# 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, while government spending multipliers are larger under fixed exchange rate regimes, the difference relative to floating exchange rates is smaller than 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.

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# 1 Introduction

The last couple of years have witnessed extraordinary swings of the fiscal policy stance. At first, since early 2009, several advanced economies embarked on an exceptional fiscal expansion to counter the recessionary impact of the global financial crisis. Prominent examples include the *American Recovery and Reinvestment Act* and the *European Economic Recovery Plan*. More recently, as public debt started to spiral, the focus has shifted towards fiscal austerity. At the time of writing sizeable measures have been implemented, notably in Europe, and further consolidation is projected for the near future. As with the first set of stimulus packages, the likely effects of austerity on economic activity are a key concern in economies with weak growth prospects. The government spending multiplier is a frequently employed, if somewhat crude, statistic to summarize the effects of fiscal policy on economic activity. It measures the percentage change of output due to an increase of government spending by 1% of GDP.[1]

In this paper we ask whether the multiplier depends on the exchange rate regime and, if so, how strongly? This question deserves attention, because several of the European countries subjected to large fiscal adjustments – such as Ireland, Italy or Spain – are members of the European Monetary Union, while others – such as the U.K. – let their currency float freely. Traditional analysis based on the Mundell-Fleming model suggests that the exchange rate regime has a first-order effect on the fiscal 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.[2] In this case, the increased activity due to higher government spending puts upward pressure on interest rates, which triggers capital inflows and leads to 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 empirically explore the role of the exchange rate regime for the size of the fiscal multiplier. Both Acconcia, Corsetti, and Simonelli (2011) and Nakamura and Steinsson (2011) suggest that regional multipliers within monetary unions are indeed size-

[1]Our analysis focuses on the short-run multiplier, more specifically, on the (average) percentage change of output during the first two years after an initial increase of government spending by 1% of GDP. Rather than focusing on the multiplier, one may also investigate the dynamic effects of a specific fiscal adjustment plan, see Cogan, Cwik, Taylor, and Wieland (2010).

[2]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 distinguish between an exchange rate peg and the membership in a currency union. We acknowledge that the two regimes may differ, notably to the extent that the credibility of the exchange rate parity differs. We thus abstract from credibility issues of exchange rate regimes.

able. The latter study reports an "open economy relative multiplier" of 1.5 for U.S. states, the former a point estimate of 1.2 for Italian provinces. These estimates reflect local output effects due to changes in local public spending, that is, fiscal multipliers for members of a currency union. Ilzetzki, Mendoza, and Vegh (2011) perform an empirical analysis which compares multiplier effects across exchange rate regimes. Their sample includes data for 44 developing and industrialized countries. Using a panel VAR framework, they estimate (long-run) multipliers to be sizeable in countries with fixed exchange rates (1.65), but to be zero in countries with floating exchange rates. Corsetti, Meier, and Müller (2011c) report similar results for a panel of OECD countries on the basis of an alternative identification scheme. Taken at face value, these findings support the predictions of the Mundell-Fleming model. However, there is little empirical support for the specific transmission channel at the heart of that model. As documented by Ilzetzki et al. (2011) and Corsetti et al. (2011c), there is neither evidence for a significant real exchange rate appreciation nor for a significant crowding out of net exports under floating exchange rates.

Against this background, the contribution of the present paper is twofold. First, we provide fresh evidence on the fiscal transmission mechanism under fixed and floating exchange rates relying on a unique data set for OECD countries. Using this data set allows us – in contrast to earlier studies – to control for anticipated changes in government spending while estimating the effects of unanticipated government spending shocks in a panel VAR model. As we discuss in more detail below, "fiscal foresight" has been stressed as a major pitfall in the empirical analysis of the fiscal transmission mechanism, see Leeper, Walker, and Yang (2011b). Our VAR estimates suggest a short-run multiplier of about 1.2 under fixed exchange rates and 0.75 under floating exchange rates. Hence, the multiplier differs across exchange rate regimes – but to a lesser extent than what earlier studies and the received wisdom suggests. Moreover, we confirm earlier findings whereby the dynamics of the exchange rate and net exports provide little support to the fiscal transmission mechanism at the heart of the Mundell-Fleming model.

Hence, we investigate – as a second contribution – whether the time-series evidence can be rationalized on the basis of a New Keynesian small open economy model. In this regard 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 evidence on the fiscal transmission mechanism under floating exchange rates.[3] Given the empirical success of the model, we perform a number of experiments to inspect the fis-

[3] 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 (2011a).

cal transmission mechanism in greater detail. In particular, we illustrate – drawing on earlier work by Corsetti, Kuester, and Müller (2011a) – 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.

The present paper is related to a number of recent studies which highlight the state dependence of the fiscal multiplier. Empirical work by Auerbach and Gorodnichenko (2012a,b) shows that multipliers tend to be larger during recessions than during booms. Corsetti et al. (2011c), in turn, find for a panel of OECD countries that the multiplier is considerably larger during times of financial crisis relative to a "normal times" scenario. Theoretical work by Christiano, Eichenbaum, and Rebelo (2011) and Woodford (2011), among others, illustrates that multipliers are considerably larger if monetary policy is constrained by the zero lower bound.[4] Considering the New Keynesian model Corsetti et al. (2011a) and Nakamura and Steinsson (2011) analyze how the multiplier depends on the exchange rate regime, focusing on a small open economy model and a two-country model, respectively. In contrast, we analyze the ability of the model to quantitatively account for the time-series evidence on the fiscal transmission mechanism – across both exchange rate regimes.[5]

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. First and foremost, this requires us to take a stand on identification. Over the last decade or so, issues pertaining to the identification of government spending shocks have taken center stage in the literature on the fiscal transmission mechanism. In a classic contribution, Blanchard and Perotti (2002) identify government spending shocks in quarterly U.S. time-series data by assuming

[4]In this case, as actual policy rates are too high relative to the recessionary state of the economy, monetary policy does not counteract the inflationary impulse of higher government spending by raising policy rates. As a consequence, real interest rates fall, stimulating private demand. Yet another complication arises, if, in addition to the zero lower bound constraint, sovereign risk is a distinct characteristic of the macroeconomic environment. In this case, the multiplier is likely to be smaller than in normal times or, in fact, even negative (see Corsetti, Kuester, Meier, and Müller 2012). A general lesson emerging from these analyses is the key role of monetary policy for the transmission of fiscal policy and hence the size of the multiplier (see also Bilbiie, Meier, and Müller 2008).

[5]Erceg and Lindé (2012a) use a medium-scale DSGE model and compare the effects of spending cuts and tax hikes in a monetary union, also highlighting the role of the exchange rate regime. 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.

that government spending is predetermined relative to the other variables included in the VAR model. This assumption appears plausible to the extent that government spending includes government consumption (and possibly investment), but not transfers which will generally respond automatically and contemporaneously to the state of the economy. Furthermore, government spending, so the argument goes, is not adjusted immediately to the state of the economy in a discretionary manner, because of decision lags in the policy process.

While frequently applied, the Blanchard-Perotti approach has been criticized for its inability to deal with anticipated shocks to government spending. In a highly 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 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 in 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") impairs 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).[6] Leeper et al. (2011b) 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 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 1985:2 to 2011:1 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 one observation period.[7] 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.

[6] 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).

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

## 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 real interest rate, $r_{i,t}$, the log of the real exchange rate, $rx_{i,t}$, and the net export-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

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

The VAR model reads as follows

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

where $\mu_i$ denotes a vector of constants, capturing country fixed effects. In the estimation, we also control for time fixed effects. $C_k$ are appropriately defined matrices. In our baseline specification we allow for two lags, that is we set $K = 2$. In addition, we remove country-specific linear time trends.

We identify government spending shocks by assuming that government spending is predetermined relative to the other variables in the VAR model, including the forecast of government spending growth for the next six month. This assumption is in spirit of Blanchard and Perotti (2002), but more restrictive, as we consider semiannual rather than quarterly data.[8] Given the reduced form innovations $u_t$, the mutually uncorrelated structural shocks, $\varepsilon_t$, are recovered on the basis of the following 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).

We depart from earlier studies which employ variants of the Blanchard-Perotti identification scheme, including Ilzetzki et al. (2011), as we include the forecast for spending growth in the VAR model. This enables us to ensure the fundamentalness of the identified shocks in the face of exogenous, but *anticipated* changes of government spending. To assess this formally, we use the structural model

[8] 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.

outlined in section 3 below and test whether the "poor man's invertibility condition" developed by Fernández-Villaverde et al. (2007) is satisfied. Our baseline model features only unanticipated shocks to government spending. Hence, to perform the test, we consider a modified version of the model, where exogenous changes of government spending are anticipated over a horizon of six month. In this case, we find that dropping the spending growth forecast $fc_t^{t+1}$ from the vector of observable variables results in non-invertibility. Including $fc_t^{t+1}$, in contrast, ensures invertibility.[9] We conclude that including forecasts for government spending growth is an appropriate way to control for anticipated changes of government spending, while we attempt to identify unanticipated changes of government spending.[10]

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 Ilzetzki, Reinhart, and Rogoff (2009). Specifically, we consider all countries with an exchange rate regime of "a de facto crawling band narrower than or equal to +/-2 %" or tighter as a country with a fixed exchange rate (values of 1-8 in the classification of Ilzetzki et al. 2009). Conversely, countries with a more flexible exchange rate regime are classified as countries with a floating exchange rate regime. Figures A.1 and A.2 in the appendix provide details on how countries are actually classified. 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 is measured in semiannual percentage points. The horizonal axis measures time in half year units.

The left column shows results for our sample of countries which we classify as having a fixed exchange rate regime. The right column shows results for the floaters. The response of government

[9]In relying on the condition put forward by Fernández-Villaverde et al. (2007), we are able to obtain clear cut results regarding invertibility. Sims and Zha (2006) instead employ an alternative procedure which assesses the extent to which a given vector of observable variables allows recovering the shocks of a structural model.

[10]Note that this conclusion is based on the structural model which we use in our theoretical analysis below. 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.

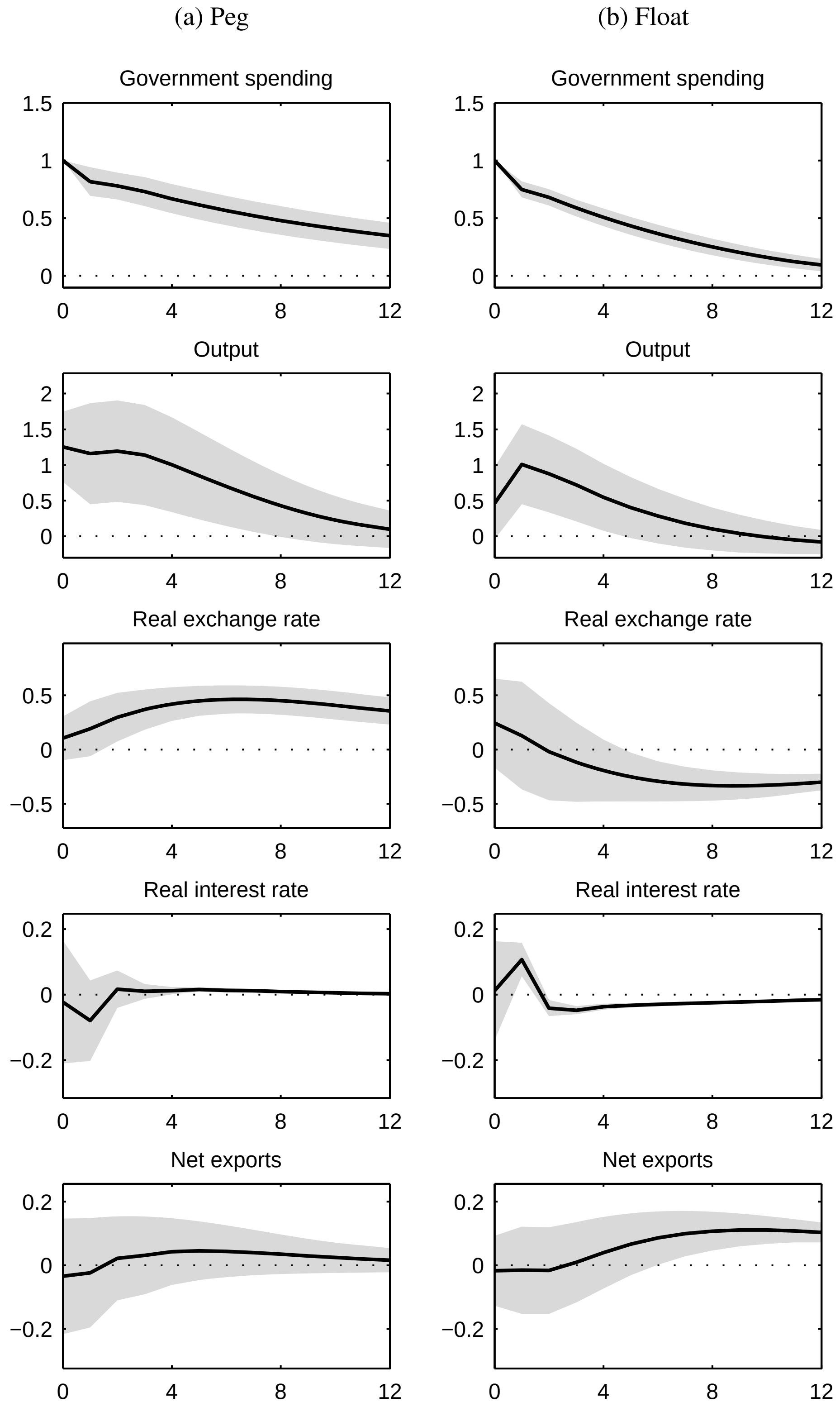


Figure 1: Impulse responses to unanticipated government spending shock. Notes: exogenous increase of government spending by 1% of GDP. Solid lines: point estimates; shaded areas: bootstrapped 90% confidence intervals. Horizontal axes indicate half years. Vertical axes measure percentage deviation from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

spending displays a gradual decline after the initial impulse. It shows a higher degree of persistence under fixed exchange rates. The response of output is shown in the second row. The *impact* effect is estimated to be about 1.25 under fixed exchange rates and about 0.45 under floating exchange rates. The dynamic adjustment also differs across exchange rate regimes. Under fixed exchange rates output gradually returns to its trend level after about 5 years. Under floating rates, the output response is hump-shaped. It peaks after half a year and returns to trend rather quickly. During the first two years after the shock, the fiscal multiplier averages at about 0.75 (1.2) percentage points of GDP under a float (peg). We refer to this as the "*short-run* multiplier".

Our estimates for the government spending multiplier fall well within the range documented by various studies on the basis of alternative identification schemes, see, for instance, the overview provided by Hall (2009). As discussed above, Ilzetzki et al. (2011) explicitly focus on the effects of government spending shocks across exchange rate regimes, as do Corsetti et al. (2011c).[11] Relative to our findings, both studies report rather stark differences across exchange rate regimes: they find no significant output effect of government spending shocks under floating exchange rates, but an output response above unity in case of fixed exchange rates.

The third row of figure 1 displays the response of the real exchange rate. It appreciates under both exchange rate regimes, but significantly so only under fixed exchange rates. In this case the real exchange rate continues to appreciate for an extended period. The maximum appreciation of 0.5 percent obtains after about 2-3 years.[12] Under flexible exchange rates, we find an appreciation on impact, but only the ensuing decline of the real exchange rate relative to trend, that is, the depreciation is statistically significant. A depreciation of the exchange rate of floaters has been recently documented by a number of studies.[13] Looking at different exchange rate regimes, Ilzetzki et al. (2011) find that the real exchange rate appreciates initially, but the effect is small and short-lived.[14] The dynamic adjustment pattern is similar to our findings. Beetsma, Giuliodori, and Klaasen (2008) report an appreciation of the real exchange rate for EU countries, a sample dominated by countries with a fixed exchange rate regime.

The response of the short-term real interest rate is reported in the fourth row of figure 1. As it reflects

[11]Both studies employ different empirical strategies. Ilzetzki et al. (2011) estimate a panel VAR model using quarterly data for 44 countries and group countries according to fixed and floating exchange rates. Corsetti et al. (2011c) use annual data 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.

[12]Such a pattern of "delayed overshooting" has been documented for the response of the exchange rate to monetary policy shocks, see Eichenbaum and Evans (1995) and Scholl and Uhlig (2008).

[13]See Kim and Roubini (2008), Enders, Müller, and Scholl (2011), and Corsetti, Meier, and Müller (2011b) for evidence for the U.S. based on alternative identification schemes. Monacelli and Perotti (2010) and Ravn, Schmitt-Grohé, and Uribe (2012) provide evidence for a number of OECD countries.

[14]They find no significant response under a peg. Corsetti et al. (2011c) find an appreciation of the real exchange rate for fixed exchange rates and a depreciation for floaters.

the joint response 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. We find a decline of the real interest rate under a peg, but an increase under floating exchange rates.[15] Finally, the response of net exports (shown in the last row of figure 1) is remarkably similar across exchange rate regimes. In both regimes, there is no significant response in the short run. Only under floating exchange rates we find a significant increase after about 2 years. An increase of the trade balance in response to government spending shocks has been documented by various studies for the U.S., although the issue remains controversial to date.[16] Ilzetzki et al. (2011) and Corsetti et al. (2011c) also find no significant response of net exports, both under fixed and floating exchange rate regimes.

Table 1: 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) |
| | 3 | 0.78 (0.06) | 0.68 (0.04) | 0.10 (0.07) |
| | 5 | 0.67 (0.07) | 0.51 (0.04) | 0.16 (0.08) |
| Output | 1 | 1.26 (0.25) | 0.46 (0.26) | 0.79 (0.37) |
| | 3 | 1.19 (0.36) | 0.88 (0.27) | 0.32 (0.47) |
| | 5 | 1.00 (0.34) | 0.55 (0.24) | 0.46 (0.42) |
| Real exchange rate | 1 | 0.10 (0.10) | 0.24 (0.21) | −0.14 (0.23) |
| | 3 | 0.30 (0.11) | −0.02 (0.23) | 0.32 (0.26) |
| | 5 | 0.42 (0.08) | −0.19 (0.14) | 0.61 (0.17) |
| Real interest rate | 1 | −0.02 (0.10) | 0.01 (0.08) | −0.03 (0.12) |
| | 3 | 0.02 (0.03) | −0.04 (0.01) | 0.06 (0.03) |
| | 5 | 0.01 (0.01) | −0.04 (0.00) | 0.05 (0.01) |
| Net exports | 1 | −0.03 (0.09) | −0.02 (0.06) | −0.02 (0.10) |
| | 3 | 0.02 (0.07) | −0.02 (0.07) | 0.04 (0.10) |
| | 5 | 0.04 (0.05) | 0.04 (0.06) | 0.00 (0.08) |

[a] see figure 1 for details; horizon measured in half-year units, standard errors in parentheses.

Overall, we find remarkable differences of the fiscal transmission mechanism across exchange rate

[15] In an alternative specification, we include both the short-term nominal interest rate and the actual inflation rate, rather than the real interest rate. Our results are robust with respect to this specification, see figure A.7 in the appendix.

[16] Kim and Roubini (2008) and Müller (2008), for instance, find an increase, Monacelli and Perotti (2010) find a decline.

regimes. Table 1 reports the point estimates of the impulse response for selected horizons. In addition to the responses for the case of a peg and a float, the table also shows the average difference across exchange rate regimes obtained by bootstrap sampling (standard errors in parentheses). According to this statistic, the impact response of output is significantly different across exchange rate regimes. Yet the difference of the multiplier is less pronounced than what the textbook variant of the Mundell-Fleming model suggests. While the impact multiplier under a peg is about 2-3 times as large as the multiplier under the float, the difference is smaller if one considers the average output response over the first two years. In this case, it is 0.75 for floaters vs 1.2 for the fixed exchange rate regime (short-run multiplier).[17]

Moreover, we detect sizable and significant differences in the responses of the real interest rate and the real exchange rate. For net exports, instead, we do not find significant differences across exchange rate regimes. In fact, none of the responses are significant during the first two years after the shock. This finding together with the observation that the real exchange rate does not appreciate strongly under a float casts into doubt the mechanism at the heart of the Mundell-Flemming model. Before we attempt to rationalize the evidence on the basis of a New Keynesian small open economy model, we explore the robustness of our results.

### 2.3 Sensitivity analysis

We conduct a number of experiments which explore the robustness of our results with respect to variations of our baseline specification. The appendix provides figures which contrast the impulse responses obtained under the baseline specification to those obtained under alternative specifications.

As a first experiment, 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, as figure A.4 shows, 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 is quite sizeable.

As a second experiment, we investigate how sensitive our results are with respect to (i) restricting the fixed exchange rate sample to Euro area countries, and (ii) using a different cut-off for the determination of the exchange rate regime. Rather than considering the categories 1-8 of Ilzetzki et al. (2009) as defining a peg, we now consider category 7 ("De facto crawling peg") as a cut-off. These experiments address the concern that nominal exchange rates have been fluctuating in some of the countries which are classified as pegs (see figure A.3). Again, as shown in figure A.5, results are quite similar to those

[17] 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 1 and 1.4, respectively.

obtained under the baseline specification.[18]

As a third robustness check, we 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. Figure A.6 summarizes the result of this exercise compactly. It suggests that the results for the baseline specification are not dominated by observations for a single country.

Fourth, 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.7 displays the impulse responses, with row 4 and 5 showing the dynamic adjustment of the nominal short-term interest rate and inflation, respectively.

As a further sensitivity check, we estimated 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 small number of time periods for the individual countries in our unbalanced sample, estimates at the country level are estimated somewhat imprecise.[19]

# 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 open-economy workhorse model suggested by Galí and Monacelli (2005). 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.[20] 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

[18]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 (available on request) 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.

[19]Hence, we rely on the pooled estimation results as our baseline case (results for the mean-group estimator are available on request). 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.

[20]This holds true only to the extent that there is no endogenous adjustment of government spending giving rise to spending reversals. As the VAR evidence does not suggest such reversals for our sample period, we assume throughout that government spending follows an AR(1) process.

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).[21] 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.[22] We 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 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, $\sigma$ 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 $\omega$ measures the weight of imports in the production of final consumption 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.

[21] 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.

[22] Galí and Monacelli (2008) develop a model of a monetary union which consists of a continuum of small open economies and analyze optimal fiscal policy.

### 3.1.2 Intermediate good firms

Intermediate goods are produced under imperfect competition according to the linear production function: $Y_t(j) = H_t(j)$, 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

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

where $\Lambda_{t,t+k}$ denotes the stochastic discount factor. $Y_{t,t+k}(j)$ 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.[23] Following Bilbiie et al. (2008) we assume that while our model is populated by a continuum of households $[0, 1]$, only a fraction $1 - \lambda$ are 'asset holders', indexed with a subscript 'A'. These households own firms and trade, 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 $\Xi_{t+1}$ 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 $\Upsilon_t$ denotes profits of intermediate good firms.

[23] 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. 2011a).

**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:

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

with $\Pi_{H,t} = P_{H,t}/P_{H,t-1}$ measuring domestic inflation 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 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 $\psi$ 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 $\varepsilon_t$ 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:

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

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: $Y_t = \left(\int_0^1 Y_t(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}$. Substituting for $Y_t(j)$ 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, $\beta$, is set to $0.98$. We assume the coefficient of relative risk aversion, $\gamma$, to take the value one. We set the parameter governing openness, $\omega$, to $0.353$, 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, $\epsilon$, is set to 11, implying a steady-state markup of $10\%$. In specifying monetary policy under a float, we choose the frequently used value of $\phi_\pi = 1.5$. We set $\psi$, the parameter capturing the responsiveness of taxes to debt, to $0.021$. This value ensures that public debt is on a non-explosive trajectory.[24]
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. We can estimate the parameter vector of interest, $\widehat{\theta}$, 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.[25] This procedure yields a consistent estimator with asymptotic variance

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

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

[25]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[a]

| | $\rho_{float}$ | $\rho_{peg}$ | $\sigma$ | $\lambda$ | $\xi$ | $\varphi$ |
|---|---|---|---|---|---|---|
| Estimate | 0.839 | 0.904 | 0.455 | 0.324 | 0.747 | 0.617 |
| s.e. | (0.028) | (0.020) | (0.402) | (0.396) | (0.052) | (0.561) |

[a]Estimates are obtained by matching impulse responses for 7 periods.

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, $\varphi$, the trade price elasticity, $\sigma$, the fraction of 'non-asset holders', $\lambda$, the degree of price-stickiness, $\xi$, and the autocorrelation coefficient for government spending, $\rho$. 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 $\rho_{peg}$ and $\rho_{float}$ by fitting an AR(1) process to the empirical impulse responses of government spending over 7 periods. We then pin down the other four parameters by matching the impulse responses for 7 periods after the initial shock. This is an adequate time horizon to capture the short-run dynamics, given that we consider semiannual observations.

We report parameter estimates in table 2. The estimated values for the autocorrelation coefficients $\rho_{peg} = 0.904$ and $\rho_{float} = 0.839$ reflect our finding that government spending is somewhat more persistent for our sample of countries with fixed exchange rates. We find a value for the trade-price elasticity $\sigma$ suggesting limited substitutability in response to terms of trade fluctuations. This is consistent with a large body of evidence from macroeconometric studies, see, for instance, Enders and Müller (2009). Our estimate for $\lambda$ 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 $\xi$, we find sizeable nominal rigidities, as our estimate implies average price duration of about two years. *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 $\varphi$ suggests a rather high Frisch elasticity, but not uncommon in macroeconometric studies (see, for instance, the discussion in Prescott 2004). Overall, given the findings in the literature, we consider the estimated parameters as plausible.

### 3.2.2 Model performance

Figure 2 compares the model predictions for the effects of government spending shocks under fixed (left column) and floating (right column) exchange rates 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 matching the empirical responses, not only under fixed exchange rates, for which theoretical and empirical impulse responses have been matched, but also under floating exchange rates, that is, for 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 impact multiplier exceeds unity in the former case, but not in the later. Similarly, the dynamics of the real exchange rate are captured well by the model, at least in the short run. While the model responses exhibit less persistence than the VAR responses, the distinct patterns of adjustment conditional on the exchange rate regime are partly reflected by the model predictions. Notably, the hump-shaped dynamics of the real exchange rate under fixed exchange rates is also predicted by the theoretical model.

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

In the following, we attempt to shed some light on the fiscal transmission mechanism. We start from two observations. First, in contrast to predictions of the Mundell-Fleming model, the trade balance hardly responds to the fiscal shock. The peak response of net exports to an increase of government spending by 1% of GDP falls in the range of 0.05–0.1 percentage points of GDP. Second, the short-run multiplier is larger under fixed exchange rates, although the difference is less sharp than the predictions of the textbook Mundell-Fleming model.

Given the first observation, differences in the output multiplier largely reflect differences in the adjust-

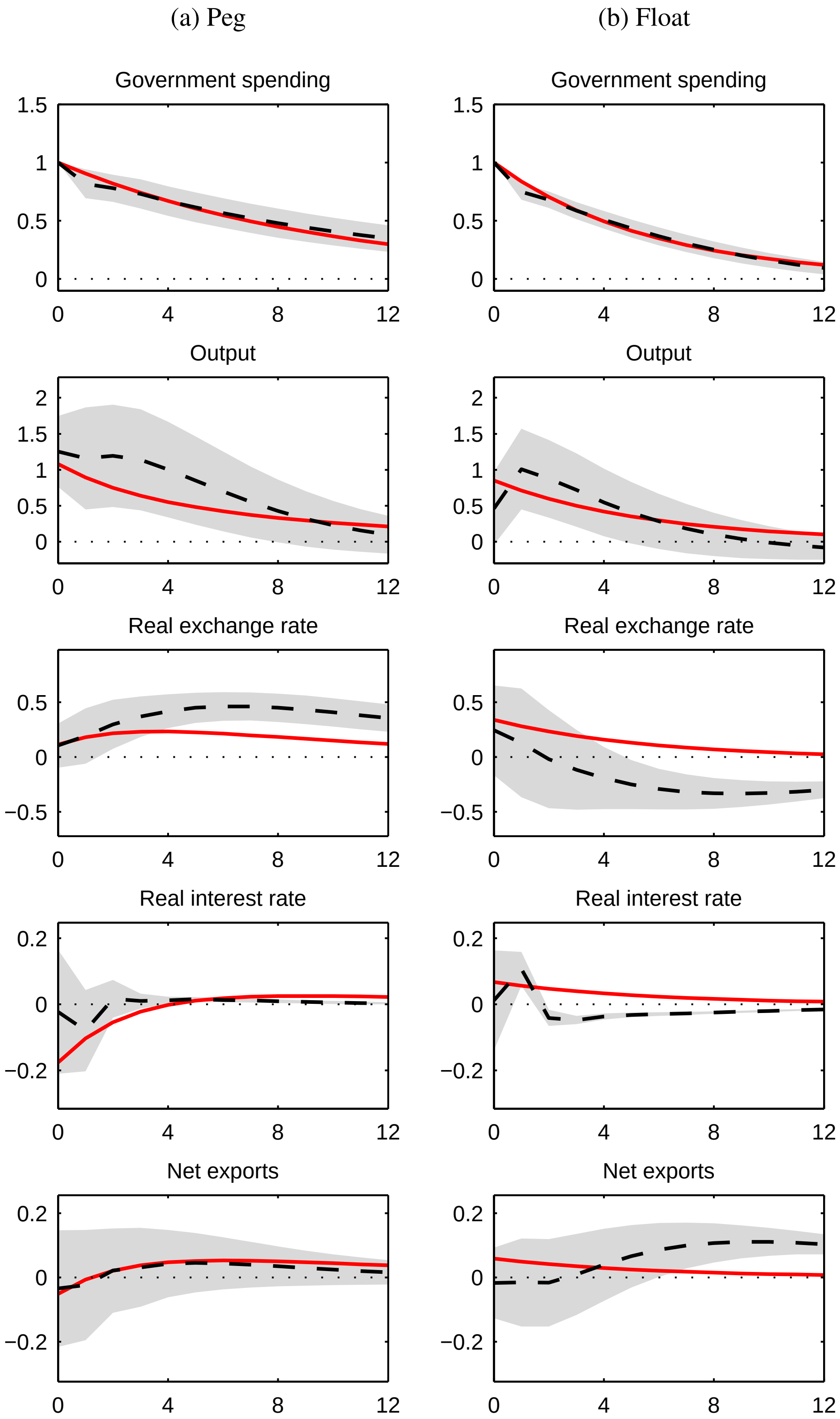


Figure 2: Dynamic adjustment to unanticipated government spending shock in small open economy model and according to VAR estimates. Notes: solid lines display model predictions, dashed lines point estimate of VAR with shaded areas indicating 90 percent confidence bounds, see also figure 1.

ment of private expenditures across exchange rate regimes. Corsetti et al. (2011a) provide a detailed analysis of how the exchange rate regime alters the intertemporal decisions which determine private expenditures (of those agents which participated in asset markets). Here we briefly outline the main insights in order to provide intuition for our results. Using small letters to denote log-linear deviations from steady state, consumption expenditures of asset holders can be shown to be tightly linked 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 $\pi_t$ is CPI inflation and $\bar{r}_t$ denotes the long-term real interest rate.[26]

The equilibrium condition (22) illustrates why there is potentially a differential impact of fiscal innovations across exchange rate regimes. Consider the floating exchange rate regime first. In this case, monetary policy follows a conventional interest rate rule whereby it raises the nominal rate more than one-for-one with an increase in inflation (Taylor principle). Higher government spending raises inflation, as firms adjust prices upward in the face of higher public demand (if they are able to do so). The short-term real interest rate rises as a result which is reflected by long-term real interest rates rising on impact – in line with declining expenditures of asset holders. In other words, we observe "crowding out" of private expenditures under a floating exchange rate regime.

Yet consumption of asset holders is also crowded out under a fixed exchange rate regime. In this case, the nominal interest rate is constant throughout the adjustment path in order to maintain the exchange rate peg.[27] 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 hence

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

as nominal interest rates are constant under fixed exchange rates.

Turning to the expenditure decisions of agents which do not participate in asset markets, we note that they are driven to a large extent by changes in disposable income. As discussed in detail by Bilbiie et al. (2008), as firms meet higher public demand, employment and wages tend to increase in the

[26] 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.

[27] Recall that we consider a small open economy in which the ROW is unaffected by the domestic fiscal expansion.

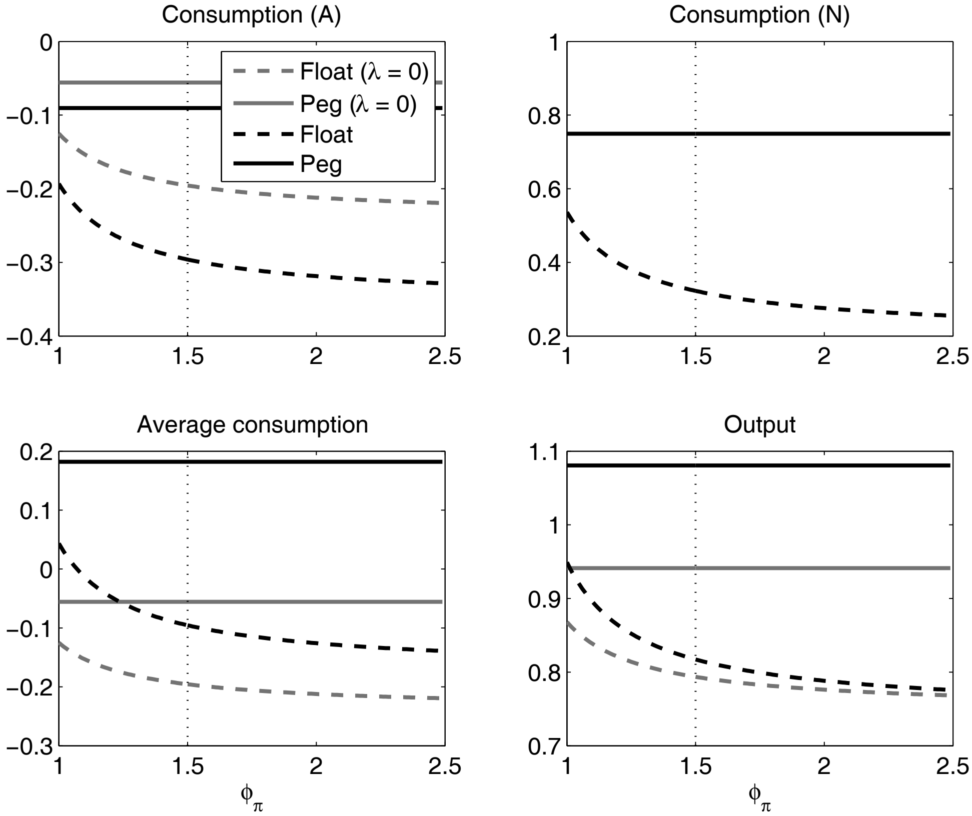


Figure 3: Impact response of consumption and to output to government spending shock by 1% of GDP. Notes: vertical axis measures deviation from steady state in percent of output. Horizonal axis: measures $\phi_\pi$ (monetary policy activism). Fixed exchange rate regime given by solid black and grey line (with $\lambda$ as in baseline scenario and zero, respectively). Float: dashed black and grey line.

New Keynesian model. This raises disposable income and consumption of non-asset holding households. As a result, overall private expenditures may rise or decline in response to higher government spending, depending on the relative weight of non-asset holders in the population.

Figure 3 displays the impact response of output and consumption expenditures for alternative assumptions regarding the exchange rate regime and, more generally, the conduct of monetary policy.[28] The upper left panel shows the impact response of asset holders' expenditures as a function of $\phi_\pi$, which measures how strongly the central bank reacts to inflation. In our model simulations above, we use the frequently employed value of 1.5 for this parameter. In figure 3, we consider a fairly wide range for this parameter in order to analyze the role of monetary policy under floating exchange rates. The solid black and grey lines show the response under a fixed exchange rate regime, respectively, for the baseline case with non-asset holders and an alternative scenario with $\lambda = 0$. As discussed above,

[28]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 $\rho = .9$, irrespectively of the exchange rate regime.

the response of consumption of asset holders is negative and independent of $\phi_\pi$. The dashed black and grey lines show the impact response under a float, again distinguishing our baseline case with non-asset holders from a counterfactual scenario where all agents have access to asset markets. In both cases, the influence of $\phi_\pi$ on asset holders' consumption is apparent: the stronger the response of monetary policy to inflation, the larger the increase of the real interest rate and the larger the decline of asset holders' consumption.[29]

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. 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 (that is, for lower values of $\phi_\pi$).

The lower panels of figure 3 show the average consumption (left) and the output (right) impact response. Recall that, as the response of net exports is muted, the average consumption response largely accounts for differences across exchange rage regimes. In an economy with full asset market participation, the output multiplier is below unity – under fixed and floating exchange rates, as discussed above. In the presence of non-asset holding agents, however, the multiplier reaches a value of about 1.1, close to what the time-series evidence suggests. Under floating exchange rates the multiplier depends on the monetary stance. It ranges from close to unity for low values of $\phi_\pi$ to about 0.75 for higher values of $\phi_\pi$.

These results reflect an accommodating monetary stance under the assumed interest rate feedback rule, which allows inflation to rise in response to higher government spending. In this regard the present model differs from the textbook Mundell-Fleming model according to which monetary policy – under floating exchange rates – does not accommodate the demand for domestic currency. It is instructive to analyze such a scenario in the context of the present model by assuming that monetary policy responds not only to inflation, but also to output deviations from steady state. Specifically, we study a counterfactual scenario in which monetary policy stabilizes output perfectly at its steady-state level and explore the implications for the equilibrium dynamics triggered by the fiscal shock.

Figure 4 displays the impulse response functions for this scenario. For comparison purposes, the dashed lines reproduce the responses for the baseline scenario under floating exchange rates (see figure 2 above). The solid lines, in contrast, are based on computations assuming a very high output-

[29]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.

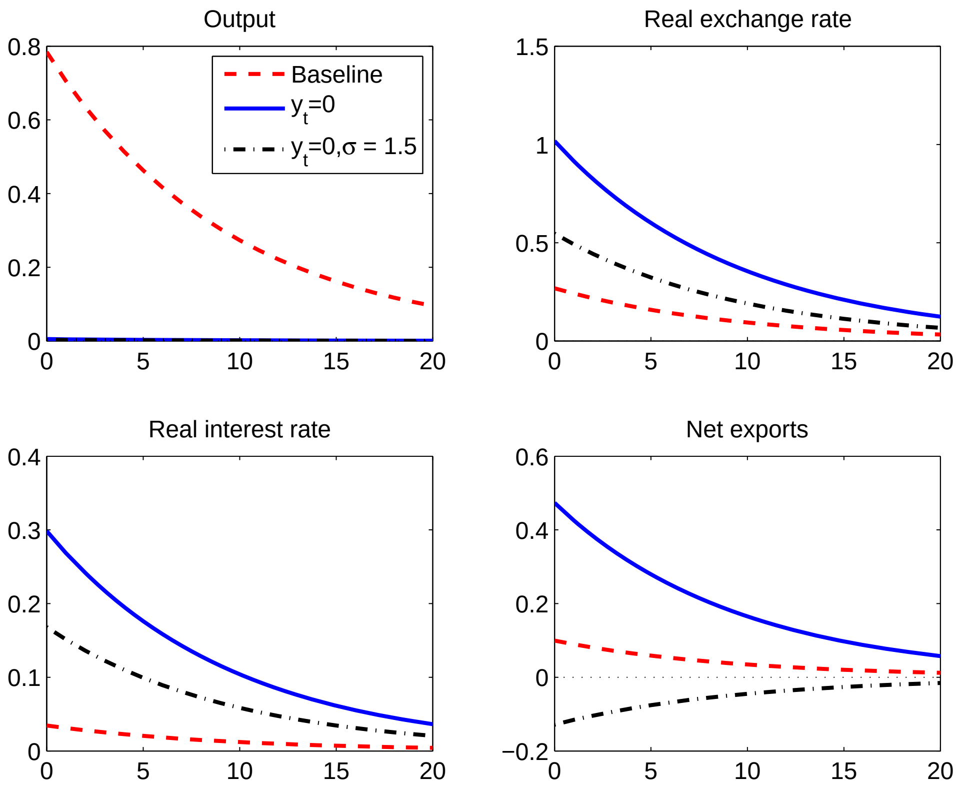


Figure 4: Dynamic adjustment to government spending shock by 1% of GDP under float. Notes: dashed line shows responses for baseline scenario. Solid lines show result for baseline parameterization under complete output stabilization. Dashed-dotted lines show results for complete output stabilization and high trade-price elasticity.

response coefficient in the interest rate rule: output is fully stabilized in this case. This is the result of a much tighter monetary policy stance reflected not only in a much stronger increase of the real interest rate, but also in a sharp appreciation of the real exchange rate.[30] Net exports increase sharply in response to the appreciation, as our baseline estimate for the trade price elasticity is quite low. This implies that valuation effects dominate substitution effects (see Müller 2008).

As final experiment, we therefore consider the case of full output stabilization together with a high trade price elasticity ($\sigma = 1.5$). Results are shown by the dashed-dotted lines in figure 4. In particular, for this case we find a decline of net exports in response to higher government spending: substitution effects dominate valuation effects and net exports decline with an appreciated currency. This reduction of external demand requires monetary policy to take a less aggressive stand in order to stabilize output. Overall, this scenario has the flavor of results obtained under the textbook Mundell-Flemming model. Yet the predicted decline of net exports conflicts with the time-series evidence established above.[31]

## 4 Conclusion

The initial policy response to the global financial crisis was an extraordinary fiscal expansion. As the financial crisis morphed into the sovereign debt crisis, the focus has shifted to austerity measures. Either way, the effects on output – as captured by the fiscal multiplier – are of primary interest. In this paper we have addressed the issue from a particular angle: Does the fiscal multiplier depend on the exchange rate regime and, if so, how strongly? This aspect of the fiscal transmission mechanism is particularly relevant as a number of the economies that face extraordinary fiscal adjustment are members of EMU and hence feature a fixed exchange rate regime. In this regard, a conventional analysis based on the Mundell-Flemming model suggests that the multiplier is likely to be large – much larger than in case of a freely floating currency.

We find that multipliers are indeed larger if the exchange rate is fixed. Yet the difference across exchange rate regimes is less dramatic than what the received wisdom suggests: we find a short-run multiplier of about 1.2 under a peg and of about 0.75 under a float. As a second result, we stress that there is no empirical evidence in support of the transmission mechanism at the heart of the Mundell-Fleming model. In line with earlier results by Ilzetzki et al. (2011) and Corsetti et al. (2011c) we find that there is hardly any appreciation of the real exchange rate under floating exchange rates and no crowding out of net exports.

A third result of our analysis pertains to a possible explanation of our empirical findings. We show

[30] While monetary policy sets the nominal interest rate, it only indirectly affects the path of short-term real interest rates. Nevertheless, the path of the real short-term rate provides a comprehensive measure for the monetary policy stance.

[31] Not only our VAR evidence suggests a fairly flat response of net exports. Ilzetzki et al. (2011) and Corsetti et al. (2011c) also find no significant decline of the trade balance.

that a fairly standard version of the New Keynesian open economy model provides a satisfactory account of the time-series evidence. Importantly, the model is able to capture the key features of the transmission mechanism under both exchange rate regimes – also from a quantitative point of view. Drawing on the analysis in Corsetti et al. (2011a) 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.

Overall, we thus find that, even if the exchange rate is fixed, the effects of fiscal policy on economic activity remain limited – at least if compared to the predictions of the Mundell-Fleming model or relative to a situation where monetary policy is constrained by the zero lower bound. Moreover, while our analysis accounts for financial frictions in the form of an exclusion from asset markets, we have assumed throughout that government debt is riskless. However, in the presence of sovereign risk the multiplier is likely to be smaller relative to normal times if monetary policy is constrained (see Corsetti et al. 2012). As a final caveat, however, we stress that our small open economy framework cannot account for cross-country spillover effects. As such spillovers may be sizeable, notably within monetary unions (see Beetsma, Giuliodori, and Klaasen 2006 and Corsetti and Müller 2011), they should not be neglected in a full-fledged assessment of fiscal adjustment plans.

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# A Appendix

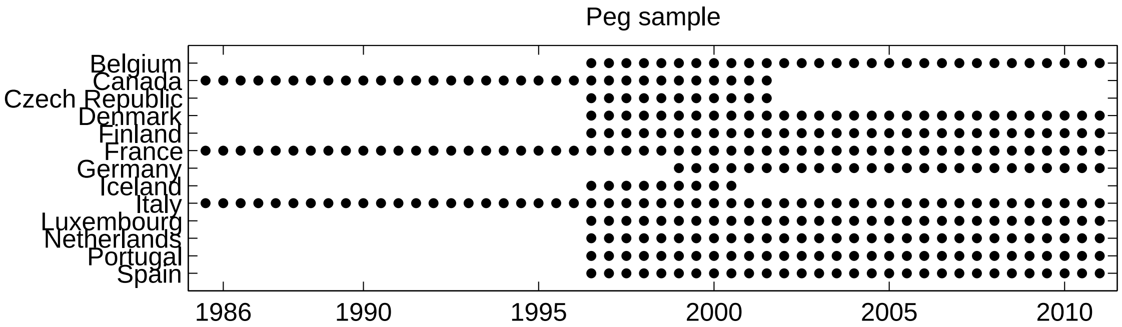


Figure A.1: Countries with fixed exchange rate regime.

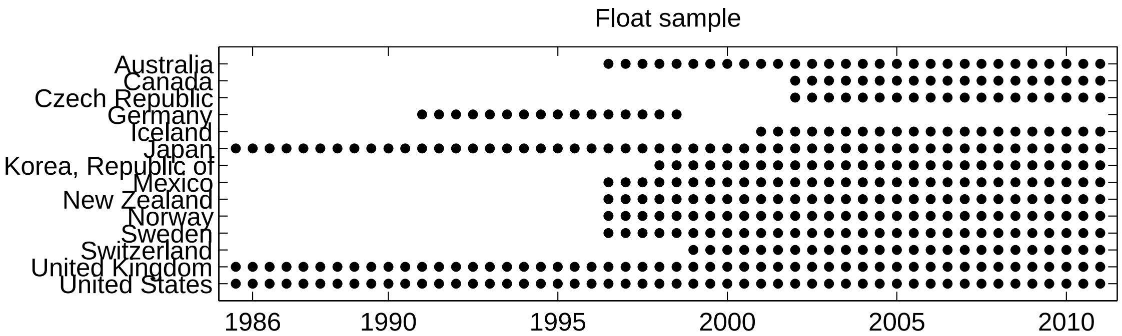


Figure A.2: Countries with floating exchange rate regime.

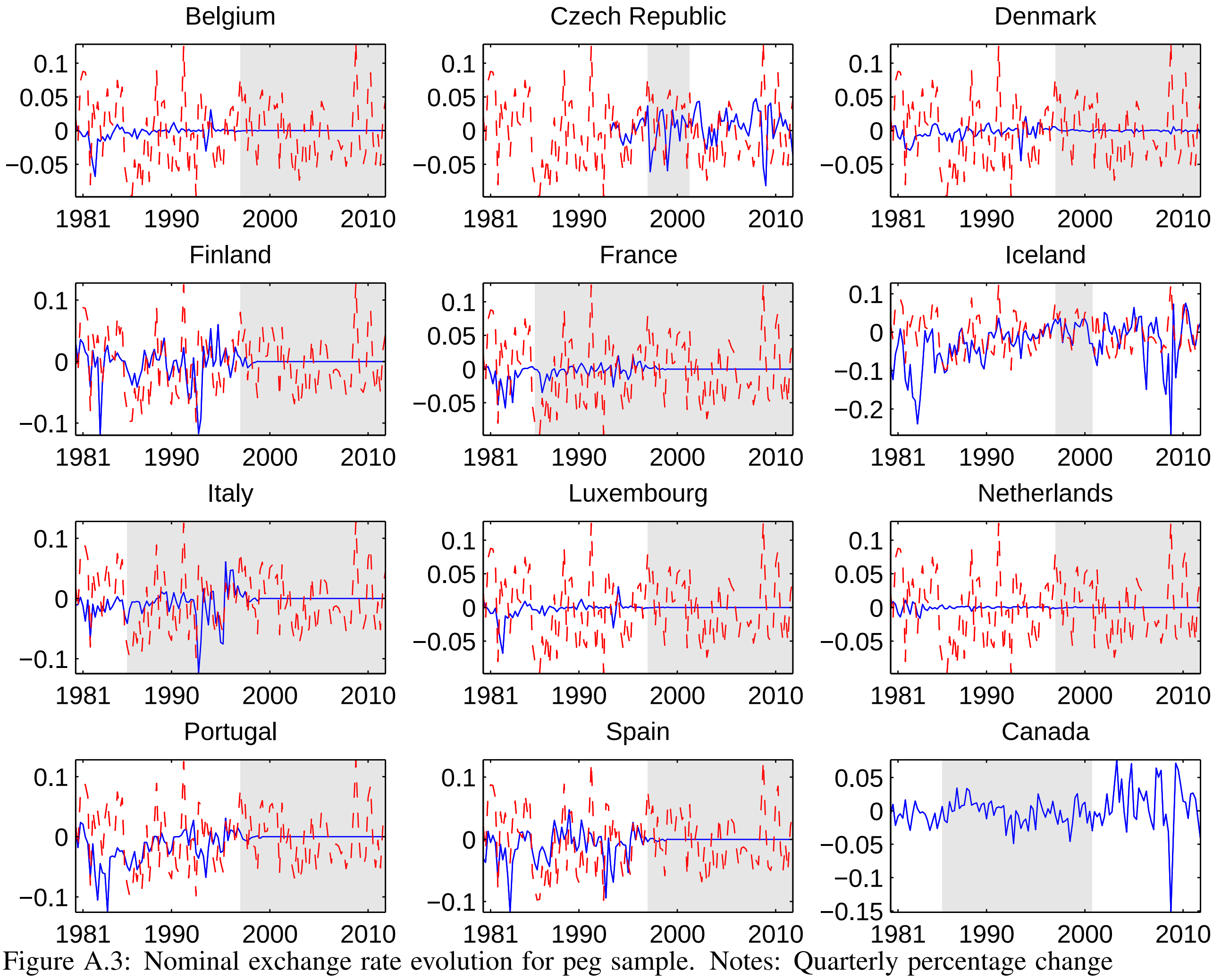


Figure A.3: Nominal exchange rate evolution for peg sample. Notes: Quarterly percentage change in nominal local currency-DEM (USD for Canada) exchange rate (solid blue line) and DEM-USD exchange rate (dashed red line); gray area indicates period with fixed exchange rate.

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). |

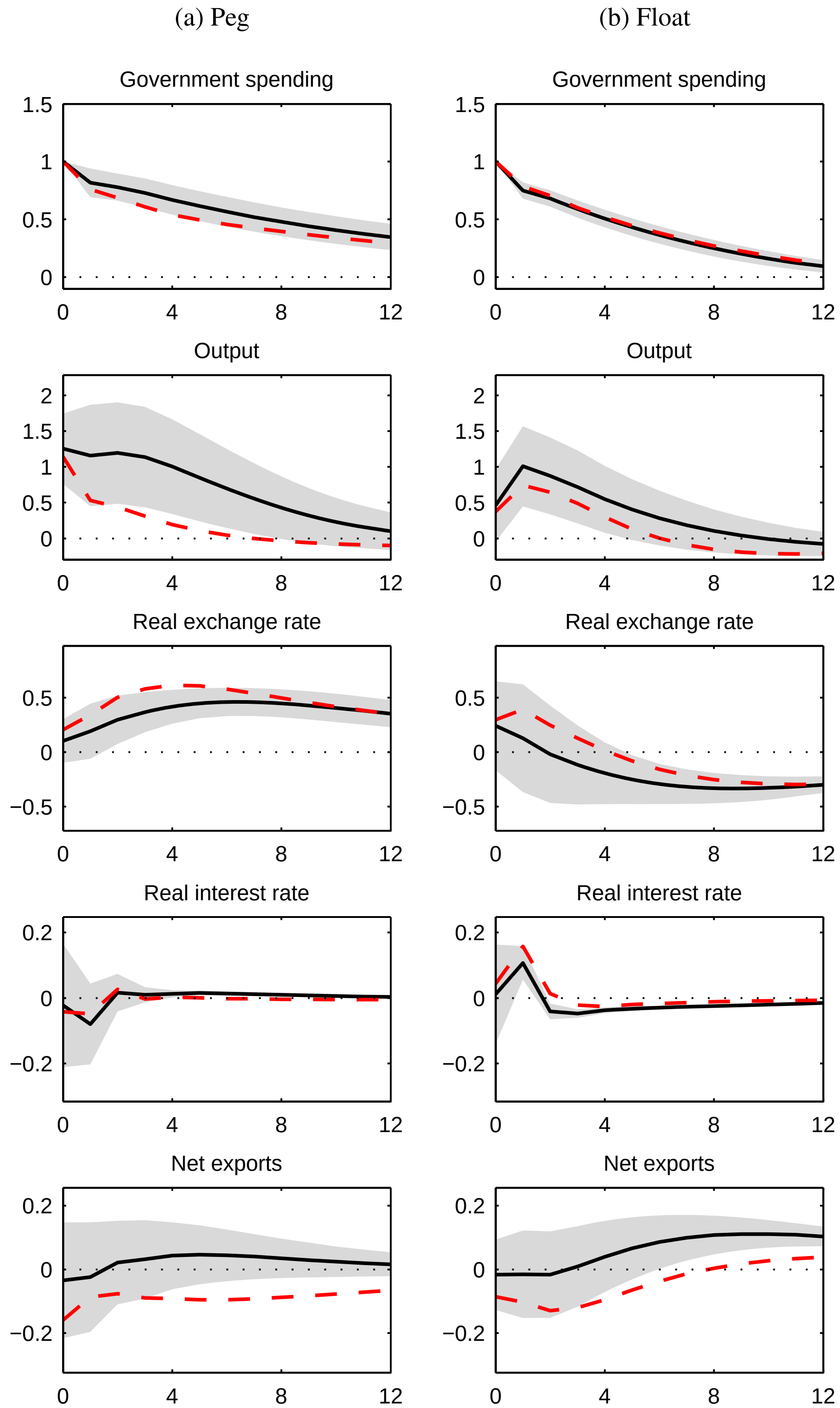


Figure A.4: Sample ends in 2007:1. Notes: see figure 1; solid black: baseline sample; dashed red line: sample ends in 2007:2; shaded areas: bootstrapped 90 percent confidence intervals for baseline sample.

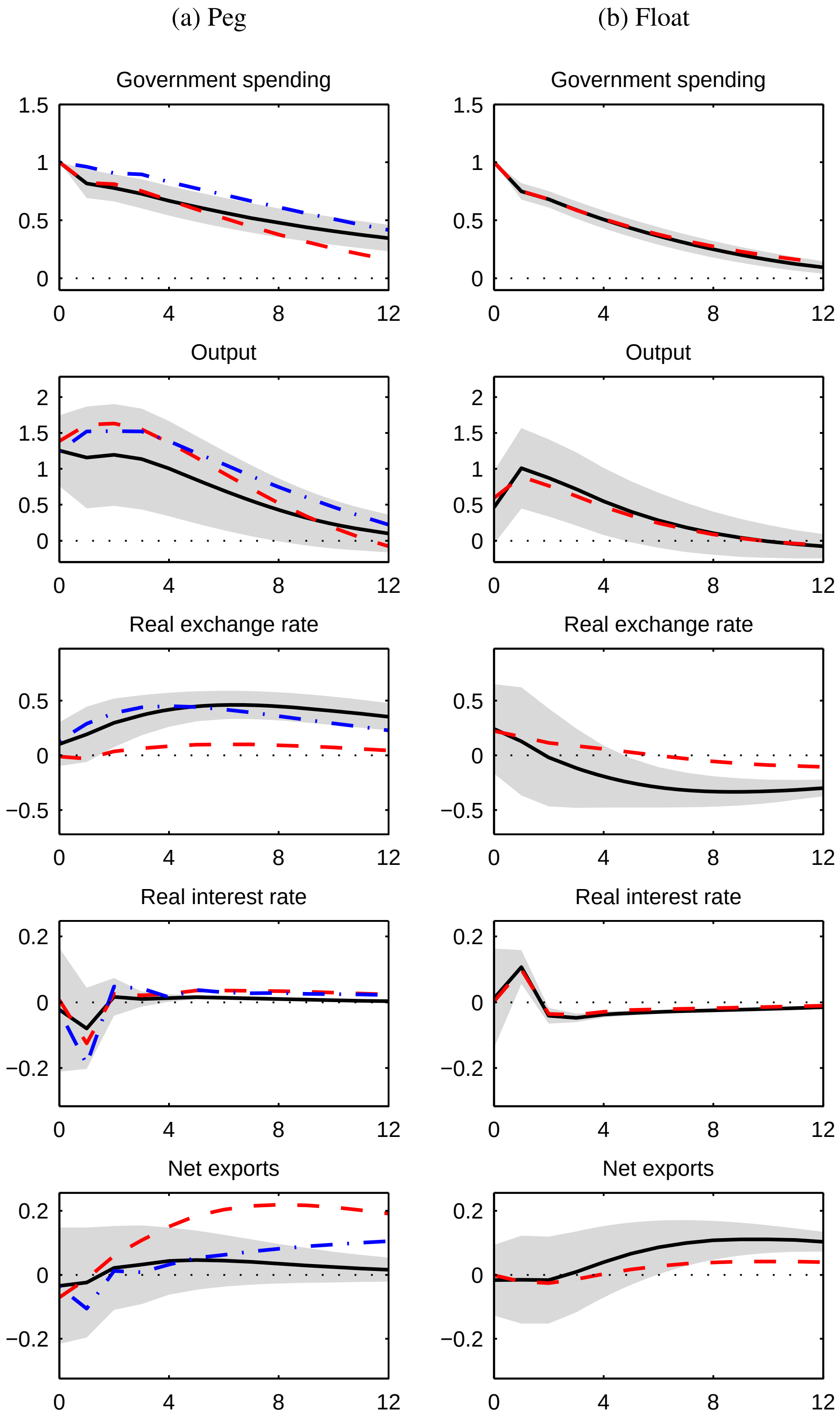


Figure A.5: Different peg/float compositions. Notes: see figure 1; solid black: baseline sample; blue dash-dotted line: peg sample including euro area countries only; dashed red line: alternative FX classification; shaded areas are bootstrapped 90 percent confidence intervals for the baseline sample.

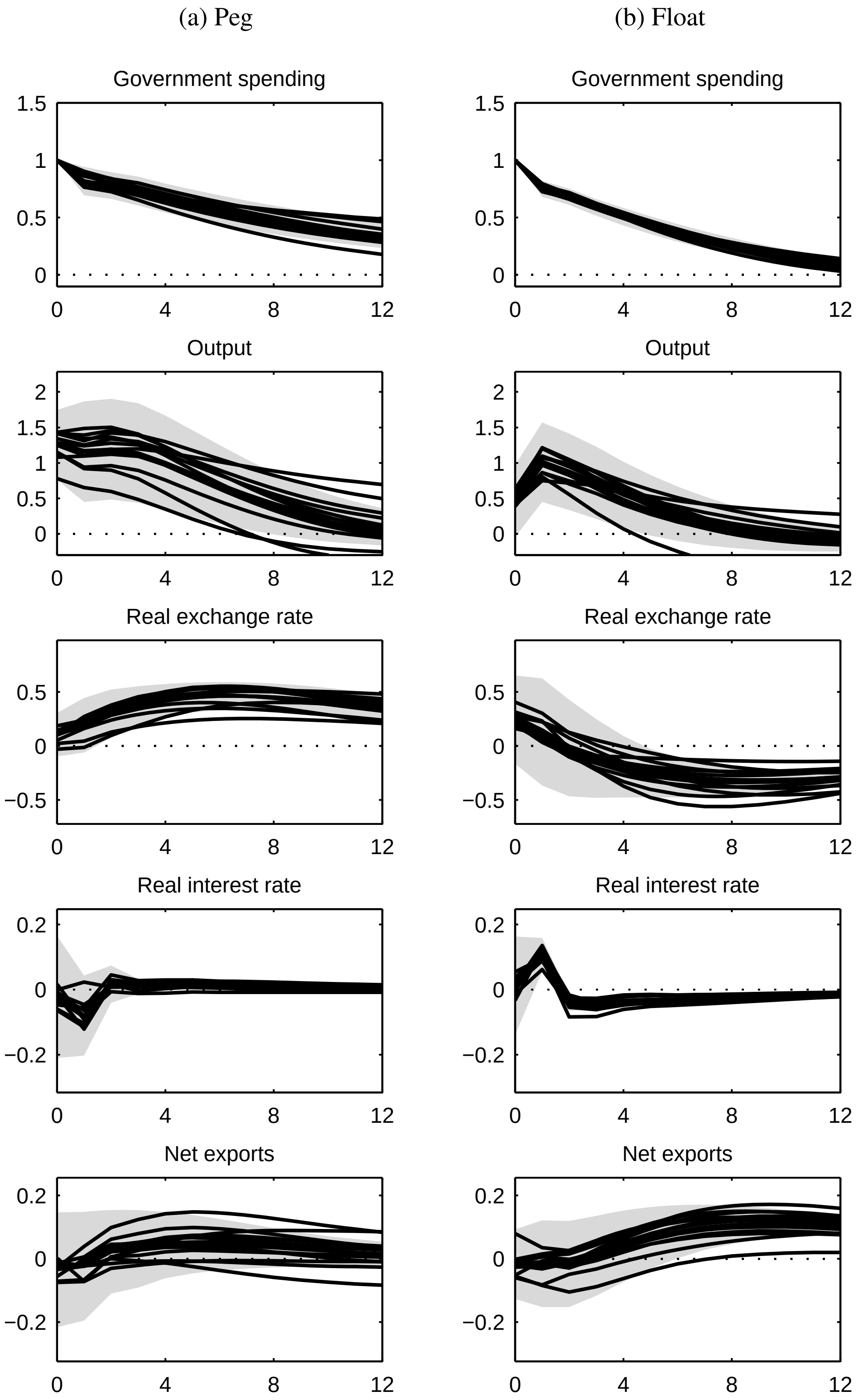


Figure A.6: Sensitivity to excluding countries. Notes: see figure 1; shaded areas are bootstrapped 90 percent confidence intervals for the baseline sample; solid lines display point estimates for VAR models where one country at a time is dropped from the sample.

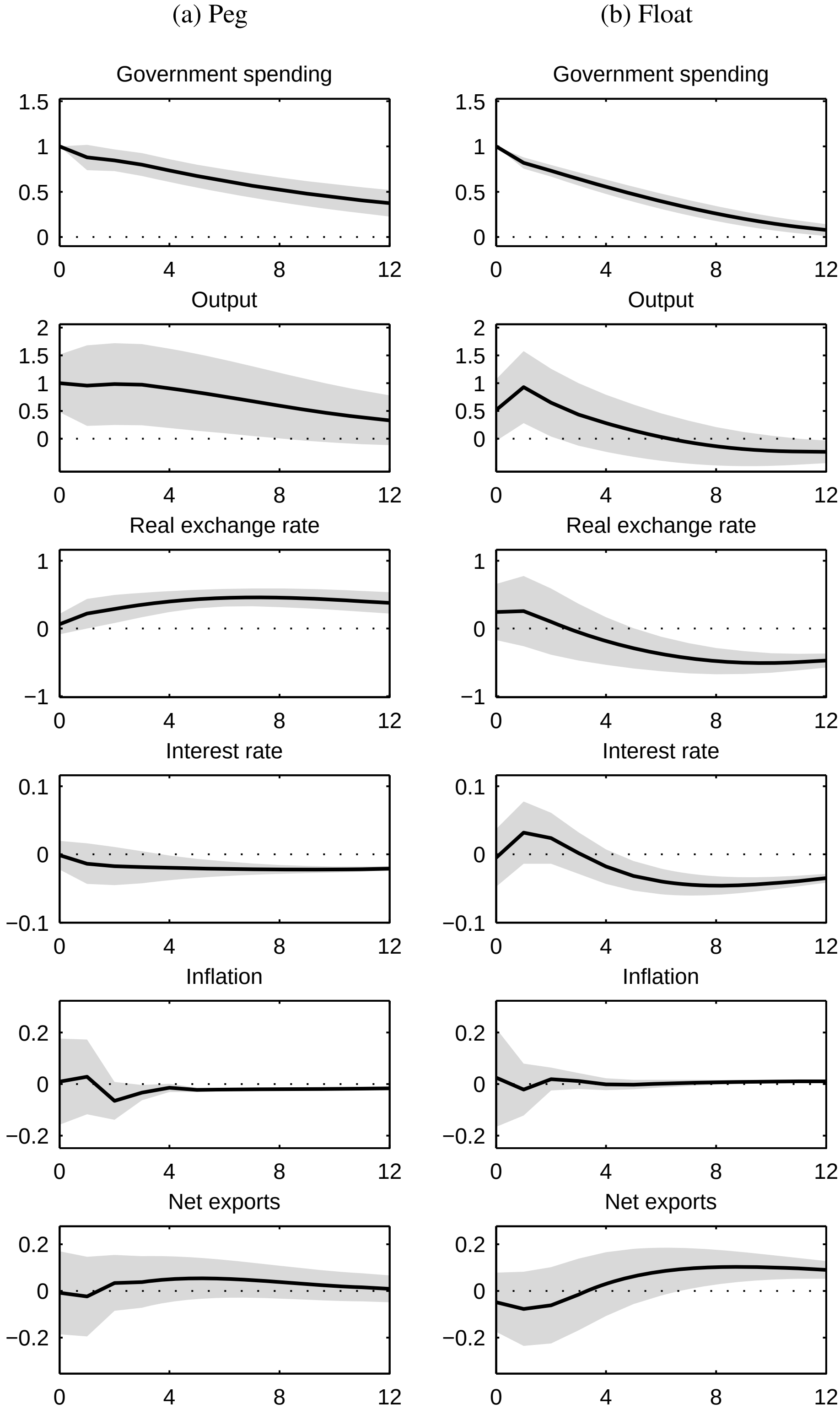


Figure A.7: VAR with short-term nominal interest rate and actual inflation rate. Notes: see figure 1.