Exchange rate regimes and fiscal multipliers

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Abstract

Does the fiscal multiplier depend on the exchange rate regime and, if so, how strongly? To address this question, we first estimate a panel vector autoregression (VAR) model on time-series data for OECD countries. We identify the effects of unanticipated government spending shocks in countries with fixed and floating exchange rates, while controlling for anticipated changes in government spending. In a second step, we interpret the evidence through the lens of a New Keynesian small open economy model. Three results stand out. First, government spending multipliers are considerably larger under fixed exchange rate regimes, in line with what traditional Mundell-Fleming analysis suggests. Second, there is little evidence for the specific transmission channel which is at the heart of the Mundell-Fleming model. Third, the New Keynesian model provides a satisfactory account of the evidence.

Keywords: Fiscal policy, Exchange rate regime, Fiscal multiplier, Monetary policy, Panel VAR, New Keynesian model
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1 Introduction

Does the exchange rate regime matter for the fiscal multiplier, that is, the percentage change of output triggered by an increase of government spending by 1% of GDP? Traditional analysis based on the Mundell-Fleming model suggests that the exchange rate regime has a first-order effect on the multiplier: it is predicted to be large in economies which maintain an exchange rate peg or which are part of a currency union, but to be zero in economies with a freely floating exchange rate.[1] In the latter case, the increased activity due to higher government spending puts upward pressure on interest rates, triggering capital inflows and an appreciation of the currency. This, in turn, crowds out net exports and eventually offsets the effect of increased public spending on the demand for domestic goods. Under fixed exchange rates, in contrast, monetary policy accommodates the increased demand for domestic currency to prevent the currency from appreciating. As a result, private demand rises along with public demand, while net exports remain unchanged. The multiplier exceeds unity.

Only recently a number of studies have started to explore empirically the role of the exchange rate regime for the size of the fiscal multiplier. Corsetti, Meier, and Müller (2012) and Ilzetzki, Mendoza, and Végh (2012) conduct analyses which contrast the effects of fiscal policy across exchange rate regimes. Both studies (CMM and IMV for short) differ in terms of econometric approach and in terms of the sample under consideration; yet two major findings are common to both studies. First, the fiscal multiplier is considerably larger under fixed exchange rate regimes – in line with the predictions of the Mundell-Fleming model.[2] Second, there is little evidence for government spending to appreciate the real exchange rate and to crowd out net exports under floating exchange rates – a puzzling finding from the perspective of the Mundell-Fleming model.

Against this background the contribution of the present paper is twofold. First, we reassess the evidence regarding the role of the exchange rate regime for fiscal policy transmission. Relying on a unique data set for OECD countries, we address a major concern regarding time-series studies of the fiscal transmission mechanism: a possible misspecification of the timing of fiscal policy shocks due to anticipation effects or foresight (Ramey 2011 and Leeper, Walker, and Yang 2012). Specifically, and in contrast to CMM and IMV, we control explicitly for anticipated changes of government spending while estimating the effects of unanticipated government spending shocks in a panel VAR model. It turns out that – in the context of our empirical analysis – results are quite robust with respect to

[1] Here we refer to the baseline variant of the Mundell-Fleming model as outlined in macroeconomics textbooks (see e.g. Mankiw 2007). In what follows we do not generally distinguish between an exchange rate peg and the membership in a currency union. However, below we report empirical results for the subset of countries which are part of the euro area since 1999.

[2] In fact, both studies find a positive and significant multiplier effect under fixed exchange rates, but none under floating exchange rates. Acconcia, Corsetti, and Simonelli (2011) and Nakamura and Steinsson (2011) report large estimates of regional multipliers within monetary unions, exceeding conventional estimates of multipliers considerably.

controlling for anticipation effects; we confirm the main findings of CMM and IMV.[3]

As a second contribution, we investigate whether the time-series evidence can be rationalized on the basis of a New Keynesian small open economy model.[4] We find that a small-scale variant of the model is able to account for the impulse response functions obtained from the panel VAR model. Specifically, while we calibrate the model to match the empirical impulse response functions obtained for countries with fixed exchange rates, we find that the model is also able to account for the VAR evidence under floating exchange rates.[5] Given the empirical success of the model, we perform experiments to inspect the fiscal transmission mechanism in greater detail. In particular, we illustrate that the difference of the multiplier across exchange rate regimes is driven by differences in the monetary policy stance, as in the Mundell-Fleming model. Yet, in contrast to the predictions of the latter, these differences play out via an adjustment of the level of private expenditure rather than through a redirection of trade flows.

Our analysis draws on earlier work by Corsetti, Kuester, and Müller (2011a) who show in detail how monetary policy determines the fiscal transmission mechanism under alternative exchange rate regimes. It is also related to a number of studies highlighting the role of real interest rates, and hence monetary policy, for the transmission of government spending shocks, including Bilbiie, Meier, and Müller (2008), Davig and Leeper (2011), and Coenen et al. (2012); a case of particular interest is the situation where monetary policy is constrained by the zero lower bound (see, e.g., Christiano, Eichenbaum, and Rebelo 2011 and Woodford 2011).[6]

The remainder of the paper is organized as follows. The next section discusses our empirical framework and establishes evidence on the fiscal transmission mechanism across exchange rate regimes. Section 3 outlines a New Keynesian small open economy model, performs quantitative analyses, and interprets the time-series evidence through the lens of the model. Section 4 concludes.

2 Time-series evidence

We use a panel VAR framework to provide new evidence on the fiscal transmission mechanism, contrasting the effects of government spending shocks in economies with fixed and floating exchange rate regimes. In terms of identification we draw on Blanchard and Perotti (2002) and assume that government spending is predetermined relative to the other variables included in the VAR model. At the same

[3] As a caveat, we note that, due to data availability, we control only for anticipated government spending growth over a horizon of six months.

[4] CMM and IMV do not perform an explicit model analysis.

[5] Note that the estimated impulse responses are obtained on the basis of a minimum set of identification restrictions. We interpret these responses quantitatively through the lens of a New Keynesian business cycle model – rather than estimating this model directly on the basis of likelihood methods. This strategy accommodates concerns that standard business cycle models impose too tight a range for fiscal multipliers, see Leeper, Traum, and Walker (2011).

[6] Erceg and Lindé (2012b) contrast the effects of fiscal policy under a fixed exchange rate regime and under a floating exchange rate regime when monetary policy is constrained by the zero lower bound.

time, we address concerns regarding the correct timing of government spending shocks. In an influential contribution, Ramey (2011) argues that several findings obtained under the Blanchard-Perotti approach may be the result of an incorrect timing of the identified government spending shocks. For what the VAR picks up as a shock under the Blanchard-Perotti approach, so the argument goes, may in fact have been anticipated by market participants for some time. Consequently, the adjustment to the shock may well be under way, once the increase of government spending actually materializes. Estimated impulse response functions will be biased as a result.

From the perspective of a structural model, anticipation is a source of “non-fundamentalness”. Non-fundamentalness (or “non-invertibility”) may impair the ability of the econometrician to uncover the structural shocks from the innovations of an estimated VAR model, as discussed by Lippi and Reichlin (1994) and, more recently, by Fernández-Villaverde, Rubio-Ramírez, Sargent, and Watson (2007).[7] Leeper et al. (2012) focus on fiscal policy, and more specifically on tax policies, and provide a detailed analysis of the econometric implications of anticipation or “foresight”. As a result of fiscal foresight, the econometrician’s information set is typically smaller than that of the agents in the economy, giving rise to “non-invertibility” and possibly compromising attempts to identify fiscal shocks within standard VAR models.

In order to address the complications arising from possibly anticipated government spending shocks, we construct a particular data set. The data stems from the OECD and contains semiannual observations for the period from 1986 to 2011 for an unbalanced panel of OECD countries. A key feature of this data set is that it comprises, among other variables, explicit forecasts for government spending. The OECD prepares these forecasts in June and December of each year, that is, at the end of an observation period.[8] As discussed below, including the forecast for government spending in our VAR model allows us to control for anticipated changes in that variable, at least over a horizon of six months.

2.1 VAR specification and identification

We estimate a panel VAR model in order to identify unanticipated shocks to government spending. We use i to index countries and t to index time periods. The VAR model includes six variables: government spending (consumption expenditures), $g_{i,t}$, and GDP, $y_{i,t}$, each measured in logs and real terms, the log of the real exchange rate, $rx_{i,t}$, the ex post real interest rate, $r_{i,t}$, and the net export-to-

[7] Technically, in case of non-fundamentalness, the state-space representation of the approximate model solution cannot be inverted into an infinite-order VAR representation in the variables observed by the econometrician. In practice, VAR models are estimated on a finite number of lags. This may give rise to lag-truncation bias, an issue which we ignore in what follows, see Chari, Kehoe, and McGrattan (2008).

[8] As discussed in detail by Auerbach and Gorodnichenko (2012), these forecasts have been shown to perform quite well. Auerbach and Gorodnichenko (2012) use these data to estimate government spending multipliers on the basis of local projections, contrasting results for recessions and booms.

GDP ratio, $nx_{i,t}$. Finally, we include $fc_{i,t}^{t+1}$, which denotes the period-t forecast of the growth rate of government spending for period $t+1$. We use the forecast of the growth rate rather than the level forecast, because the base year used by the OECD changes several times during our sample period. Data sources, variable definitions and a list of countries included in the analysis are provided in the appendix.

Our vector of endogenous variables, $x_{i,t}$, is given by

$$x_{i,t} = \begin{bmatrix} g_{i,t} & fc_{i,t}^{t+1} & y_{i,t} & rx_{i,t} & r_{i,t} & nx_{i,t} \end{bmatrix}'.$$

The VAR model reads as follows

$$x_{i,t} = \mu_i + \sum_{k=1}^{2} C_k x_{i,t-k} + u_{i,t},$$

where μ_i denotes a vector of constants, capturing country fixed effects. In the estimation, we also control for time fixed effects and remove country-specific linear time trends. C_k are appropriately defined matrices.

We identify government spending shocks by assuming that government spending is predetermined relative to the other variables in the VAR model. This assumption is in spirit of Blanchard and Perotti (2002), but more restrictive, as we consider semiannual rather than quarterly data.[9] Given the reduced form innovations, u_t, the mutually uncorrelated structural shocks, ε_t, are recovered on the basis of the mapping $\varepsilon_t = A^{-1}u_t$, where A is assumed to be a lower-triangular matrix. While the zeros in the first row of A reflect our identification assumption, the remaining zeros are a convenient normalization (see Christiano, Eichenbaum, and Evans 1999). Under this identification scheme, all variables, including the forecast of government spending growth for the next six months, are allowed to respond contemporaneously to a government spending shock.

We depart from earlier studies which employ variants of the Blanchard-Perotti identification scheme, notably CMM and IMV, as we include the forecast for spending growth in the VAR model. This allows us to identify better the effects of *unanticipated* spending shocks in the face of exogenous, but *anticipated* changes of government spending. To assess this formally, we rely on an extended version of the open economy model outlined in section 3 below.[10] In addition to unanticipated shocks

[9] In fact, it is often argued that governments may easily respond to the state of the economy within a year, or even within six months, in order to, say, stimulate the economy via increased spending. Yet Born and Müller (2012) test the restriction that government spending does not respond to the variables typically included in VAR models within an entire year. They consider quarterly time-series data for four OECD countries and find the restriction cannot be rejected. Beetsma, Giuliodori, and Klaassen (2009) report similar results.

[10] Giannone and Reichlin (2006) put forward an alternative test of fundamentalness of the shocks recovered from a VAR model. It does not rely on a particular model, but on extending the vector of observable variables used in the VAR. If additional variables Granger cause the original set of variables, the shocks recovered from the original VAR model are shown to be non-fundamental.

to government spending, this model version features also government spending shocks which are anticipated over a horizon of six month. Given the model, we test whether the “poor man’s invertibility condition” developed by Fernández-Villaverde et al. (2007) is satisfied. We find that including fc_t^{t+1} in the vector of observable variables may be critical for ensuring invertibility.

Generally, however, results depend on the specific parameter values under which the open economy model is solved. Moreover, as Leeper et al. (2012) make clear, the problems associated with non-invertibility are not $0-1$: a model can fail the poor man’s test, but quantitatively the non-invertibility might not be a problem for inference (see also Sims and Zha 2006). We therefore conduct a number of Monte Carlo experiments to assess the performance of our VAR model. We find that dropping fc_t^{t+1} from the vector of observable variables can affect the VAR performance adversely if anticipated changes to government spending are an important source of business cycle fluctuations.[11]

Before turning to the results, we note that we estimate the panel VAR for countries with fixed and floating exchange rates separately. In classifying countries according to exchange rate regimes we draw on the IMF “de facto” exchange rate classification (see e.g. Ghosh, Ostry, and Tsangarides, 2010) which we extend to match our sample period. Specifically, we consider all countries with an exchange rate regime of “pegged within horizontal bands” or tighter as a country with a fixed exchange rate (values of 1-7 in the fine classification). Conversely, countries with a more flexible exchange rate are classified as countries with a floating exchange rate regime. Note that, for our sample, our classification yields an identical sample split as one based on the “de jure” classification of the IMF. Figure A.1 in the appendix provides details. In our discussion of the results we use “peg” and “fixed exchange rate regime” interchangeably.

2.2 Results for baseline specification

In figure 1 we report results for the baseline VAR model. It displays the dynamic effects of an exogenous and unanticipated increase in government spending by 1% of GDP. The solid line displays the point estimate, shaded areas indicate 90 percent confidence bounds obtained by bootstrap sampling. On the vertical axes government consumption, net exports, and output are measured in percentage points of output relative to trend. The output response thus provides a measure for the government spending multiplier on output. The real exchange rate is measured in percentage deviations from trend, while the real interest rate and the spending growth forecast are measured in semiannual percentage points. The horizontal axes measure time in half year units.

The left column shows results for our sample of countries which we classify as countries with a fixed

[11] Specifically, we consider a scenario where government spending shocks account for 20 percent of output volatility, with anticipated and unanticipated shocks contributing equally. In this case including fc_t^{t+1} in the set of observable variables hardly matters. If, however, anticipated spending shocks account for 19 percent of output volatility (and unanticipated spending shocks therefore for only 1 percent), including fc_t^{t+1} in the VAR is critical for accurately estimating the true impulse responses. Results are available on request.

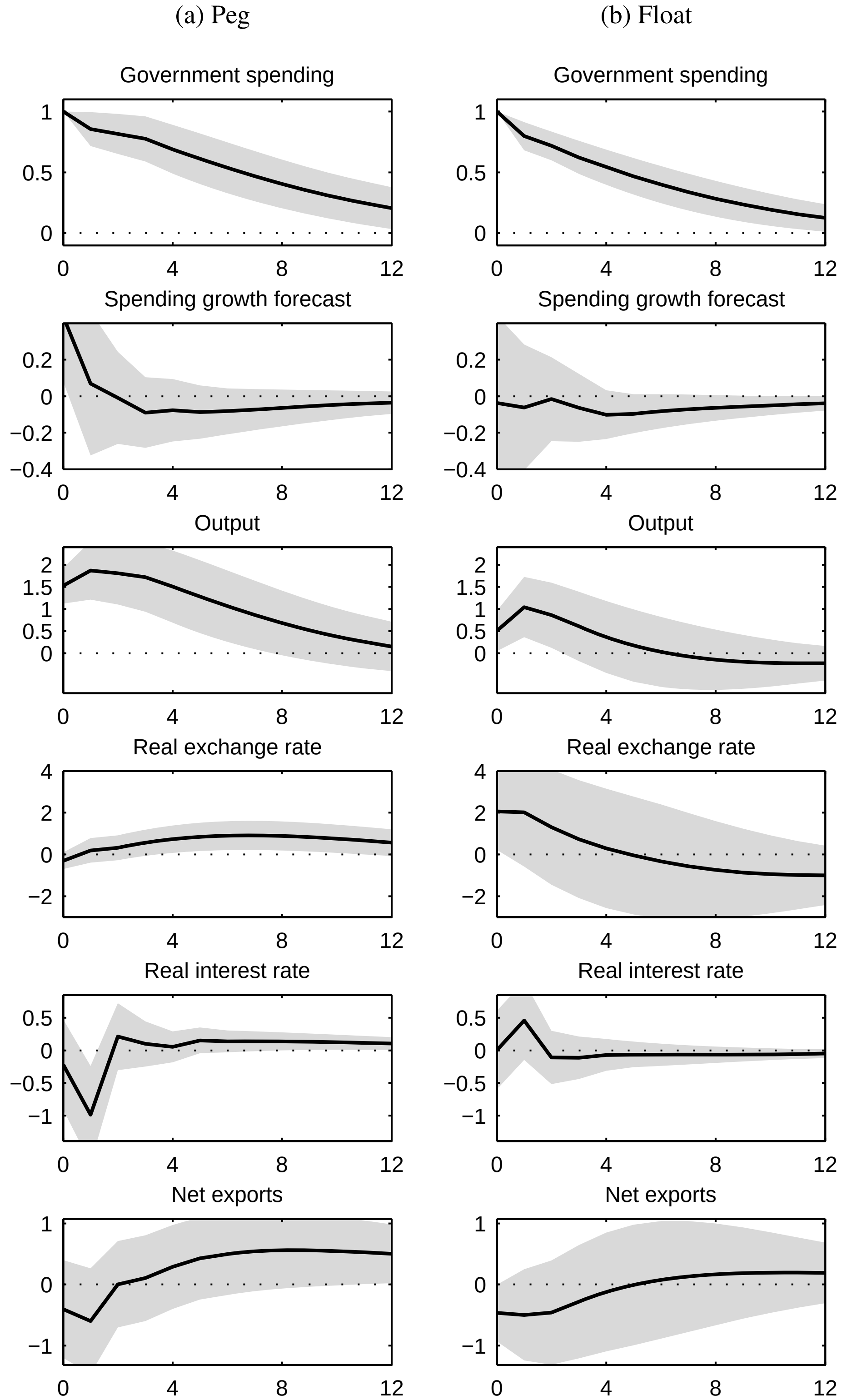

Figure 1: Impulse responses to unanticipated government spending shock. Notes: exogenous increase of government spending by 1% of GDP. Solid lines: point estimates; shaded areas: bootstrapped 90% confidence intervals. Horizontal axes indicate half years. Vertical axes measure percentage deviation from trend in output units (government spending, GDP, and net exports), percentage deviations from trend (real exchange rate), and semiannual percentage points (real interest rate and spending growth forecast).

exchange rate regime. The right column shows results for the floaters. The response of government spending, shown in the first row, displays a gradual decline after the initial impulse. It shows a somewhat higher degree of persistence under fixed exchange rates. The response of the growth forecast for government spending, shown in the second row, is consistent with these dynamics to the extent that it shows a negative response. For, after the initial increase, government spending growth decelerates as government spending returns to its trend level. A positive impact response of the growth forecast under the peg may partly reflect the higher persistence of government spending under the peg, but also additional information contained in the OECD forecast for government spending.

The response of output is shown in the third row. The impact effect is estimated to be 1.5 under fixed exchange rates and 0.5 under floating exchange rates. The dynamic adjustment is hump-shaped under both exchange rate regimes, but more strongly so under floating exchange rates. Under fixed exchange rates, output returns to its trend level after about six years; under floating rates, the trend level is reached after about three years. During the first two years after the shock, the fiscal multiplier averages at about 0.75 (1.7) percentage points of GDP under a float (peg). We refer to this as the "short-run" multiplier.[12]

The fourth row of figure 1 displays the response of the real exchange rate. It appreciates under both exchange rate regimes, yet the dynamic adjustment differs. On impact, there is no appreciation under a peg, but a marginally significant appreciation under a float by almost two percent. Over time the initial response is reversed, as the exchange rate appreciates significantly under the peg reaching a maximum of almost one percent. Under the float, the (insignificant) point estimate suggests real depreciation after about 2 years.

The response of the short-term real interest rate is reported in the fifth row of figure 1. As it reflects the joint adjustment of the short-term nominal interest rate and the inflation rate, it provides a comprehensive measure of the monetary policy stance during the transmission of government spending shocks.[13] In the short run, we find a rather sharp decline of the real interest rate under a peg and a somewhat more moderate increase under floating exchange rates. In the medium-term the sign of the response of real rates is reversed. Finally, the response of net exports (shown in the last row of figure 1) is quite similar across exchange rate regimes. We find a decline of the trade balance by about 0.5 percent of GDP during the first year after impact. Under both regimes, the trade balance recovers and moves into positive territory after one (peg) and three (float) years.

In sum, we find sizeable differences of the fiscal transmission mechanism across exchange rate regimes. We assess whether these differences are significant by bootstrapping samples for which

[12]If we normalize the average output response over the first two years with the average government spending response over the first two years, we obtain values of 0.9 and 2, respectively.

[13]In an alternative specification, we include both the short-term nominal interest rate and the inflation rate, rather than the real interest rate. Our results are robust with respect to this specification, see figure A.2 in the appendix.

Table 1: Bootstrapped Impulse Responses to Spending Shock[a]

Variable	Horizon	Peg	Float	Peg - Float
Spending	1	1.00 (0.00)	1.00 (0.00)	0.00 (0.00)
	2	0.79 (0.08)	0.73 (0.07)	0.06 (0.11)
	4	0.60 (0.11)	0.47 (0.08)	0.12 (0.14)
Output	1	1.48 (0.25)	0.50 (0.28)	0.98 (0.36)
	2	1.69 (0.40)	0.98 (0.42)	0.71 (0.57)
	4	1.20 (0.47)	0.24 (0.48)	0.97 (0.66)
Real exchange rate	1	-0.22 (0.24)	1.94 (1.12)	-2.18 (1.13)
	2	0.33 (0.36)	1.66 (1.58)	-1.34 (1.62)
	4	0.76 (0.38)	-0.78 (1.72)	1.54 (1.77)
Real interest rate	1	-0.19 (0.42)	0.01 (0.37)	-0.20 (0.55)
	2	-0.92 (0.45)	0.48 (0.37)	-1.40 (0.59)
	4	0.22 (0.21)	-0.16 (0.20)	0.38 (0.29)
Net exports	1	-0.38 (0.49)	-0.45 (0.28)	0.07 (0.57)
	2	-0.51 (0.52)	-0.39 (0.45)	-0.11 (0.70)
	4	0.36 (0.43)	0.16 (0.56)	0.20 (0.71)

[a]horizon measured in half-year units, standard errors in parentheses.

we compute the difference between the responses under peg and float. Table 1 reports, for selected horizons, the average responses for the cases of peg, float, and the difference between peg and float. Standard errors are in parentheses. According to this statistic, the impact response of output is significantly different across exchange rate regimes. Moreover, we detect a significant difference in the responses of the real interest rate at horizon 2. Yet there are no significant differences in the responses of the real exchange rate and net exports. This finding casts into doubt the mechanism which governs the difference in output multipliers according to the Mundell-Flemming model. Before we attempt to reassess the evidence on the basis of a New Keynesian small open economy model, we compare our findings to those of earlier studies and explore the robustness of our results.

2.3 Relation to other studies and sensitivity analysis

Overall, our results – notwithstanding some noteworthy differences – are well in line with those reported by earlier studies, in particular those of CMM and IMV. Before discussing differences, we highlight what strikes us as a high degree of accordance. This accordance is particularly remarkable, because CMM and IMV consider different data samples and data frequencies, and pursue different econometric strategies.[14] Moreover, CMM and IMV employ an alternative exchange rate classification scheme. Specifically, CMM and IMV define as "peg" an exchange rate regime of "a de facto crawling band narrower than or equal to +/-2 %" or tighter (values of 1-8 in the classification of Ilzetzki, Reinhart, and Rogoff 2009). Countries with a more flexible exchange rate regime are classified as "floaters". We also report results based on this classification scheme below (IRR-based classification, for short).

Comparing our baseline results to CMM and IMV, we note that both also report spending shocks to be more persistent under fixed exchange rates and, importantly, that output multipliers are considerably larger in this case. Regarding the real exchange rate under floating exchange rates, IMV report adjustment dynamics very similar to ours, including an appreciation in the short run and a depreciation in the medium run. CMM, in turn, find a depreciated real exchange rate throughout, in line with a number of recent studies focusing on individual countries with flexible exchange rate (see Kim and Roubini (2008), Enders, Müller, and Scholl (2011), and Corsetti, Meier, and Müller (2011b) for evidence for the U.S.; Monacelli and Perotti (2010) and Ravn, Schmitt-Grohé, and Uribe (2012) for evidence for a number of OECD countries). For fixed exchange rates, CMM find an appreciation, in line with our result, as do Canova and Pappa (2007) in their analysis of U.S. states and EMU members.[15] IMV find an insignificant response for the real exchange rate in this case.

Turning to the response of interest rates, a comparison is less straightforward because different studies focus on different concepts. Interestingly, however, IMV report a decline of policy rates under fixed exchange rates and an increase under floating exchange rates. To the extent that inflation adjusts sluggishly, this pattern of adjustment squares well with our finding for the behavior of real interest rates. To explore this issue more directly, we estimate a VAR model which includes the nominal interest rate as well as inflation, rather than the short-term real interest rate. We find our basic conclusions unaffected by these changes. Figure A.2 displays the impulse responses, with rows 5 and 6 showing the dynamic adjustment of the nominal short-term interest rate and inflation, respectively. The response of nominal interest rates, in particular, is in line with the findings of IMV.

Finally, regarding net exports, also CMM and IMV find no evidence for crowding out effects to

[14] IMV estimate a panel VAR model using quarterly data for 44 countries and group countries according to fixed and floating exchange rates. The data availability differs across countries, but for the majority of countries observations are available from the mid-1990s onwards. CMM consider annual data for 17 OECD countries ranging from 1975 to 2008 and pursue a two-step strategy. Government spending shocks are identified in the first step on the basis of estimated fiscal rules. In the second step, the effects of government spending shocks are estimated while controlling for the exchange rate regime, but also for fiscal and financial crises.

[15] Beetsma, Giuliodori, and Klaasen (2008) and Bénétrix and Lane (2012) report an appreciation of the real exchange rate for EU and euro area countries, respectively. In both instances, the sample includes the euro period as well as instances of more flexible exchange rates.

be stronger under floating exchange rates. In fact, IMV find that net exports increase under both exchange rate regimes, and significantly so under floating exchange rates. CMM find a significant decline of net exports, but only under fixed exchange rates. More generally, however, we note that the literature has not reached a consensus regarding the sign of the response of the trade balance to fiscal shocks.[16]

Despite the high overall accordance of results, we find two noteworthy differences vis-à-vis either CMM or IMV, or both. First, while we find a positive and significant output response, CMM and IMV find no significant output response for floating exchange rate regimes. While their finding squares well with the prediction of the basic Mundell-Fleming model, it conflicts with results obtained by various studies for individual countries which operate a floating exchange rate regime, see, e.g., Perotti (2007), Monacelli and Perotti (2010), Ramey (2011) or Ravn et al. (2012). In fact, the majority of these studies suggests a positive output response to higher public spending (see Hall (2009) for a recent discussion of the evidence for the U.S.). Eventually, however, reconciling these conflicting findings requires more evidence on a country-by-country basis which will likely be forthcoming as more and longer times-series data become available.

Second, CMM report – in contrast to IMV and our results – that nominal interest rates increase under fixed exchange rates and decline under floating exchange rates in response to a government spending shock. As CMM report a muted response of inflation, the implied response of real interest rates also differs from what we find. CMM stress that their finding conflicts with the notion that monetary policy is more accommodative under a peg. They account for their finding by observing that their sample period (starting in 1975) comprises episodes when central banks had to defend a currency peg by raising interest rates in the face of tensions in the currency market triggered by expansionary fiscal policies. This possibility is unaccounted for in models assuming a perfectly credible exchange rate peg.

As a distinct feature of our analysis (relative to CMM and IMV), we attempt to control for anticipated changes of government spending. One may thus ask to what extent this feature accounts for differences in the results. To address this question we estimate our VAR model without the forecast for government spending growth. Results (dashed red lines) are shown and contrasted with those for the baseline VAR model (solid black lines) in figure A.3 in the appendix. It turns out that differences are rather moderate. In the light of this result and given the Monte Carlo results discussed in section 2.1 above, we conjecture that anticipation of changes in government spending play a limited quantitative role for the dynamic adjustment to unanticipated government spending shocks.[17] Of course, this is

[16]For the U.S., Kim and Roubini (2008) and Müller (2008), among others, find an increase, Monacelli and Perotti (2010) find a decline of the trade balance due to expansionary fiscal shocks. Corsetti and Müller (2006) and Cardi and Müller (2011) document differences across countries.

[17]For the U.S., results by Perotti (2011) suggest a similar interpretation.

subject to the caveat that we control for anticipated spending changes over a horizon of six months only.[18]

A second major difference of our study relative to CMM and IMV is our reliance on the IMF-based exchange rate classification scheme. We therefore consider two alternatives. First, we consider the IRR-based classification. Second, we restrict the fixed exchange rate sample to euro area countries since 1999. This addresses the concern that for our baseline group of countries with fixed exchange rates, parities have been neither fully fixed, nor fully credible. In fact, nominal exchange rates have been fluctuating in some of the countries which are classified as pegs. Results are shown in figure A.4 in the appendix. Overall, they are quite similar to those obtained under the baseline specification. An exception is the behavior of the real exchange rate for the euro sample, as we find less of an appreciation than in the baseline model.[19]

Finally, we conduct additional experiments exploring further the robustness of our results. This includes an alternative setup where we limit our sample to the period up to 2007:2, that is, we drop the observations for the period of the global financial crisis. This addresses concerns that policy makers have been extraordinarily quick in using fiscal policy as a stabilization tool during the crisis. Yet we find that results are fairly similar to those obtained for the baseline case. Importantly, while the output responses are weaker relative to baseline, the difference across exchange rate regimes remains quite sizeable. We also ensure that our results are not driven by the inclusion of a particular country in our sample. We therefore re-estimate the panel VAR model for countries with fixed and floating exchange rate regimes, dropping one country at a time. We find results for the baseline specification are not dominated by observations for a single country.[20] Moreover, we estimate the panel VAR using a mean-group estimator (see Pesaran and Smith 1995). This estimator yields consistent estimates of the average effects under slope heterogeneity as the number of time periods increases to infinity. Overall, we find results similar to the estimates reported above, notably regarding the difference of the size of the fiscal multiplier across both exchange rate regimes. Yet we find that due to the limited number of time periods for the individual countries in our unbalanced sample, estimates at the country level are estimated somewhat imprecisely.[21]

[18] Instead, the results of Ramey (2011) are likely to depend on large military episodes where rising expenditure is arguably anticipated over longer horizons.

[19] Related, we also explored to what extent our results depend on the definition of the exchange rate. Note that the baseline VAR model includes the real effective exchange rate of a country. Results are virtually unchanged if we consider instead the real exchange rate only vis-à-vis the countries with which a fixed nominal exchange rate is maintained.

[20] Results of both experiments are reported in the working paper version of this paper, see Born, Juessen, and Müller (2012).

[21] Hence, we rely on the pooled estimation results as our baseline case. Note also that Rebucci (2010) provides Monte Carlo evidence showing that (i) slope heterogeneity must be very high to be a serious problem for the pooled fixed effects estimator and (ii) in cases where the heterogeneity bias of the fixed effects estimator is indeed sizeable, the time dimension of the panel has to be very long for the mean group estimator to outperform the pooled fixed effects estimator. A natural alternative to our baseline approach – which we intend to pursue in future research – is thus to resort to Bayesian mean-group estimation.

3 A structural account of the fiscal transmission mechanism

In the following we interpret the time-series evidence through the lens of a standard New Keynesian model. Specifically, we consider a variant of the small open-economy workhorse model suggested by Galí and Monacelli (2005).[22] Corsetti et al. (2011a) analyze the fiscal transmission mechanism in this model, both under fixed and floating exchange rates. They show that government spending tends to crowd out private expenditure under both exchange rate regimes.[23] As a result, provided that net exports are not very responsive to changes in government spending, the government spending multiplier will be smaller than one. To account for our empirical finding that the multiplier exceeds unity under fixed exchange rates, we allow for a financial friction, whereby a fraction of households is excluded from financial markets, as in Galí, López-Salido, and Vallés (2007) and Bilbiie et al. (2008).

3.1 Model

Given that the model is standard, our exposition is kept short and focuses on the domestic economy and its interaction with the rest of the world (ROW, for short).[24] Alternatively, in case we consider a fixed exchange rate regime, one may think of the ROW as the rest of the monetary union. In either case, assuming that we are dealing with a small open economy allows us to ignore possible feedback effects of domestic shocks via the ROW. However, the domestic economy is specializing in the production of a particular set of goods such that domestic developments generally alter the economy's terms of trade. While this has no consequences for the ROW (the weight of domestically produced goods is zero in world consumption), it affects - because of home bias in domestic consumption - the real exchange rate as well as the consumption-based real interest rate. We now briefly describe the behavior of the different agents in the model and state the equilibrium conditions.

3.1.1 Final good firms

Competitive final good firms bundle domestically produced intermediate goods, $Y_{H,t}(j)$, as well as imported intermediate goods, $Y_{F,t}(j)$, into final goods, C_t. Using $j \in [0, 1]$ to index intermediate good firms as well as their products and prices, the CES aggregation technology of final good firms

[22] Assuming a small open economy facilitates the analysis considerably, but rules out spillover effects. Erceg and Lindé (2012a) use a medium-scale DSGE model and compare the effects of spending cuts and tax hikes in a monetary union, highlighting the role of the exchange rate regime as well as spillover effects; see also Beetsma, Giuliodori, and Klaasen (2006) and Corsetti and Müller (2011).

[23] This holds true only to the extent that there is no endogenous adjustment of government spending giving rise to spending reversals.

[24] In outlining the model we draw on Corsetti et al. (2011a), but we consider a somewhat simplified setup. In particular, we assume that production is linear in labor, international financial markets are complete, and government spending is determined exogenously.

is given by

$$C_t = \left[(1-\omega)^{\frac{1}{\sigma}} \left(\left[\int_0^1 Y_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}} \right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left(\left[\int_0^1 Y_{F,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} . \quad (1)$$

Here, σ measures the trade-price elasticity, that is, the extent of substitution between domestically produced goods and imports triggered by a change in the terms of trade. $\epsilon > 1$ measures the price elasticity across intermediate goods produced within the same country, while ω measures the weight of imports in the production of final goods.

Expenditure minimization implies the following price indices for domestically produced and imported intermediate goods, respectively,

$$P_{H,t} = \left(\int_0^1 P_{H,t}(j)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}, \qquad P_{F,t} = \left(\int_0^1 P_{F,t}(j)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}} . \quad (2)$$

The price of consumption is given by

$$P_t = \left((1-\omega) P_{H,t}^{1-\sigma} + \omega P_{F,t}^{1-\sigma} \right)^{\frac{1}{1-\sigma}} . \quad (3)$$

For the ROW, we assume an isomorphic aggregation technology.

3.1.2 Intermediate good firms

Intermediate goods are produced under imperfect competition according to the linear production function: $Y_{H,t}(j) = H_t(j)$, where $H_t(j)$ measures the amount of labor employed by firm j. Price setting is constrained à la Calvo (1983). Each period, an intermediate firm can re-optimize its price with probability $1-\xi,\ 0 < \xi < 1$. Given this possibility, a generic firm j sets $P_{H,t}(j)$ in order to maximize its discounted stream of future profits

$$\max E_t \sum_{k=0}^{\infty} \xi^k \Lambda_{t,t+k} Y_{H,t,t+k}(j) \left[P_{H,t}(j) - W_{t+k} \right], \quad (4)$$

where $\Lambda_{t,t+k}$ denotes the stochastic discount factor. $Y_{H,t,t+k}(j)$ denotes demand in period $t+k$ if prices have been set optimally in period t. W_t denotes the wage and E_t denotes the expectations operator. Prices are set in the producer's currency. Moreover, we assume that the law of one price holds at the level of intermediate goods.

3.1.3 Households

To capture the possible importance of financial frictions for fiscal policy transmission – albeit in a stylized manner – we assume that households differ in their ability to participate in asset markets.[25]

[25] Earlier work by Galí et al. (2007) suggests that such frictions may be important to account for the dynamics of private expenditure after a government spending shock (see also Leeper et al. 2011).

Following Bilbiie et al. (2008) we assume that our model is populated by a continuum of households $[0, 1]$, only a fraction $1-\lambda$ of which are 'asset holders', indexed with a subscript 'A'. These households own firms and trade assets, both domestically and internationally. The remaining households do not participate at all in asset markets, that is, they are 'non-asset holders', indexed with a subscript 'N'.

Asset holders A representative asset-holding household chooses consumption, $C_{A,t}$, and supplies labor, $H_{A,t}$, to intermediate good firms in order to maximize

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{C_{A,t+k}^{1-\gamma}}{1-\gamma} - \frac{H_{A,t+k}^{1+\varphi}}{1+\varphi} \right). \tag{5}$$

We assume that asset-holding households trade a complete set of state-contingent securities with agents in the ROW. Let Ξ_{t+1} denote the payoff in units of domestic currency in period $t+1$ of the portfolio held at the end of period t. The budget constraint of an asset-holding household is given by

$$E_t \left\{ \Lambda_{t,t+1} \Xi_{t+1} \right\} + P_t C_{A,t} = W_t H_{A,t} + \Xi_t + \Upsilon_t - T_t \ , \tag{6}$$

where T_t are nominal lump-sum taxes, and Υ_t denotes profits of intermediate good firms.

Non-asset holders A representative non-asset holder chooses consumption, $C_{N,t}$ and labor, $H_{N,t}$, in order to maximize its utility flow on a period-by-period basis

$$\frac{C_{N,t}^{1-\gamma}}{1-\gamma} - \frac{H_{N,t}^{1+\varphi}}{1+\varphi} \ , \tag{7}$$

subject to the constraint that consumption expenditure equals net income

$$P_t C_{N,t} = W_t H_{N,t} - T_t \ . \tag{8}$$

3.1.4 Government

The conduct of monetary policy depends on the exchange rate regime. Under flexible exchange rates, we assume that the central bank sets the nominal short-term interest rate, R_t, following a Taylor-type rule:

$$\log(R_t) = \log(R) + \phi_\pi(\Pi_{H,t} - \Pi_H) + \phi_y \log(Y_t/Y), \tag{9}$$

with $\Pi_{H,t} = P_{H,t}/P_{H,t-1}$ measuring domestic inflation, Y_t measuring aggregate output (defined below), and (here as well as in the following) variables without a time subscript referring to steady-state values. Under this specification, the nominal exchange rate is free to adjust in accordance with the equilibrium conditions implied by the model.

Under fixed exchange rates, the monetary authorities are required to adjust the policy rate so that the exchange rate remains constant at its steady-state level. A feasible policy that ensures this as well as equilibrium determinacy is given by:

$$\log(R_t) = \log(R_t^*) + \phi_{\mathcal{E}} \log(\mathcal{E}_t/\mathcal{E}), \tag{10}$$

where R_t^* and $\mathcal{E}_t$ are the nominal interest rate in the ROW and the nominal exchange rate (the price of domestic currency in terms of foreign currency), respectively. Assuming $\phi_{\mathcal{E}} > 0$ ensures equilibrium determinacy, see Ghironi (2000) and Benigno, Benigno, and Ghironi (2007). The rule (10) implies that the nominal exchange rate is constant at all times. The implied equilibrium allocation is therefore equivalent to the one obtained in a currency union.

We assume that government spending falls on an aggregate of domestic intermediate goods only:

$$G_t = \left(\int_0^1 Y_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}} \tag{11}$$

and that intermediate goods are assembled so as to minimize costs. Thus the price index for government spending is given by $P_{H,t}$. Government spending is financed either through lump sum taxes, T_t, or through issuance of nominal one-period debt, D_t. The period government budget constraint is then given by

$$R_t^{-1} D_{t+1} = D_t + P_{H,t} G_t - T_t \,. \tag{12}$$

Defining $D_{Rt} = D_t/P_{t-1}$ as a measure for real, beginning-of-period, debt, and $T_{Rt} = T_t/P_t$ as taxes in real terms, we posit that taxation is described by the following feedback rule from debt to the level of taxes:

$$T_{Rt} = \psi D_{Rt}, \tag{13}$$

where ψ captures the responsiveness of taxes to debt. The path of government spending is exogenously given by

$$G_t = (1-\rho)G + \rho G_{t-1} + \varepsilon_t \,, \tag{14}$$

where ε_t measures an exogenous iid shock to government spending.

3.1.5 Equilibrium

Aggregate consumption and labor supply are given by

$$C_t = \lambda C_{N,t} + (1-\lambda) C_{A,t} \tag{15}$$

$$H_t = \lambda H_{N,t} + (1-\lambda) H_{A,t}, \tag{16}$$

where $H_t = \int_0^1 H_t(j)dj$ is aggregate labor employed by domestic intermediate good firms.

As a general remark, we note that it is natural to think of C_t as purchases of non-durable consumption goods. To the extent, however, that the model is set up to rationalize the empirical evidence reported above, the amount of purchases of the composite good C_t are meant to represent private spending, that is, the private sector's purchase of investment goods as well as durable and non-durable consumption goods. Under this interpretation the household experiences direct utility from investment goods as, for example, in Rotemberg and Woodford (1997).

Market clearing in the intermediate goods market implies supply to equal demand from final good firms, the ROW, and the government:

$$Y_{H,t}(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon} \left((1-\omega)\left(\frac{P_{H,t}}{P_t}\right)^{-\sigma} C_t + \omega \left(\frac{P^*_{H,t}}{P^*_t}\right)^{-\sigma} C^*_t + G_t\right), \tag{17}$$

where $P^*_{H,t}$, P^*_t, and C^*_t denote the price index of domestic goods expressed in foreign currency, the foreign price level and foreign consumption, respectively.

As in Galí and Monacelli (2005), it is convenient to define an index for aggregate domestic output: $Y_t = \left(\int_0^1 Y_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}$. Substituting for $Y_{H,t}(j)$ using (17) gives the aggregate relationship

$$Y_t = (1-\omega)\left(\frac{P_{H,t}}{P_t}\right)^{-\sigma} C_t + \omega \left(\frac{P^*_{H,t}}{P^*_t}\right)^{-\sigma} C^*_t + G_t. \tag{18}$$

We also define the trade balance in terms of steady-state output, and the real exchange rate as

$$TB_t = \frac{1}{Y}\left(Y_t - \frac{P_t}{P_{H,t}} C_t - G_t\right), \text{ and } Q_t = \frac{P_t \mathcal{E}_t}{P^*_t}, \tag{19}$$

respectively.

3.2 Accounting for the evidence

We now assess to what extent the model can account for the time-series evidence established in section 2. We rely on numerical solutions while considering a log-linear approximation of the equilibrium conditions around a deterministic steady state. For this steady state we assume that trade is balanced and inflation and public debt are zero. In parameterizing the model, we eliminate degrees of freedom by matching the estimated impulse responses under fixed exchange rates. We then contrast the model predictions for the effects of government spending shocks under a floating exchange rate with the VAR evidence.

3.2.1 Calibration

We proceed in two steps to pin down the parameter values. First, we fix parameters that are uncontroversial or easily inferred from first moments of the data. As time periods, we consider half year units. The discount factor, β, is set to 0.98. We assume the coefficient of relative risk aversion, γ, to take the value one. We set the parameter governing openness, ω, to 0.35, matching the average import-to-GDP ratio in our sample. In addition, we assume that government spending accounts for 20 percent of GDP, close to the average in our sample period. The elasticity of substitution parameter for intermediate goods, ϵ, is set to 11, implying a steady-state markup of 10%. In specifying monetary policy under a float, we follow Taylor (1993) and set $\phi_\pi = 1.5$ and $\phi_y = 0.25$ (given that interest rates are measured in semiannual percentage points). We set ψ, the parameter capturing the responsiveness of taxes to debt, to 0.021. This value ensures that public debt is on a non-explosive trajectory.[26] Finally, we fix σ at a relatively low value of 1/3.[27]

In order to obtain estimates for the remaining five parameters, we match empirical (VAR) and theoretical (DSGE) impulse responses (see, e.g., Rotemberg and Woodford 1997 and Christiano, Eichenbaum, and Evans 2005). Let IR^e be the empirical impulse response function obtained from estimating the VAR, and let $IR = IR(\theta)$ be its theoretical counterpart obtained from the DSGE model. Specifically, we focus on the first 11 periods of the responses of government spending, output, the real exchange rage, the (ex post) real interest rate, and net exports (using appropriate definitions in the model).[28] We estimate the parameter vector $\widehat{\theta}$ by minimizing the weighted distance between empirical and theoretical impulse response functions under fixed exchange rates:

$$\widehat{\theta} = \arg\min \left(IR^e - IR(\theta)\right)' W \left(IR^e - IR(\theta)\right), \tag{20}$$

where W represents a diagonal matrix whose entries are the reciprocal values of the variances of the empirical impulse responses.[29] This procedure yields a consistent estimator with asymptotic variance

$$\widehat{Avar}\left(\widehat{\theta}\right) = \left(J'WJ\right)^{-1}\left(J'W\widehat{\Sigma}WJ\right)\left(J'WJ\right)^{-1}, \tag{21}$$

where $J = \nabla_\theta IR$ represents the Jacobian of the impulse response function generated from the model and $\widehat{\Sigma}$ denotes the bootstrapped covariance matrix of the VAR impulse responses.

The parameters we estimate are the inverse of the Frisch elasticity of labor supply, φ, the fraction of 'non-asset holders', λ, the degree of price-stickiness, ξ, and the autocorrelation coefficient for government spending, ρ. The latter parameter governs the exogenous driving process in the model. Rather than pinning it down by matching all impulse response functions (under fixed exchange rates), we allow it to differ across exchange rate regimes. Specifically, we set ρ_{peg} and ρ_{float} by fitting an AR(1) process to the empirical impulse responses of government spending.

[26] Given a log-linear approximation to the equilibrium conditions, stability of public debt requires $\psi > 1/\beta - 1$ if monetary policy is active. Determining ψ by matching impulse responses yields an estimate at the lower bound.

[27] This is a low value for the trade-price elasticity, but close to estimates by several macroeconometric studies (e.g., Lubik and Schorfheide 2006 and Enders and Müller 2009). Determining σ by matching impulse responses yields an estimate of zero.

[28] Our procedure yields very similar parameter estimates if we match, rather than the response of the real interest rate, those of nominal interest rates and inflation, as displayed in figure A.2 in the appendix. Results are available on request.

[29] Our procedure only admits solutions which are saddle-path stable and thus rules out by construction any parameterization of the model which would give rise to equilibrium indeterminacy.

Table 2: Estimated Model Parameters

	ρ_{float}	ρ_{peg}	λ	ξ	φ
Estimate	0.85	0.90	0.34	0.86	1.83
s.e.	(0.04)	(0.03)	(0.53)	(0.14)	(4.34)

We report parameter estimates in table 2. The estimated values for the autocorrelation coefficients reflect our finding that government spending is somewhat more persistent for our sample of countries with fixed exchange rates. Our estimate for λ suggests that financial frictions are sizeable. The estimated share of households excluded from capital markets amounts to about one third and is very close to the estimate reported by Bilbiie et al. (2008) for the U.S. in the post-1980 period based on a very similar (closed-economy) model, but somewhat lower than the values considered in Galí et al. (2007). Regarding ξ, we find sizeable nominal rigidities. *Prima facie* this seems to be in conflict with evidence from microeconomic studies such as Nakamura and Steinsson (2008). Nonetheless, a relatively high degree of price rigidity is consistent with a model with a higher frequency of price adjustment which also allows for real rigidities, such as non-constant returns to scale in the variable factor of production or non-constant elasticities of demand, see, for instance, Galí, Gertler, and López-Salido (2001). To simplify the exposition we abstract from such rigidities. Finally, the value of φ suggests a moderate Frisch elasticity, in line with recent evidence (e.g. Domeij and Flodén 2006).

3.2.2 Model performance

Figure 2 displays the model predictions for the effects of government spending shocks under fixed (left column) and floating (right column) exchange rates together with the respective VAR evidence (replicating the results shown in figure 1 above). In both instances, we consider the dynamic adjustment of selected variables to an unanticipated increase of government spending by one percent of GDP. The horizonal axes measure time in half year units. The model performs well in reproducing the evidence, not only under fixed exchange rates, for which theoretical and empirical impulse responses have been matched, but also under floating exchange rates, that is, with regard to moments that have not been targeted in the model calibration.

The increase of government spending is more persistent under fixed exchange rates. In both cases it is well captured by the AR(1) process assumed in the model. The model also predicts that the impact of government spending on output is larger under a fixed than under a floating exchange rate regime. The short-run multiplier, that is, the average output response over the first four periods, is approximately 1.35 and 0.5 under peg and float, respectively. Similarly, the dynamics of the real exchange rate are captured relatively well by the model. Notably, the hump-shaped dynamics of the real exchange rate under fixed exchange rates is also predicted by the theoretical model.

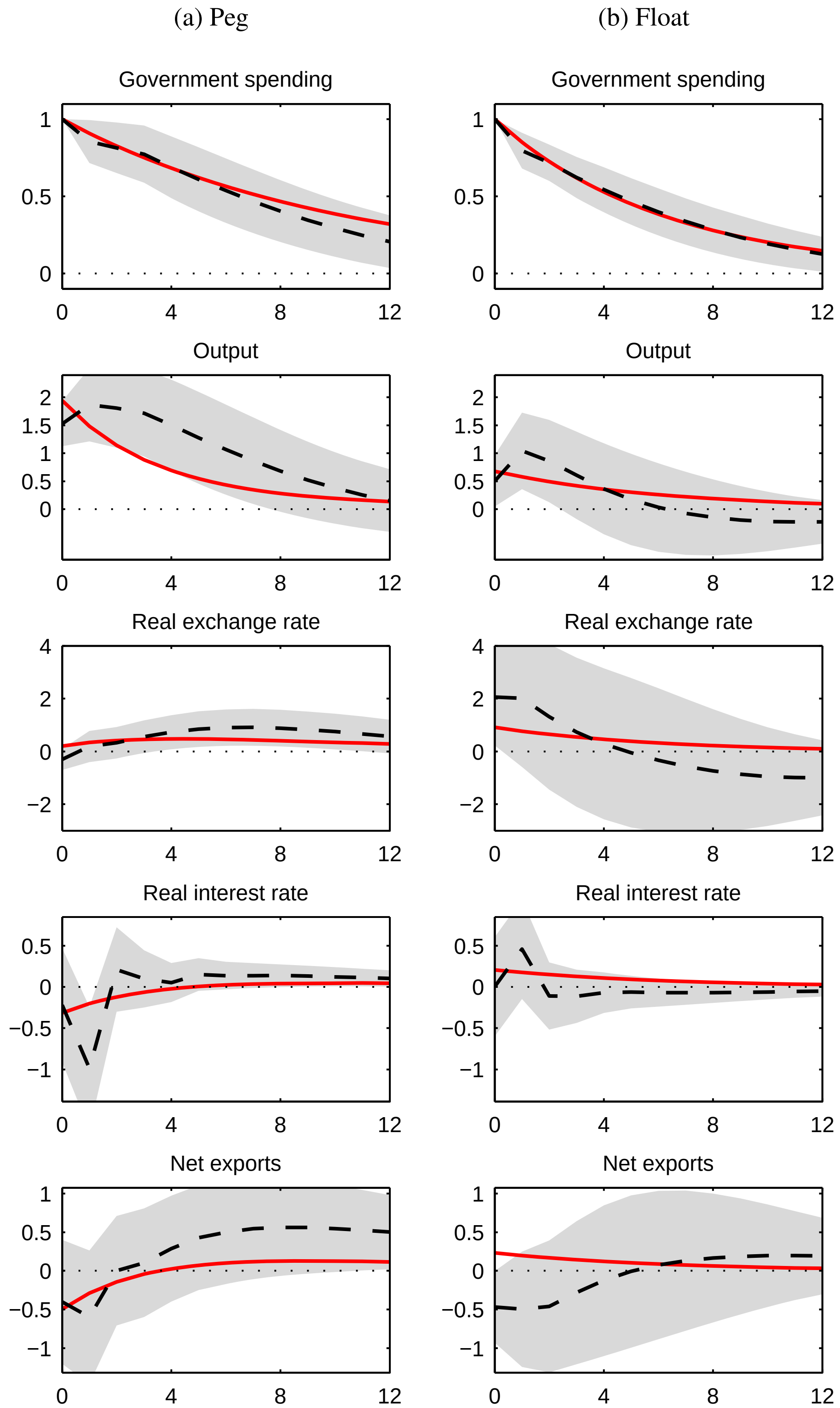

Figure 2: Dynamic adjustment to unanticipated government spending shock in small open economy model and according to VAR estimates. Notes: solid lines display model predictions, dashed lines point estimate of VAR with shaded areas indicating 90 percent confidence bounds, see also figure 1.

Similar observations apply with respect to the responses of the real interest rate and the muted response of net exports. The model captures somewhat better the dynamics under the fixed exchange rate, which have been used as a calibration target. Yet it also predicts the initial increase of the real interest rate under a float – a distinct pattern of adjustment, given the initial decline of real interest rates under the peg. In sum, we find that the model, although quite stylized, is able to account for the time-series evidence on the fiscal transmission mechanism across both exchange rate regimes. Not only does it capture quantitative features of the transmission mechanism. It also predicts the differences across exchange rate regimes quite accurately.

3.3 Inspecting the mechanism

We now use the small open economy model to shed some light on the fiscal transmission mechanism, focusing on the difference across exchange rate regimes. The main object of interest, the short-run multiplier on output, is considerably larger under fixed exchange rates. The behavior of net exports cannot account for this observation, because they are crowded out more strongly under fixed exchange rates – in contrast to what the Mundell-Fleming model suggests. Differences in the short-run multiplier across exchange rate regimes are therefore due to differences in the adjustment of private expenditure to government spending shocks. In the following we explore to what extent this adjustment depends on the exchange rate regime.

Aggregate private expenditure is the sum of expenditures by intertemporally optimizing agents (asset holders) and agents who do not participate in asset markets. How the former adjust to government spending shocks under different exchange rate regimes is analyzed in detail by Corsetti et al. (2011a). Importantly, given a shock to government spending captured by an AR(1) process, they will reduce their expenditures, *irrespective of the exchange rate regime and the initial response of short-term real interest rates*. To see this formally, we use small letters to denote log-linear deviations from steady state and relate consumption expenditures to the entire path of future real interest rates:

$$c_{A,t} = -\frac{1}{\gamma} E_t \underbrace{\sum_{s=0}^{\infty} (r_{t+s} - \pi_{t+1+s})}_{\equiv \bar{r}_t}, \tag{22}$$

where π_t is CPI inflation and $\bar{r}_t$ denotes the long-term real interest rate.[30] The response of asset holders' consumption to government spending can be rationalized through the behavior of long-term real interest rates.

To begin with, note that higher government spending raises inflation, as firms adjust prices upward in the face of higher public demand. Under flexible exchange rates monetary policy follows a conven-

[30]The derivation of expression (22) assumes that the economy is stationary and that there are transitory shocks only. The long-term real interest rate, by the expectations hypothesis, is equivalent to the real rate of return on a bond of infinite duration; see, for example, Woodford (2003), p. 244.

tional interest rate rule whereby it raises the nominal rate more than one-for-one with an increase in inflation (Taylor principle). The short-term real interest rate rises, as do long-term real interest rates – in line with declining expenditures of asset holders. In other words, we observe "crowding out" of private expenditures under a floating exchange rate regime.[31]

Turning to fixed exchange rate regimes, we note that the nominal interest rate is constant in order to maintain the exchange rate parity, as the ROW is unaffected by the domestic fiscal expansion. As inflation increases with higher public demand, the *short-term* real interest rate *declines* initially. However, as PPP holds in the long run and the nominal exchange rate is fixed, the *long-term* real interest rate *increases* on impact with the initial increase of inflation. Intuitively, because of PPP, any initial increase of inflation must be reversed in the long run. Formally, we have $\sum_{t=0}^{\infty} \pi_t = 0$ and therefore

$$\bar{r}_0 = \underbrace{\left(- \sum_{t=0}^{\infty} \pi_{t+1} \right) - \pi_0}_{=0} + \pi_0 = \pi_0.$$

Hence, private expenditures of optimizing agents decline in response to higher government spending under both exchange rate regimes, although the quantitative response may differ. Yet aggregate private expenditures also depend on expenditures of agents who do not participate in asset markets. As discussed in detail by Bilbiie et al. (2008), as firms meet higher public demand, employment and wages tend to increase in the New Keynesian model. This raises disposable income and consumption of non-asset holding households. In fact, the response of private expenditures to higher government spending is determined by how strongly both type of agents adjust their expenditures and their relative weight in the population.

To illustrate these relationships for our calibration, we focus on the short-run response of selected variables, that is, the average response to a government spending shock over the first four periods. The size of the shock is 1 percent of output.[32] In figure 3 we display the responses of output and consumption expenditures for alternative assumptions regarding the exchange rate regime and, more generally, the conduct of monetary policy. Specifically, we increase, in each panel, from left to right the value of ϕ_π and ϕ_y jointly from 1 and 0 to 2 and 0.5, respectively (horizontal axes indicate value of ϕ_π). The dotted vertical line indicates the values of 1.5 and 0.25 used in our simulations above. Solid and dashed black lines measure the response under a peg and float, respectively, for the baseline case with non-asset holders (and, in grey, for a counterfactual scenario with $\lambda = 0$) in percent of output.

The upper left panel shows the impact response of asset holders' expenditures. As discussed above,

[31] Conversely, if monetary policy (temporarily) fails to satisfy the Taylor principle, asset holders' expenditures is crowded in (see Davig and Leeper 2011).

[32] Unless stated otherwise, parameter values are unchanged relative to what was assumed above. We assume throughout a value for the persistence of government spending of $\rho = 0.9$, irrespective of the exchange rate regime.

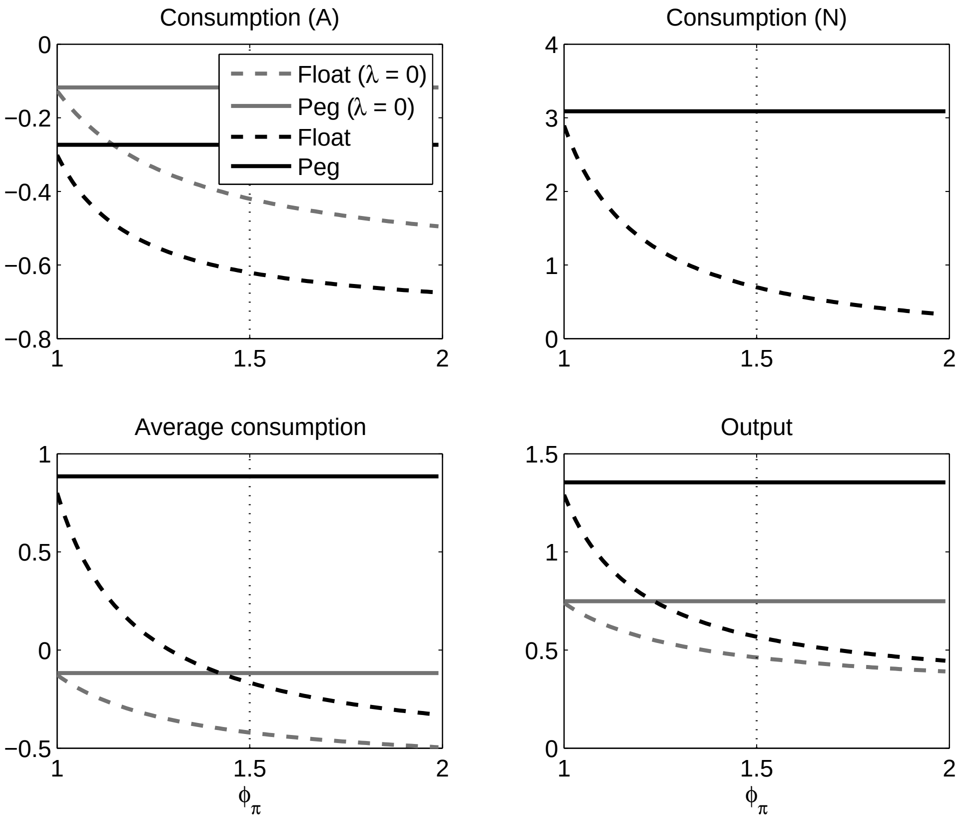

Figure 3: Short-run response of consumption and output to government spending shock by 1% of GDP. Notes: short-run is average over first four periods; vertical axis measures deviation from steady state in percent of output. Horizonal axis measures monetary policy activism (the value of ϕ_π and ϕ_y rises jointly from 1 and 0 to 2 and 0.5). Fixed exchange rate regime given by solid black and grey line (with λ as in baseline scenario and zero, respectively). Float: dashed black and grey line.

the response of consumption of asset holders is always negative, irrespective of the exchange rate regime. Comparing our baseline case with non-asset holders to a counterfactual scenario where all agents have access to asset markets, the influence of monetary policy on asset holders' consumption is apparent: the stronger the response of monetary policy to inflation and output, the larger the increase of the real interest rate and the larger the decline of asset holders' consumption.[33] Yet irrespective of the specific values assumed for the Taylor-rule coefficients, asset holders' consumption declines more under flexible exchange rate, reflecting a tighter monetary stance.

The upper right panel of figure 3 shows the impact response of non-asset holders' expenditure. It is positive under both exchange rate regimes, but larger under a fixed exchange rate regime. Under a floating exchange rate regime, the response becomes weaker, as monetary policy responds more aggressively to inflation and output. Although interest rates do not directly impact the consumption decision of non-asset holders, their consumption response is indirectly affected by the role monetary policy plays for the consumption of asset holders. As a more aggressive monetary policy leads to a stronger decline of asset holder's consumption, aggregate demand, and hence wages rise less relative to a scenario with a more accommodative monetary stance.

Finally, recall that, as net exports decline more strongly under the peg than under the float, the larger multiplier observed under the peg is due to a larger increase of private expenditures. This is borne out by the lower panels of figure 3: they show the average short-run response of consumption (left) and output (right). Aggregate private expenditures rise strongly under the peg and fall under the float, given the assumed values for the monetary policy rule (dotted vertical line). The short-run multiplier thus exceeds unity under the peg, but is only about 0.5 under the float. A looser monetary stance under the float, in turn, would give rise to larger multipliers. Yet in the counterfactual scenario with full asset market participation, private expenditures always decline and the output multiplier is below unity – irrespective of the exchange rate regime and the specific monetary policy stance.[34]

4 Conclusion

The question of how strongly the fiscal multiplier depends on the exchange rate regime has a direct bearing on many policy issues. It has been recently taken up empirically by CMM and IMV as well. Our contribution is twofold.

First, our empirical analysis is based on a panel VAR model, estimated separately on samples of countries with fixed and floating exchange rates. Importantly, and in contrast to CMM and IMV, our data set allows us to address concerns regarding the appropriate timing of the identified government

[33] Whether or not non-asset holders are present in the economy matters for the behavior of asset holders, too. Intuitively, as non-asset holders raise consumption at times when government spending is high, the increase of the real interest rate is stronger and asset holders' decline of consumption is more pronounced.

[34] Leeper et al. (2011) also identify "non savers" as a key model feature in order to obtain large multipliers.

spending shocks. Specifically, in identifying government spending surprise shocks, we are able to control for anticipated changes in government spending, at least over a horizon of six months. Eventually, however, it turns out that this has little bearing on our findings. In fact, we largely confirm those of CMM and IMV. Importantly, multiplier effects tend to be considerably larger under fixed exchange rate regimes.

As a second contribution, we show that a fairly standard version of the New Keynesian small open economy model provides a satisfactory account of the time-series evidence. Importantly, the model is able to capture key features of the transmission mechanism under both exchange rate regimes – also from a quantitative point of view. Moreover, we illustrate that differences in the monetary stance across exchange rate regimes are driving the difference in the multiplier, as in the Mundell-Fleming model. However, these differences play out via an adjustment of the level of private expenditure rather than through a redirection of trade flows.

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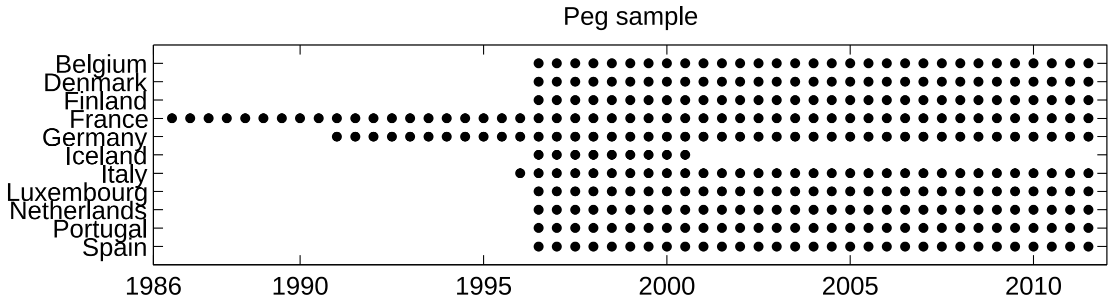
A Appendix

(a) Countries with fixed exchange rate regime.



(b) Countries with floating exchange rate regime.

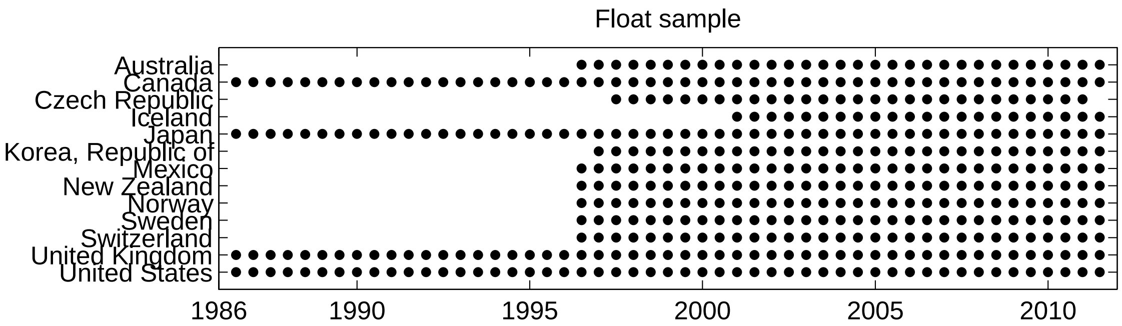


Figure A.1: Data Sample.

Table 3: Data Sources and Definitions

Data	Definition	Data Sources
Government spending	Log of real government consumption	OECD Economic Outlook: final government consumption expenditure (CGV).
Gov. spending growth forecast	Log of real government consumption forecast minus log of real government consumption	OECD Economic Outlook: final gov. cons. expenditure (CGV) (vintage data).
GDP	Log of real GDP	OECD Economic Outlook Database: gross domestic product (GDPV).
Real interest rate	Short-term rate minus actual GDP-deflator inflation	OECD Monthly Monetary and Financial Statistics: short-term interest rate (IRS); OECD Economic Outlook Database: GDP deflator (PGDP).
Real exchange rate	Log of CPI-based real effective exchange rate	OECD Monthly Monetary and Financial Statistics: relative consumer price indices.
Net export-GDP ratio	Exports minus imports divided by GDP	OECD Economic Outlook: exports (XGSV), imports (MGSV).

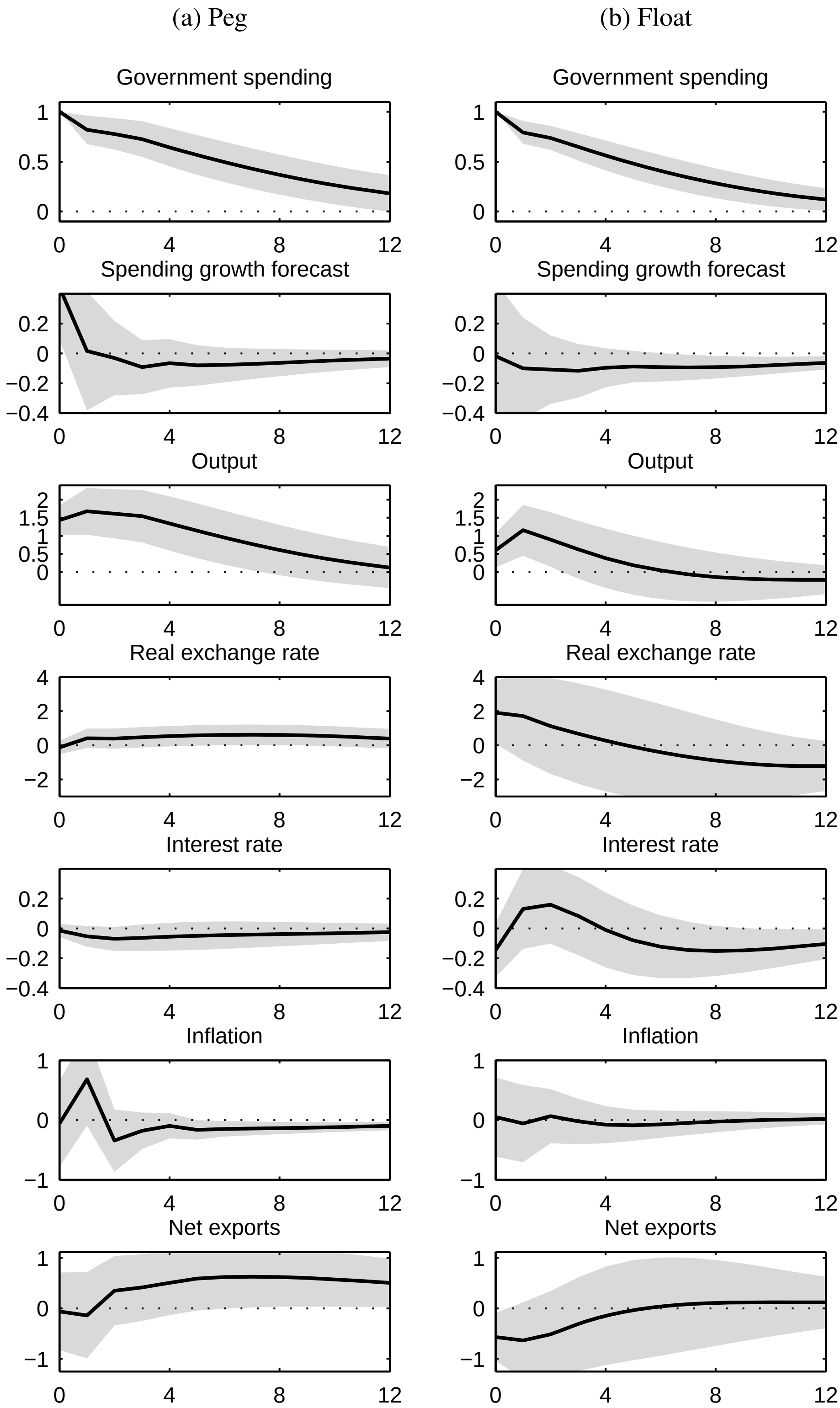


Figure A.2: VAR with short-term nominal interest rate and inflation rate. Notes: see figure 1.

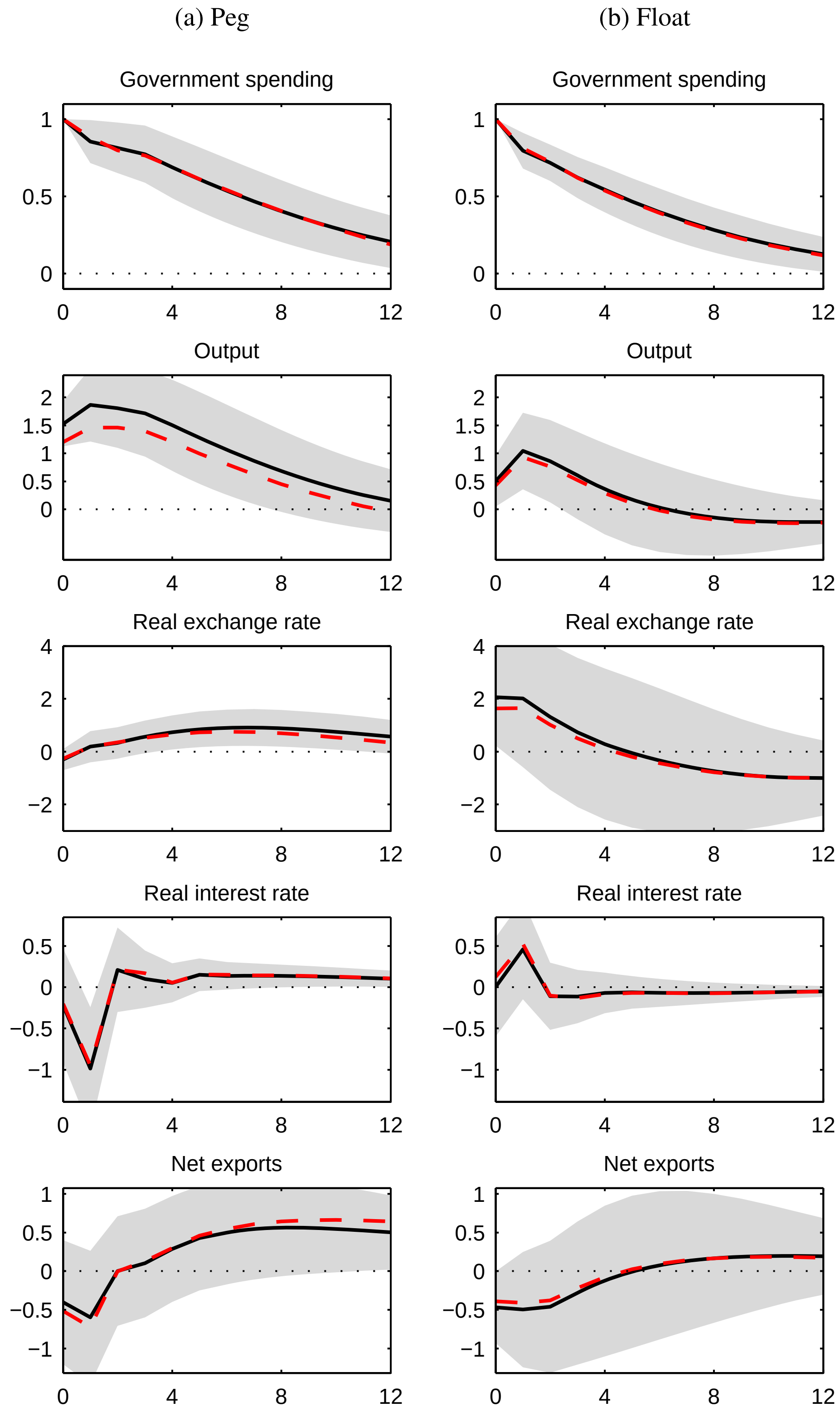


Figure A.3: Impulse responses to unanticipated government spending shock. Notes: see figure 1; solid black: baseline sample (shaded areas indicates bootstrapped 90 percent confidence intervals); dashed red line: VAR model without forecast of government spending growth.

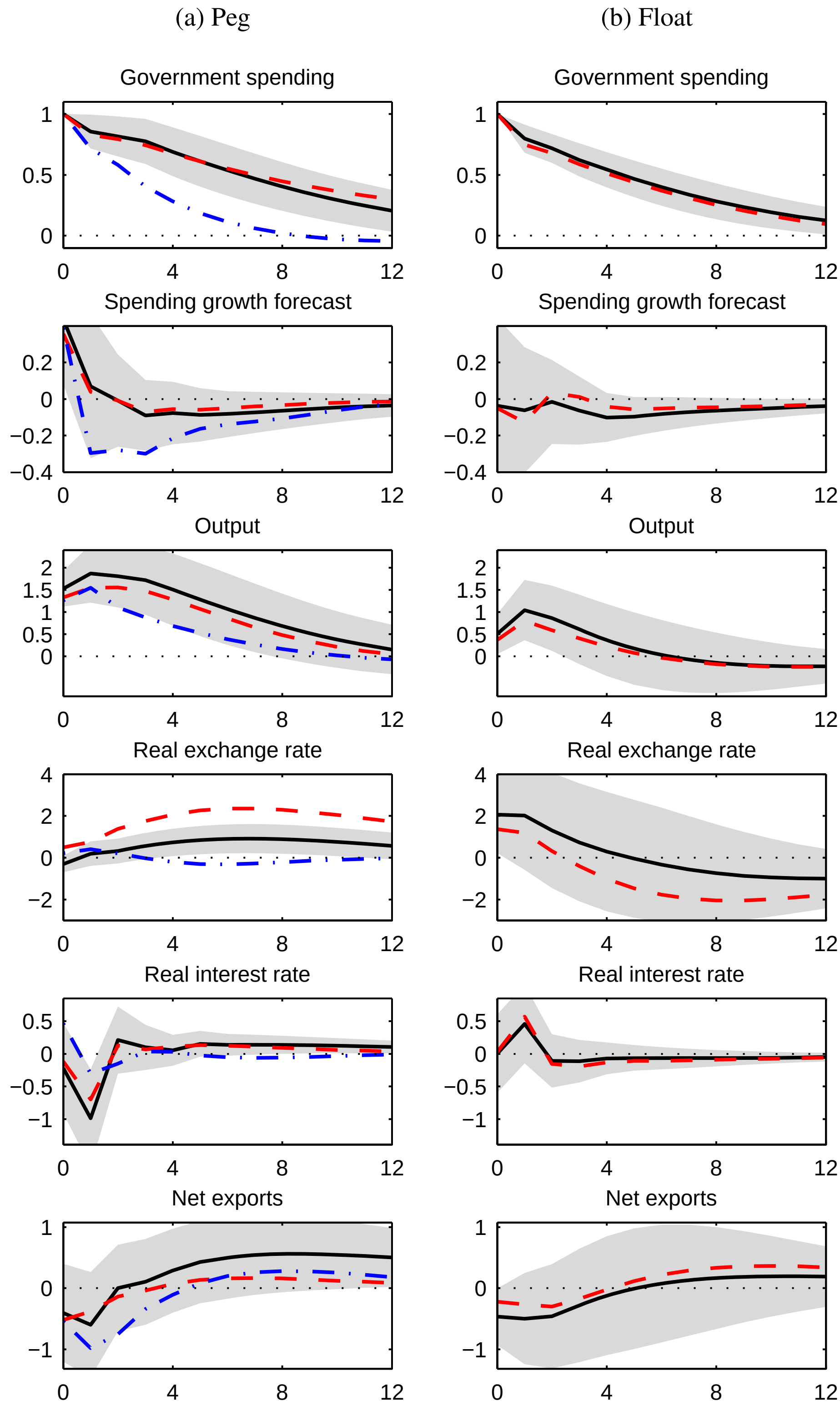


Figure A.4: Different peg/float compositions. Notes: see figure 1; solid black lines: baseline sample (shaded areas: bootstrapped 90 percent confidence intervals); red dashed lines: alternative exchange rate classification; blue dash-dotted lines: euro countries since 1999.