Abstract

This paper identifies shocks to the German government spending in a Bayesian VAR model using sign restrictions to estimate the country-specific spillover effects of a German fiscal expansion on 15 European economies. The paper finds that an increase in German government spending depreciates German real exchange rate and deteriorates German trade balance. The trade balance deterioration is driven by a quick build-up in imports demand, which suggests some degree of cross-border spillovers. On impact, a one percent GDP increase in German government spending is associated with about 0.5% increase in the output of non-GIIPS Euro countries, but crowds-out the output of GIIPS countries by about 0.5%. The international fiscal multiplier effects on the output of non-Euro countries exhibit some degrees of heterogeneity, ranging from 0% for the UK and Norway to 0.5% for Denmark on impact. In the long run, German government spending has a positive spillover effect only on French output. There is also significant heterogeneity in the dynamic responses of bilateral real exchange rates across different groups of countries.

Key words: Fiscal Policy; Cross-border Spillovers; Structural VARs; Sign Restrictions

JEL classification: E62, F41, F42.
1 Introduction

Events of the last decade have shown that fiscal policy has regained traction in macroeconomic discourse, as discretionary fiscal measures are widely adopted as stabilization tools in many developed and emerging economies.\footnote{Following the recent financial crisis, the United States government enacted and implemented a sizeable fiscal stimulus package, the American Recovery and Reinvestment Act (ARRA), to aid the recovery of the US economy. Similarly, the European Union commissioned the European Economic Recovery Plan (EERP) aimed at stimulating the recovery of European economies from the effects of the financial crisis. Several studies have attempted to quantify the effect of ARRA stimulus on output and employment. For instance, Romer & Bernstein (2009) estimate that, by 2010:Q4, the ARRA should increase output by 3.7% while jobs should increase by 3,675,000. Wilson (2012) quantifies the job-multiplier effect of the ARRA stimulus to be about $125,000 per job, while Feyrer & Sacerdote (2011) estimate the per-job cost to be about $170,000 or $100,000 when education spending is excluded. Across the Atlantic, Coenen et al. (2013) estimate the multiplier effect if the EERP stimulus to be 0.52 and 0.57 in the first two years.} A new set of literature has shown that fiscal measures have sizeable multiplier effects (Ramey 2011a, Leeper et al. 2017),\footnote{While many studies document sizeable fiscal multipliers, some other studies, such as Cogan et al. (2010), find much smaller multiplier effects.} but these effects vary across the states of the economy (Auerbach & Gorodnichenko 2012, Candelon & Lieb 2013). There is also a growing literature on the international spillover effects of domestic fiscal policy with many studies observing sizeable international multipliers, which has prompted some policymakers to advocate for joint fiscal actions in order to forestall any future occurrence of global recession (Auerbach & Gorodnichenko 2013, Corsetti & Müller 2014).

In this paper, we investigate the effect of an increase in German government spending on the domestic economy and the economies of fifteen European economies. This research is motivated by the recent calls by policymakers and institutions, such as the International Monetary Fund and the European Union, for the German government to increase its spending in order to boost economic activities in the rest of the Euro countries.\footnote{Following the announcement of a German fiscal surplus of €23.7 billion or 0.8 percent of GDP for the fiscal year 2016, which is the fifth year of budget surplus in a row and the highest recorded since reunification in 1991, some policymakers and institutions, such as the International Monetary Fund and the European Union, have called on Germany to increase public spending on investment, education, childcare and migration (International Monetary Fund 2017, EUobserver 2017a, b). The call is driven by Germany’s large and persistent current account surplus, which is second to none among G7 countries and in sharp contrast to the reality in the rest of the Euro Area (Jaumotte & Sodsriwibooboon 2010). Some economists argue that Germany’s huge current account surplus is harmful, creating “a deflationary bias for the euro area, as well as for the world economy” (U.S. Treasury 2013, Krugman 2013b). The German government refutes this claim, arguing that the country’s surplus is due to its economic competitiveness and world demand for its quality product (Spiegel 2013). But, as Krugman (2013a) notes, high-quality exports do not drive current account surpluses, rather its the balance of saving and investment.} Their argument is based on the premise that a German fiscal expansion will boost domestic demand, thereby increasing the demand for foreign goods as well as stimulating income and inflation in the rest of Euro countries. In contrast, the German monetary authority argues that such fiscal expansion will have relatively small spillover effects on other European economies due to the low import content of German public expenditure.\footnote{See the keynote speech of the president of the Deutsche Bundesbank presented at a recent joint IMF-Bundesbank conference (Weidmann 2018).} We empirically evaluate this debate in the light of existing literature on international transmission of fiscal policy. Specifically, this paper addresses the following policy questions: What are the effects of an expansion in German government spending on domestic demand for foreign goods? Does an increase in German government spending lead to output expansion in other Euro countries? Is there heterogeneity in the responses of foreign economies to German spending shocks?

To address these questions, we proceed in two steps. First, we estimate an open-economy Bayesian vector autoregressive (BVAR) model for the German economy in order to quantify the effects of...
German fiscal expansion on domestic demand for foreign goods. This methodology involves taking a number of draws and identifying the shocks to each draw using Uhlig (2005)’s agnostic identification method which imposes sign restrictions on the impulse response functions. Specifically, we identify a debt-financed government spending shock which moves government spending, government debt and output in the same direction while we remain agnostic about the real exchange rate and net exports, which are the key variables of interest for examining the spillover effects of German fiscal policy. In the second stage, we quantify the specific net effect of German fiscal expansion on fifteen European economies by replacing the external sector variables with bilateral real exchange rates and foreign output.\(^5\) In estimating the international spillover effects of German fiscal policy, we follow the idea of Corsetti & Müller (2014) by explicitly controlling for endogenous fiscal adjustments of foreign countries by including German government spending in relative terms; that is German spending relative to partner’s spending.

This paper makes three contributions. First, our analysis is among the few studies to estimate country-by-country spillover effects of cross-border fiscal shocks within a sign-restricted structural VAR model. This methodology allows us to analyse country-specific responses of other European countries to German fiscal shock. Similar empirical studies by Canzoneri et al. (2003), Corsetti & Müller (2014) and Beetsma & Giuliodori (2011) all employed the recursive identification method or Blanchard & Perotti (2002) identification approach, which has been criticised for being too restrictive and the restrictions may not be consistent with the underlying theoretical model (Canova 2007). Whereas, in this paper, the identifying restrictions are based on the theoretical predictions of business cycle models and the identification strategy allows us to remain agnostic about the impulse responses of the variables of interest, thereby allowing more precise estimation. Other similar studies, such as Caporale & Girardi (2013), Hebous & Zimmermann (2013) and Dragomirescu-Gaina & Philippas (2015), have analysed area-wide cross-border fiscal transmissions among several European (or Euro Area) economies within a Global VAR, but country-by-country spillover responses to international fiscal shocks cannot be analysed using this methodology. This is the focus of this paper.

Second, this paper is one of the first to empirically investigate country-specific international transmission of fiscal shocks to a large number of countries within and outside the monetary union.\(^6\) We analyse country-specific spillover effects of German fiscal expansion on 15 European economies, taking into consideration their exchange rate regimes, relative size and the degree of sovereign debt risks — GIIPS (Greece, Ireland, Italy, Portugal, and Spain) and non-GIIPS.\(^7\) Third, the data for our analysis extends beyond the period of financial crisis by nearly a decade, which enables us to examine how the effects of fiscal policy have changed after the crisis period. In contrast, most of the empirical studies in the literature focused on the pre-crisis period when fiscal policy was relatively passive, compared to the post-crisis period when fiscal policy is relatively active.

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\(^5\)Similar empirical methods have been employed in the literature to estimate the cross-border effects of changes in government spending and taxes. See, for instance, Canzoneri et al. (2003) and more recently Corsetti & Müller (2014).

\(^6\)While Canzoneri et al. (2003) analyse the effect of US fiscal policy on three European countries (France, Italy and the UK), Corsetti & Müller (2014) analyse US fiscal spillovers to aggregate Euro Area and the UK. Beetsma & Giuliodori (2011) analyse the effects of government spending of the 5 largest EU countries (Germany, United Kingdom, France, Italy, and Spain) on the rest-of-EU in a panel of 14 countries. However, the impulse responses from this panel analysis are for the aggregate EU economy and not specific to each country.

\(^7\)While the Euro countries have a common currency, the non-Euro countries operate flexible exchange rate regimes. In terms of relative sizes, France, Italy, Spain and United Kingdom are relatively large countries, while countries like Austria, Belgium, Denmark, and Sweden are relatively small compared to Germany. More so, the GIIPS countries have relatively high sovereign debt risks compared to Germany; that is, their risk of default on sovereign debt in the event of a crisis is relatively high.
Our results are as follows: a debt-financed expansion in German government spending leads to a depreciation of the real exchange rate and the terms of trade, and a deterioration of the trade balance. The real exchange rate and the terms of trade both respond with lags (four and two quarters respectively), but the terms of trade returns to its pre-shock level after two years while the real exchange rate depreciates persistently till the fifth year. The fall in the trade balance is driven mainly by a sharp rise in imports demand in the first two years after the shock. On the cross-border implications of German fiscal expansion, we find a significant degree of heterogeneity in the dynamic responses of foreign output and bilateral real exchange rates across sub-groups of the sample countries. The international output multiplier of German spending is sizeable but mild, ranging between 0.5 and -0.5, which is close to the values reported in the literature. In the very short-run, an increase in German government spending leads to output expansion in the non-GIIPS Euro countries and non-Euro countries with strong trade links with Germany, such as Denmark and Switzerland, but crowds-out output of GIIPS countries. German fiscal expansion has a non-positive effect on the output of all the countries in the medium run. Also, while bilateral real exchange rate appreciates in the short run and depreciates in the medium run in non-GIIPS countries, it depreciates with lags (no initial appreciation) in most of the GIIPS countries. In non-Euro countries, the response of the bilateral real exchange rate is mixed depending on the exchange rate regime of the country relative to the eurozone. Various sensitivity analyses are conducted to check the robustness of the results to additional restrictions, variations in the sample period, and alternative assumptions of constant and trend terms in the VAR estimation. The results of these analyses show that our results are stable and robust.

The rest of this paper is organised as follows: in Section 2, we discuss the identification strategy employed for our VAR analysis. Section 3 presents the estimation results. Section 4 presents further results of various sensitivity and robustness checks, while Section 5 concludes.

2 Identifying Government Spending Shock

There is an ongoing debate in contemporary fiscal policy literature on how fiscal shocks should be identified. Four major approaches have been used in the literature: (1) the recursive approach with Cholesky decomposition, (2) the structural fiscal VAR approach of Blanchard & Perotti (2002), (3) the Uhlig (2005)’s agnostic identification approach with sign restrictions and (4) the narrative or event-study approach of Ramey & Shapiro (1998), which was further developed recently by Ramey (2011b). While structural VARs based on zero restriction (the recursive or the Blanchard-Perotti approach) are rather atheoretical in the sense that the underlying DSGE model rarely imply zero restriction, this is not the case for the sign restrictions (Canova 2007, Ch. 4). Meanwhile, standard fiscal VAR models have been critiqued on the grounds that the government spending innovations are non-fundamental (or non-invertible) as the model does not contain sufficient information (such as market expectation) to recover the actual fiscal shocks. This has been argued to be the case mainly in high frequency (quarterly) series where agents act on news of future changes in fiscal policy at some quarters before the actual implementation of the policy. Also, Benati & Surico (2009) argue that VAR models may give uninformative results when used to analyse policy stimulus during regime changes.

To account for the omitted variables in fiscal VAR, Ramey & Shapiro (1998) use a natural exper-
iment to construct US war-date series based on large military announcements in the press. Ramey (2011b) incorporates this war-date series, and the Survey of Professional Forecasters as an alternative, in a fiscal VAR model for the US economy and suggests that both series should be ordered first. The main criticism of this identification method is the subjective approach of constructing the war-date series, which is at the mercy of the researcher. Fisher & Peters (2010) also control for private agents’ expectation on changes in US government spending by incorporating the excess stock returns of large (top 3) military contractors to the US government in their fiscal VAR model.

2.1 Sign Restriction VAR Identification

The identification of structural VAR models using sign restrictions can be described as follows. Consider a reduced-form VAR model of order $p$:

$$ Y_t = \sum_{j=0}^{d} \mu_j t^j + \sum_{i=1}^{p} B_i Y_{t-i} + e_t, \quad \text{for} \quad t = 1, \ldots, T $$

(1)

where $Y_t$ is a $k$-dimensional vector of endogenous variables, $\mu_0$ is a constant, $t$ is the trend term with a maximum polynomial order of $d$, $B_i$ are $k \times k$ coefficient matrices, and $e_t$ is a $k$-dimensional vector of one-step-ahead reduced-form innovations with variance-covariance matrix $\Sigma_e = E[e_t e_t']$.

The essence of VAR identification is to translate the reduced-form VAR innovations into economically meaningful and invertible structural shocks, $\varepsilon_t$, which are assumed to be orthonormal; that is, they are mutually orthogonal and have normalized unit variance. Hence, $E[\varepsilon_t \varepsilon_t'] = I_m$. The theory of the structural VAR identification assumes that the structural shocks, $\varepsilon_t$, are related to the reduced-form predictor errors, $e_t$, through a matrix $A$ such that:

$$ e_t = A \varepsilon_t, \quad \text{and} $$

$$ \Sigma_e = E[\varepsilon_t \varepsilon_t'] = AE[\varepsilon_t \varepsilon_t']A' = AA'. $$

(2)

(3)

The $n$th column of matrix $A$ represents the impulse vector or the immediate impact of a one standard error innovation to the $n$th structural shock. However, matrix $A$, in its current form, is not uniquely identified. Conventional identification methods impose $k(k-1)/2$ restrictions on matrix $A$ or its inverse either via recursive assumption using Cholesky decomposition or short-run structural relationships or long-run structural relationships or a combination of both.

To identify the structural model, we adopt the agnostic identification method proposed by Uhlig (2005), and applied to monetary and fiscal policy analysis by Scholl & Uhlig (2008) and Mountford & Uhlig (2009). The method imposes sign restrictions on the impulse response functions of the endogenous variables for a specific number of periods after the shock. Unlike in other identification methods, an interesting feature of this method is that the number of structural shocks to be identified can be less than the number of endogenous variables; that is $m \leq k$. Thus, this method is more suitable for our analysis since we seek to identify just a single shock – the government spending shock. Fry & Pagan (2011) identify some issues with sign-restriction identifications. They argue

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9 When $d$ is set to 0, the VAR model includes only a constant term; $d = 1$ implies a constant and a linear time trend, while $d = 2$ implies a constant and quadratic time trend. When the first term on the right-hand side of equation (1) is excluded, then the VAR model is estimated with a no-constant no-trend assumption.

10 Given our specification of the VAR model, matrix $A$ is the inverse of the contemporaneous matrix.

11 Several other papers have employed the sign-restriction method to identify a single shock. For instance, Uhlig
that sign restrictions are set restriction and therefore a range of different model can satisfy the sign restriction. Therefore, selecting the median of each impulse response function is wrong because the median of each impulse response function might have been generated by a different underlying DSGE model. They suggested minimising the distance of each draw from the median.

The implementation of the sign restriction identification involves a number of stems. First, the reduced-form VAR model is estimated using Bayesian method and estimates of $\hat{B}$, $\hat{e}_t$ and $\hat{\Sigma}_e$ are obtained. Following Uhlig (2005), the Bayesian prior for estimating the VAR parameters ($B$, $\Sigma_e$) has a density that belongs to the Normal-Wishart distribution. By implication, the posterior density will also belong to the Normal-Wishart family. Next, a unique lower-triangular matrix $P$ can be computed from the estimated variance-covariance matrix, $\hat{\Sigma}_e$, using some decompositions, e.g Cholesky decomposition, such that $PP' = \hat{\Sigma}_e$. Alternatively, $P' = \text{chol}(\hat{\Sigma}_e)$. Next, using the Bayesian method, $n$ random samples of $\hat{B} = [\hat{B}_0 \hat{B}_1 \ldots \hat{B}_k]$ and $\hat{\Sigma}_e$ are drawn from their posterior distributions. Then, random selections of a combination ($\hat{B}$, $\hat{\Sigma}_e$) are drawn from the constructed $n$ samples in the earlier step to construct an orthonormal matrix $Q$ which satisfies $QQ' = I_k$. Given the property of $Q$, the matrix $\hat{A}$ can be recovered from the Cholesky decomposition of $\hat{\Sigma}_e$ as follows:

$$PI_kP' = \hat{\Sigma}_e$$
$$PQQ'P' = \hat{\Sigma}_e = \hat{A}\hat{A}'$$

where $\hat{A} = PQ$ is a candidate matrix of the structural model. If the implied impulse response functions satisfy the identifying restrictions, we retain $Q$; otherwise, $Q$ is discarded. The above steps are repeated for a large number of times while recording each $Q$ that satisfy the sign restrictions and saving the corresponding impulse functions.

Given this information, estimates of the structural shocks can be computed as:

$$\hat{e}_t = \hat{A}\hat{\varepsilon}_t$$

By construction, $\hat{e}_t$ is serially uncorrelated. Fry & Pagan (2007, 2011) suggest that it is more efficient to work with shocks that have unit variance. This can be done by dividing each estimated structural shock, $\hat{\varepsilon}_t^{(k)}$, by its standard deviation. Let $\hat{S}$ be a diagonal matrix of the estimated standard deviations of the structural shocks. Thus, we can rewrite the estimated version of equation (2) as:

$$\hat{e}_t = \hat{A}\hat{S}\hat{S}^{-1}\hat{\varepsilon}_t = \hat{T}\hat{\varepsilon}_t$$

where $\hat{T} = \hat{A}\hat{S}$ is the rescaled version of the impact matrix, and $\hat{e}_t = \hat{S}^{-1}\hat{\varepsilon}_t$, which is the rescaled version of $\hat{\varepsilon}_t$, is the vector of normalised structural shocks with unit variance.

After the computation, summary statistics of the grid of impulse responses that satisfy the sign restrictions are reported, such as the median impulse response and its percentile bounds —say, 16th and 84th. Scholl & Uhlig (2008) and Vargas-Silva (2008) analyse only the effect of monetary policy shock on US output, exchange rates, and the US housing market respectively. Dedola & Neri (2007) estimate a structural VAR model with sign restrictions to identify only technology shock. Fujita (2011) identifies and analyzes only the effect of aggregate shock on US labour market, while Chen & Liu (2018) study the individual effect of government consumption and government investment spending on Chinese real exchange rate.

12For step-by-step details of the QR decomposition for constructing $Q$, see Kilian & Murphy (2012). Note that, while $Q$ is constructed from randomly selected combinations of $\hat{B}$ and $\hat{\Sigma}_e$, it does not depend on the data (Kilian & Lütkepohl 2017, ch. 13).
84th percentiles. As Fry & Pagan (2011) note, the percentile bounds, in this case, do not correspond to standard confidence intervals obtained from Bayesian estimations or bootstrapping which depict critical regions.

2.2 Data and Estimation Strategy

To conduct the estimation for this empirical analysis, we rely on time series data at quarterly frequency for the period 1995:Q1 – 2016:Q4. Our choice of 1995 as the start date is partly motivated by the German unification date (1991) when reliable data become available for the German federation, and partly by the availability of reliable quarterly series for the response countries analysed in this paper. The sample countries are Germany (the source country of the fiscal shock), along with 10 other Euro Area countries (Austria, Belgium, Finland, France, Greece, Ireland, Italy, the Netherlands, Portugal and Spain) and five non-Euro countries (Denmark, Norway, Sweden, Switzerland and the United Kingdom). The choice of sample countries is motivated by existing studies in the literature (see Beetsma & Giuliodori (2011), Corsetti & Müller (2014), Canzoneri et al. (2003)). In addition to the 14 European Union (EU) countries included in the panel analysis of Beetsma et al. (2006, 2008) and Beetsma & Giuliodori (2011), our sample also includes Norway and Switzerland, which are non-EU countries. To the best of our knowledge, this paper is one of the first to analyse country-specific cross-border effects of fiscal policy for member and non-member countries of the European monetary union.

To address the questions raised in this paper, we estimate two variants of the baseline VAR estimation. First, we estimate the effects of an exogenous shock to German government spending on the domestic economy. The German fiscal VAR model contains six time series: four main variables (log of real government spending, log of real GDP (output), consolidated government debt-to-GDP ratio and ex-post long-term real interest rate) and two external sector variables (we rotate, in turn, log of real effective exchange rate and log of the terms of trade, and also rotate exports-to-GDP ratio, imports-to-GDP ratio and trade balance ratio). The real variables are constructed using the GDP price deflator series. All the variables are multiplied by 100 so that the impulse responses can be interpreted directly as percentage deviation from steady state or percentage points deviation from pre-shock level for real interest rate and ratio variables.

In the second variant of the VAR model, we estimate the spillover effects of German spending shock on foreign output and real exchange rate. To do this, we replace the external sector variables in German fiscal VAR with foreign output and the bilateral real exchange rate of the partner countries. To correctly estimate the country-specific net effect of German fiscal spillover, we follow the idea of Corsetti & Müller (2014) by including German government spending in relative terms; that is German government spending relative to partner country-’s government spending. This transformation is necessary in order to control for the endogenous response of fiscal policy in foreign economies. When the endogenous fiscal adjustments in a foreign country are not controlled for, the estimated spillover effects become rescaled versions of the effect in the source country (see, for instance, Canzoneri et al. (2003)).

The data for this analysis are collated from various sources. The series of GDP components are obtained from the Eurostat, the exchange rate series are collected from the database of Bank for International Settlements, while the interest rate data is obtained from OECD Main Economic Indicators database. The government debt data is collected from the World Bank’s Quarterly Public
Table 1: Identifying Sign Restrictions for Government Spending Shock

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<th>Response of</th>
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<td>Output</td>
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<td>Pappa (2009), Galí et al. (2007)</td>
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<td>Real Interest Rate</td>
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<td>Effective RER, TOT</td>
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<td>expy, impy, thy</td>
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| **Foreign Economy Variables** |               |        |                                                     |
| Foreign output            | ?           |        |                                                     |
| Bilateral RER             | ?           |        |                                                     |

Notes: This table shows the sign restrictions on the impulse responses for the identified government spending shock. RER stands for real exchange rate, TOT stands for terms of trade, “expy” stands for exports-to-GDP ratio, “impy” stands for imports-to-GDP ratio while “thy” stands for net exports-to-GDP (trade balance) ratio. A ‘+’ sign implies that the impulse response of the variable in question is restricted to be positive for four quarters following the shock, including the quarter of impact. A ‘?’ implies that we are agnostic about the response of the variable in question; that is, no restrictions have been imposed.

Sector Debt database. The baseline VAR estimation includes a constant and a quadratic time trend in order to adequately control for time effect and major area-wide and country-specific event episodes.13

2.3 Identifying Restrictions

Government spending shock can be defined in several ways. A surprise (unanticipated) shock to government spending has an impact effect on government spending and other macroeconomic variables. In contrast, a few studies have shown that fiscal actions are well anticipated by agents due to decision and implementation lags. As a result, fiscal announcements lead to changes in macroeconomic and financial variables before the actual time of impact of the policy. This is referred to as anticipated fiscal shock, or simply fiscal foresight (Forni & Gambetti 2016, Leeper et al. 2012, Ramey 2011b).

Government spending shock can also be classified according to how it is financed. A tax-financed government spending shock moves government spending and taxes in the same direction with no change in deficit for a given period. On the other hand, a deficit-financed government spending shock moves government spending and deficit/debt in the same direction for a given period with no change in taxes (Mountford & Uhlig 2009, Pappa 2009, Canova & Pappa 2007).

In this paper, we focus on a surprised debt-financed government spending shock. However, following Forni & Gambetti (2016) and Yang (2007), we control for bond market signals about anticipated changes in government spending by incorporating long-term real interest rate in our model. A summary of the set of identifying sign restrictions imposed on the impulse responses is provided in Table 1. We define a debt-financed government spending shock as a shock that moves government consumption spending, government debt and output in the same direction for four quarters following the shock, including the impact period. Following Mountford & Uhlig (2009), a tight restriction of four quarters is imposed in order to rule out highly transitory shock to government spending. For instance, a fall in government spending in one or two quarters after an initial increase. This restriction is also consistent with annual fiscal planning in many countries.

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13The major event episodes observed in the data which may affect the results of our analysis include the establishment of the common monetary system in the Euro Area in 1999, the global financial crisis of 2008-2009, the sovereign debt crisis of 2012-2013, and the peg of the Swiss franc ceiling again the Euro over the period 2011:Q3 – 2015:Q1.
The identified sign restriction on output is consistent with both standard real business cycle (RBC) models and even highly stylistic New-Keynesian dynamic stochastic general equilibrium (DSGE) models, such as that of Smets & Wouters (2003, 2007) and Christiano et al. (2005). In these models, an increase in government spending raises output mainly due to its additive effect on the economic resource constraint.\textsuperscript{14} In more specialised models, such as Gali et al. (2007)’s model with rule-of-thumb consumers, or models in which government spending directly enters household preferences as in Coenen et al. (2013), government spending raises output through its effect on household consumption. Also, empirical studies based on structural VAR models often produce positive fiscal multipliers. In a survey carried out by Ramey (2011a), the estimate of government spending multiplier in the literature ranges between 0.6 to 1.8, though some other studies, such as Cogan et al. (2010), find much smaller fiscal multipliers. Pappa (2009) also restricted output to rise in response to government spending shock while remaining agnostic about employment and real wage.

Regarding the restriction on the impulse response of the real interest rate, we initially remain agnostic given the inconclusiveness of findings in the empirical literature. RBC models predict that real interest rate should rise in response to a government spending shock to reflect the cost of deficit-financing. Similar results are observed in New-Keynesian DSGE models where both nominal interest and inflation rise in response to spending shock,\textsuperscript{15} but the rise in nominal interest relative to inflation depends on the monetary accommodativeness of the central bank. Empirical studies of Kim (2015) and Kim & Roubini (2008) find evidence in support of the theoretical model that real interest rate rises in response to government spending shock; whereas, Ramey (2011b), Corsetti et al. (2012) and Corsetti & Müller (2014) document a fall in real interest rate, suggesting monetary accommodativeness of fiscal policy. However, Ramey (2011b) notes that the fall in real interest rate may be due to the erratic behaviour of US inflation.

Following the standard practice in empirical literature, we remain agnostic about the responses of our variables of interest. Standard business cycle models predict that a positive shock to government spending raises the relative price of domestic goods, causing a real appreciation of the domestic currency and the terms of trade and a deterioration of the trade balance. However, in a New-Keynesian DSGE model, Corsetti et al. (2010, 2012) show that government spending increase could depreciate the real exchange rate if the long-term real interest rate falls in anticipation of a medium-term consolidation to slow down the path of government debt. The key factor here is the anticipated spending reversal. Corsetti et al. (2012) also document empirical evidence in support of the spending reversal hypothesis along with a depreciation of the real exchange rate in an analysis for the US economy. In another empirical analysis for the US economy relative to an aggregate of industrialized economies comprising the Euro Area, Japan, Canada and the UK, Enders et al. (2011) derive robust sign restrictions for government spending shock within a New-Keynesian DSGE model but impose no restriction on real exchange rate, terms of trade and net exports. Their findings show that an expansion in government spending depreciates both the real exchange rate and the terms of trade.

To the best of our knowledge, we are not aware of any existing empirical study that estimates country-specific international fiscal spillover in a sign-identified VAR model. Theoretical postulations from two-country DSGE models suggest that cross-border effect of home-country government spending shock on foreign output could be positive or negative depending on the calibration of the model.

\textsuperscript{14}For a closed-economy model, the resource constraint is given as: \( Y_t = C_t + I_t + G_t \).

\textsuperscript{15}See, for instance, Enders et al. (2011).
However, previous VAR estimations based on zero-restriction identification often produce positive spillover effects (see Canzoneri et al. (2003) and Corsetti & Müller (2014)). Based on these facts, we impose no restriction on the impulse responses of foreign output. But, to consistently estimate the spillover effects for each foreign economy, we impose sign restrictions on all German main variables in the VAR model, including the real interest rate.16

3 Results

In this section, we report the results of our estimated sign-restricted VAR model. First, we estimate the VAR model described in Section 2.1 on time series data for the German economy, comprising government spending, government debt ratio, output, real interest rate, and external sector variables. German exports, imports and net exports ratios are rotated in turn, likewise the real effective exchange rate and the terms of trade. In the second stage, we re-estimate the VAR model in order to quantify the net spillover effects of German spending increase by replacing German spending with German-to-partner’s spending and replacing external sector variables with foreign output and bilateral real exchange rate.17

3.1 Domestic Effects of German Government Spending

Figure 1 displays the impulse responses computed from the estimated fiscal VAR model for the German economy. The debt-financed government spending shock is identified as a shock that moves government spending, government debt and output in the same direction for four quarters. The shock being analysed here is a normalised one standard deviation shock. For ease of interpretation, the impulse responses of all variables have also been rescaled by the impact response of government spending. Hence, output response can be interpreted as impact effects (see Ramey (2016)). The solid lines denote the median impulse responses, while the dotted-dashed lines plot the 16th and 84th percentiles. Vertical lines indicate imposed sign-restrictions. The horizontal axes measure the quarters while the vertical axes measure the percentage deviation from trend level or percentage points deviation from pre-shock level for interest rate and ratio variables.

From the top left panel of Figure 1, government spending rises persistently and remains significantly above its trend level up to the third year. For a one percent increase in government spending, German output increases by nearly one percent on impact. However, the initial rise in output is limited to the period for which we imposed sign restrictions, slowing down up to the end of the third year and then rising again until the fifth year. Mountford & Uhlig (2009) and Enders et al. (2011) find a similar weak response for output after a spending increase. In line with the evidence reported by Corsetti et al. (2012) and Corsetti & Müller (2014), debt-to-GDP ratio rises persistently until the fourth year and then fall below its trend level, implying higher taxes in the future and medium-run debt consolidation. Although the long-term real interest rate is left unrestricted, it initially rises by about 50 basis points after two quarters, but falls significantly below its pre-shock level after 6 quarters. The initial rise

16In the spillover VAR estimation, we rely on the initial response of the real interest rate in the baseline VAR model for Germany to identify the appropriate restriction for the variable. As discussed in the next section, German real interest rate rises in the first year, though with a lag. Hence, the modified identifying restrictions for the spillover VAR entail that German relative spending, output, government debt and real interest rate all rise in the first year after the shock, while no restriction is imposed on foreign variables.

17In estimating the VAR models reported in this section, this paper benefits greatly from the use of Ambrogio Cesa-Bianchi’s VAR toolbox, which is available for download here: https://sites.google.com/site/ambropo/MatlabCodes
in real interest rate reflects the rising cost of government borrowing, while the subsequent fall is due to agents’ anticipation of fiscal consolidation as reflected in the medium-term response of government debt. This result is consistent with the findings of Forni & Gambetti (2016) and Corsetti et al. (2012) that long-term interest rate falls after one year in response to a positive unanticipated government spending shock, though their empirical strategy is different from ours.

Turning to our variables of interest, the second and third columns of the middle panel of Figure 1 show the impulse responses of German real effective exchange rate and terms of trade to the government spending shock. In response to a debt-financed government spending shock, real exchange rate depreciates contemporaneously but significantly only after one year. Similarly, terms of trade worsen after two quarters but returns to its pre-shock level after two years. In line with the findings of Corsetti et al. (2012), responses of the real exchange rate and the terms of trade seem to be driven by the anticipation effect of a future consolidation on the real interest rate. In anticipation of a future debt-consolidation financed by an increase in taxes, the real interest rate falls which, in turn, leads to a depreciation of the real exchange rate and terms of trade. This result is also consistent with the empirical findings of Enders et al. (2011) and Kim & Roubini (2008) for the US, Monacelli & Perotti (2010) for the US, UK and Australia, and Kim (2015) for a panel of 18 advanced countries which show that a positive spending shock is followed by a real currency depreciation. Whereas, Born et al. (2013), Ilzetzki et al. (2013), Beetsma & Giuliodori (2011) and Beetsma et al. (2008) all document a real appreciation of the exchange rate, while Beetsma et al. (2006) find no significant response for real
exchange rate after a government spending increase.

The last row of Figure 1 displays the impulse responses of external trade to government spending shock. A positive government spending shock deteriorates the trade balance up to the fourth year. This result seems to be driven mainly by an increase in domestic demand for foreign goods as imports-to-GDP rises on impact by about 0.5 percentage points, further rising to a peak effect of 1 percentage points after two quarters before returning to its pre-shock level after two years. On the other hand, German exports-to-GDP marginally deteriorates in the second year. This result is in line with the findings of Kollmann et al. (2015) which show that an expansion in German government consumption or investment spending raises German GDP and deteriorates the current account position. Meanwhile, the empirical literature on the effect of fiscal policy on trade and current account balance is inconclusive. While Beetsma et al. (2008), Monacelli & Perotti (2010) and Born et al. (2013) find a deterioration of the trade balance after a fiscal expansion, Kim & Roubini (2008), Ilzetzki et al. (2013) and Kim (2015) find evidence in support of an improvement in the current account balance.

In summary, our analysis shows that a debt-financed increase in German government spending depreciates the real exchange rate and deteriorates the trade balance position. These results are well-documented by existing studies that employed standard zero restrictions. Evidence from our analysis suggests that the deterioration of the net exports is not necessarily driven by a decline in exports (which would have suggested an increase in domestic absorption of home-produced goods or imports substitution), but by an increase in domestic demand for imports. Given the degree of leakage in domestic income through imports, it is likely that an increase in German government spending may have some effects on foreign output, especially in countries with strong trade ties. This is the focus of the next section.

3.2 Spillover Effects of German Government Spending

In Figure 2 and 3, we turn to the analysis of cross-border spillover effects of German government spending shock on other European economies. As discussed above, we net off the domestic fiscal response of foreign government spending in order to ascertain the net effects of German government spending on foreign output. Hence, the fiscal instrument of interest here is the German government spending relative to country-\(i\)'s spending. Like before, the shock analysed is a normalised one standard deviation shock. Hence, output response can be expressed as impact effects. The real exchange rate responses can be interpreted as percentage changes in the bilateral real exchange rate resulting from one percent net increase in German government spending. An increase in the bilateral real exchange rate implies a real depreciation of the partner-country’s exchange rate relative to Germany. For comparison purpose, the Euro countries are classified into GIIPS (Greece, Ireland, Italy, Portugal, and Spain) and non-GIIPS (Austria, Belgium, Finland, France, and the Netherlands) countries. The GIIPS countries are among the most affected countries in Europe during the financial crisis, with high public debt growth and high sovereign risk premia (Beetsma et al. 2013). Given that our study period covers nearly a decade after the financial crisis, it is likely that the response of foreign output and exchange rates in GIIPS and non-GIIPS countries may differ.

Figure 2a shows the computed impulse responses for the non-GIIPS countries. German government spending appears to have a sizeable expansionary effect on the output of non-GIIPS Euro countries. German spending shock crowds-in output on impact in most of the countries, but this effect is reversed after one year and then recovering again after 10 quarters. Since German spending is relatively
ineffective after this period, the latter recovery of foreign output may be associated with individual partner-country’s own-fiscal policy rather than German fiscal policy. The initial output responses are much stronger in Austria and the Netherlands with strong trade ties with Germany, reaching a peak effect of about 0.5 percent. In Belgium and France, the initial output response is relatively mild and marginally significant with a peak effect of about 0.3 percent, while Finland’s output response is insignificant in the first two years.

The effect of German government spending shock on the bilateral real exchange rate is noticeable for almost all the non-GIIPS Euro countries, except for the Netherlands. German spending shock appreciates the bilateral real exchange rates of non-GIIPS countries in the first two to three years and then depreciate afterwards. On average, the initial appreciation of the bilateral real exchange rate peaks at about 0.3 percent in Belgium to about 0.8 percent in Finland, while the subsequent depreciation peaks at about 0.2 percent in Belgium to 0.5 percent in Austria. However, since these countries have a common currency with Germany, these effects simply reflect changes in relative prices in response to an increase in German demand for foreign goods.

In Figure 2b, we plot the impulse responses for output and the bilateral real exchange rate of the GIIPS countries. German spending shock appears to have a non-positive effect on the output of GIIPS
countries. An exception is the case of Italy where output marginally increases in the first two quarters with a peak effect of about 0.3 percent in the second quarter, but then slow down in the medium run. Greek output peaks at about -0.7 percent after six quarters while Spanish and Portuguese output peak at about -0.6 percent after two years. Changes in German government spending does not seem to have any significant effect on Irish output and bilateral real exchange rate. On average, an expansion in German government spending depreciates the bilateral real exchange rates of the GIIPS countries with a lag of 6–12 quarters. The medium run depreciation of the real exchange rate peaks at about 0.2 percent in Greece, Italy and Portugal and at 0.4 percent in Spain. Interestingly, the result shows a strong correlation in output and real exchange rate responses across the countries on the Iberian peninsula (Spain and Portugal). In both countries, German spending shock depreciates the bilateral real exchange rate and crowds-out output with 4–8 quarters lag.

The estimated impulse responses for the non-Euro countries are displayed in Figure 3. Compared to the Euro countries, output and real exchange rate responses in non-Euro countries exhibit significant heterogeneity. While German government spending crowds-in foreign output in Denmark and

Figure 3: Spillover Effects of German Government Spending Shock on Non-Euro Countries.

*Notes:* The shock being analysed is a one standard normalised deviation shock. The fiscal instrument here is the relative German-to-partner’s government spending in logs. Solid lines display the median impulse responses while the dotted-dashed lines show the 16th and 84th percentiles. For the bilateral real exchange rate, an increase implies a depreciation.
Switzerland with a peak effect of about 0.5 percent in the first year, it crowds-out Swedish and UK output in the medium run with a peak effect of about -1 percent by the end of the second year, while it has no significant effect on Norway’s output. Similarly, while German spending shock significantly appreciates bilateral real exchange rates in the Scandinavian countries (Denmark, Norway and Sweden), it has no significant effect on Switzerland and UK’s real exchange rates, at least in the short to medium run. However, the inflow of foreign exchange into the Scandinavian countries only translates to output expansion in Denmark, which maintains a pegged exchange rate to the euro even though it is not a member-country of the Euro Area. A possible explanation for this could be the strong appreciation of bilateral real exchange rates in Norway and Sweden which crowds-out the gains from trade. This also appears to be the case for Finland. Compared to Denmark with a peak appreciation of 0.5 percent, the peak effect of real exchange rate appreciation in Norway and Sweden is 4 times as much, and near twice as much in Finland.

Comparing the results of German fiscal spillovers for Euro and non-Euro countries, two empirical findings stand out. First, there is a significant degree of homogeneity in the dynamic responses of output and real exchange rate in Euro countries, compared to heterogeneous responses in non-Euro countries. A good explanation for this could be the strong economic integration among Euro countries with a common currency and monetary policy. Although the European Monetary Union was established in 1999, many of the member-countries already maintained a fixed exchange rate with Germany as at the beginning of our study period in 1995. Second, percentage changes in bilateral real exchange rates are relatively larger in non-Euro countries compared to the Euro countries. Also, unlike in most Euro countries where real exchange rate depreciates in the medium run after an initial appreciation, real exchange rates in non-Euro countries do not depreciate in the medium. This result could be attributed to the exchange rate policy maintained by the different partner countries. While a fixed nominal exchange rate is maintained within the entire Euro Area, non-Euro countries maintain floating nominal exchange rates against the euro. Denmark is an exception with a pegged exchange rate against the euro. Also, the upper limit of the Swiss franc was pegged against the euro between September 2011 and January 2015.

Overall, our results suggest that most of the increase in German domestic demand for foreign goods, due to fiscal expansion, are channelled towards goods from non-GIIPS Euro countries and non-Euro countries with strong degree of integration with the German economy. These results are comparable to existing empirical findings documented in the literature. For instance, Beetsma & Giuliodori (2011) estimate a panel VAR model with zero-restriction for 14 EU countries for the period 1970-2004. They find that an increase in government spending of large EU countries (France, Germany, Italy, Spain or the UK) leads to an expansion in output of the rest of Europe with a peak effect of 0.35 percent after three years. In a similar study to ours, Corsetti & Müller (2014) estimate country-specific effects of US government spending on the UK and the Euro Area in a fiscal VAR model identified using both Blanchard & Perotti (2002) and Ramey (2011b) identification methods. They find that the results are similar under both identification methods with an exogenous expansion in US government spending raising UK and Euro Area output by 1 and 0.5 percent respectively. Regarding the dynamics of the exchange rate, Corsetti & Müller (2014) find that US bilateral real exchange rate relative to the UK and the Euro Area depreciates in response to US spending shock. In another similar study, Canzoneri et al. (2003) find that an exogenous shock to US government spending persistently increases the output of Italy, UK and France with a peak effect of 38%, 70% and 75% of US GDP, and leads
Figure 4: Sensitivity Analysis I: Single-Shock vs. Multiple-Shock model.

Notes: See Figure 1. The monetary policy shock is identified first and it is orthogonal to the fiscal policy shock. Solid lines denote baseline responses from the single-shock model, dashed lines denote multiple-shock model, while the dotted-dashed lines are the 16th and 84th percentiles for the multiple-shock models.

4 Sensitivity Analysis

In order to check the robustness of the results presented in the previous section, we conduct several sensitivity analyses, including sensitivity to additional restrictions and shocks, the post-financial crisis events, and constant and trend terms in the model specification. First, following some concerns to a real depreciation of their real effective exchange rate, though France’s real exchange rate initially appreciates.
raised in the literature regarding the identification of a single-shock within sign-restricted structural VARs, we check whether the results of our single-shock model are sensitive to additional identifying restrictions or shocks. To do this, we identify a new shock which raises the real interest rate, appreciates the real exchange rate and causes the output to fall in the first four quarters. This shock can be interpreted as a monetary policy shock. Following Mountford & Uhlig (2009), the monetary policy shock is identified first and it is orthogonal to the fiscal policy shock.

Figure 4 displays the impulse responses computed from the multiple-shock model. Solid lines display baseline responses from the single-shock model while the dashed lines depict impulse responses from the multiple-shock model. The dotted-dashed lines show the 16th and 84th percentiles. Figure 4b compares impulse responses for government spending shock under the single-shock and multiple-shock signed-VARs. The results show that there is no significant change in the impulse responses from both models as the median responses overlay each other in most cases. This shows that our estimated fiscal shock is robust to additional restrictions and is not biased by the identification of additional shocks.

From Figure 4a, in response to a monetary policy shock, real interest rate rises for the first four quarters for which the sign restriction is imposed and then fall afterwards. As a result, real exchange rate (falls) appreciates in the first four quarters and then depreciates as real interest rate falls. The initial appreciation of the real exchange rate transfers international competitiveness to the foreign economy and leads to the deterioration of the trade balance. Output falls for an extended period in response to a monetary policy shock, but rises as real interest rate fall below its pre-shock level. Given the initial rise in the cost of borrowing, public debt quickly builds up, reaching a peak effect of about 6 percent after two years before gradually slowing down towards its pre-shock level. To dampen the effect of a high real interest rate on output, government spending initially rises but quickly returns to its pre-shock level after three quarters.

Second, we check whether our result is sensitive to the events of the last decade following the financial crisis. This period is particularly characterised by low inflation, effective lower-bound on

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**Figure 5: Sensitivity Analysis II: Pre-Crisis vs. Full Sample Period**

*Notes:* See Figure 1. Solid lines depict baseline responses, dashed lines depict responses for the alternative pre-crisis model, while the dotted-dashed lines are the 16th and 84th percentiles for the alternative model.
interest rates, and productivity stagnation in many European countries. And as existing studies have shown, these features could significantly affect the relative strength of fiscal policy and the dynamics of fiscal multipliers (see Correia et al. (2013) and Fernández-Villaverde et al. (2015)). To check this, we exclude the period after the financial crisis from our sample period; that is, data up to 2008:Q4. This left us with only 60 percent of our initial sample observation. Due to the small sample size, we include only one lag in this VAR estimation. Figure 5 shows the result of this estimation. Solid lines depict baseline responses, dashed lines depict impulse responses for the alternative pre-crisis model, and the dotted-dashed lines are the 16th and 84th percentiles for the alternative model. Focusing on our variables of interest, the responses of the real exchange rate and net exports are directly comparable in both versions of the model. German spending depreciates the real exchange rate with a lag and causes deterioration of the trade balance. However, the real exchange rate response in the baseline model lies outside the 84th percentile of the alternative model after three years, while the response of net exports in the baseline model marginally lies outside the 84th percentile of the alternative model between the third and eighth quarter. This result shows that our agnostic identification of German fiscal shock produces relatively stable results across the time period.

Finally, we check the robustness of our results to the inclusion of constant and trend terms in the baseline model. There is no consensus in the literature regarding the appropriate assumption for constant and trend to be included in the estimation of fiscal VARs. For instance, Mountford & Uhlig...
(2009) assume no constant or time trend, Enders et al. (2011) include only a constant, Corsetti & Müller (2014) include a constant and a linear time trend, while Ramey (2016) considers a constant and a quadratic time trend. For this reason, we compare our baseline model, with a constant and a quadratic time trend, to models with no constant or trend term, with constant only and with both a constant and a trend term. Figure 6 plots the result of this exercise. The response of government spending is highly persistent and does not show any sign of returning to its steady state after 5 years in all the alternative specifications. This is also the case for output response under the specifications with no trend. The specifications with time trend generate identical median responses for most variables except for government spending, suggesting the relative importance of including time trend that matches data moment in VAR. Focusing on our variables of interest, the median responses of the real exchange rate and net exports are directly comparable under all specifications but statistically insignificant under specifications with no time trend. When the VAR model is estimated under the no-constant and no-trend assumptions, the real exchange rate response lies outside the 84th percentile of the baseline model, while the response of net exports under the no-trend assumption lies outside the 84th percentile of the baseline model. Overall, this analysis shows that our baseline model is relatively stable compared to other specifications and can generate reasonable impulse responses.

5 Conclusion

Motivated by the recent calls on the German government to increase its spending in order to boost economic activities in the rest of the Euro countries, this paper examines the effect of such fiscal expansion on German domestic demand for foreign goods and on foreign output. Using Bayesian approach, we estimate a structural VAR model identified with Uhlig (2005)’s agnostic identification method which imposes sign restrictions on the impulse response functions. The imposed sign restrictions are derived from the predictions of standard business cycle models. The model is estimated on quarterly time series data for Germany and 15 other European countries (10 Euro and 5 non-Euro countries), including all the 14 EU countries analysed by Beetsma & Giuliodori (2011).

The VAR estimation is carried out in two steps. First, we estimate an open-economy fiscal VAR model on six German variables (government spending, output, government debt, real interest rate, real exchange rate, net exports) in order to estimate the effect of government spending shock on demand for foreign goods. We identify a debt-financed government spending shock which is defined as a shock that moves government spending, output and government debt in the same direction in the first four quarters, including the impact period. Evidence from this analysis shows that German government spending depreciates the domestic real exchange rate and the terms of trade and deteriorates the trade balance. The deterioration of the trade balance is driven by a sharp increase in the demand for imports, which rises much faster than exports, suggesting some degrees of output spillover.

In the second step, we estimate the country-specific net effect of German spending spillovers on European trading partners. To do this, we replace the external sector variables in the baseline VAR model with foreign output and the bilateral real exchange rate of each country. Following Corsetti & Müller (2014), we control for the endogenous fiscal adjustments in foreign economies by expressing German government spending in relative terms to partner’s spending. Our results show that an increase in German government spending leads to output expansion on impact in non-GIIPS Euro countries, but have a non-positive effect on the output of GIIPS countries. Also, in non-GIIPS Euro
countries, bilateral real exchange rates initially appreciate in the short run to reflect the inflows of foreign exchange and then depreciates in the medium run; whereas, in the GIIPS countries, bilateral real exchange rates mostly depreciate with about a year lag. The results for non-Euro countries are mixed and significantly different across countries.

Given the policy implication of our analysis, expansion in German government spending can improve economic activity in other Euro countries. However, the degree of integration with the German economy, the strength of trade links and the internal dynamics (such as the responsiveness of domestic prices or high sovereign debt risks as in the case of the GIIPS countries) of foreign economies could influence the extent of gains from trade.
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