Fiscal Shocks and the Real Exchange Rate*

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We estimate the real exchange rate impact of shocks to government spending for a panel of member countries of the euro area. Our key finding is that the impact differs across different types of government spending, with shocks to public investment generating larger and more persistent real appreciation than shocks to government consumption. Within the latter category, we also show that the impact of shocks to the wage component of government consumption is more persistent than that of shocks to the non-wage component. Finally, we highlight the different exchange rate responses between this group and a group of countries with floating exchange rates.

JEL Codes: E62, F31.

1. Introduction

The aim of this paper is to study the effects of government spending shocks on the real exchange rate in member countries of the euro area.

Our study is motivated by several factors. First, from a policy perspective, it is important to understand the impact of fiscal shocks on the real exchange rate. For instance, if fiscal expansion induces real appreciation, it may contribute to competitiveness problems

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that are hard to reverse inside a monetary union (Lane 2010). In related fashion, policymakers may also seek to deploy national fiscal policy to correct an external imbalance inside a monetary union (whatever its source), given the elimination of the currency devaluation option. The real exchange rate response also matters for the sectoral impact of a fiscal shock across tradables and non-tradables, which is a major concern for policymakers for both economic and political reasons. Accordingly, in calibrating optimal fiscal policy, it is important to have a quantitative sense of the relation between various types of government spending and the real exchange rate.

Second, from a theoretical perspective, competing models offer different predictions concerning the relation between fiscal shocks and the real exchange rate. On the one side, traditional and contemporary versions of open-economy macroeconomic models with nominal rigidities typically project that an expansion in government spending should be associated with real appreciation (Corsetti and Pesenti 2001). However, it is also possible to construct models in which a fiscal expansion is associated with real depreciation, as in Kollman (2010), Monacelli and Perotti (2010), and Ravn, Schmitt-Grohe, and Uribe (2012).

Third, recent empirical research has provided mixed evidence. For a four-country sample (Australia, Canada, the United Kingdom, and the United States), Monacelli and Perotti (2010) and Ravn, Schmitt-Grohe, and Uribe (2012) find that a shock to government consumption produces real depreciation. However, Beetsma, Giuliodori, and Klaassen (2008) show that a shock to government absorption is associated with real appreciation for a panel of fourteen EU member countries. Accordingly, it seems that further empirical work is desirable in order to make progress in understanding the relation between fiscal shocks and the real exchange rate.

We seek to make several contributions. First, we wish to obtain estimates for a sample of EMU countries, since the role of national fiscal policies is especially important for members of a monetary union. While the duration of EMU is too short to allow estimation just on post-1999 annual data, much can be learned from estimation over a longer period, and we also examine differences in results between the pre- and post-1999 periods.

Second, we provide estimates for different types of government spending since the impact of a fiscal shock on the real exchange rate is likely to differ across categories. In particular, the composition of spending between tradables and non-tradables may differ between public investment and public consumption and between the wage and non-wage components of the latter category (see, amongst others, Lane and Perotti 2003 and Galstyan and Lane 2009).

Third, we seek to understand better the differences in real exchange rate responses to fiscal shocks across different groups of countries. In particular, we use a common estimation approach to study the real exchange rate responses for the EMU group and the floating-currency group previously studied by Monacelli and Perotti (2010) and Ravn, Schmitt-Grohe, and Uribe (2012). By adopting a common estimation framework, we are able to make progress in isolating the differences across the different country samples.

The closest study to ours is Beetsma, Giuliodori, and Klaassen (2008), which estimates a six-variable panel VAR using fourteen EU countries. However, we innovate along several dimensions. First, we estimate a more parsimonious three-variable benchmark system (government spending, output, and the real exchange rate). Second, we highlight that the impact of government spending may differ across its components. Accordingly, we allow public investment to operate differently to government consumption. Furthermore, within the latter category, we permit differences between its wage and non-wage components. Third, in order to assess whether the response of the real exchange rate to fiscal shocks may be influenced by the exchange rate regime, we estimate the model for two samples: (i) the group of member countries of the euro area that have been in a monetary union since 1999, and (ii) a sample of floating-currency economies (Australia, Canada, the United Kingdom, and the United States).

For the EMU group, we find that a shock to total government absorption appreciates the real exchange rate. Moreover, we identify differences across the components of government spending, with shocks to public investment generating a larger and more persistent impact on the real exchange rate than shocks to government consumption. Within the latter category, we also show that the impact of shocks to the wage component of government consumption is more persistent than for shocks to the non-wage component. These results carry over to different measures of the real exchange rate.

However, when we estimate the model for the floating sample, we find that fiscal shocks are typically associated with real depreciation.

We conjecture that this difference in results may be ascribed to the differences in currency regime (see also Ilzetzki, Mendoza, and Végh 2010 and Corsetti, Meier, and Müller 2012b).

The remainder of the paper is organized as follows. In section 2, we describe the data set. Section 3 presents the strategy to identify exogenous spending shocks. In section 4, we present the baseline estimates for the EMU sample. Section 5 presents different robustness checks of the baseline results. In section 6, we study the responses of alternative relative price indices for the EMU sample. Section 7 estimates the model for the sample of floating-currency countries. Finally, we offer some concluding remarks in section 8.

2. Data

The literature on fiscal shocks has considered a range of different measures of government spending. Most papers have focused on government consumption, whether in the aggregate or in relation to sub-components.[1] Beetsma, Giuliodori, and Klaassen (2006, 2008) provide an exception, by analyzing total government absorption and also the individual public investment and public consumption sub-components.

We adopt a general approach and consider five measures of government spending: total government absorption (the sum of total government consumption and government fixed investment); government fixed investment; government consumption; wage government consumption; and non-wage government consumption.[2] The time span of our data is 1970 to 2008 and the frequency is annual.

Our main sample consists of eleven member countries of EMU, since our primary interest is in the relation between fiscal shocks and the real exchange rate for countries that share a common currency.

[1] Recent studies of total government consumption include Blanchard and Perotti (2002) and Monacelli and Perotti (2010). Monacelli and Perotti (2008) focus on non-wage government consumption, while Cavallo (2005, 2007) studies wage government consumption and Giordano et al. (2007) compare the effects of wage and non-wage government consumption.

[2] In common with the rest of the literature, we exclude transfer payments (pensions, welfare benefits) from the analysis, since it is less clear that transfer payments should strongly affect the composition of spending across tradables and non-tradables.

We exclude Luxembourg for two reasons: limited availability of fiscal variables and no data for the real effective exchange rate vis-à-vis the rest of the euro area.[3] Our focus is on explaining the intra-area movements in real exchange rates—the price level in a member country relative to a trade-weighted average of the price levels (measured in a common currency) of the other member countries. This is the relevant concept in understanding divergent real exchange rate behavior among the member countries.

The source for almost all of these variables is the OECD Economic Outlook. The only exception is government fixed investment for Greece, where we use national sources.[4] Since we are interested in the effect of real government spending, we use government deflators instead of GDP deflators. Each fiscal variable is deflated with its own deflator, with the exception of non-wage government consumption, for which we use the deflator for total government consumption.[5]

Although the data coverage is extensive, it is not complete. In particular, we do not have government wage consumption for Belgium between 1970 and 1975, Germany in 1970, and Portugal between 1970 and 1977. The latter country also lacks data for total government consumption and government fixed investment for the same period. Germany also lacks total government consumption for 1970.[6]

The second variable used in our baseline model is GDP in constant local currency units. The source of this variable is also the OECD Economic Outlook. The last variable in our baseline estimations is the CPI-based real effective exchange rate vis-à-vis the rest of the EMU, published by the European Commission.

[3]The European Commission publishes a combined real exchange rate measure for Belgium and Luxembourg. We take this combined measure as a proxy for the real effective exchange rate of Belgium.

[4]We thank George Tavlas for providing these data.

[5]That is, our focus is on shocks to the volume of government spending. It is also potentially interesting to consider shocks to "government prices" (e.g., public-sector wages), but this might require a different VAR scheme. For instance, private-sector wages might have to be included as well as public-sector wages in view of the joint dynamics of wages across sectors (Holm-Hadulla et al. 2010).

[6]Data from West Germany and Germany are combined by splicing growth rates in 1991.

2.1 Database in Relative Terms

Since we are interested in evaluating how fiscal shocks affect real exchange rates among the EMU countries, we construct a set of indices which measure the deviations of our variables of interest from the rest-of-EMU countries.[7] To this end, we define I as an index that measures the deviations of the variable of interest from the rest-of-EMU countries. This index takes a value equal to 100 in the year 2000 and evolves according to equations (1) and (2).

$$I_{i,t} = I_{i,t-1} * \frac{Z_{i,t}}{Z_{i,t-1}} \tag{1}$$

$$\frac{Z_{i,t}}{Z_{i,t-1}} = \frac{X_{i,t}}{X_{i,t-1}} - \frac{X_{i,t}^{EMU}}{X_{i,t-1}^{EMU}} \tag{2}$$

The sub-index i stands for the home country while j denotes other EMU economies. $X_{i,t}$ is the real value of the spending variable being considered or the real GDP of country i at time t. $X_{i,t}^{EMU}$ is the same variable for other EMU countries. The last term of (2) is defined as

$$\frac{X_{i,t}^{EMU}}{X_{i,t-1}^{EMU}} \equiv \prod_{j \neq i} \left(\frac{X_{j,t}}{X_{j,t-1}} \right)^{\omega_{ij}}. \tag{3}$$

We refer to the expression in (3) as the *benchmark*, where ω_{ij} is the time-invariant trade weight of country j in country i, given by (4).[8]

$$\omega_{ij} = \frac{\Sigma_{t=t_0}^{T} (EXP_{ij,t} + IMP_{ij,t})}{\Sigma_{t=t_0}^{T} (EXP_{i,t} + IMP_{i,t})} \tag{4}$$

$EXP_{ij,t}$ are nominal exports from country i to country j in period t, and $IMP_{ij,t}$ are nominal imports of country i from country j in

[7]This step is not carried out by Beetsma, Giuliodori, and Klaassen (2006, 2008), who examined the impact of country-level variables on the real exchange rate. Thus, they are not just looking at intra-EU differentials. However, these authors do include time dummies, such that the country-level variables can be interpreted as deviations from the global mean. In contrast, we construct a different "rest of the world" for each country in the panel, in line with variation in trade weights.

[8]Since these trade weights are very stable in the 1970 to 2008 period, there is no significant change in the results by considering either $\omega_{ij,t}$ or ω_{ij}.

period t.[9] Both are measured in current U.S. dollars. $EXP_{i,t}$ represents total exports of country i to the EMU in period t while $IMP_{i,t}$ stands for total imports of country i from the EMU in period t. We set $t_0 = 1971$ and $T = 2008$. For years where X_t is not available, we set ω_{ij} to zero and renormalize.

The reason for using trade weights instead of GDP weights lies in the finding by Beetsma, Giuliodori, and Klaassen (2006). This paper shows that trade spillovers from discretionary fiscal policy are important between EU countries. Moreover, we use trade weights since these are more consistent with the third variable of our model, the real effective exchange rate.[10]

3. Shock Identification

The literature on fiscal policy implements different strategies to identify fiscal shocks. One approach is to study the dynamic effects of large and unexpected changes in fiscal variables, such as sudden increases in government expenditure for military buildups. This is the "dummy variable" approach implemented in Ramey and Shapiro (1998), Edelberg, Eichenbaum, and Fisher (1999), Burnside, Eichenbaum, and Fisher (2004), Romer and Romer (2010), and Ramey (2011), among others. This strategy uses narrative evidence to date large and exogenous fiscal shocks. Its main advantage is that these shocks are unlikely to be anticipated, as is often the case for shocks based on standard VAR methods and quarterly data.[11] One

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[9] The source of these data is the Direction of Trade Statistics of the International Monetary Fund.

[10] Trade weights used in the real effective exchange rate published by the European Commission are not exactly the same as those used in the benchmark variable. The former retrospectively includes Slovenia as an EMU country, while we exclude Slovenia from the output and fiscal measures, since its inclusion would be problematic in terms of data availability prior to the mid-1990s.

[11] Blanchard and Perotti (2002) test the existence of anticipated fiscal policy with future values of estimated fiscal shocks using quarterly frequency. To this end, they include future values of a dummy variable that measures fiscal shocks in their empirical model. They show that anticipation effects are not important in the United States. However, there are studies suggesting that fiscal policy may be anticipated one or two quarters in advance. Using a new variable based on narrative evidence that improves the Ramey-Shapiro military dates, Ramey (2011) shows the existence of anticipation effects. Moreover, she shows that these produce qualitative changes in the responses of consumption and real wages.

limitation of this strategy is that the effects of these episodes on the rest of the economy are assumed to be the same, since these events are coded with a dummy variable. In addition, similar narrative data are not available for many countries.[12] For these reasons, this approach would not be well suited for the purposes of this paper.

A second strategy is to identify shocks by means of sign restrictions that are imposed on the impact response of certain endogenous variables. Canova and Pappa (2007) follow this approach in studying the dynamic effect of fiscal shocks on inflation differentials within the euro area and across U.S. regions. As we do here, they estimate a panel VAR model with variables that are deviations from an EMU benchmark. Using sign restrictions, they define two types of spending shocks. The first one is a shock that generates contemporaneous positive co-movements between government deficit and output across countries. The second one is a shock that has no contemporaneous impact on the government balance but produces negative co-movements in regional outputs.

Although the research question is similar, we do not follow their empirical strategy. The reason is that using sign restrictions requires taking a strong stand on the predicted sign impact of fiscal shocks. This is hard to motivate theoretically, since the sign of the impact response of private consumption, employment, and GDP can be different depending on the theoretical approach.[13] In addition, the sign choice becomes harder to motivate in the context of a panel of EMU countries that exhibited changing exchange rate regimes during the sample period. A set of sign restrictions may be valid for a single country under a stable policy regime but not for a panel of countries or for countries with floating exchange rate regimes instead of fixed exchange rate regimes.

A third approach is to identify fiscal shocks imposing structural restrictions in VAR models that are estimated with quarterly data. Most studies in this group implement the procedure developed by Blanchard and Perotti (2002) and Perotti (2005) that decouples the

[12] A partial exception is provided by Devries et al. (2011). However, that study only looks at fiscal consolidations and does not include the breakdown of government spending between transfers, consumption, and investment components.

[13] As an example, Corsetti, Meier, and Müller (2012a) show how the response of the real exchange rate to a fiscal spending shock depends on the timing assumptions about the persistence of the fiscal shock.

systematic and non-systematic discretionary components of fiscal policy. This is achieved by assuming that the systematic discretionary part of the fiscal policy is absent in quarterly data. This is a plausible assumption given that decision lags make it difficult for policymakers to implement discretionary changes in government spending within a quarter.

Since high-quality detailed quarterly fiscal data are not available for many EMU countries, we opt to employ annual data.[14] The use of annual data to identify fiscal shocks has some advantages over the approach based on quarterly data (Beetsma, Giuliodori, and Klaassen 2008). First, the measured shocks may correspond more closely to actual shifts in the fiscal position, since fiscal policy decisions for government expenditure typically follow an annual cycle. Second, the use of annual data reduces the role of anticipation effects. These are usually present in shocks obtained from VAR models estimated with quarterly data (Ramey 2011). Finally, the impact of seasonal effects is less important in models estimated with annual data, since seasonal changes in fiscal variables are unlikely to have cycles that last longer than a year. For these reasons, we follow Beetsma, Giuliodori, and Klaassen (2006, 2008) and identify fiscal shocks using a Choleski decomposition for a panel VAR model estimated with annual data.

Our three-variable structural model in companion form can be written as follows:

$$A_0 Z_{i,t} = A(L) Z_{i,t-1} + C X_{i,t} + \varepsilon_{i,t}, \tag{5}$$

where $Z_{i,t}$ is a vector of endogenous variables containing the government spending differential from the rest-of-EMU countries ($\mathrm{g}_{i,t}$), the real GDP differential ($\mathrm{y}_{i,t}$), and the real effective exchange rate ($\mathrm{e}_{i,t}$). All of these variables are in log-levels.

$X_{i,t}$ is a vector with the country-specific intercepts (c_i), country-specific linear trends ($\mathrm{t}_{i,t}$), and year dummies (d_t). The subscripts i and t denote the country and the year. The country-specific intercepts are included to deal with country-specific heterogeneity. We

[14]Ilzetzki, Mendoza, and Végh (2010) have compiled an extensive fiscal data set at the quarterly frequency. However, the coverage for EMU countries only starts in the late 1990s in some cases; in addition, this data set does not have the breakdown between wage and non-wage government consumption.

add country-specific trends since many variables, even if they are defined as deviations from the other EMU members, show trending behavior at the individual country level. Furthermore, although variables are defined as deviations from the rest of the EMU, the use of fixed trade weights may produce common fluctuations across countries. To control for this and to mitigate cross-country contemporaneous residual correlation, we also include time fixed effects (d_t).

Matrix A_0 captures the contemporaneous relations between the endogenous variables; the matrix $A(L)$ is the matrix polynomial in the lag operator L that captures the relation between the endogenous variables and their lags. We set the lag length of each model to 2, following Beetsma, Giuliodori, and Klaassen (2006, 2008) and according to the Akaike information criterion and the Schwarz Bayesian information criterion. (This lag length ensures that the model residuals are not autocorrelated.) Matrix C contains the coefficients of the country fixed effects, the country-specific linear trends, and the time fixed effects.

The vector $\varepsilon_{i,t}$ contains the orthogonal structural shocks to each equation of the VAR and $\mathrm{var}(\varepsilon_{i,t}) = \Omega$. Thus,

$$Z_{i,t} = \begin{bmatrix} \mathrm{g}_{i,t} \\ \mathrm{y}_{i,t} \\ \mathrm{e}_{i,t} \end{bmatrix} \qquad A_0 = \begin{pmatrix} 1 & -\alpha_{\mathrm{yg}} & -\alpha_{\mathrm{eg}} \\ -\alpha_{\mathrm{gy}} & 1 & -\alpha_{\mathrm{ey}} \\ -\alpha_{\mathrm{ge}} & -\alpha_{\mathrm{ye}} & 1 \end{pmatrix}$$

$$X_{i,t} = \begin{bmatrix} \mathrm{c}_i \\ \mathrm{t}_{i,t} \\ \mathrm{d}_t \end{bmatrix} \qquad \varepsilon_{i,t} = \begin{bmatrix} \varepsilon^{\mathrm{g}}_{i,t} \\ \varepsilon^{\mathrm{y}}_{i,t} \\ \varepsilon^{\mathrm{e}}_{i,t} \end{bmatrix}.$$

Pre-multiplying (5) by A_0^{-1}, we obtain our model in reduced form,

$$Z_{i,t} = B(L)Z_{i,t-1} + DX_{i,t} + u_{i,t},$$

where $B(L) = A_0^{-1}A(L)$, $D = A_0^{-1}C$, $u_{i,t} = A_0^{-1}\varepsilon_{i,t}$, $u_{i,t} = [u^{\mathrm{g}}_{i,t} \quad u^{\mathrm{y}}_{i,t} \quad u^{\mathrm{e}}_{i,t}]'$, and $\mathrm{var}(u_{i,t}) = \Sigma$.

In order to recover $\varepsilon_{i,t}$ and Ω from the reduced form, we impose $\alpha_{\mathrm{yg}} = \alpha_{\mathrm{eg}} = \alpha_{\mathrm{ey}} = 0$ to matrix A_0. Imposing these restrictions is equivalent to assuming that government spending differentials do not react contemporaneously to shocks in GDP differentials or to shocks to the exchange rate.

These identification assumptions are in line with previous research in ordering g before y. This ordering is motivated by the fact that government spending is planned before the period starts. As further support for this approach, Beetsma, Giuliodori, and Klaassen (2006) estimate a panel VAR in public spending (g) and output (y) for seven EU countries with non-interpolated quarterly fiscal data assuming that g does not react to y within a quarter. From these results they construct an estimate of the response of public spending to output (at annual frequency) and find that contemporaneous public spending impact responses to output shocks are statistically zero.[15]

The use of the above recursive ordering yields a vector of shocks for each country. To better understand these, tables 1 and 2 report the timing and country location of large fiscal shocks, defined as the cases in which $|\varepsilon^{g}_{i,t}| > 2 * Stdev(\varepsilon^{g}_{i,t})$. Table 1 reports positive large shocks, while table 2 shows the large negative fiscal shocks. A striking feature of tables 1 and 2 shows that the European periphery experienced greater fiscal volatility than the core countries, with large positive and negative shocks experienced by Greece, Ireland, Portugal, and Spain. However, some of these large fiscal shocks also took place in Austria, Belgium, and Italy. In terms of the timing, these tables show that large fiscal shocks were more frequent during the 1980s. Furthermore, even if our fiscal variables are measured as deviations from other EMU member countries, many of the negative fiscal shocks match the dates of the large fiscal consolidation events reported in Devries et al. (2011).

[15] A detailed assessment of the plausibility of this assumption for European countries can be found in Beetsma, Giuliodori, and Klaassen (2009). This paper evaluates the validity of the identification restrictions constructing within-period changes in variables for a model estimated with annual data. These changes are based on estimates obtained from a quarterly data model. They do not find evidence of government spending responding to GDP shocks within a year. Thus, they conclude that it is reasonable to impose zero restrictions to identify government spending shocks in VAR models using annual data. Born and Müller (2012) address the same issue but follow a different approach and focus on different countries (Australia, Canada, the United Kingdom, and the United States). More precisely, they specify and test restrictions in a quarterly data model that ensure government spending being predetermined at annual frequency. Their findings are in line with Beetsma, Giuliodori, and Klaassen (2009): government spending is predetermined.

Table 1. Large Positive Fiscal Shocks

Year	GEXP	GINV	GC	WGC	NWGC
1972		GRC			
1973				ESP	
1975	GRC	GRC	GRC		GRC
1978				BEL	
1980	PRT	BEL	PRT		PRT
1981	GRC		GRC		GRC
1982	ESP	ESP		IRL	
1983	GRC			PRT	
1984	GRC				
1986				ESP	
1987			ESP		ESP
1988	PRT	GRC	PRT		
1989	ESP	ESP	GRC		
1990			IRL		
1991	PRT		PRT		PRT
1992				PRT	
1995					GRC
2000	GRC		GRC		GRC
2001	IRL		IRL		
2002			GRC		
2003	ITA	ITA			
2006	NLD		NLD		
2007					GRC

Notes: Large fiscal shocks are cases in which the structural errors term in equation (5) hits the two-standard-deviation threshold. The latter is computed including fiscal shocks data for all countries in the panel.

4. Baseline Empirical Model

4.1 Impulse Response Analysis

We estimate the VAR system on an equation-by-equation basis using least squares in RATS for each spending type. The first model is estimated for total government absorption (GEXP), defined as the sum of total government consumption and government fixed investment.

Table 2. Large Negative Fiscal Shocks

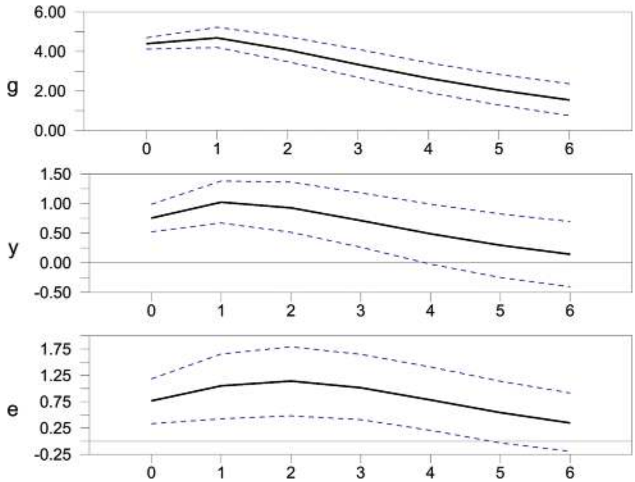
Year	GEXP	GINV	GC	WGC	NWGC
1972				ESP	
1974		GRC			
1978	ESP	ESP			
1979		ESP			BEL
1980	GRC	GRC	GRC		
1982	PRT, GRC	PRT	GRC	PRT, BEL	
1983				IRL	
1984	PRT			BEL	
1985				PRT	
1987	IRL		IRL		IRL, PRT
1988	IRL	IRL	IRL, GRC	IRL	GRC
1989		BEL	DEU, IRL	IRL	
1990					GRC
1992			PRT, GRC		PRT
1995			ITA		
1997		AUT		AUT	
2001		AUT		AUT	
2002	ITA	ITA			
2005	GRC	GRC			
2006	PRT				

Notes: Large fiscal shocks are cases in which the structural errors term in equation (5) hits the two-standard-deviation threshold. The latter is computed including fiscal shocks data for all countries in the panel.

Figure 1 reports the mean response and confidence bands associated with a 1 percent of GDP shock to this variable.[16] It shows that the effect of a positive shock to government absorption appreciates the real exchange rate and increases output vis-à-vis other EMU members. More precisely, the real exchange rate appreciates on impact by 0.77 percent and continues appreciating until year 5, while

[16]We scale these responses using the cross-country average of government expenditure to GDP ratios in the 1970–2008 period. For the case of government absorption, this scaling factor is 0.226. We follow the same procedure for shocks to government investment, government consumption, and the wage/non-wage government consumption breakdown. Here, the scaling factors are 0.03, 0.196, 0.113, and 0.082, respectively.

Figure 1. Responses to a Shock in Government Absorption (1 Percent of GDP)



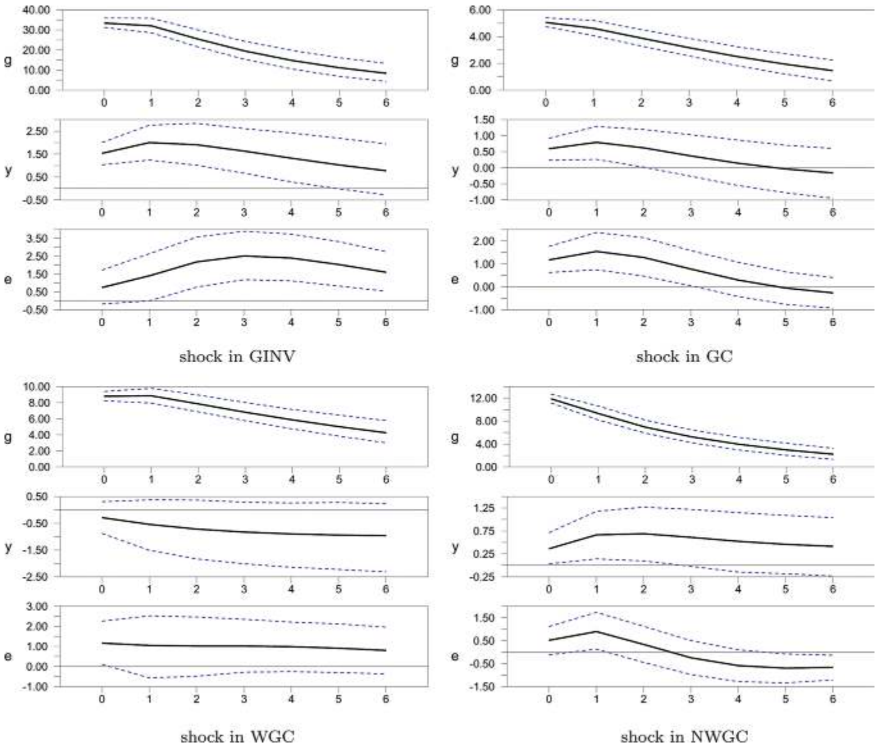
Notes: Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), and the percentage appreciation of the real effective exchange rate (e).

the GDP differential increases on impact by 0.79 percent with a maximum of 1.02 percent in year 1. From this point onwards it starts shrinking and becomes statistically zero by year 4. These results are in line with the findings of Beetsma, Giuliodori, and Klaassen (2008), even if our approach is different in several dimensions.

Next, we examine shocks to individual categories of government spending. To this end, we look at dynamic effects produced by shocks to government consumption (GC) and government investment (GINV), as in Perotti (2007). In the same way as in Lane and Perotti (2003), Cavallo (2005, 2007), and Giordano et al. (2007), we also study the effects of shocks to government consumption subcomponents: wage (WGC) and non-wage government consumption (NWGC).

Such a disaggregated approach is potentially important for several reasons. First, the tradable/non-tradable goods composition plausibly varies across different types of public spending, and this

Figure 2. Responses to a Shock in Government Sub-Components (1 Percent of GDP)



Notes: Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), and the percentage appreciation of the real effective exchange rate (e).

may affect the dynamic response of the exchange rate and GDP. For instance, publicly produced services are part of the non-traded sector, such that a fiscal shock that takes the form of an increase in publicly provided services will be clearly concentrated on the non-traded sector. In contrast, at least part of the public procurement of goods and services from the private sector will consist of demand for tradable products.

Figure 2 shows that the impulse response functions associated with these shocks are in line with the results for overall government absorption: these appreciate the real exchange rate. However, as expected, the impulse response functions are quantitatively different. For the case of government investment, the exchange rate appreciates with some delay and exhibits a maximum appreciation of 2.5 percent in year 3. By contrast, a shock to government consumption appreciates the exchange rate on impact by 1.2 percent with a maximum of 1.6 percent in year 1. This becomes statistically zero from year 3 onwards.

In terms of the GDP differential, figure 2 shows that a shock to government investment produces a larger and more persistent increase than a shock to government consumption. For the latter, the increase in GDP differential is statistically significant for a short period.

As discussed above, the difference in the exchange rate and GDP responses may be explained by sectoral composition of the shock—namely, government investment being skewed towards non-tradable goods. The relatively larger exchange rate response associated with this shock is in line with the empirical evidence on the relation between fiscal shocks and the sectoral composition of output (Bénétrix and Lane 2010). In particular, Bénétrix and Lane (2010) find that a shock to government investment has a greater impact on production of non-tradables than a shock to government consumption.[17]

Figure 2 also shows the responses for shocks to the wage and non-wage sub-components of government consumption. A shock to the former produces real appreciation on impact, while a shock to the latter appreciates the exchange rate in year 1. For the GDP differential, the only statistically significant response is for the period before year 3 in response to a non-wage government consumption shock.[18]

[17] As an extra check, we also ran our system for the relative price of non-tradables and found that government investment shocks have a greater impact on this relative price than government consumption shocks. These findings are available upon request.

[18] We also considered wider confidence bands between the 16th and 84th percentiles. In that case, we find that the real appreciation associated with a shock to government wages is statistically significant for the full impulse response horizon. A shock to non-wage government consumption now appreciates the real exchange rate on impact as well. Finally, the increase in the GDP differential produced by this shock is statistically significant until year 6.

In summary, a 1 percent of GDP shock to each definition of government spending (measured as a deviation from the rest-of-EMU trade-weighted average) induces appreciation of the real effective exchange rate. The magnitude and persistence differs from case to case. The largest appreciation is produced by a shock to government investment. By contrast, shocks to wage and non-wage government consumption yield exchange rate responses that are only marginally significant.[19] These results illustrate the importance of knowing the composition of shocks to government spending in working out the impact on the real exchange rate and output.

5. Robustness Checks

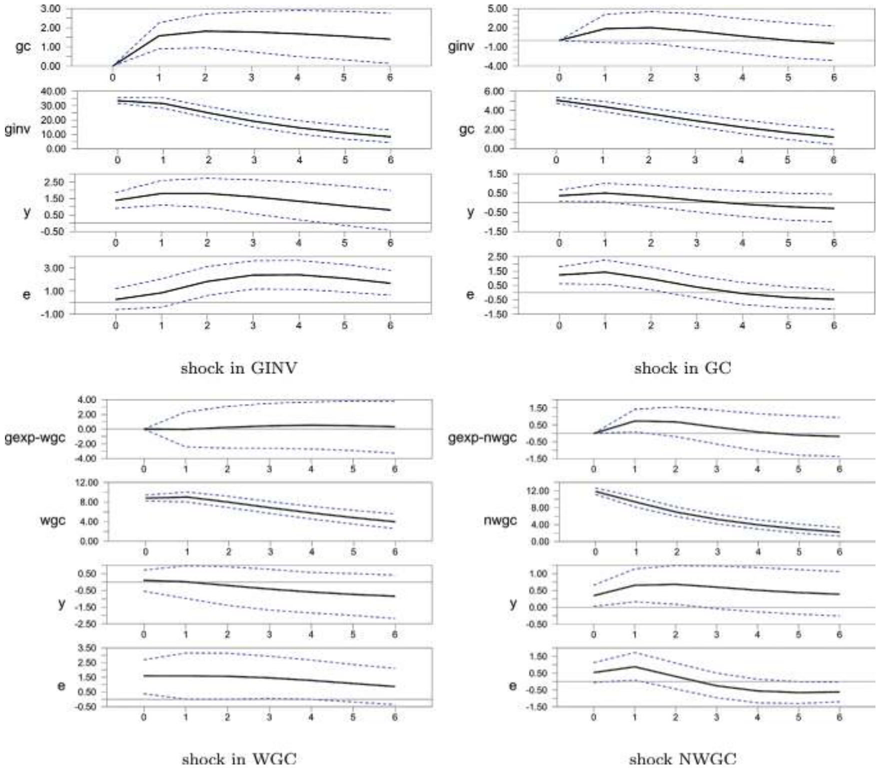
In order to verify the strength of our previous results, we conduct several robustness checks.[20]

First, we test whether the measured fiscal shocks in the baseline model might be distorted by the exclusion of other components of government spending. This is relevant in examining the impact of sub-components of aggregate government absorption, since a shock to public investment may be correlated with shocks to non-investment spending, which would not be picked up in the three-variable system. Accordingly, we consider an expanded four-variable system, in which the "complement" of the fiscal variable in question is also included. This is defined as the difference between total government absorption and the spending variable being considered. The advantage of including this fourth variable is that it minimizes potential biases in the reduced-form coefficients due to the omission of other types of government spending that are correlated with the spending variable being studied. Figure 3 shows that the exchange

[19]To complement the impulse response analysis, we also studied the variance decomposition in all the equations of these models. For the real exchange rate equations, we find that the largest proportion of the forecast-error variance that is attributable to the fiscal shock is in the case of public investment. This ranges between 0.6 and 14.9 percent. The second largest is associated with a shock in total government absorption, with values ranging between 2.6 and 9.5 percent. By contrast, government consumption and its sub-components explain a tiny proportion of the exchange rate forecast-error variance. For the GDP equations, we find similar results.

[20]Figures associated with the results mentioned in the text but not included in the paper are available upon request.

Figure 3. Baseline Model Augmented with Fiscal Complement



Notes: The shocked fiscal variable is ordered in the second position. Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending and GDP differentials (y), and the percentage appreciation of the real effective exchange rate (e).

rate responses to all fiscal shocks are unaltered by this change in the specification.[21] In addition, the inclusion of the complement fiscal

[21] To identify shocks, we adopt the conservative approach of assuming that the fiscal variable of interest is ordered after the fiscal complement. However, we have also run the system with the opposite ordering of the fiscal variables, and the impulse response functions are similar across the two specifications.

variable makes the exchange rate response to a shock in government wages statistically significant for a longer period.

Second, we vary the sample period. One check is to restrict the sample period to 1970 to 1998, to see if the pre-EMU period generates different results. In fact, the impulse response functions in figure 4 are very similar to the baseline.

Next, we focus on the 1999–2008 EMU period.[22] We find some qualitative differences relative to the whole-sample estimates. Figure 5 shows that the real appreciation has a larger impact effect in response to most of the shocks but is typically less persistent. However, the cumulative real appreciation is smaller for the post-EMU period relative to the whole-sample estimates (the greatest difference is for a shock to public investment).[23]

Finally, we restrict the sample period to 1980 to 2008, in line with the evidence reported in Perotti (2005) and Romer and Romer (2010) that the variance of fiscal policy shocks and their effects on output have declined after 1980. We find that the output and real exchange rate responses do not change relative to the whole-sample estimates.

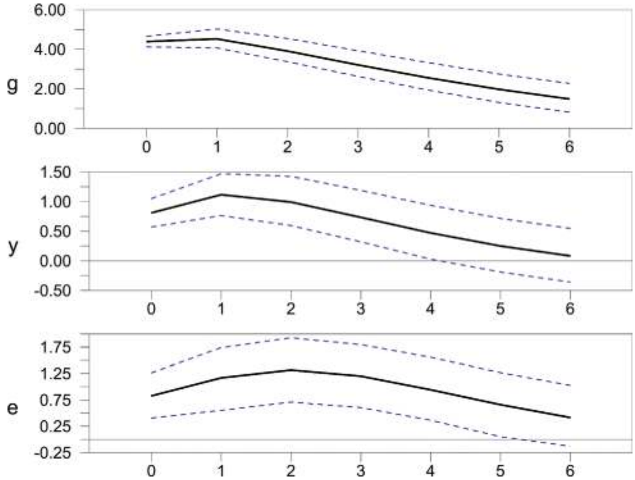
A third robustness check is to augment the model by including the long-term real interest rate differential as an additional endogenous variable. This variable is constructed by taking the difference between each country's interest rate and the trade-weighted average of the other EMU member countries.[24] As before, we focus on pre- and post-EMU periods. Figure 6 reports the impulse response functions for the former period and shows that the inclusion of this

[22]To generate the impulse response functions for the 1999–2008 period, we interact a dummy variable that takes the value 1 in 1970–98 with the three endogenous variables (government spending, GDP, and the real exchange rate). Then we include these interactions terms and the period dummy as exogenous variables in each equation of the system. This approach differs from the strategy of simply taking 1999–2008 data. The latter implicitly assumes that all variables in the system (including the country fixed effects and country-specific linear trends) break between 1998 and 1999. The former strategy, however, assumes that the coefficients of the country fixed effects and linear trends do not change between periods. Moreover, the use of 1999–2008 data only would be problematic due to the short time span.

[23]Interestingly, the GDP response changes qualitatively between periods for shocks to wage and non-wage government consumption. The former now boosts output while the latter contracts it.

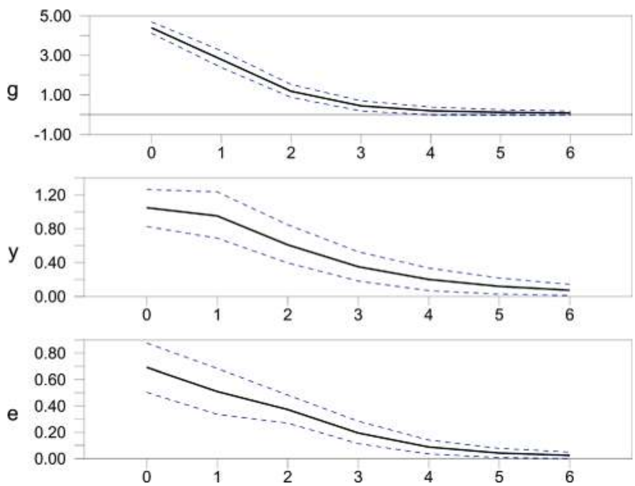
[24]The source of these variables is the OECD Economic Outlook.

Figure 4. Baseline Model Estimated for the Period 1970–98



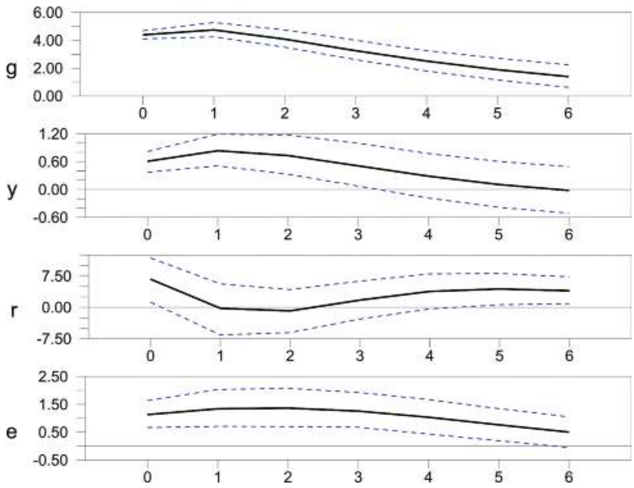
Notes: Responses to a shock in government absorption (1 percent of GDP). Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), and the percentage appreciation of the real effective exchange rate (e).

Figure 5. Baseline Model Estimated for the Period 1999–2008



Notes: Responses to a shock in government absorption (1 percent of GDP). Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), and the percentage appreciation of the real effective exchange rate (e).

Figure 6. Baseline Model Including Long-Run Interest Rate Differential: 1970–98

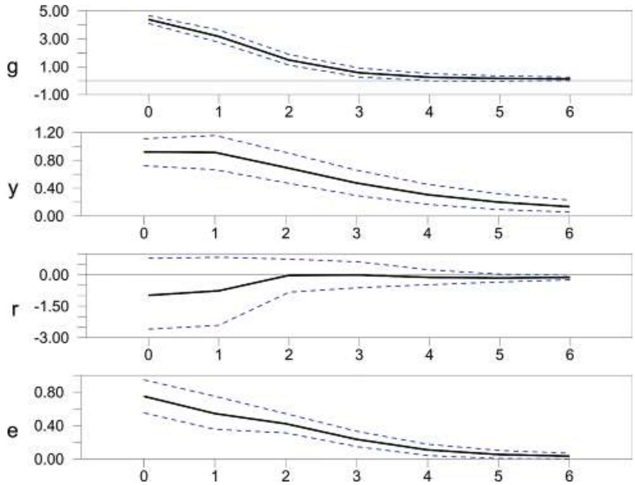


Notes: Responses to a shock in government absorption (1 percent of GDP). Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), the long-run real interest rate differential (r), and the percentage appreciation of the real effective exchange rate (e).

additional variable does not affect the baseline results. Shocks to government absorption, investment, consumption, and wage government consumption appreciate the real exchange rate. For the case of wage government consumption, the real appreciation is greater than in the baseline.

However, the effect of shocks to non-wage government consumption changes when the interest rate differential is included. In the baseline and in the model estimated for the 1970–98 period, a shock to non-wage government consumption appreciates the real exchange rate on impact and in year 1. However, this effect becomes statistically zero when the interest rate differential is included. Figure 7 reports the responses for models including the interest rate differential estimated for the EMU years. In line with figure 5, the real exchange rate responses have a larger impact effect and a smaller degree of persistence.

Figure 7. Baseline Model Including Long-Run Interest Rate Differential: 1999–2008



Notes: Responses to a shock in government absorption (1 percent of GDP). Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), the long-run real interest rate differential (r), and the percentage appreciation of the real effective exchange rate (e).

In a fourth robustness check, we also tested whether the exchange rate responses change if we allow government spending to systematically respond to the level of public debt. To this end, we follow Beetsma, Giuliodori, and Klaassen (2008) by including the logarithm of the first two lags of the general consolidated gross debt scaled by GDP in each equation of the system. Our baseline results are not affected by this change. As highlighted in the above study, this may be the result of the country-specific trends picking up the effects of movements in the debt-GDP ratios.

As a fifth check, we estimated a version of the baseline model including tax revenue, since Devries et al. (2011) and Favero, Giavazzi, and Perego (2011) show that shocks to spending and taxes may not be independent from each other. Since our baseline specification includes GDP, it already accounts for the changes in tax revenues that are systematically linked to changes in GDP. However, by including government revenues in the model, it is possible to also account for non-cyclical changes in government revenues. This robustness check confirms our previous findings for the impact of fiscal spending shocks on the exchange rate and the GDP differential.

Sixth, we tackle an econometric issue. Nickell (1981) and Arellano (2003) show that the introduction of lagged regressors in panels with fixed effects induces serial correlation between the residuals and future values of the regressors. When the time dimension of the panel is fixed and the cross-section dimension tends to infinity, this correlation produces a bias in the coefficient of the lagged dependent variable. Our panel has eleven EMU countries and annual data for the period 1970 to 2008. This means that, if present, biases in the coefficients may be small. However, we tested this by using the mean group estimator (as encoded in RATS) and also by excluding the country fixed effects and found that the baseline results do not change.

As the seventh robustness check, we isolated large but transitory fiscal shocks. To this end, we took the residual vector of each government spending equation in the baseline specification and coded as a dummy variable each case in which the residual was greater than two standard deviations. We then estimated how the endogenous variables responded to these dummy variables. We estimated two sets of models in which the fiscal shock dummy enters each equation of the system as an exogenous variable. The first set is formed by three-variable VAR models in which we take GDP, the real exchange rate, and the fiscal complement as the endogenous variables. The second set is formed by two-variable VAR models that just include relative GDP and the real exchange rate as endogenous variables.

Although this specification deals with temporary fiscal shocks (these are set to last only one year), the associated qualitative results are very much in line with the baseline results. Namely, fiscal expansions generate real appreciation. Moreover, most shocks produce a positive impact real exchange rate appreciation, with a degree of persistence that varies across different fiscal shocks.

6. The Mechanics of Real Exchange Rate Movements

In this section, we seek to examine some channels by which fiscal shocks may affect the real exchange rate response. In particular, we study the dynamic effects of fiscal shocks on the nominal exchange rate and relative inflation.

As a measure of the former, we take the nominal effective exchange rate vis-à-vis the rest of the EMU members. Inflation differentials are constructed as the ratio of home to foreign price indices, with the latter being a trade-weighted average of foreign prices. Since the real effective exchange rate used previously is based on consumption prices, we consider the CPI-based nominal effective exchange rate and construct CPI-based inflation differentials.[25]

After the euro area was formed in 1999, the nominal exchange rate component has been mechanically zero by construction. However, this channel may have played a role during the pre-EMU period. Thus, we examine the dynamic effect of fiscal shocks in the pre- and post-EMU sub-periods.[26]

Figures 8 and 9 report the impulse response functions for a shock to government absorption. The former shows that the real exchange rate appreciation in figure 4 was the result of a nominal appreciation being greater, in absolute value, than the contraction in relative inflation. This qualitative result also emerges for shocks to government consumption and its non-wage sub-components. For a shock to government investment, however, the real appreciation is associated with an increase in the nominal exchange rate. (Relative inflation falls on impact but becomes zero afterwards.) Finally, the real appreciation produced by a shock to wage government consumption is associated with an increase only in the inflation differential.[27]

The study of the EMU period shows, as expected, that a government absorption shock appreciates the real exchange rate via an increase in inflation differentials, as shown in figure 9. The magnitude of this increase varies across fiscal shocks. The largest effect is for government wages and the smallest for government investment.

Accordingly, these results demonstrate the changing nature of the relation between fiscal shocks and the inflation differential between 1970–98 and 1999–2008. In the former period, the inflation

[25]The source for the nominal effective exchange rate is the European Commission. We take the consumer price index from the AMECO database.

[26]As previously, we split the sample period with dummy variables and interaction terms with the four endogenous variables (government spending, GDP, nominal exchange rate, and inflation differentials).

[27]The impulse response functions for shocks to government spending subcomponents are available upon request from the authors.

differential declines in response to all types of fiscal shocks, with the exception of government wage consumption. In the latter period, the inflation differential increases since real appreciation takes the form of inflation differentials among members of a monetary union.[28,29]

7. The Sample of Floaters

In contrast to our results, several papers find that shocks in government absorption or government consumption produce real depreciation.[30] The common denominator across these studies is that they focus on countries with floating exchange rate regimes (Australia, Canada, the United Kingdom, and the United States).

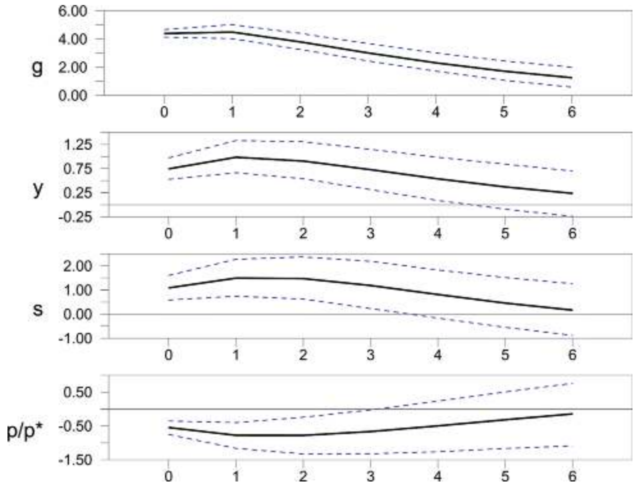
Here, we attempt to make progress in isolating the differences across this and the EMU sample. To this end, we study the dynamic effects of fiscal shocks on the exchange rate of both groups using a common estimation framework. Rather than estimating panel VAR

[28] As an additional exercise, we estimated the responses of the real exchange, nominal exchange rate, and inflation differentials for the five members of the euro area (Austria, Belgium, France, Germany, and the Netherlands) that historically had relatively little bilateral exchange rate variability. When the full period is considered (1970–2008), the shocks appreciating the real exchange rate are to investment and wage government consumption. A shock to non-wage government consumption depreciates the real exchange rate from year 1 onwards. When we focus on the two sub-periods, we find that the real exchange rate appreciates in response shocks to government absorption, investment, and wage consumption in 1970–98. These real appreciations are associated with increases in the nominal exchange rate (inflation differentials do not change). In contrast, a shock to non-wage government consumption depreciates the real exchange rate and is associated with a fall in the nominal exchange rate. When we focus on the 1999–2008 period, all shocks produce real appreciation via an increase in inflation differentials. As was the case for the broader EMU 11 group, the weakest responses are associated with shocks to public investment.

[29] We further explored the mechanics of the exchange rate movements by looking at the relative price of non-tradables channel. In line with the results discussed in the text and related literature (see, for instance, Monacelli and Perotti 2008), we find that fiscal shocks typically increase the relative price of non-tradables. This result is in line with governments mostly consuming non-tradable goods. Still, as noted in the main text, the impact of fiscal spending shocks on the relative price of non-tradables varies across the different categories.

[30] For instance, Monacelli and Perotti (2010) and Ravn, Schmitt-Grohe, and Uribe (2012) find real depreciation for Australia, the United States, and the United Kingdom while Kim and Roubini (2008) and Enders, Müller, and Scholl (2011) report depreciation for the real effective exchange rate in the United States.

Figure 8. Real Exchange Rate Response Decomposition: Responses to a Shock in Government Absorption (1 Percent of GDP): 1970–98



Notes: Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), the percentage appreciation in the nominal effective exchange rate (s), and the relative inflation (p/p*).

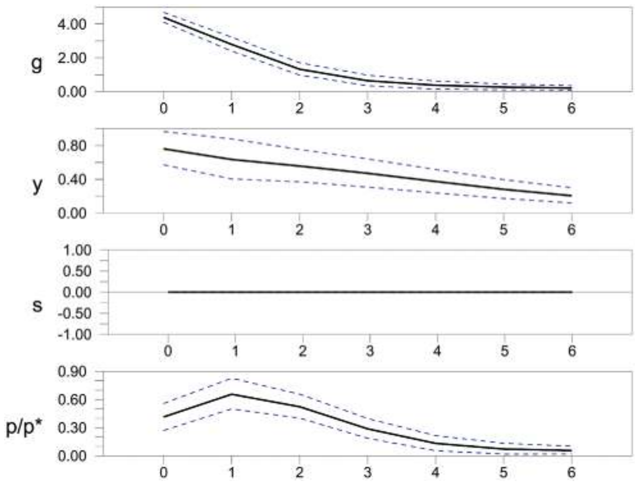
models with quarterly data, as in papers studying the floating sample, we use annual data.

Figure 10 shows the real exchange rate responses to a 1 percent of GDP shock in government absorption in the EMU and the sample of floaters. In line with the related literature, we also find that the latter exhibits a real depreciation, despite the different data frequency. The maximum depreciation is 3.5 percent in year 3.

These dynamics are quite different from those in the EMU sample, which show a maximum real appreciation of 1.1 percent in year 2. These contrasting results also emerge in response to shocks in government consumption and non-wage government consumption.[31]

[31] An exception is that a shock to wage government consumption generates real appreciation in the floating sample, while a shock to public investment does not significantly affect the real exchange rate.

Figure 9. Real Exchange Rate Response Decomposition: Responses to a Shock in Government Absorption (1 Percent of GDP): 1999–2008

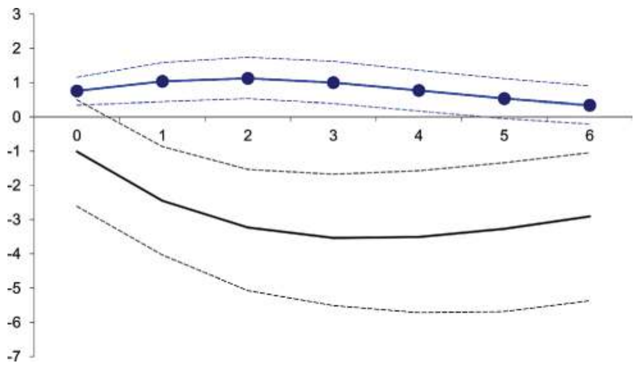


Notes: Solid lines are the point estimates of the impulse response mean. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications. The vertical axis indicates the percentage deviation from the rest-of-EMU countries for government spending (g), GDP differentials (y), the percentage appreciation in the nominal effective exchange rate (s), and the relative inflation (p/p*).

Accordingly, the results reported by Monacelli and Perotti (2010) and Ravn, Schmitt-Grohe, and Uribe (2012) are not sensitive to the frequency of the data but, rather, are driven by the selection of countries in the sample.

We conjecture that the differences in results between the EMU sample and the floating sample may be related to the exchange rate regime. Specifically, the nominal exchange rates of the floating group are allowed to undergo large movements—the monetary regimes in these countries do not target the exchange rate. In contrast, the intragroup nominal exchange rates among the EMU group have been fixed since the start of EMU, while these exchange rates were also targeted (albeit with different degrees of severity in different countries and at different time periods) during the pre-EMU period. Our conjecture is in line with Ilzetzki, Mendoza, and Végh

Figure 10. Real Exchange Rate Responses to a Shock in Government Absorption (1 Percent of GDP): EMU vs. Sample of Floaters



Notes: Dotted line is EMU. Solid line is the sample of floaters. Dashed lines are the 5th and 95th percentiles from Monte Carlo simulations based on 1,000 replications.

(2010) and Corsetti, Meier, and Müller (2012b) showing that the effect of a government consumption shock on the exchange rate varies systematically across exchange rate regimes.

To further investigate the role of the nominal exchange rate in driving real exchange rate movements for the floating sample, we repeat the analysis of section 6 and decompose the real exchange rate into nominal exchange rate and inflation differentials for the floating sample. For this set of countries, fiscal shocks are associated with nominal depreciation and an increase in the inflation differential. This differs from the pattern for the EMU group, where these variables moved in the opposite direction during the pre-EMU period, while the inflation differential is the only source of real exchange rate movements (in relation to intra-area real exchange rates) for the post-1999 period.

8. Conclusions

This paper makes several contributions to the literature on fiscal shocks in open economies. First, we show that fiscal expansion is typically associated with real appreciation for the EMU group of countries. This holds for both the pre-EMU and post-EMU periods. However, the mechanism by which real appreciation occurs has changed. During the pre-EMU period, real appreciation took the form of nominal appreciation, while a positive inflation differential has mechanically been the mechanism during the post-EMU period.

Second, we show that the composition of government spending matters. In particular, the largest peak appreciation is produced by shocks to public investment. Within the government consumption category, a shock to wage government consumption generates persistent real appreciation while a shock to the non-wage government consumption does not. These results are consistent with differences in the non-traded/traded mix across the different spending categories.

Taken together, these results are important for several key dimensions relating to external adjustment dynamics inside the euro area. In relation to the accumulation of large external imbalances during the pre-crisis period, increases in government spending in some peripheral countries may have contributed to competitiveness losses by pushing up demand for non-tradables and inducing a resource switch out of the tradables sector. In the other direction, the quantitative estimates for the relation between the different types of fiscal spending shocks and the real exchange rate may also be helpful in designing policy interventions to facilitate export-orientated adjustment for high-deficit countries.

Finally, we contrast the results for the EMU group with the findings for a sample of floating-currency economies. For the latter group, fiscal expansion is associated with real depreciation. We conjecture that the difference across samples may be attributed to differences in the exchange rate regime, but further research is warranted on the differential real exchange rate response to fiscal shocks across these country groups.

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