Government Spending, Downward Wage Rigidity, and Exchange Rate Dynamics*

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Abstract

In this paper, we show that government spending impacts the real exchange rate asymmetrically, depending on whether spending is raised or cut. We first consider an extension of the small open economy model put forward by Schmitt-Grohé and Uribe (2016) in order to illustrate the mechanism. The key feature of the model is that wages are (only) downwardly rigid and that monetary policy is generally unable to fully offset the effect of this nominal rigidity. In a second step, we estimate local projections using quarterly data for 38 advanced and emerging market economies, covering the period from the early 1990s to 2017. We find that positive government spending shocks appreciate the real exchange rate. Negative spending shocks have no significant effect. This result is robust across alternative identification schemes.

Keywords: downward nominal wage rigidity, government spending shocks, real exchange rate

JEL Classification: E62, F41, H30

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1 Introduction

During the years prior to the financial crisis, government consumption was on the rise in most countries of the euro area. An expansion of the public sector seemed warranted in light of rising income and convergence prospects, partly as a result of the inception of the euro. At the same time, most countries experienced a substantial erosion of competitiveness—their real exchange rates appreciated considerably. The left panel of Figure 1 plots the change of the effective real exchange rate against the change of government spending. There is a strong and significant negative correlation: a declining real exchange rate (an appreciation) is associated with higher government spending. After 2010, on the other hand, government spending was cut substantially while the real exchange rate moved very little. For the countries shown in Figure 1, the correlation between the change in government spending and the one of the real exchange rate is insignificant during the period 2010–2015 (right panel).[1]

Against this background, we reassess how government spending impacts the real exchange rate. Specifically, we ask whether the real exchange rate responds asymmetrically to government spending innovations depending on whether they raise or lower spending. This focus sets our paper apart from earlier research. It seems warranted in light of the evidence on display in Figure 1 but also—and more fundamentally—in light of theoretical considerations. In an open economy model of the type put forward in Schmitt-Grohé and Uribe (2016), where wages are upwardly flexible, but downwardly rigid, the exchange rate is bound to respond asymmetrically to government spending shocks unless monetary policy is able to undo the effect of nominal rigidities altogether.

In the first part of our analysis, we explore this conjecture formally. We extend the original model put forward by Schmitt-Grohé and Uribe (2016) along two dimensions. First, we allow for government spending. Specifically, we assume that the government consumes a fraction of nontradable goods. In order to finance its purchases, it runs a balanced budget. Second, we consider a somewhat richer menu of monetary and exchange rate policies. We consider the limiting case of pure float and a pure peg, but we also consider an intermediate regime in which monetary policy allows for limited exchange rate flexibility only. Otherwise we follow the original model.

We find our conjecture fully borne out as we solve the model. Consider first, as a natural benchmark, the case of flexible exchange rates. Specifically, we assume for this case that monetary policy uses the exchange rate to stabilize employment. In doing so, it offsets completely the effect of the downward nominal wage rigidity. In this case, an increase of government spending appreciates the real exchange rate in the same way as a decrease induces it to depreciate. In contrast, under an exchange rate peg the response of the exchange rate is asymmetric. Starting at a situation of full employment, an increase of government spending does not alter production. Instead, the exchange rate appreciates, which in turn crowds out private consumption completely. The resulting government spending multiplier is zero. The

[1] Figure 1 comprises all countries of the euro area that are included in the database, except for Greece, which we exclude because of the default event on 2012. The basic pattern displayed in the figure remains unchanged, however, once data for Greece is included.

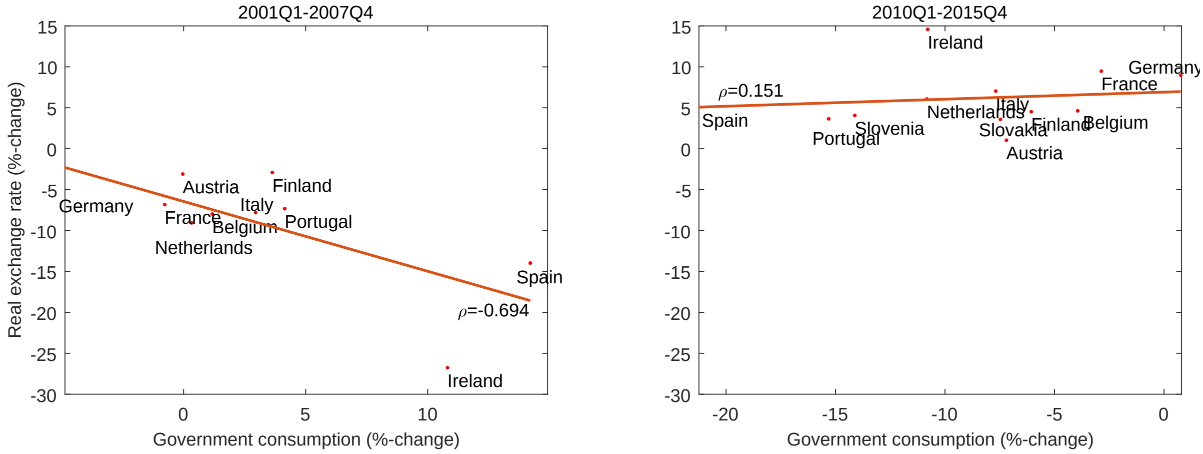


Figure 1: Government spending and real exchange rates: horizontal axis measures change of government consumption, vertical axis measures change of real effective exchange rate (positive change corresponds to depreciation); sample consists of the euro area countries in our database (see main text for details). Left panel shows changes for 2001Q1–2007Q4, right panel shows change for 2010Q1–2015Q4.

nature of the adjustment differs in case government spending is reduced. Output declines as real wages can not fall sufficiently in the face of reduced demand for nontraded goods. To the extent that the real exchange rate somewhat depreciates, private consumption is crowded in, but this effect is insufficient to stabilize output. Overall, we find a sizeable asymmetry in the exchange rate response to government spending shocks under the peg. There is strong appreciation in response to higher spending, but weak depreciation in response to reduced spending. For intermediate monetary policy regimes there is still considerable asymmetry.

In the second part of the paper we turn to the data. We rely on the database for fiscal shocks assembled by Born, Müller, et al. (2018). It contains quarterly time series data for government spending shocks for a panel of up to 38 countries including both advanced and emerging market economies. The data runs from the early 1990s to the end of 2017. Importantly, the database includes two distinct shock series which are based on alternative strategies to compute surprise innovations of government spending. First, as in Ramey (2011), government innovations are measured as the difference between actual government spending growth and the forecast of professional forecasters. Second, as in Blanchard and Perotti (2002), government spending innovations are measured by means of a forecast error derived from a vector autoregression model.

We estimate the response of the real exchange rate and other variables to both shock series in isolation. For this purpose we rely on local projections à la Jordá (2005). This approach is particularly suitable for the purpose at hand, since it allows us to estimate responses for positive and negative shocks separately. Again we find our initial conjecture fully borne out by the data. In response to higher government spending the exchange rate appreciates, while it does not significantly depreciate in response to government spending cut. This finding is robust across alternative specifications and in particular it holds for both spending shock series under consideration.

There are several recent studies which assess the effect of government spending shocks on the real exchange rate. While standard business cycle models predict government spending to appreciate the real exchange rate, this prediction is not necessarily borne out by the data. A large number of studies has obtained conflicting results (Corsetti, Meier, et al., 2012b; Ilzetzki et al., 2013a; Kim and Roubini, 2008; Miyamoto et al., 2017; Monacelli and Perotti, 2010; Ravn et al., 2012). However, these studies do not allow for asymmetric responses to spending increases and spending cuts which, in light of our result, may go some way towards an explanation of the conflicting results.

Our paper also relates to studies which have focused on other nonlinearities in the fiscal transmission mechanism. This includes the role of the business cycle and the zero lower bound on interest rates (Auerbach and Gorodnichenko, 2012; Christiano et al., 2011; Ramey and Zubairy, 2018) or sovereign risk (Born, Müller, et al., 2018; Corsetti, Kuester, Meier, et al., 2013). Other studies have highlighted features of particular relevance for the fiscal transmission mechanism that are specific to open economies such as the role of the exchange rate regime (Born, Juessen, et al., 2013; Corsetti, Kuester, and Müller, 2013; Corsetti, Meier, et al., 2012a; Erceg and Lindé, 2012; Ilzetzki et al., 2013b) or sudden stops (S. Liu, 2018).[2] Another relevant study is Bianchi, Ottonello, et al. (2018), on optimal fiscal policy under a currency peg in the presence of downward wage rigidity and sovereign risk. Last, Crucini et al. (2014) investigate the role of sticky wages in accounting for real exchange rate dynamics, but they do not examine the asymmetric effects of government spending.

The remainder of the paper is organized as follows: Section 2 presents the baseline model. Section 3 illustrates the transmission mechanism at work through the lens of a toy model. Section 4 discusses the parametrization and the quantitative results of the simulations. Section 5 establishes empirically that the model prediction holds up in the data – namely, that the appreciation of the exchange rate in response to spending increases is stronger than the depreciation in response to spending cuts in a sample of advanced and developing countries. Section 6 concludes.

2 Model

In this section we describe a two-sector model of a small open economy operating different exchange rate regimes. We build on Schmitt-Grohé and Uribe (2016)'s model and extend it by introducing fiscal policy and an exchange rate policy.

2.1 Households

Household's preferences are given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{c_t^{1-\sigma}}{1-\sigma} + \frac{(g_t^N)^{1-\sigma_g}}{1-\sigma_g} \right] \tag{1}$$

[2] In the model of S. Liu (2018) government spending is also shown to impact the economy asymmetrically, depending on whether it is cut or raised.

where $\mathbb{E}_t$ is the expectation operator, c_t denotes private consumption in period t, g_t^N denotes government consumption of nontradable goods, β is the discount factor, σ and σ_g are the inverse intertemporal elasticities of private and public consumption, respectively.
The consumption good c is a CES aggregator with elasticity of substitution $1/(\eta+1)$ between tradables (c^T) and nontradables (c^N) given by:

$$c_t = [\omega(c_t^T)^{-\eta} + (1-\omega)(c_t^N)^{-\eta}]^{-\frac{1}{\eta}}, \quad \eta > -1, \quad \omega \in (0,1). \tag{2}$$

Households can trade in one-period foreign bonds, which are denominated in units of tradables. The budget constraint is given by:

$$\mathcal{E}_t \frac{b_{t+1}}{1+r_t} + P_t^T c_t^T + P_t^N c_t^N = \mathcal{E}_t b_t + P_t^T y_t^T + \phi_t + W_t h_t - \tau_t \tag{3}$$

where P_t^T and P_t^N denote the price of tradable and nontradable goods, respectively, $\mathcal{E}_t$ is the nominal exchange rate defined as the domestic currency price of one unit of foreign currency, b_{t+1} denotes bond holdings chosen at the beginning of time t, r_t is the world interest rate, W_t is the nominal wage, h_t denotes hours worked, ϕ_t denotes firm's profits, defined below, and τ_t denotes lump-sum taxes levied by the government. The stochastic endowment of y_t^T follows an AR(1) process.
We assume that the law of one price holds for tradables and that the foreign currency price of tradables is normalized to unity, so that the nominal price of tradables is equal to the nominal exchange rate, $P_t^T = \mathcal{E}_t$. The representative agent faces a credit constraint that limits his total amount of debt not to exceed an exogenous debt limit $\bar{b}$:

$$b_{t+1} \geq -\bar{b}. \tag{4}$$

As in Schmitt-Grohé and Uribe (2016), wage rigidity takes the form

$$W_t \geq \gamma W_{t-1}, \tag{5}$$

where $\gamma > 0$ governs the degree of downward nominal wage rigidity.
Actual hours must satisfy

$$h_t \leq \bar{h} \tag{6}$$

at all times. Similarly, the following complementary slackness condition must hold for all dates and states:

$$(\bar{h} - h_t)(W_t - \gamma W_{t-1}) = 0. \tag{7}$$

This condition implies that in periods of unemployment ($h_t < \bar{h}$) the wage rigidity constraint is binding. When the wage constraint is not binding ($W_t > \gamma W_{t-1}$), the economy must be in full employment.

Let

$$p_t^N := \frac{P_t^N}{P_t^T}$$

denote the relative price of nontradables. The household's first order conditions are given by:

$$p_t^N = \frac{A_2(c_t^T, c_t^N)}{A_1(c_t^T, c_t^N)} \tag{8}$$

$$\lambda_t = U'(A(c_t^T, c_t^N))A_1(c_t^T, c_t^N) \tag{9}$$

$$\lambda_t = \beta(1 + r_t)\mathbb{E}_t\lambda_{t+1} + \mu_t \tag{10}$$

$$b_{t+1} \geq -\bar{b}, \text{with equality if } \mu_t > 0 \tag{11}$$

where λ_t/P_t^T and μ_t are the Lagrange multipliers associated with (3) and (4), respectively.

2.2 Firms

Nontraded output y_t^N is produced by perfectly competitive firms operating the following production technology:

$$y_t^N = h_t^\alpha. \tag{12}$$

Firms choose the amount of labor input to maximize profits, given by:

$$\phi_t := P_t^N y_t^N - W_t h_t. \tag{13}$$

The optimal choice of labor h_t is given by:

$$p_t^N = \frac{W_t/\mathcal{E}_t}{\alpha h_t^{\alpha-1}}. \tag{14}$$

2.3 Fiscal policy and exchange rate policy

The government only consumes nontradable goods according to a balanced budget:

$$P_t^N g_t^N = \tau_t. \tag{15}$$

Government spending g_t^N follows an exogenous process.

Let $w_t := W_t/\mathcal{E}_t$ denote the real wage in terms of tradables, w_t^f the real wage at full employment, and $\epsilon_t := \frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}$ the gross rate of devaluation of the domestic currency.
As proved by Schmitt-Grohé and Uribe (2016), any exchange rate policy satisfying

$$\epsilon_t \geq \gamma \frac{w_{t-1}}{w_t^f}$$

ensures full employment at all times. From this class of full-employment policies, the one that minimizes movements in the nominal exchange rate is given by

$$\epsilon_t = \max\left\{\gamma \frac{w_{t-1}}{w_t^f}, 1\right\},$$

so that the nominal exchange rate only varies when the full-employment wage falls below the lower bound γw_{t-1}. The policy therefore yields the minimum devaluation needed to maintain full employment during a crisis. The exchange rate policy we assume (as in S. Liu (2018)) can capture alternative exchange rate arrangements:

$$\epsilon_t = \max\left\{\gamma \frac{w_{t-1}}{w_t^f}, 1\right\}^{\phi_\epsilon}$$

with $\phi_\epsilon \in [0, 1]$. The case $\phi_\epsilon = 0$ implements a pure peg, whereas $\phi_\epsilon = 1$ corresponds to a pure float. In general, the smaller ϕ_ϵ, the less powerful the exchange rate policy, for the nominal exchange rate is allowed to change less and less strongly in response to a shock.

2.4 Market clearing and definition of equilibrium

Market clearing in the nontradable sector requires

$$y_t^N = c_t^N + g_t^N. \tag{16}$$

Market clearing in the tradable sector requires

$$c_t^T = y_t^T + b_t - \frac{b_{t+1}}{1 + r_t}. \tag{17}$$

We assume that the world interest rate is constant, that is

$$r_t = r \tag{18}$$

for all t.

An equilibrium is defined as a set of stochastic processes $\{c_t^T, c_t^N, h_t, p_t^N, b_{t+1}, w_t, w_t^f, \lambda_t, \mu_t\}_{t=0}^{\infty}$

satisfying

$$c_t^T = y_t^T + b_t - \frac{b_{t+1}}{1+r} \tag{19}$$

$$\lambda_t = U'(A(c_t^T, h_t^\alpha - g_t^N))A_1(c_t^T, h_t^\alpha - g_t^N) \tag{20}$$

$$\lambda_t = \beta(1+r)\mathbb{E}_t\lambda_{t+1} + \mu_t \tag{21}$$

$$b_{t+1} \geq -\bar{b} \tag{22}$$

$$\mu_t \geq 0 \tag{23}$$

$$\mu_t(b_{t+1} + \bar{b}) = 0 \tag{24}$$

$$\frac{1-\omega}{\omega}\left(\frac{c_t^T}{h_t^\alpha - g_t^N}\right)^{1+\eta} = \frac{w_t}{\alpha h_t^{\alpha-1}} \tag{25}$$

$$w_t \geq \gamma\frac{w_{t-1}}{\epsilon_t} \tag{26}$$

$$h_t \leq \bar{h} \tag{27}$$

$$(\bar{h} - h_t)\left(w_t - \gamma\frac{w_{t-1}}{\epsilon_t}\right) = 0 \tag{28}$$

$$\epsilon_t = \max\left\{\gamma\frac{w_{t-1}}{w_t^f}, 1\right\}^{\phi_\epsilon} \tag{29}$$

given an exchange rate policy $\{\epsilon_t\}_{t=0}^\infty$, initial conditions $\{w_{-1}, b_0\}$, and exogenous stochastic processes $\{y_t^T, g_t^N\}_{t=0}^\infty$.

3 Analytical Example

In this section, we discuss an analytical example to illustrate the adjustment to a temporary government spending shock under perfect foresight. Assume that preferences are given by $U(c_t) = \ln(c_t)$ and $A(c_t^T, c_t^N) = c_t^T c_t^N$. The production function for nontradables is $F(h_t) = h_t$. Furthermore, assume that the economy starts with no outstanding debt, $b_0 = 0$, and that the endowment of tradables, y^T, and the world interest rate, r, are constant over time. Finally, assume that $\beta(1+r) = 1$, that $\gamma = 1$, and that $\bar{h} = 1$. The economy is subject to a negative government spending shock at time 0. Assume the following process for government spending:

$$g_t^N = \begin{cases} 0 < \bar{g} < 1 & \text{if } t < 0 \\ 0 < \underline{g} < \bar{g} & \text{if } t = 0 \\ \bar{g} & \text{if } t > 0. \end{cases}$$

Assume that, prior to the shock at time 0, the economy has been at the full-employment equilibrium, with $b_{t+1} = 0$, $c_t^T = y^T$, $c_t^N = 1 - g_t^N$ and $w_t = \frac{y^T}{1-g_t^N}$.
Given the preferences and the functional forms above, we obtain the following equilibrium

conditions:

$$\lambda_t = U'(A(c_t^T, h_t - g_t^N))A_1(c_t^T, h_t - g_t^N) = \frac{1}{c_t^T} \tag{30}$$

$$\lambda_t = \lambda_{t+1} + \mu_t \tag{31}$$

$$p_t^N = \frac{A_2(c_t^T, h_t - g_t^N)}{A_1(c_t^T, h_t - g_t^N)} = \frac{c_t^T}{h_t - g_t^N} \tag{32}$$

$$p_t^N = \frac{w_t}{F'(h_t)} = w_t \tag{33}$$

$$w_t \geq \frac{w_{t-1}}{\epsilon_t} \tag{34}$$

$$h_t \leq \bar{h} \tag{35}$$

$$\epsilon_t = \max\left\{\frac{w_{t-1}}{w_t^f}, 1\right\}^{\phi_\epsilon} \tag{36}$$

Assume that the borrowing constraint never binds, that is, $b_{t+1} > -\bar{b}$ and $\mu_t = 0$ for all t, and that $b_t = b_1 \geq b_0 = 0$ for $t \geq 1$. This implies constancy of tradable consumption, i.e., $c_t^T = c_{t+1}^T$ for all t. In period 0, nontradable output is equal to $y_0^N = c_0^N + \underline{g}$ and the real wage is given by $w_0 = \frac{y^T}{h_0 - \underline{g}}$. Consider now how output and hours worked vary depending on the exchange rate arrangement. In particular, we focus on the two polar cases, namely the pure peg and the pure float. Assume that $h_0 < 1$. Then it must be that $w_0 = \frac{w_{-1}}{\epsilon_0}$.

Peg ($\phi_\epsilon = 0$): The gross devaluation rate is equal to $\epsilon_0 = 1$. The real wage is given by $w_0 = \frac{y^T}{h_0 - \underline{g}} = \frac{y^T}{1-\bar{g}}$. This implies $1 - \bar{g} = h_0 - \underline{g} < 1 - \underline{g}$, that is, $\bar{g} > \underline{g}$, which is true by assumption. More specifically, we have $y_0^N = h_0 = \frac{y^T}{w_{-1}} + \underline{g} = 1 - (\bar{g} - \underline{g})$.

Float ($\phi_\epsilon = 1$): The gross devaluation rate is given by $\epsilon_0 = \frac{w_{-1}}{w_0^f}$, with $w_0^f = \frac{y^T}{1-\underline{g}}$, because $\epsilon_0 = \frac{1-\underline{g}}{1-\bar{g}} > 1$. This implies $1 - \bar{g} = \frac{h_0 - \underline{g}}{1-\underline{g}}(1 - \bar{g})$. The assumption that $h_0 < 1$ therefore leads to a contradiction: $1 - \underline{g} = h_0 - \underline{g} < 1 - \underline{g}$. So it must be that $y_0^N = h_0 = 1$.

Furthermore, we have $p_{-1}^N = \frac{y^T}{1-\bar{g}}$, $p_0^N = \frac{y^T}{h_0 - \underline{g}}$ and $RER = A_1(P^{-1}(p^N, 1)) = \frac{y^T}{p^N}$. In particular, it holds that $p_{0,peg}^N = \frac{y^T}{h_0 - \underline{g}} = \frac{y^T}{1-\bar{g}} > \frac{y^T}{1-\underline{g}} = p_{0,float}^N$. This implies that a cut in government spending causes a fall in p^N and an increase in RER, that is, depreciation, under the pure float, whereas it leaves private consumption and therefore the relative price unaffected under a pure peg. In other words, there is no depreciation under a pure peg. This is a consequence of a linear production function, which yields a flat supply schedule.

Consider now a positive government spending shock hitting the economy at the full-employment equilibrium. Assume that government spending takes on values in $(0, 1)$, as before, and that its process is given by:

$$g_t^N = \begin{cases} \bar{g} & \text{if } t < 0 \\ g' > \bar{g} & \text{if } t = 0 \\ \bar{g} & \text{if } t > 0. \end{cases}$$

Assume that the shock does not bring about involuntary unemployment, that is, $h_0 = 1$. Then it must be that $w_0 > \frac{w_{-1}}{\epsilon_0}$. In particular, $w_0 = \frac{y^T}{1-g'} > \frac{y^T}{(1-\bar{g})\epsilon_0}$.

Peg ($\phi_\epsilon = 0$): The gross devaluation rate is equal to $\epsilon_0 = 1$, which implies that $1 - \bar{g} > 1 - g'$. This is true by assumption, because $\bar{g} < g'$.

Float ($\phi_\epsilon = 1$): The gross devaluation rate is equal to $\epsilon_0 = \max\left\{\frac{1-g'}{1-\bar{g}}, 1\right\} = 1$, as in the previous step, so it must be that $h_0 = 1$.

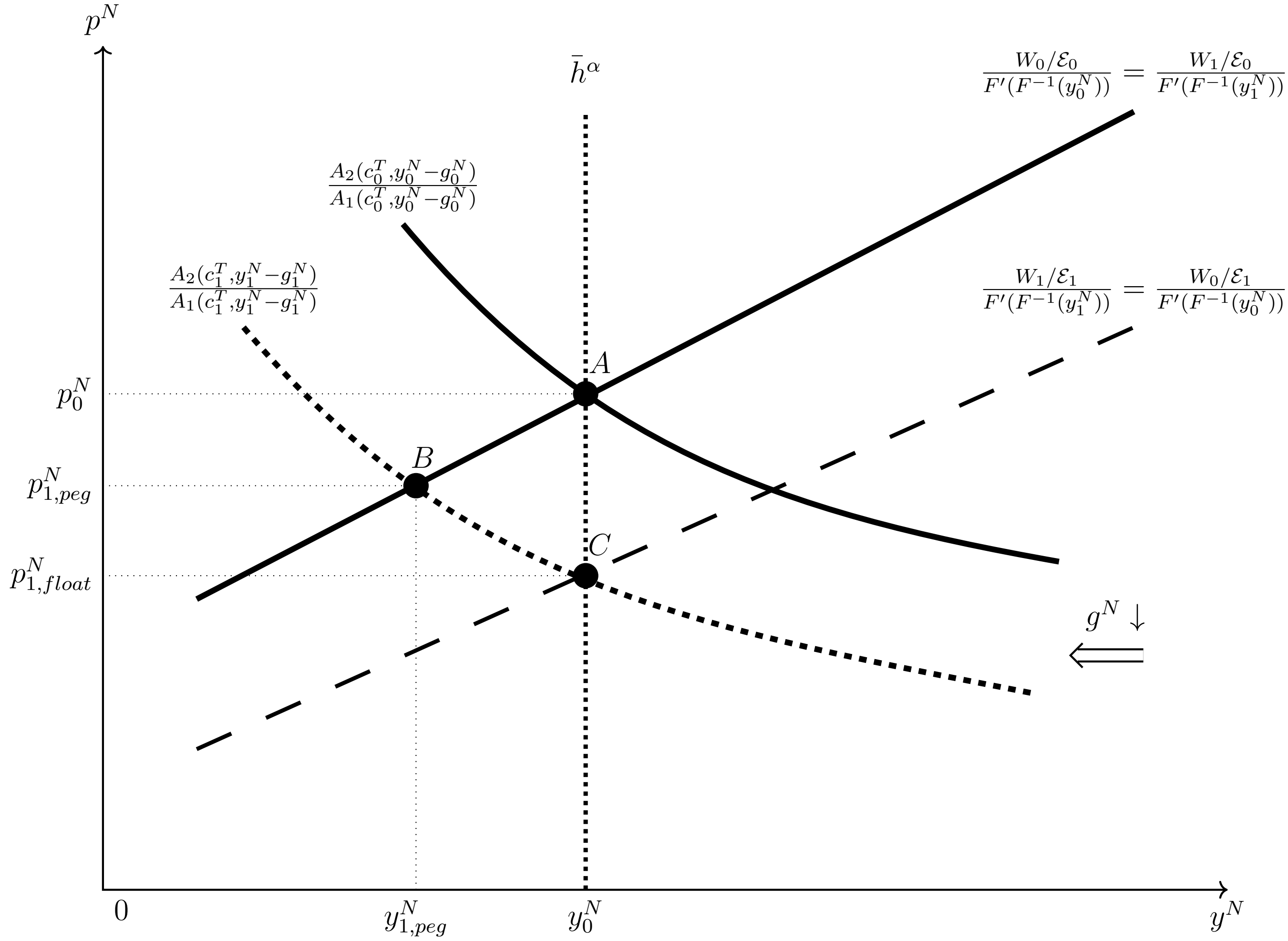
Now, it holds that $p^N_{0,peg} = p^N_{0,float} = \frac{y^T}{1-g'} > \frac{y^T}{1-\bar{g}} = p^N_{-1}$. That is, an increase in government spending brings about the same amount of appreciation.

We now turn to a graphical analysis. Let us relax the conditions above, except for $\gamma = 1$, and consider the special case of equality of intra- and intertemporal elasticities of substitution. We can therefore separate the tradable consumption decision from the level of activity in the nontradable sector and focus exclusively on this sector, for shocks will not spill over to the tradable sector. Figure 2 illustrates the transmission mechanism of a one-time negative spending shock to the market for nontradables for the peg and the float scenarios. The figure plots the demand and supply schedules for nontradables in terms of output, and therefore in terms of employment, because in equilibrium $y_t^N = F(h_t)$, given g_t^N and w_t. Suppose that the initial position of the nontraded sector is at point A, where the economy is in full employment. Suppose now that, for some exogenous reason, the government decides to cut consumption of nontradables. The decline in public demand from g_0^N to g_1^N leads to a leftward shift of the demand schedule. Excess supply now develops in the market. As a result, under a pure peg (i.e., $\phi_\epsilon = 0$) the relative price falls and private consumption c^N increases, but not enough to fully offset the cut in public demand. The new equilibrium B features a lower level of output and involuntary unemployment. Under a pure float (i.e., $\phi_\epsilon = 1$), instead, the devaluatory exchange rate policy shifts the supply schedule to the right, thus reducing the relative price further, until the economy reaches the new equilibrium C. In this point, the economy experiences again full employment. For intermediate values of ϕ_ϵ, the new equilibrium lies between the points B and C.

Figure 3 illustrates the case of a positive spending shock, starting again from the full-employment point A. An increase in public spending leads to a rightward shift of the demand schedule, thus bringing about excess demand for labor. This drives up the nominal wage, which is upwardly flexible, thereby shifting the supply schedule up and to the left to point C, where the equilibrium in the labor market is restored. As a result, the relative price is further increased, contributing to a stronger reduction in private consumption. Figures 2 and

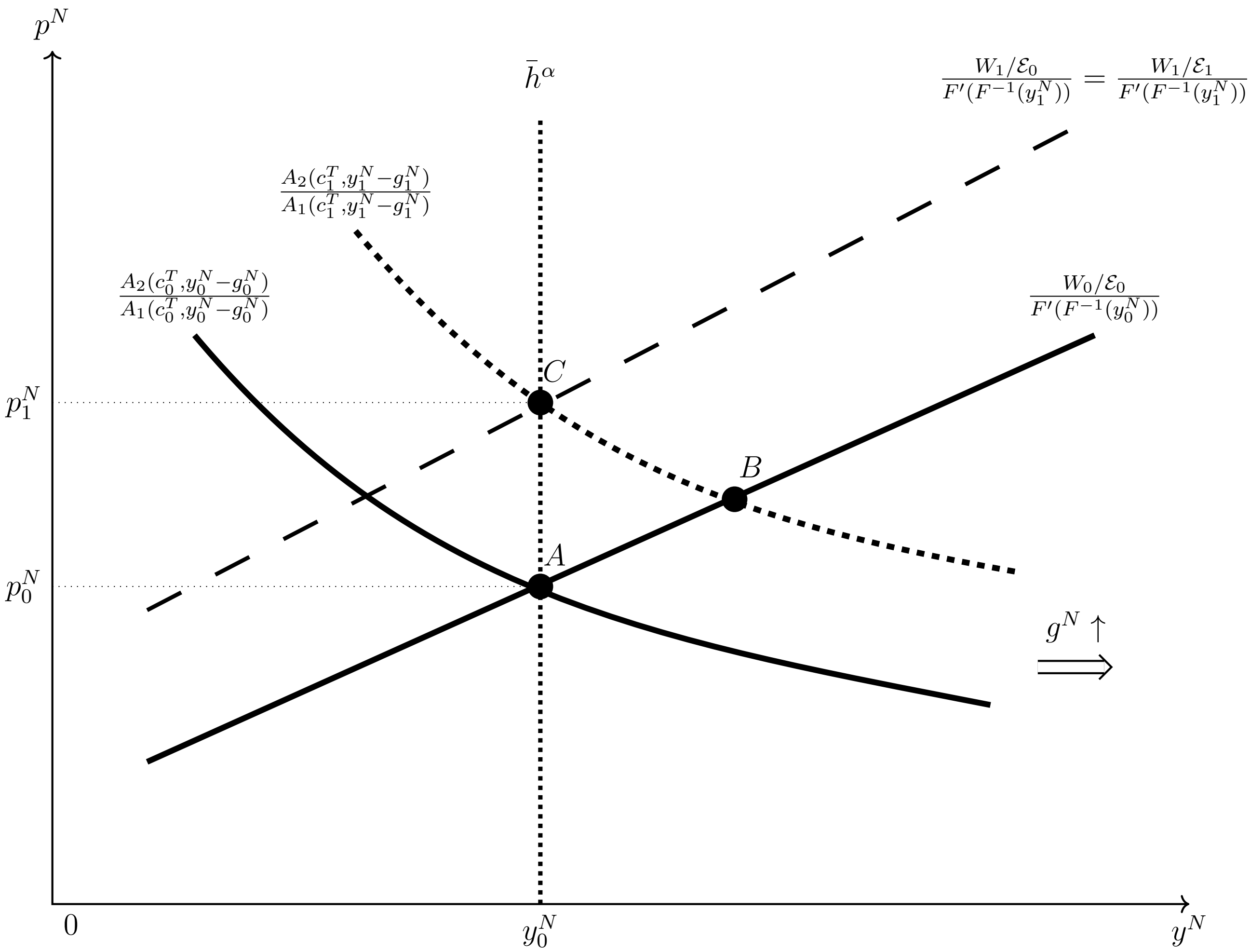
3, together, show that the less flexible is the exchange rate arrangement, the stronger is the asymmetry in the response of the relative price, and therefore of the real exchange rate. In particular, there is no asymmetry under a pure float.

Figure 2: Nontradable Sector. Adjustment to a Negative Government Spending Shock.



Note: This figure is drawn under the assumption that $\gamma = 1$.

Figure 3: Nontradable Sector. Adjustment to a Positive Government Spending Shock.



Note: This figure is drawn under the assumption that $\gamma = 1$.

4 Quantitative Analysis

This section presents the parametrization of the model and the quantitative results of our experiments. More precisely, we seek to determine the impact of positive and negative spending shocks on the real exchange rate and on output. The real exchange rate is calculated as $[\omega^{1/(1+\eta)} + (1-\omega)^{1/(1+\eta)}(p^N)^{\eta/(1+\eta)}]^{-(1+\eta)/\eta}$.

4.1 Parametrization

The model is solved numerically using the time iteration method presented in Bianchi, C. Liu, et al. (2016), which has been modified to address downward nominal wage rigidity. The algorithm solves the decentralized equilibrium by backward recursive substitution of the model's optimality conditions. To discretize the past real wage, w_{-1}, we use 300 points, which are equally spaced in a log scale. We set the lowest grid value of w_{-1} at 2.75 and the highest at 5.5. To discretize current debt, b_t, we use 100 points and use a finer grid for low values to improve accuracy near the lower bound. The debt limit $\bar{b}$ is set at -0.8. We fix the upper bound at 0.2 and the lower bound at -0.8. In this numerical exercise, we parametrize the model at quarterly frequency. The world interest rate is exogenous and equal to 0.5 percent. The subjective discount factor β is set at 0.99. The wage rigidity parameter γ is equal to 0.995, higher than in Schmitt-Grohé and Uribe (2016). This means that nominal wages can fall at most by 2 percent per year. As for the intratemporal elasticity of substitution between tradables and nontradables, $1/(1+\eta)$, we set it equal to 0.44, following again Schmitt-Grohé and Uribe (2016). This value is in the range of estimates reported by Bianchi (2011). The Markov process of the tradable endowment y^T includes three realizations. The transition probability matrix is determined using the Tauchen algorithm. The parameters ρ_y and σ_y for the stochastic process of y^T have been estimated by Bianchi (2011) using data for Argentina. His estimates are $\rho_y = 0.54$ and $\sigma_y = 0.059$. The Markov process of government spending includes nine realizations, the average being 0.18. Again, we determine the values of these realizations and their transition probability matrix using the Tauchen algorithm. The algorithm uses the parameter values $\rho_g = 0.99$ and $\sigma_g = 0.01$. We choose to focus on the special case of equality of intra- and intertemporal elasticity of substitution, therefore the inverse of the intertemporal elasticity of substitution for private consumption σ is set equal to 2.27. This implies that we can separate the tradable consumption decision from the level of activity in the nontradable sector. To simplify numerical computations, the labor share in the nontradable sector α is set equal to 1. The weight on tradables in the CES aggregator ω is set at 0.26, as in Schmitt-Grohé and Uribe (2016). The coefficient ϕ_ϵ takes on different values. We analyze the two polar cases, namely $\phi_\epsilon = 0$, which implements a pure peg, and $\phi_\epsilon = 1$, which corresponds to a pure float, as well as the intermediate scenario $\phi_\epsilon = 0.5$.

4.2 Impulse responses

We compute generalized impulse responses on the basis of stochastic simulations comparing the dynamics after a random shock to government spending and the dynamics in the absence of the shock. More specifically, we set the initial value of government spending equal to 0.18 and the size of the shock equal to 1 percentage point on impact. This corresponds to the smallest shock allowed by the grid. We then average over 10,000 replications.

Figure 4 displays impulse responses to government spending shocks that represent, in turn, a spending increase (dashed line) and a spending cut (solid line). In the figure, we report the dynamics of government spending, g^N, nontradable output, y^N, and the real exchange rate, RER for three exchange rate regimes. The left column shows the case of perfectly flexible exchange rates, the right column shows results for a hard peg. The middle column shows the result for an intermediate regime where exchange rate flexibility is limited ($\phi_\epsilon = 0.5$). In all instances, vertical lines represent percentage deviations from the average unshocked path

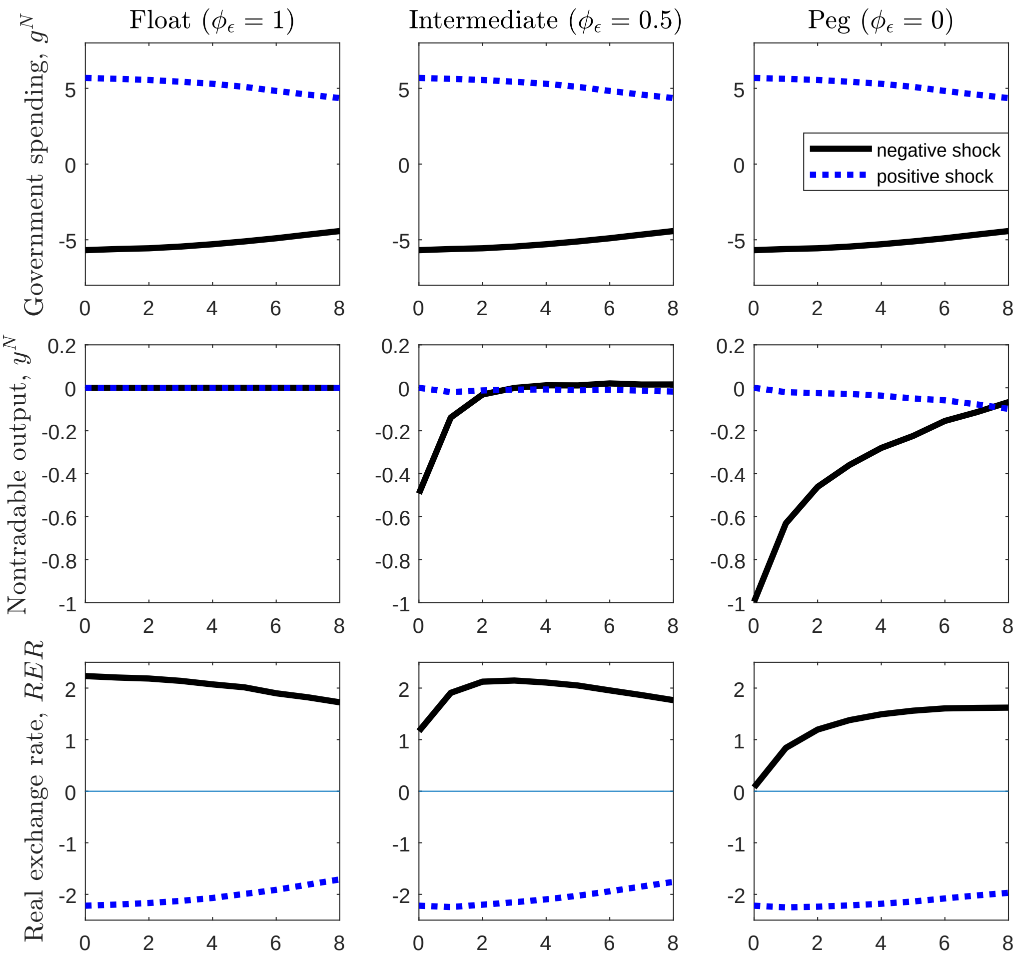


Figure 4: Impulse responses to positive and negative spending shocks.

and horizontal lines represent quarters. Notice that, as before, a decline of RER represents a real appreciation.

A number of observations are noteworthy. First, the dynamics of government spending (top row) are independent of the exchange rate regime because we consider an exogenous variation of government spending throughout. Second, the adjustment to positive spending shocks is independent of the exchange rate regime, too. This is because monetary policy matters only to the extent that nominal rigidities matter. In our model, there is only a downward rigidity. Yet, in response to higher spending wages rise and they are not constrained to do so in any of the regimes under consideration. Third, turning to the output response (second row), we observe that it is fully stabilized under flexible exchange rate, irrespectively of the sign of the shock, but that it declines in response to negative spending shocks if exchange rate flexibility is limited. This is the case where the downward nominal wage rigidity binds. It does not bind in case government spending is increased. As a result, full employment is maintained in response to positive spending shocks. Hence, we find a multiplier of zero in response to spending increases. Instead, in response to spending cuts the multiplier is larger than zero—that is, unless exchange rates are fully flexible.

Finally, we turn to the exchange rate response (last row). Here we observe again a high degree of asymmetry in response to the shock, provided that exchange rates are not fully flexible. Government spending appreciates the real exchange rate in all scenarios. Spending cuts, in turn, induce a depreciation. In particular, the depreciation is not immediate under a peg, rather, it only builds up over time.

5 Evidence

In this section, we reassess the effect of government spending on the real exchange rate. A number of recent studies have explored the issue and reported different, partly conflicting results regarding the sign of the response (Corsetti, Meier, et al., 2012b; Ilzetzki et al., 2013a; Kim and Roubini, 2008; Monacelli and Perotti, 2010; Ravn et al., 2012). In what follows we take a fresh look: informed by the model-based analysis above, we ask whether spending increases and cuts impact the real exchange rate symmetrically or not.

Our analysis builds on Born, Müller, et al. (2018), both in terms of data and in terms of identification. Our sample covers quarterly observations from the early 1990s up until 2017Q4 for 38 emerging and advanced economies. We consider two identification schemes going back to Blanchard and Perotti (2002) and Ramey (2011), respectively (see also Ramey and Zubairy (2018) for a recent discussion). In both instances, the idea is to establish first the surprise component of government spending, in the first case on the basis of an estimated vector autoregression (VAR) model, in the second case on the basis of a professional forecast. In a second step, we establish the effect of the fiscal surprise on the real exchange rate by means of local projections à la Jordá (2005). For this purpose we assume that government spending surprises are predetermined relative to other developments in the macroeconomy. This assumption is explicit in Blanchard and Perotti (2002) and implicit in Ramey (2011).[3]

5.1 Empirical specification

In what follows we briefly outline our empirical specification. We start with the second step which establishes the effect of government spending on the exchange rate. For this purpose we rely on fiscal shocks, $\varepsilon_{i,t}$, computed in the first step. Here, indices i and t refer to country i and period t, respectively. We sort fiscal shocks depending on whether they are positive or negative and define $\varepsilon^{g+}_{i,t} = \varepsilon^{g}_{i,t}$ if $\varepsilon^{g}_{i,t} \geq 0$ and 0 otherwise, and similarly for negative shocks, $\varepsilon^{g-}_{i,t}$.

Local projections are particularly suited to account for potentially asymmetric effects of positive and negative shocks. Our specification follows Kilian and Vigfusson (2011). Letting $x_{i,t+h}$ denote the exchange rate in period $t+h$, we estimate how it responds to fiscal shocks in period t on the basis of the following specification:

$$x_{i,t+h} = \alpha_{i,h} + \eta_{t,h} + \psi^{+}_{h}\varepsilon^{+}_{t} + \psi^{-}_{h}\varepsilon^{-}_{t} + \gamma Z_{i,t} + u_{i,t+h} \ . \tag{37}$$

Here ψ^{+}_{h} and ψ^{-}_{h} provide a direct estimate of the impulse response at horizon h to a positive and negative shock, respectively. $Z_{i,t}$ is a vector of control variables which includes lags of

[3] In her paper, she considers two approaches. One based on military news, the other based on forecast errors. Our discussion refers to the latter.

government spending (growth), output (growth), and the real exchange rate.[4] The error term $u_{i,t+h}$ is assumed to have a zero mean and strictly positive variance.

5.2 Identification

Our identification strategy is explained in Born, Müller, et al. (2018) in some detail. Here we summarize the essential aspects. Importantly, we pursue two alternative strategies to construct fiscal innovations. One strategy has been introduced by Ramey (2011). The idea is simply to purge actual government spending growth of what professional forecasters project spending growth to be. Formally, we have

$$\varepsilon^{g}_{i,t} = \Delta g_{i,t} - \mathbb{E}_{t-1}\Delta g_{i,t},$$

where $\Delta g_{i,t}$ is the realization of government consumption growth and $\mathbb{E}_{t-1}\Delta g_{i,t}$ is the previous period's forecast.

The second strategy employs a panel VAR model to compute spending surprises. Let $X_{i,t}$ denote a vector of endogenous variables, which includes government spending, output, and the real effective exchange rate. We estimate the following model:

$$X_{i,t} = \alpha_i + \eta_t + A(L)X_{i,t-1} + \nu_{i,t},$$

where $A(L)$ is a lag polynomial and $\nu_{i,t}$ is a vector of shocks. In our analysis, we allow for four lags since the model is estimated on quarterly data.

Our identifying assumption, dating back to Blanchard and Perotti (2002), is that the forecast error of government spending growth is not caused by contemporaneous innovations, so that it represents a genuine fiscal *shock*. Importantly, this identification assumption is also implicit in the first strategy due to Ramey (2011). The only difference between the two strategies is the way in which the forecast error is computed, once on the basis of professional forecasts, once on the basis of a VAR. In each instance, the assumption is that the forecast error is not in part caused by an endogenous response of government spending to other structural innovations. The rationale for this assumption is that government spending can be adjusted only subject to decision lags. Also, there is no automatic response, since government spending does not include transfers or other cyclical items.

5.3 Data

Table 1 summarizes the coverage of our sample. Altogether there are 38 countries, but professional forecasts for government spending for which we rely on *Oxford Economics* are available only for a subset of those. Instead, the data required for our VAR-based forecast

[4] For the specification using professional forecasts, $x_{i,t+h}$ is the cumulative change between t and $t+h$ as in Stock and Watson (2018). We use growth rates rather than levels of government spending because there are irregular base year changes for the countries in this sample that would show up as breaks if we considered levels.

Table 1: Sample range for alternative forecasting models

	Oxford Economics		VAR	
Country	Range	T	Range	T
Argentina	1999Q3-17Q4	59	1993Q3-17Q4	74
Australia	2003Q1-10Q3	28	2002Q4-10Q3	16
Austria	1997Q1-17Q4	80	1993Q3-17Q4	93
Belgium	-	-	1991Q3-17Q4	101
Brazil	-	-	1996Q1-17Q4	83
Bulgaria	-	-	2000Q1-17Q4	67
Chile	1999Q3-17Q4	72	1999Q1-17Q4	71
Colombia	-	-	2000Q1-17Q4	67
Croatia	-	-	2003Q4-17Q4	52
Czech Republic	2004Q1-17Q4	56	2003Q4-17Q4	52
Denmark	1997Q1-17Q4	73	1991Q1-17Q4	90
Ecuador	-	-	1994Q4-17Q4	72
El Salvador	-	-	2002Q1-17Q3	58
Finland	1999Q2-17Q4	73	1992Q1-17Q4	99
France	1999Q1-17Q4	74	1998Q4-17Q4	72
Germany	2004Q1-17Q4	56	2003Q4-17Q4	52
Greece	2001Q4-17Q4	60	1995Q1-17Q4	79
Hungary	1999Q3-17Q4	72	1998Q4-17Q4	72
Ireland	2004Q1-17Q4	56	1995Q1-17Q4	87
Italy	1997Q1-17Q4	80	1991Q1-17Q4	103
Latvia	-	-	2005Q4-17Q4	44
Lithuania	-	-	2005Q1-17Q4	47
Malaysia	1999Q3-17Q4	72	2000Q1-17Q4	67
Mexico	-	-	1993Q3-17Q4	93
Netherlands	1999Q1-17Q4	74	1998Q4-17Q4	72
Peru	-	-	1996Q4-17Q4	75
Poland	-	-	2002Q1-17Q4	59
Portugal	1998Q4-17Q4	75	1995Q1-17Q4	87
Slovakia	2005Q2-17Q4	51	2003Q4-17Q4	52
Slovenia	-	-	2002Q4-17Q4	56
South Africa	-	-	1994Q3-17Q4	89
Spain	1997Q1-17Q4	80	1995Q1-17Q4	87
Sweden	1998Q3-17Q4	69	1993Q1-17Q4	78
Thailand	1999Q3-17Q4	72	1997Q1-17Q4	79
Turkey	2000Q1-17Q4	70	1998Q1-17Q4	75
United Kingdom	1997Q1-17Q4	80	1995Q1-17Q4	87
United States	2007Q4-17Q4	41	2007Q3-17Q3	36
Uruguay	-	-	2001Q1-17Q4	58
Total		1523		2701

Notes: Range refers to the first and last observation available. Note that the VAR-approach requires 5 observations to construct 4 lags of growth rates. T refers to the number of observations used for the particular country after accounting for missing values and lag construction in the unconditional model.

error is available for all 38 countries. Born, Müller, et al. (2018) provide a detailed description of the data set.

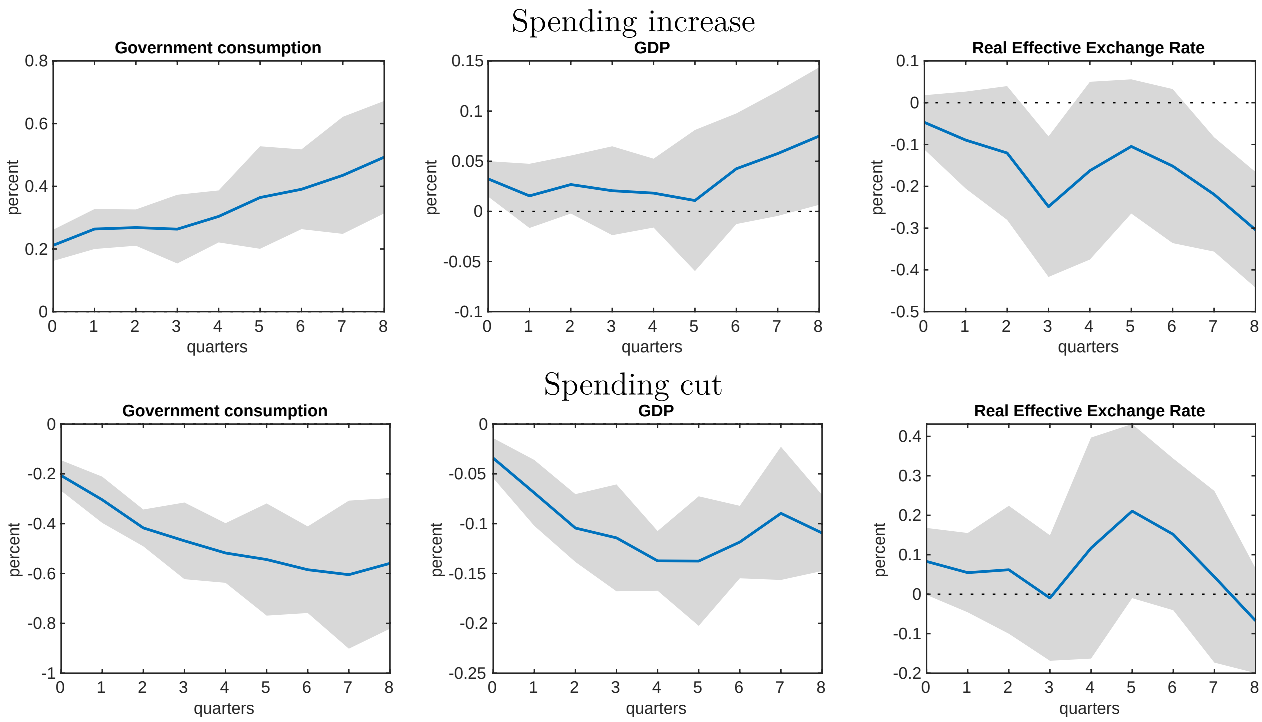


Figure 5: Adjustment to government spending shock: identification based on forecast error of professional forecasters. Shaded areas represent 90 percent confidence intervals.

5.4 Results

In what follows, we report results for both identification strategies. Figure 5 shows results for the forecast error based on professional forecasts. The top panel displays the impulse responses to a positive government spending shock, the bottom panel considers a negative response. Throughout, solid lines represent the point estimate, while shaded areas indicate 90 percent confidence intervals.

The response of government spending, shown on the left, is fairly transitory in both cases. We also show the response of output in the middle column. There is a significant, but moderate response on impact. The drop of output in response to a spending cut appears somewhat stronger and, in particular, more persistent. Last, we turn to the response of the real exchange rate, shown in the rightmost column.[5]

Here the asymmetry is most pronounced. In response to higher government spending, the real exchange appreciates. It does not depreciate, however, in response to a reduction of government spending.

In Figure 6 we show results based on the VAR forecast error. Note that in this case our sample is quite a bit larger. However, by and large, we find very similar results. In particular, we find the response of the exchange rate to be asymmetric — in line with the predictions of the model. Overall, our evidence supports the notion of substantial downward wage rigidities that are not (completely) neutralized by monetary policy.

[5]We use the index compiled by the BIS. An increase indicates a depreciation of the economy's currency against a broad basket of currencies.

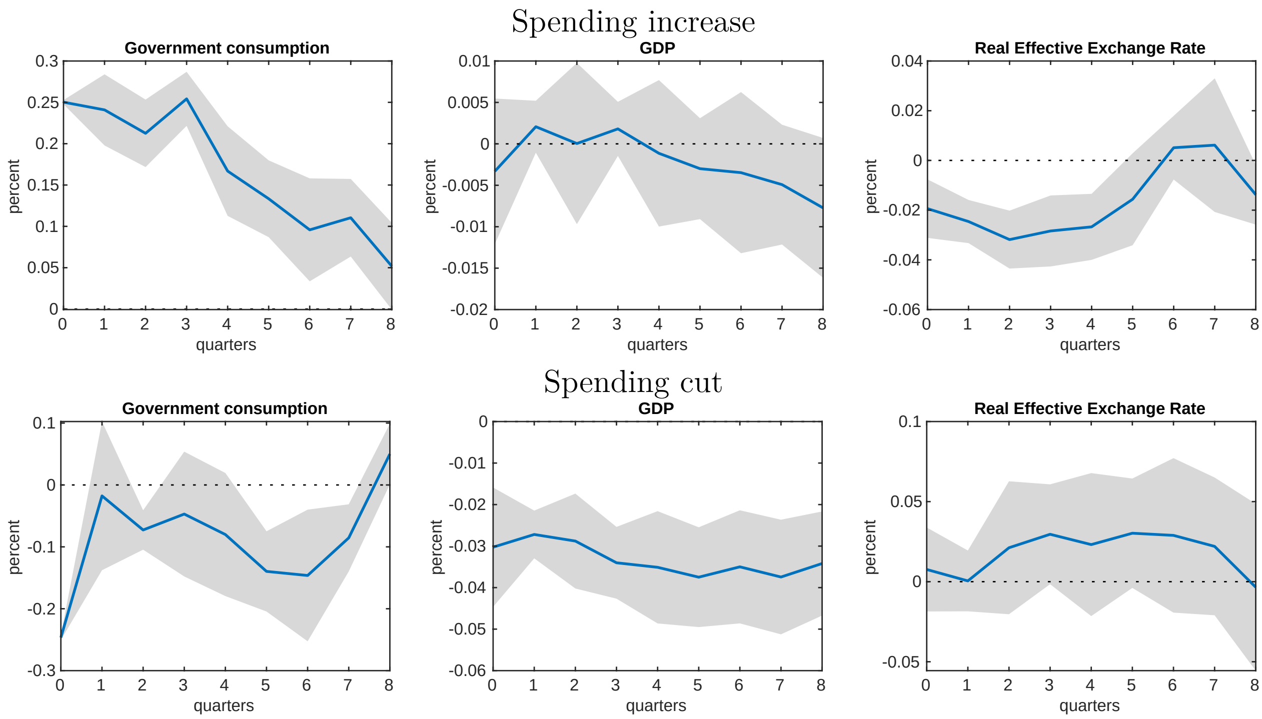


Figure 6: Adjustment to government spending shock: identification based on VAR forecast error. Shaded areas represent 90 percent confidence intervals.

6 Conclusion

In this paper, we show that government spending impacts the real exchange rate asymmetrically, depending on whether spending is raised or cut. In particular, we rely on a simple model that departs from Schmitt-Grohé and Uribe (2016) by introducing government spending and a somewhat richer menu of exchange rate policies. The key feature of the model is that wages are (only) downwardly rigid. We consider the limiting cases of pure float and pure peg, but we also consider an intermediate regime in which monetary policy allows for limited exchange rate flexibility. If the spending shock is large enough to make the wage constraint binding, the presence of a currency peg contributes to a potentially strong asymmetry. On the other hand, economies characterized by a higher degree of exchange rate flexibility can mitigate or totally undo the real effects stemming from the downward wage rigidity, which results in a weaker asymmetry or no asymmetry altogether under a pure float. In a second step, we take the issue empirically and estimate local projections using quarterly data for 38 advanced and emerging market economies, covering the period from the early 1990s to 2017. We find that the real exchange appreciates in response to higher government spending, whereas it does not depreciate in response to a reduction of government spending. This result is robust across alternative identification schemes.

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