkircher, 2017). Third, while the GVAR literature cited above mostly focuses on spillovers among selected EU Member States, our dataset is much broader, including countries from the CESEE region but also other major emerging and advanced economies such as the BRICs and the G-8 (offering a better representation of the world economy). Fourth, in comparison to the existing literature our dataset provides an extensive coverage of macroeconomic and financial variables, addressing a range of potential transmission channels. All data are up to date until end-2015, ensuring that most recent trends are accurately reflected in our analysis.

2 Econometric framework

In this section, we will summarize the key features of our model. After presenting the structure of our GVAR model in fairly general terms we will describe the prior specification adopted and the way structural fiscal shocks have been identified.

2.1 Bayesian GVAR with stochastic volatility

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Our model is based on the GVAR model put forth in Pesaran et al. (2004). The GVAR builds on a sequence of N+1 country-specific submodels that are combined to yield a global large-scale VAR model with parametric restrictions governed by a set of trade weights. We assume that for country *i*, *a* k_i -dimensional vector of macroeconomic time series x_{ij} follows a *VARX(p, q)* process,

$$\Phi_i (L_p) x_{it} = \Psi_i (L_q) x_{it}^* + \varepsilon_{it}, \qquad (1)$$

with $\Phi_i(L_p)$, $\Psi_i(L_q)$ being conformable lag polynomials of order p and q, respectively. The weakly exogenous variables x_{ii}^* are constructed by taking weighted averages of other countries' endogenous variables and ε_{ii} is a normally distributed vector white noise process with time-varying variances,

$$\varepsilon_{it} \sim N(0, \Sigma_{it}),$$

 $\Sigma_{it} = U_i H_{it} U_i'.$

Here, we let U_i be a lower uni-triangular matrix (i.e., lower triangular with unit diagonal) and H_{ii} is a diagonal matrix with typical diagonal elements $h_{ij,t}$ (*j*=1,..., k_i). We assume that the logarithm of $h_{ij,t}$ follows

$$og(h_{ij,i}) = \mu_{ij} + \rho_{ij} \left(log(h_{ij,i-1}) - \mu_{ij} \right) + \eta_{ij,i},$$
⁽²⁾

where μ_{ij} denotes the mean of the log-volatility, ρ_{ij} the persistence parameter, and η_{ijt} is a white noise error with fixed variance.

It is straightforward to show that the country-specific models can be connected using a suitable weighting matrix W_i of dimension $k \times k = \sum_{i=0}^{N} k_i$ to retrieve the global VAR representation of the model,

$$\Gamma(L_s) x_t = e_t. \tag{3}$$

The lag polynomial $\Gamma(L_s)$ is constructed as a nonlinear combination between the country-specific coefficients in equation (1) and the weights in W_i . The errors e_i are normally distributed with a full $k \times k$ variance-covariance matrix Σ_i . For more details on the derivations, see Huber (2016).

The country-specific models in equation (1) are heavily parameterized. In light of the limited length of our sample we thus adopt a Bayesian approach to shrink the parameter space toward a simpler model specification. By pursuing a two-step procedure (first estimating single country models and then combining them in a second step) the GVAR framework already exhibits a form of data reduction. Nevertheless, introducing another layer of discipline on the coefficients by using Bayesian shrinkage methods further improves the estimation of GVARs. This has been shown in Crespo Cuaresma et al. (2016) and Dovern et al. (2016); the latter also emphasize the importance of allowing residual variance to vary over time (i.e., stochastic volatility).

The prior framework adopted is closely related to the specification stipulated in Huber and Feldkircher (2017). Specifically, we impose a global-local shrinkage prior in the spirit of Griffin and Brown (2010) on the autoregressive coefficients of equation (1) and the covariance parameters in H_{ii} . This prior setup implies that each coefficient (i.e., autoregressive coefficient and covariance parameters) β_{ij} is a priori normally distributed with zero mean and a variance that depends on a global shrinkage parameter λ_i and a local scaling parameter τ_{ii} ,

$$\beta_{ij} \mid \tau_{ij} \sim N \bigg(0, \frac{2}{\lambda_i} \tau_{ij} \bigg), \ \tau_{ij} \sim Gamma \big(\vartheta_i, \, \vartheta_i \big), \ \lambda_i \sim Gamma \big(a_i, b_i \big),$$

with ϑ_i being a scalar hyperparameter that controls the excess kurtosis of the corresponding marginal prior and α_i , b_i controlling the overall degree of shrinkage on all coefficients. This prior specification provides a large degree of flexibility, allowing for non-zero regression coefficients in the presence of heavy global shrinkage induced by large values of λ_i . Regarding stochastic volatility, we use a Gamma(1/2,1/2) prior on the innovation variances of the log-volatilities, which translates into a standard normally distributed prior on the (signed) square root of the variance and thus allows for shrinkage toward zero. Hence, if the actual process was homoscedastic, our Bayesian setup would shrink actual variation in the log-volatilities toward zero (or equivalently push the full history of the logvolatilities toward the long-run unconditional mean) whereas if stochastic volatility was more appropriate we would allow for movements in the underlying latent processes.

Typically, Bayesian analysis relies on relatively few hyperparameters that determine the weight associated with the prior information introduced. In the present framework, which we borrow from Huber and Feldkircher (2017), we integrate out uncertainty with respect to the choice of the hyperparameters by imposing yet another layer of hierarchy and specifying a set of uninformative priors on these hyperparameters. This allows us to make the analysis more robust in this respect and to infer suitable hyperparameters for the broad range of countries included in the study. The corresponding MCMC algorithm iterates between sampling from well-known full conditional posterior distributions for all autoregressive coefficients and covariance parameters. The only exceptions are the full history of the log-volatilities, which are simulated by means of the algorithm outlined in Kastner and Frühwirth-Schnatter (2014). The algorithm has to be carried out N+1 times in parallel, rendering the estimation problem tractable.

2.2 Identification of structural fiscal shocks

In our GVAR model, we identify a fiscal policy shock via restrictions that are imposed on the signs of the impulse response functions. Sign restrictions have been frequently used to identify fiscal shocks in structural, single-country VAR settings (e.g., Caldara and Kamps, 2008; Candelon and Lieb, 2013; Canova and Pappa, 2011; Dungey and Fry, 2009; Mountford and Uhlig, 2009). Faccini et al. (2016) use sign restrictions to identify a government spending shock and impose them onto a regime-change factor model for the U.S.A. and its main trading partners to study the dynamic response of foreign output to unanticipated government purchases in the U.S.A. However, the few papers that study fiscal shocks in the context of a global VAR model have so far not drawn upon sign restrictions but have relied on narrative identification (Favero et al., 2011) or used generalized impulse response functions (GIRFs) as an alternative to structural identification (Caporale and Girardi, 2013; Dragomirescu-Gaina and Philippas, 2015; Hebous and Zimmermann, 2013; Nickel and Vansteenkiste, 2013; Ricci-Risquete and Ramajo-Hernández, 2015). GIRFs, however, fail to attach an economic interpretation to the origins of the shock.

Following Dees et al. (2007) and Feldkircher and Huber (2016), we apply structural shock identification locally to the country of shock origin, i.e., Germany, and the resulting spillovers are then studied for the whole system. Table 1 summarizes the applied sign restrictions. Note that restrictions are imposed on impact only. This represents a very weak approach to identification, ensuring that results are strongly data-driven as opposed to being overly shaped by assumptions³. As we are interested in fiscal shocks generated both on the spending and on the revenue side of the government budget, we distinguish between different policy scenarios. In our baseline results we apply the identification scheme of Canova and Pappa (2011) and use sign restrictions to identify a deficit-financed expansionary government spending shock (FP_1, top panel of table 1). Spending-driven fiscal easing (i.e., an increase in both government spending (*gspend*) and the inversely defined budget balance (gdef) translates into an increase in output (y), inflation (Dp) and the short-term interest rate (stir). As an alternative, we rely on Mountford and Uhlig (2009) and identify a deficit-financed expansionary tax cut (FP_2, bottom panel of table 1). This revenue-driven fiscal easing (i.e., a reduction in government revenues (*grev*) and an increase in *gdef*) is associated with the same responses of the other variables mentioned before. Along with each of these two different types of fiscal shocks, we further identify a monetary policy (MP) shock and an aggregate supply (AS) shock. Identifying additional shocks - and thus including more restrictions – should yield a stronger identification for the shock under consideration (Fry and Pagan, 2011; Paustian, 2007). Note that our sign restrictions are defined in a way that ensures the mutual exclusiveness of the three different shocks. When we resort to FP_2, we also impose a negative response of government revenues to a contractionary aggregate supply shock (mimicking Mountford and Uhlig, 2009). Finally, to cope with the issue of non-unique rotation matrices, we search for an orthonormal rotation matrix that fulfills the described sign restrictions using the algorithm outlined in Rubio-Ramírez et al. (2010) and

³ Fry and Pagan (2011) show that adding on sign restrictions for longer lags in the impulse responses does not necessarily provide stronger identifying information.

Applied sign restrictions								
Shock type/ endogenous variables		У	Dp	stir	rer	gspend	grev	gdef = (gspend – grev)/y
FP_1	Deficit-financed expansionary government spending shock	>0	>0	>0		>0		>0
MP	Monetary policy shock	<0	<0	>0				
AS	Aggregate supply shock	<0	>0	>0	>0		<0	
FP_2	Deficit-financed expansionary tax cut shock	>0	>0	>0			<0	>0
MP	Monetary policy shock	<0	<0	>0				
AS	Aggregate supply shock	<0	>0	>0	>0		<0	

choose the matrix that yields impulse responses that are closest to the median response (as proposed by Fry and Pagan, 2011).

Source: Authors' calculations.

Note: These constraints for the signs of the impulse response functions are imposed in the German country model on impact only. Shaded blue areas mark the equations in the system to which the shocks are applied.

3 Data

We use quarterly data spanning the period from Q1 1995 to Q4 2015 and a broad country set. The countries covered are eleven euro area countries (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain), ten CESEE economies (Bulgaria, the Czech Republic, Croatia, Hungary, Poland, Romania, Russia, Slovakia, Slovenia⁴ and Turkey), and large advanced and emerging international economies (the U.S.A., Canada, Great Britain and Japan, on the one hand, and Brazil, China, India and Mexico, on the other hand). For each country we have collected standard macroeconomic data on variables, such as real GDP (y), consumer price inflation (Dp), short and long-term interest rates (stir, ltir), real exchange rates vis-à-vis the U.S. dollar (rer) and real equity prices (*eq*), both deflated by consumer prices, and the stock of total private sector credit (tc). Following Fadejeva et al. (2017) we adjust data on total credit for foreign exchange rate movements for countries whose credit markets are characterized by large shares of foreign currency-denominated credit (i.e., all the ten CESEE countries mentioned before). With the exception of long-term interest rates, data are available with wide country coverage. Since local capital markets in emerging countries (e.g., in the CESEE region) are still developing, data on government yields are hardly available for these economies.

For the purposes of modeling the fiscal shock, the German model deviates from the rest of the sample in terms of variable inclusion. More specifically, we add government spending (gspend), the overall budget balance (gdef) and – in a robustness exercise – government revenues (grev) for Germany. There is a broad discussion in the literature whether different types of public expenditures and revenues have a different impact on economic output. This discussion is based on,

⁴ The grouping of countries is for illustration purposes only. Since we focus on spillovers to CESEE economies we have included Slovakia and Slovenia in the group of CESEE countries. Overall results for euro area countries are unaffected by this choice due to the two countries' comparably small economic significance in terms of purchasing power parities.

inter alia, endogenous growth theory that distinguishes between "productive" and "non-productive" public spending as well as "distortionary" and "non-distortionary" taxation and assigns a different long-run growth impact to these categories (see, e.g., Devarajan et al., 1996). To address these composition arguments, we use a narrow definition of government spending and taxation (in line with Perotti, 2004). We argue that public spending on goods and services has different effects than transfers: Only the former directly affects the use of resources by the private sector. Hence, our narrowly defined variable for government purchases of goods and services (*gspend*) consists of government consumption (compensation of public employees plus intermediate consumption) plus government investment (government gross fixed capital formation), while transfers (social benefits, social transfers in kind, subsidies) are subtracted from total government revenues to yield our variable for net taxes (grev). The inclusion of net taxes should capture the net impact on the private sector and is supported by the view that in the short and medium run fiscal policy operates mostly via the demand channel. The variable describing the overall government budget balance, *gdef*, is defined as *gspend* minus grev and expressed as a percentage of GDP. An increase in gdef can therefore be interpreted as fiscal easing.

The fiscal data we use are Eurostat data (quarterly non-financial accounts for general government). We work with quarterly ESA 1995 instead of ESA 2010 data because, for Germany, the latter are only available starting with 2002. Fiscal variables enter in real terms (nominal figures have been deflated by using the HICP) and in seasonally adjusted terms (based on the Tramo-Seats procedure). We do not explicitly exclude data outliers, such as a revenue peak caused by the sale of UMTS licenses in Germany in 2000; however, level variables are in logarithmic form and this should dampen the impact of data outliers.

Last, we use trade weights to capture cross-country linkages and to construct the weakly exogenous variables x_{ii}^* through which spillovers are transmitted. More specifically, we use average annual bilateral export and import flows of goods and services from the IMF's DOTS data base. Since we use a shrinkage prior on the coefficients we can include a broad set of foreign variables in each country model. More specifically, the set of foreign variables comprises all macroeconomic variables used in the model (y^* , Dp^* , stir*, ltir*, rer*, eq^* , tc^*) and the focal variable, Germany's government budget balance-to-GDP ratio (gdef*). This implies that we allow for a large range of potential transmission channels and let the data determine which of these channels are empirically relevant.

4 Results

In this section, we first discuss the domestic effects for Germany and then, in a second step, analyze cross-country spillovers from fiscal easing in Germany (both spending- and revenue-driven). All of the results presented below are based on 5,000 posterior draws after a burn-in phase of 5,000 draws and a thinning interval⁵ of 0.2. This leaves us with 1,000 posterior draws for inference. For each of these draws we look for 4 rotation matrices that fulfill the restrictions outlined in

⁵ In large-dimensional models, often a thinning interval is used to limit requirements regarding computer storage and computational speed proves convenient. In our case we "thin" the valid 5,000 posterior draws to obtain 1,000 final draws. These are then used to calculate impulse responses.

table 1 and choose the matrix that yields the impulse responses that are closest to the median impulse response given the 4 matrices.

4.1 Domestic responses in Germany

Chart 1 shows the domestic effects of a deficit-financed expansionary government spending shock. Impulse response functions for an increase in the government budget balance by one standard deviation are shown. The solid line in each panel corresponds to the posterior median, the shaded area represents the 50% credible set.⁶

First, we find that there is a certain amount of inertia in the conduct of discretionary fiscal policy as fiscal easing persists for several quarters after the shock. Real GDP responds in a typical hump-shaped way; the positive output response reaches its peak on impact and only gradually dies down. By contrast, consumer prices adjust more quickly, but effects are also positive and significant in the short term. To offset the increased demand for money on the back of the expansion in output/income, short- and long-term interest rates should pick up – the latter to a smaller extent. Chart 1 shows that short-term interest rates indeed increase, in particular in the short run (on impact), after which they adjust quickly. Long-term interest rates are not significantly affected. The increase in (short-term) interest rates coupled with an increase in prices deters external competitiveness as indicated by the negative (though statistically insignificant) short-term response of the real exchange rate. Responses of equity prices and total credit (not shown) are both fraught with estimation uncertainty. In general, however, the fiscal expansion triggers an increase in total credit and equity prices.⁷

Last, as a crude plausibility check of the validity of the fiscal shock, we show the structural error in the right bottom panel of chart 1. Positive (negative) spikes indicate periods of fiscal easing (tightening) in Germany. Several of them coincide with well-known episodes of discretionary fiscal stimulus measures⁸, most clearly the fiscal stimulus package implemented right after the global financial crisis of 2008.⁹

To add further confidence to our results we have benchmarked the implied fiscal multiplier against empirical estimates for Germany recently presented in the relevant literature. To this end we have run a robustness exercise, directly

⁶ The credible set is the Bayesian equivalent to a frequentist confidence interval and differs slightly in interpretation. In our case, it guarantees that 50% of possible values of the impulse response function fall into the region spanned by the credible set (assumption: random parameters, fixed bounds of the credible set). A 50% frequentist confidence interval, by contrast, would guarantee that 50% of possible confidence intervals contain the impulse response function (assumption: fixed parameter, random bounds of the confidence interval). Note that in smallscale vector autoregressions, such as one-country applications, more stringent intervals such as 68% or 95% are typically used. In multi-country applications and in the context of spillover analysis it is not uncommon to use the more generous 50% interval, though (see, e.g., the IMF's 2015 spillover report retrieved at www.imf.org/external/np/pp/eng/2015/060815.pdf and the reference to Almansour et al., 2015, therein).

⁷ In a robustness exercise, we have also estimated the GVAR model in such a way that the German budget balance does not directly enter into the other country models, excluding one potential spillover channel. Domestic responses for Germany are qualitatively very similar to those presented here.

⁸ Recall that Germany was subject to an excessive deficit procedure (according to Art. 126 of the Treaty on the Functioning of the European Union) during the periods 2002–2007 and 2009–2012.

⁹ According to the European Commission (2009), the cumulative 2009–2010 net effect of the German fiscal stimulus package is estimated to amount to 1.9% of GDP as recorded in 2008 (with revenue-decreasing effects outweighing expenditure-increasing ones, and about 70% of the stimulus occurring in 2009 and the rest in 2010).

Chart 1

Deficit-financed government spending shock in Germany: domestic responses and structural error



Budget balance



Short-term interest rates



















Source: Authors' calculations.

Note: Responses to an increase in Germany's government budget deficit (% of GDP) by one standard deviation. The shaded area in each panel corresponds to the 50% credible set; the median is represented by a solid blue line. A real exchange rate increase implies a gain in competitiveness against the U.S. dollar. The bottom panel on the right-hand side shows the posterior median of the structural error.

shocking government spending (by one standard deviation) instead of the fiscal deficit variable. The resulting impact multiplier is about ½ and thus well in the range of German multipliers reported in Berg (2014), who uses a time-varying vector autoregressive approach. Note also that a multiplier smaller than unity is not uncommon in an open economy model, since part of the additionally generated demand boosts demand abroad through imports.

4.2 Cross-border spillovers

So far, we have established that a spending-driven fiscal expansion boosts real GDP in Germany. Naturally, a part of the generated demand should spill over to neighboring countries through the trade and the financial channels. We capture spillovers via the first channel by including the real exchange rate and effects that are transmitted through the financial channel by incorporating interest rates, equity prices and private sector credit developments. In the context of fiscal spillovers, there might be a third channel at work, i.e., the "sovereign-risk channel" – a notion that reflects the idea that after a fiscal expansion confidence in the sustainability of a country's fiscal policy deteriorates, which in the longer term might dampen positive effects on output. Following ECB (2014), our empirical analysis does not model confidence effects other than the direct impact on long-term financing conditions. Depending on economic interlinkages, spillovers might differ considerably. To get a first overall impression of the international effects of a fiscal expansion in Germany we provide regional results for euro area core countries bar Germany (Austria, Belgium, Finland, France and the Netherlands), euro area periphery countries (Greece, Ireland, Italy, Portugal and Spain) and the group of 10 CESEE economies mentioned earlier. Regional aggregates are based on purchasing power parities. Distinguishing between effects in euro area core and periphery countries might be instructive in terms of better understanding cross-country differences in spillovers to CESEE economies. Consequently, charts 2 and 3 show spillovers within the euro area on the left-hand side (in blue for core and in orange for periphery countries) and spillovers to CESEE countries on the right-hand side.

Output spillovers from the German fiscal expansion to all three regions are positive and rather persistent. More specifically, responses in euro area core countries are significantly positive throughout the forecast horizon, while responses for CESEE economies and euro area periphery states are fraught with some estimation uncertainty in the short run (up to six quarters). This suggests that the 0.14% impact increase in German output needs time to affect international output in euro area periphery and CESEE economies. Indeed, in the longer term the effect on output is very similar in euro area core and periphery countries (about 0.06%) and even slightly stronger in the CESEE region (about 0.08%). In all three regions, output responses peak after about 14 quarters and then start to decline slowly.

Spillovers to consumer prices show a more diverse pattern across the three regions. While prices in euro area core countries show an immediate increase after the fiscal expansion, they respond more gradually in the periphery and CESEE economies. In the latter two groups, effects are also accompanied by wide credible sets. For euro area core countries, by contrast, the German fiscal stimulus translates into a significant and persistent price increase (up to 12 quarters).

Deficit-financed government spending shock in Germany: international spillovers (part 1)



Consumer prices



Short-term interest rates



Long-term interest rates





Consumer prices

CESEE



Short-term interest rates



Long-term interest rates



Source: Authors' calculations.

Note: Responses to an increase in Germany's government budget deficit (% of GDP) by one standard deviation. The solid lines represent median responses; the shaded areas and the areas between the dotted lines represent 50% credible sets; aggregation to regional figures based on purchasing power parities. Data on CESEE long-term interest rates were only available for Bulgaria.

Chart 2

Naturally, responses of short-term interest rates are very similar for core and periphery euro area countries. They are increased in order to absorb excess money demand stemming from the rise in economic activity (though credible sets are rather wide in this case). It could be argued that this endogenous response of monetary policy predicted from the model, while plausible from a macroeconomic point of view, does not take into account the current economic environment of ultra-low or negative interest rates. A fiscal expansion accompanied by accommodative monetary policy (i.e., no endogenous rate increase) would thus likely yield even stronger effects on output than presented here (see, e.g., in 't Veld, 2016, or Elekdag and Muir, 2014). The increase in short-term interest rates is passed on to the longer end of the yield curve but not completely. In fact, effects on long-term interest rates are modest, for both periphery and core countries. This somewhat contrasts with findings of Nickel and Vansteenkiste (2013), who report strong positive reactions of bond yields in the euro area in the wake of a German fiscal expansion. Short-term interest rates in CESEE respond negatively in the short term but not significantly so. In contrast to results for euro area countries, spillovers to Bulgarian long-term yields are significantly positive in the short run (no data available for the remaining CESEE economies).

Next, we look at the impact on real exchange rates. The increase in prices coupled with a rise in interest rates should deter external competitiveness, which is reflected in a decrease in real exchange rates against the U.S. dollar. Given the smaller reaction of prices in the euro area periphery compared to core countries, the decrease in real exchange rates is slightly stronger in the latter. Real exchange rates also appreciate in the CESEE region. However, since these economies pursue strongly different forms of exchange rate regimes, overall responses might be too crude to provide a detailed assessment. This is mirrored by wide credible sets throughout the horizon of the impulse response function.

Last, we look at spillovers to financial variables, namely real equity prices and total credit. Tobin (1969) highlights the importance of equity prices as the linkage between the real and the financial sector of the economy. From a theoretical point of view and in the context of fiscal spillovers, the impact on equity prices is ambiguous. On the one hand, a fiscal expansion might increase country-specific risk premia and hence uncertainty for investors, ultimately leading to a decrease in stock prices. On the other hand, Keynesian effects should boost consumption and growth, leading to higher equity prices (Nickel and Vansteenkiste, 2013). Which of these arguments plays the more important role remains an empirical question. Nickel and Vansteenkiste (2013) find sizable spillovers from a German fiscal expansion to stock prices in other euro area countries. Here, we generally corroborate the importance of equity prices as a transmission channel. This importance is particularly evident when we consider periphery and CESEE countries, for which we find strong, positive and significant effects on equity prices. We do also find positive effects for euro area core countries, but the credible sets are much wider. The economic expansion in Germany also drives up total credit but not significantly so. Similar to the responses of equity prices, the median effects on total credit observed for periphery and CESEE countries exceed those for euro area core countries.



Real equity prices





CESEE Real exchange rate against the U.S. dollar %







Source: Authors' calculations.

Note: Responses to an increase in Germany's government budget deficit (% of GDP) by one standard deviation. The solid lines represent median responses; the shaded areas and the areas between the dotted lines represent 50% credible sets; aggregation to regional figures based on purchasing power parities. A real exchange rate increase implies a gain in competitiveness against the U.S. dollar.

Chart 3

Summing up, we find that a spending-driven fiscal expansion¹⁰ in Germany produces positive and significant cross-border spillovers to output. Consumer prices increase in euro area core countries, while there is no evidence of significant spillovers to inflation in CESEE and euro area periphery prices in the data. Within the euro area, short- and long-term rates tend to increase in the long run and consequently the real exchange rate appreciates. Also, the economic expansion drives up total credit and real equity prices. These effects, however, are fraught with estimation uncertainty. Real equity prices in the euro area periphery and CESEE countries show a clearer reaction. They increase rather persistently and significantly up to 12 quarters after the shock. Taken at face value, our results thus reveal that both, the trade and the financial channel seem to play a role in shock transmission, the first via an appreciation of the real exchange rate and the second via an increase in equity prices. The positive response of equity prices might indicate that wealth effects play an important additional role in providing stimulus to overall GDP growth.

4.3 Spillovers to CESEE - a mixed picture

In this section we investigate cross-country differences in the extent of spillovers to CESEE economies. For that purpose we look at posterior median peak effects of spillovers together with the accompanying 50% credible sets. These are depicted in chart 4. Note that the timing of the peak responses typically differs strongly between the country where the shock originates (i.e., Germany) and spillover-receiving countries. In the shock-originating country, peak effects typically coincide with immediate responses, while for the spillover-receiving countries they occur in the medium to long term (about 10 quarters). It is also important to stress that the size of peak effects might be explained by several factors besides direct trade linkages to the country of shock origin. For example, Fadejeva et al. (2017) assess the importance of second-round effects for particular CESEE economies. Other determinants of the size of spillovers might relate to macroeconomic vulnerabilities, the exchange rate regime or capital account restrictions (Crespo Cuaresma et al., 2016).

Peak effects of spillovers to CESEE economies are positive and significant for all countries covered. Looking at the strength of spillovers, peak effects on output are close to the domestic effects observed for Germany in Slovenia, and are even slightly stronger in Croatia and Hungary. They are also pronounced for the Czech Republic and Slovakia, on the one hand, and Russia and Turkey, on the other hand (about two-thirds of the German stimulus). While spillovers to real GDP are significantly positive, estimation uncertainty precludes a cross-country differentiation of the magnitudes of these effects. This can be seen by overlapping the credible sets for all countries. Peak effects on consumer prices are most pronounced in

¹⁰ Picking up the focus on public investment put forward in the papers referenced in the introduction, we conduct a robustness exercise to decompose our narrowly defined government spending measure into its two components, i.e., government consumption and government investment. When we use government investment instead of total government spending, we get domestic responses and cross-border spillovers which are even larger, more persistent and fraught with less estimation uncertainty. For instance, median peak output responses to the public investment-driven fiscal shock are about 0.21% in Germany, about 0.14% in the examined euro area countries and a bit more than 0.15% in CESEE. When we use government consumption instead, the responses are very similar to those presented for total government spending (not surprisingly so, given that government consumption accounts for about 85% of total government spending). All these results are available from the authors upon request.

Chart 4





Short-term interest rates





Peak effects 0.60 0.40 0.20 0.00 -0.20 -0.40 -0.60 -0.80 -1.00 DE Core Per. SK SL CZ HU PL BG RO HR RU TR

Total credit



Source: Authors' calculations.

Note: The panels show posterior median peak effects with surrounding 50% credible sets in response to an increase in Germany's government budget deficit (% of GDP) by one standard deviation. Peak effects of the real exchange rate refer to minimum effects (i.e., appreciation/loss of external competitiveness vis-à-vis the U.S. dollar.



Long-term interest rates





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Germany; the stimulus to prices in the other examined euro area core countries is already about three times smaller but still precisely estimated, while price rises in euro area periphery countries are estimated with a considerable margin of error. By contrast, prices in Romania and Turkey increase significantly and peak effects are even close to German domestic effects. Both countries have historically witnessed prolonged periods of high rates of inflation, which might account for the strong impact on consumer prices in these economies. Consumer prices also increase significantly in the Czech Republic and Slovenia, but to a smaller degree. With the exception of Croatia, peak effects of short-term interest rates are insignificant, while long-term interest rates in Bulgaria increase. The increase in short-term interest rates coupled with the rise in consumer prices erodes external competitiveness against the U.S. dollar in Germany, mirrored in a negative peak effect in the real exchange rate. These effects are, however, surrounded with large credible sets. Real exchange rates appreciate in the CESEE region as well, significantly so in Poland (which has already allowed its currency to adjust freely in the past), Bulgaria (response similar to the euro area given its currency board against the euro), Croatia and Romania. Real exchange rate movements are the smallest in the Czech Republic, implying a modest loss in external competitiveness only. This result might reflect the decision by the Czech National Bank (CNB) to use foreign exchange interventions to prevent a too strong appreciation of the Czech koruna against the euro.¹¹ Whereas the increase in aggregate demand drives up real equity prices in Germany and the euro area, peak effects are only significantly positive for the euro area periphery countries. By contrast, spillovers to CESEE economies are positive throughout the region and mostly significantly so. Significant peak effects of private sector credit are most pronounced for Poland and Slovenia, amounting to about 5 times the domestic response of credit in Germany. Larger spillovers relative to domestic credit effects have also been recently documented in Fadejeva et al. (2017), where this finding is attributed to the region's high degree of economic and financial integration with the euro area, structural features of the economies and boom-bust cycles during a large part of the time period under study.

Summing up, we find cross-country differences in the extent of spillovers from a German expansionary spending-driven fiscal shock. In terms of output, peak effects are particularly strong for Croatia, Hungary and Slovenia. For Slovenia and Croatia, strong responses to foreign shocks that originate in the euro area in general have been demonstrated in the empirical literature (see, e.g., Fadejeva et al., 2017, for Slovenia, and Krznar and Kunovac, 2010, and Feldkircher, 2015, for Croatia). As mentioned above, other macroeconomic country characteristics might account for the size of spillovers as well. The impact on inflation is strongest in countries that witnessed prolonged periods of high inflation during our sample period (e.g., Romania and Turkey). Also equity prices in CESEE show pronounced positive peak effects in response to the fiscal expansion in Germany. The same holds true for total credit, especially in Slovenia, Poland and Hungary.

¹¹ More specifically, the CNB decided in autumn 2012 to use the exchange rate as a monetary policy instrument and commenced foreign exchange interventions a year later with the aim of not letting the Czech koruna appreciate well above CZK 27 per euro. For more details see: https://www.cnb.cz/en/faq/the_exchange_rate_as_mone-tary_policy_instrument.html#2.

4.4 Do effects vary if the fiscal stimulus comes from a tax cut?

In this section we follow Mountford and Uhlig (2009) and identify a deficitfinanced expansionary tax cut shock. As opposed to spending-driven fiscal easing, here, the fiscal stimulus comes from a reduction in net taxes rather than an increase in government spending. The restrictions applied to pin down the shock are outlined in table 1, bottom panel (restrictions on the aggregate supply and monetary policy shock remain unaltered). This fiscal shock generated on the revenue side could potentially lead to different responses in the country of shock origin, i.e., Germany, compared to the expenditure-driven shock, which ultimately might trigger different spillovers. Selected responses in Germany and spillovers to the euro area and the CESEE region are depicted in chart 5.

The top panels show domestic responses to the shock. First, the fiscal deficit increases in parallel with a decline in revenues. The effect on both fiscal variables is significant up until 4 quarters after the shock. Compared to the spending-driven fiscal shock, the impact on real GDP is similar in size but only significant up to 2 quarters after the shock. These results imply less fiscal inertia and a more temporary output impact of a revenue-driven fiscal shock, corroborating Abbas et al. (2010), who documented a longer-lasting impact of spending-driven fiscal shocks (consolidation measures in this case), or the IMF (2012), which showed that cumulated first-year fiscal multipliers are larger for an increase in government spending than for a reduction of government revenues.

The effect on the remaining variables is very similar as in the case of the spending-driven fiscal easing shock; detailed results are available from the authors upon request. The bottom panel of chart 5 shows selected international effects of the fiscal shock. Real output increases significantly in core and periphery euro area countries up until 10 quarters after the shock, while estimation uncertainty attached to overall spillovers to CESEE economies is considerable. This is in contrast to the results for the spending-driven fiscal shock, which generated longer-lasting spillovers to output in CESEE.¹²

The remaining international effects are very similar to those described in section 4.2. Notably, effects driven by both shocks are highly correlated and range from 0.92% (euro area core countries) to 0.98% (euro area periphery).

¹² Naturally, this result does not hold for all CESEE countries to the same extent. More specifically, output increases significantly in Croatia and Slovenia (in the long run) and Hungary (in the short run) in response to the deficitfinanced expansionary tax cut shock.

Chart 5

Deficit-financed tax cut shock in Germany: selected domestic responses and international spillovers



Government revenues



Budget balance





%



Consumer prices







Spillovers to CESEE Real GDP



Consumer prices



Source: Authors' calculations.

Note: Responses to an increase in Germany's government budget deficit (% of GDP) by one standard deviation, driven by a cut of net taxes. The top four panels show selected domestic responses in Germany, the bottom four, selected responses for euro area countries and CESEE. The solid lines represent median responses; the shaded areas and the areas between the dotted lines represent 50% credible sets; aggregation to regional figures based on purchasing power parities.

5 Conclusions

Using a GVAR model with broad coverage of macrofinancial time series for 29 countries over the period 1995–2015 allows us to incorporate bilateral economic links and to explicitly take into account the second-round effects of a foreign fiscal shock. This seems to be paramount considering small open economies in Europe that not only tend to share strong trade ties within Europe, but are more generally integrated with a wide range of global trading partners. Our econometric framework is a Bayesian version of the GVAR that uses shrinkage priors on the coefficients and stochastic volatility. These features have recently been demonstrated to be of great importance for empirical macro-modeling in a VAR framework (Huber and Feldkircher, 2017).

Our main finding is that, in a majority of European economies, macroeconomic and financial variables show a comparatively strong response to a fiscal shock generated in a core economic partner country -i.e., Germany. In particular, we provide evidence for long-lasting positive cross-border *output* spillovers generated by a deficit-financed expansionary government spending shock in Germany. To be more specific, concerning the implied fiscal multiplier, a 1% increase in government spending would increase output in Germany by about 0.5%. About one-tenth of the generated stimulus is immediately transmitted to other euro area countries. In the longer term, however, the effect on output would be very similar among euro area countries (about half of the initial effect in Germany), and even slightly higher in the CESEE region (about two-thirds of the initial effect observed in Germany) – corroborating the findings of the Deutsche Bundesbank (2016) and Elekdag and Muir (2013), who also found that output in CESEE often responds more strongly to a government spending shock in Germany than output in euro area economies. Cross-border output spillovers from a deficitfinanced expansionary tax cut shock are qualitatively similar to those from the spending-driven fiscal shock, but are in general more short-lived and characterized by more estimation uncertainty in the case of CESEE economies.

As regards the cross-border spillovers to other macrofinancial variables, again some notable regional differences emerge from our analysis. As a result of fiscal easing in Germany, a significant upward impact on price levels can only be observed in the short run for the euro area core countries. In the euro area periphery and CESEE economies, on the other hand, equity prices are driven up markedly and persistently, exceeding the responses of euro area core countries by a great margin. The same holds for total private sector credit, though overall responses are not statistically significant in this case. These responses of financial variables point to a prominent role of the financial channel in transmitting a foreign fiscal shock to national output in euro area periphery and CESEE economies.

While we have just highlighted differences in our results across the three examined country groups, there is also notable heterogeneity within these country groups. For instance in CESEE, spillovers to output are particularly strong in Croatia, Hungary and Slovenia; in these three countries, the peak output response is even larger than in the country of shock origin, Germany. Larger foreign than domestic effects are not uncommon in the GVAR literature, reminding us that explicitly taking into account second-round effects may reveal larger-scale responses; their consideration is thus important when studying the propagation of international shocks. A country's macrofinancial track record apparently matters in this context: e.g., countries that have experienced prolonged periods of high inflation or pronounced credit booms in the past seem to be those whose respective price and financial variables respond more strongly to a foreign fiscal shock. A closer look at the sources of cross-country heterogeneity in fiscal spillovers is certainly an important area for future research.

In terms of policy implications, it is worth distinguishing between desired and undesired international fiscal spillovers. On the one hand, we saw that output effects from a hypothetical fiscal expansion in a key euro area country are substantially positive and long-lasting, both for the country itself and for other countries it has ties with (incorporating also spillbacks). On the other hand, we also saw that prices and financial variables respond markedly in several countries, rendering it potentially more difficult to deal with already existing macrofinancial imbalances. Also procyclicality could be a point of concern if an economy is already growing close to its potential. All in all, our results would be supportive of improving the coordination of fiscal policies in Europe. This also appears important in the current situation of monetary policy operating at the zero lower bound in most European countries.

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