Chapter 3

Government spending shocks, sovereign risk and the exchange rate regime*

"...the currency regime makes a huge difference to the stories we tell about debt."

-Paul Krugman, Mundell-Fleming Lecture 2013

IN most of the developed world, fiscal policy has made a comeback as a viable tool for macroeconomic stabilisation. Not surprisingly, the recent literature has spend much effort assessing the efficacy of fiscal policy, particularly emphasising the role of the economic environment. Estimations by Auerbach and Gorodnichenko (2012), Ilzetzki et al. (2012), and Corsetti et al. (2012b) indicate that the effects of discretionary fiscal policy on output, as measured by the fiscal multiplier, depend, among other things, on the exchange rate regime in place and the state of public finances: the multiplier tends to be larger when exchange rates are held fixed and lower in times when public finances are perceived as unsustainable. These environments have thus far been studied separately, yet anecdotal evidence by De Grauwe (2012) suggests that the effects of weak public finances on the transmission of fiscal shocks depend crucially on the exchange rate regime in place. The objective of this chapter

*This chapter is based on Bonam and Lukkezen (2014b).

is to study this interaction. In contrast to conventional wisdom, we find that in the presence of weak public finances the fiscal multiplier is larger under floating exchange rates than under fixed exchange rates.

Standard Keynesian theory predicts that government spending multipliers are larger under fixed exchange rate regimes than under flexible exchange rate regimes, a result which can be traced back to the well-known Mundell-Fleming model. According to this model, an exogenous increase in government spending raises aggregate demand, which drives up the price level. In response, the central bank raises the interest rate in an attempt to stabilise inflation, which in turn leads to an appreciation of the nominal exchange rate and a reduction in net exports, thereby reducing the size of the multiplier. However, under fixed exchange rates, the central bank has to keep the interest rate at par with the interest rate of the anchor-country in order to maintain the peg. A government spending increase would therefore not be followed by an interest rate hike and exchange rate appreciation, allowing for a larger multiplier. Recent theoretical New Keynesian models have been able to confirm these results from the static Mundell-Fleming model (see e.g. Galí and Monacelli, 2008, and Corsetti et al., 2013d).

In most theoretical work on fiscal multipliers, public finances play an auxiliary role. The government is most often assumed to be solvent at all times and concerns regarding government debt sustainability are thus absent. In this chapter, we deviate from such conventions to assess the implications of weak public finances for the size of the fiscal multiplier, under alternative exchange rate regimes. We do so by augmenting an otherwise basic New Keynesian model for a small open economy in two ways. First, we allow for the possibility that the government reneges on its outstanding debt obligations. Following Schabert and van Wijnbergen (2014), we introduce the possibility of sovereign default through the presence of a fiscal limit. This fiscal limit determines the maximum level of debt that the government is willing to service. When public debt is near the fiscal limit, an increase in government spending, or any other form of fiscal expansion, raises sovereign default expectations. In the model, this increase in sovereign risk triggers an outflow of capital by foreign investors in search of safer assets. When the exchange rate is allowed to float, a depreciation of the nominal exchange rate then follows which supports net exports. The presence of sovereign risk therefore alters the traditional fiscal transmission mechanism and generates an *exchange rate effect* which increases the multiplier. Under fixed exchange rates, the exchange rate effect is not present as the central bank prevents the exchange rate from moving.

Second, we assume that private borrowing conditions are affected by a worsening of public finances. This assumption captures heightened funding strains in the private sector induced by fiscal stress (for an empirical account of the relationship between sovereign default risk and private credit conditions, see Bruyckere et al., 2013, and references therein). Sovereign risk therefore leads to a higher risk premium on private external debt. We refer to this feature as *sovereign risk pass-through*, as in Corsetti et al. (2013c). Higher private borrowing costs reduce aggregate domestic expenditures, suggesting that sovereign risk opens up a new *crowding-out effect* of fiscal policy which reduces the multiplier. Under flexible exchange rates, the crowding-out effect is mitigated through accommodating countercyclical monetary policy. Hence, any reduction in the fiscal multiplier caused by the crowding-out effect is less pronounced under flexible than under fixed exchange rates.

Our model indicates that the exchange rate effect of sovereign risk has a positive impact on the government spending multiplier, yet only under flexible exchange rates, whereas the crowding-out effect has a smaller negative effect on the multiplier under flexible exchange rates than under fixed exchange rates. Therefore, the government spending multiplier can be larger under flexible than fixed exchange rates in the presence of sovereign risk. This result stands in contrast to the conclusions of the traditional Mundell-Fleming model and is the main result of the chapter. We present some stylized statistics that support our claim and test this hypothesis formally for several OECD countries using the two-step regression method suggested by Corsetti et al. (2012b). In the first step of this method, we estimate a simple fiscal rule which accounts for the endogenous components of fiscal policy, such as the fiscal response to the business cycle. The residuals from this estimation are identified as exogenous fiscal policy changes. In the second step, we estimate the effects of these exogenous fiscal policy changes on output and other variables of interest. In the absence of sovereign risk, we find that the output response to a government spending shock is positive and larger in countries that maintain a fixed, rather than flexible, exchange rate. If we condition on weak public finances, we find that the reverse holds: the effect of government spending on output is larger under flexible than under fixed exchange rates. In line with our theoretical exercise, these empirical results seem to be driven by the response of the exchange rate, which depreciates substantially in the presence of sovereign risk.

Our results indicate that so-called Non-Keynesian effects of fiscal policy can dominate standard Keynesian effects, thereby giving rise to the possibility of expansionary fiscal contractions (Giavazzi and Pagano, 1990). We demonstrate that a reduction in government spending can bring about a *positive* output response, yet only under fixed exchange rates. Particularly, an improvement of the fiscal balance reduces sovereign risk, thereby lowering the risk premium on private debt which raises aggregate private consumption. The stronger is the effect of fiscal policy on private credit conditions, the more likely it is that a fiscal contraction is expansionary. Fiscal contractions are, however, unlikely to be expansionary under flexible exchange rates due to an appreciation of the exchange rate, following the improvement of public finances, and the associated decline in net exports.

The remainder of this chapter is structured as follows. In Section 3.1, we extend a basic New Keynesian small open economy model with sovereign risk and sovereign risk pass-through. In Section 3.2, a reduced version of the model explains how the exchange rate and crowding-out effects of sovereign risk alter the traditional Keynesian fiscal transmission mechanism. We explore these effects further using impulse responses generated by the full model in Section 3.3, and confront our theoretical findings with the data in Section 3.4. The possibility of expansionary effects of fiscal contractions in times of sovereign risk is examined in Section 3.5. Finally, Section 3.6 concludes.

3.1 A small open economy model

Our model extends the New Keynesian small open economy model of Galí and Monacelli (2008) by introducing risky government bonds along the lines of Schabert and van Wijnbergen (2014), and by allowing for spillovers from sovereign risk to private credit conditions.

The model contains a continuum of small countries that interact on international goods and asset markets. We focus on one country, named 'Home', whose small size implies the domestic economy does not exert a significant influence on the economies of the other countries, which we lump together under the heading 'Foreign'. All Foreign variables are denoted with a '*' superscript and the subscripts H and F indicate Home and Foreign demand for a particular good or asset.

The private sector in the Home country consists of optimising households and firms. Households consume domestic and foreign goods, supply labour to firms and invest in internationally traded government and foreign bonds. Monopolistic distortions are introduced to allow for producer price rigidities as in Calvo (1983). Furthermore, there is a public sector consisting of a fiscal authority (or 'government') and a monetary authority ('central bank') who act independently from each other. Government spending is financed by lump-sum taxes and government bonds. Monetary policy either targets inflation (under a flexible exchange rate regime) or pegs the exchange rate (under a fixed exchange rate regime).

3.1.1 The public sector and sovereign risk

The first key feature of the model is the possibility that the government reneges on its outstanding debt obligations. Following Corsetti et al. (2013c) and Schabert and van Wijnbergen (2014), among others, we assume that the economy faces a *fiscal limit* which represents the maximum level of debt the government is able or willing to repay, and beyond which sovereign default ensues. Consequently, sovereign default expectations become a function of fiscal policy, a property which we refer to as *sovereign risk*. We make the simplifying assumption that the fiscal limit is determined exogenously. When examining the transition of the economy towards its fiscal limit, an endogenous fiscal limit might be necessary (e.g. Davig et al., 2010), yet this is not the purpose of this chapter.

In modelling sovereign default, we follow Schabert and van Wijnbergen (2014) and assume that the fiscal limit, say $\mathcal{B}$, is driven by unobservable political sentiments and unknown ex-ante to all agents. However, agents do know the distribution from which the fiscal limit is drawn, which occurs upon maturity of the sovereign bond contract. If it so happens that total real government debt outstanding exceeds the fiscal limit, the government fully defaults; otherwise, debt is fully repaid. Let B_t denote the total amount of nominal one-period government bonds issued at the beginning of period t, R_t the gross nominal interest rate on government bonds, and define $r_t \equiv R_t (P_t/P_{t+1})$ as the gross real interest rate, with P_t the consumer price index (CPI), and $b_t \equiv B_t/P_t$ as the real value of government debt. The ex-post default indicator, Δ_t, is then defined as

$$\Delta_t = \begin{cases} 0 & \text{if} \quad r_{t-1}b_{t-1} \leq \mathcal{B} \\ 1 & \text{otherwise} \end{cases}. \tag{3.1}$$

Since all agents know that the decision to default is governed by (3.1), and since they are familiar with the distribution of $\mathcal{B}$, they base their decisions on the ex-ante probability $\delta_t \in [0, 1)$ that the real debt burden exceeds the fiscal limit, which is given by

$$\delta_t = E_{t-1}\Delta_t = \int_0^{r_{t-1}b_{t-1}} h(\mathcal{B})\, d\mathcal{B} = \mathcal{H}(r_{t-1}b_{t-1}),$$

where E_t is the expectations operator conditional on the information available at t, $h(\mathcal{B})$ is the probability density function of the fiscal limit and $\mathcal{H}(r_{t-1}b_{t-1})$ the associated distribution function. Figure 3.1 plots a representation of $h(\mathcal{B})$ and highlights δ_t as the probability that $\mathcal{B}$ is drawn from the shaded area.

For the local analysis of the model, we make use of the *default elasticity* which indicates by how much the default probability changes for a given change in $r_{t-1}b_{t-1}$. Following Schabert and van Wijnbergen, we define the default elasticity as $\Phi \equiv \delta' rb/(1-\delta)$, where rb and δ denote the steady-state values of the real public debt burden and the default probability, respectively.

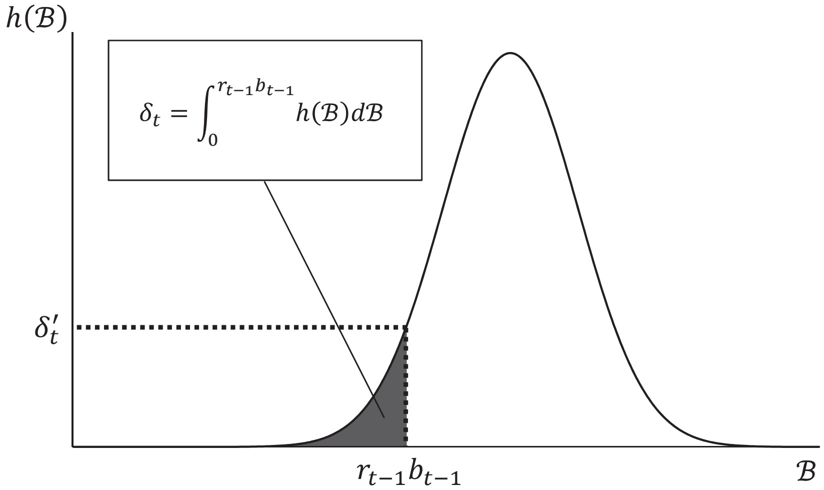
The rest of the government sector is straightforward. Real government spending g_t is financed by government bonds and real lump-sum taxes T_t. Changes in real public debt then arise due to differences in public debt outstanding (ex-post default) and the primary budget surplus, i.e.

$$b_t = (1-\Delta_t)\, r_{t-1}b_{t-1} - \frac{P_{H,t}}{P_t}(T_t - g_t), \tag{3.2}$$

where $P_{H,t}$ denotes the domestic aggregate price level. Government consumption is determined exogenously by the following AR(1) process:

$$\frac{g_t}{g} = \left(\frac{g_{t-1}}{g}\right)^{\rho_g} \varepsilon_{g,t}, \tag{3.3}$$

Figure 3.1: Distribution of the fiscal limit
and the determination of the default probability



Notes: $h(\mathcal{B})$ is the probability distribution function of the fiscal limit $\mathcal{B}$ and $r_{t-1}b_{t-1}$ denotes real gross government debt outstanding. In the grey area, the real debt burden exceeds the fiscal limit and thus sovereign default follows. The sovereign default probability δ_t is given by the surface of the grey area. Finally, $\delta_t^{'}$ is the derivative of δ_t with respect to $r_{t-1}b_{t-1}$.

where g is the level of real steady-state government consumption, $\rho_g \in [0, 1)$ the autocorrelation coefficient and $\varepsilon_{g,t} \sim N(0, \sigma_g)$ a random i.i.d. government spending shock. We assume public consumption falls entirely on domestically produced goods, reflecting the high degree of home bias in public spending in advanced economies.

Furthermore, we assume that the government follows a tax rule of the form

$$\frac{T_t}{T} = \left(\frac{b_{t-1}}{b}\right)^{\gamma_b}, \tag{3.4}$$

where T denotes steady-state taxes, chosen to ensure that steady-state real public debt b is positive, and where $\gamma_b > 0$ is set sufficiently large so as to prevent explosive debt developments.

Monetary policy is fully credible and dictated by the prevailing exchange rate regime. We consider two regimes: a flexible and a fixed exchange rate regime. Under flexible exchange rates, the central bank aims to stabilise CPI inflation $\pi_t \equiv P_t/P_{t-1}$ by setting R_t through open market operations according to the following Taylor-type rule (Taylor, 1993):[1]

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R} \left(\frac{E_t \pi_{t+1}}{\pi}\right)^{(1-\rho_R)\alpha_\pi}, \tag{3.5}$$

where $\rho_R \in [0,1]$ measures the degree of interest rate smoothing (or monetary policy inertia), $\alpha_\pi > 1$ is set sufficiently large to rule out price level determinacy and R is the steady-state gross policy rate chosen such that stability of steady-state inflation, π, is guaranteed.

Under the fixed exchange rate regime, the central bank adjusts the interest rate in order to keep the nominal exchange rate, e_t, constant at some steady-sate value, i.e.

$$e_t = e, \text{ for all } t. \tag{3.6}$$

The assumption that the central bank controls the interest rate on government bonds implies that investors are unable to negotiate upon the rate of return on bonds. Bondholders therefore respond to changes in sovereign risk by changing their *demand* for bonds, rather than adjusting the bond *price*. We will revisit this assumption later on.

3.1.2 Households and sovereign risk pass-through

The second key feature of the model is that private borrowing conditions are affected by a worsening of public finances. There are several channels through which this feature, which we refer to as *sovereign risk pass-through*, might work. First, an increase in sovereign risk deteriorates the balance sheets of financial institutions who hold significant amounts of domestic government bonds. This raises the borrowing costs of these institutions and of their clients (i.e. households and firms). Recent empirical studies have identified this channel during the euro area debt crisis.[2] Second, sovereign risk may also adversely affect private borrowing conditions when the government is forced to increase taxes significantly, appropriate private property or even trigger a currency crisis; any

[1] Here, we adopt a forward-looking interest rate rule for the central bank for analytical convenience. However, using the more familiar contemporary rule, in which the central bank targets π_t rather than $E_t \pi_{t+1}$, would not alter our main results in any significant way.

[2] Demirgüç-Kunt and Huizinga (2013) report a reduction in bank's market-to-book value (and an increase in bank credit default swap (CDS) spreads) in countries running large public deficits. Furthermore, Harjes (2011) and Acharya et al. (2014) show that sovereign credit costs were closely related to private funding costs.

such circumstances would make it more difficult for private borrowers to meet their debt payments, prompting lenders to demand a higher risk premium on private debt.[3]

We implement sovereign risk pass-through as follows. Households borrow an amount F_t^* denominated in foreign currency from international investors. Following Turnovsky (1985), the household pays a *private risk premium*, denoted by $\Xi_{h,t}^*$, on top of the foreign gross nominal interest rate, R_t^*. We assume that the private risk premium is monotonically increasing in the degree of household indebtedness and the expected loss due to sovereign default, i.e. $\delta_t b_{F,t}$, where $b_{F,t} \equiv B_{F,t}/P_t$, incurred by Foreign investors. We work with the following reduced form expression of $\Xi_{h,t}^*$:

$$\Xi_{h,t}^* = \exp\left(\chi_{h,1}\frac{q_t f_t^*}{y}\right)\exp\left(\chi_{h,2}\delta_t b_{F,t}\right), \tag{3.7}$$

where $f_t^* \equiv F_t^*/P_t^*$ denotes the total real amount of household debt, $q_t \equiv e_t P_t^*/P_t$ the real exchange rate and y is the steady-state level of aggregate domestic output. This reduced form expression of the private risk premium is similar to the 'sovereign risk channel' of Corsetti et al. (2013c), who follow Cúrdia and Woodford (2010). Corsetti et al. derive a sovereign risk channel in a closed economy with borrowers and savers. In their paper, the authors assume that a deterioration of public finances, reflected by a rise in the government bond spread, leads to an increase in loan origination costs incurred by financial intermediaries which increases the wedge between deposit and lending rates.

The coefficient $\chi_{h,1} > 0$ measures the elasticity of the risk premium with respect to external liabilities, whereas $\chi_{h,2}$ determines the degree of pass-through from public to private credit risk. As explained by Schmitt-Grohé and Uribe (2003), the non-negativity restriction on $\chi_{h,1}$ is required in small open economy models featuring incomplete asset markets to obtain a stable net foreign asset position. However, no restriction is required for $\chi_{h,2}$, which allows us to isolate the effects of sovereign risk pass-through. In particular, if $\chi_{h,2} = 0$,

[3] Durbin and Ng (2005) find that bond spreads of firms in emerging market economies are usually higher than those of their home government. They also find that the reverse holds for firms with substantial earnings abroad, which supports the argument mentioned above, as such earnings cannot be taxed or appropriated by the home government.

the expected loss from sovereign default does not translate into higher private borrowing spreads and the private risk premium depends solely on outstanding private liabilities. However, if $\chi_{h,2} > 0$, an increase in the expected loss from sovereign default raises concerns of foreign lenders about the ability of households to meet debt obligations which requires a compensating rise in the private risk premium.

The rest of the household sector is straightforward. The infinitely lived household chooses consumption, c_t, and labour supply, n_t, to maximise lifetime utility, given by

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{c_{t+k}^{1-\sigma}}{1-\sigma} - \frac{n_{t+k}^{1+\varphi}}{1+\varphi} \right), \tag{3.8}$$

with $\beta \in (0,1)$ the household's discount factor, $1/\sigma > 0$ the intertemporal elasticity of substitution, and $1/\varphi > 0$ the Frisch elasticity of labour supply, subject to an appropriate transversality condition and the following budget constraint:

$$b_{H,t} + c_t + \frac{P_{H,t}}{P_t} T_t + q_t \Xi_{h,t-1}^* r_{t-1}^* f_{t-1}^* = (1-\Delta_t) r_{t-1} b_{H,t-1} + q_t f_t^* + w_t n_t + \frac{P_{H,t}}{P_t} \psi_t, \tag{3.9}$$

where $b_{H,t} \equiv B_{H,t}/P_t$ denotes the real value of domestically held government bonds, $r_t^* \equiv R_t^* \left(P_t^* / P_{t+1}^* \right)$, w_t the real wage rate and ψ_t real dividends from firms. The solution to the household's problem leads to the following first-order conditions:

$$n_t^{\varphi} = c_t^{-\sigma} w_t, \tag{3.10}$$

$$q_t c_t^{-\sigma} = \beta E_t \left[c_{t+1}^{-\sigma} q_{t+1} \Xi_{h,t}^* r_t^* \right], \tag{3.11}$$

$$c_t^{-\sigma} = \beta E_t \left[c_{t+1}^{-\sigma} (1-\delta_{t+1}) r_t \right]. \tag{3.12}$$

Equation (3.10) describes the household's optimal intratemporal decision and determines the desired supply of labour by relating the marginal rate of substitution between consumption and leisure to the real wage rate. Equations (3.11) and (3.12) determine the household's optimal level of external debt and holdings of domestic government bonds, respectively, by relating expected consumption growth to the effective real rate of return corresponding to the two assets. Note that, since $1 = \beta R^*/\pi^*$, the private risk premium is nil in steady state (as in Schmitt-Grohé and Uribe, 2003).

Given the optimal path for c_t, the household then decides upon the allocation between Home and Foreign goods, $c_{H,t}$ and $c_{F,t}$, using a standard constant elasticity of substitution (CES) aggregator. The corresponding optimal demand schedules and the expression for the CPI are derived in Appendix 3.A.1.

Foreign households face similar preferences as Home households (i.e. $\beta^* = \beta$ and $\sigma^* = \sigma$). Furthermore, they may hold government bonds issued by the Home government, $B_{F,t}$, and loans issued by Home households, F_t^*. Since the Foreign household can invest in two types of assets, the following no-arbitrage condition must hold:

$$E_t\left[\left(c_{t+1}^*\right)^{-\sigma}\frac{R_t^*}{\pi_{t+1}^*}\right] = E_t\left[\left(c_{t+1}^*\right)^{-\sigma}\frac{q_t}{q_{t+1}}\left(1-\delta_{t+1}\right)\frac{R_t}{\pi_{t+1}}\right]. \tag{3.13}$$

Note that Equation (3.13) is a variant of the uncovered interest parity (UIP) condition.

3.1.3 Completing the model

We complete the model by adding a firm sector and providing the market clearing conditions.

There are two types of firms: monopolistically competitive intermediate goods firms, indexed by $i \in [0,1]$, and perfectly competitive final goods firms. Nominal rigidities are introduced via staggered price setting of intermediate goods firms, as in Calvo (1983). Intermediate goods firms use a linear, constant returns to scale production technology, in which only labour is allowed to enter as an input factor:

$$y_t(i) = n_t(i). \tag{3.14}$$

Subject to (3.14), the firm aims to minimise its labour costs, which results in a condition that equates the marginal cost and product of hiring one additional unit of labour:

$$mc_t(i) = \frac{P_t}{P_{H,t}}w_t, \tag{3.15}$$

where $mc_t(i)$ denotes real marginal costs.

Intermediate goods firms can set prices in excess of marginal cost, yet face a price-setting constraint. In every period, only a share, $1-\theta \in [0,1)$, of intermediate goods firms can adjust prices in response to shocks, while others keep prices unchanged. Firms that *are* able to adjust their price do so with the aim of maximising current and expected future profits. The resulting optimal reset price, $\overline{P}_{H,t}$, is a mark-up over current and expected real marginal costs (see Appendix 3.A.1 for details).

Final goods firms combine intermediate goods to produce the final good, y_t, using a standard CES production technology. Minimizing costs of assembling y_t results in the optimal demand schedule for goods produced by intermediate goods firm i, $y_t(i)$, as well as the aggregate domestic price level, $P_{H,t}$ (see Appendix 3.A.1). We assume that the Law of One Price holds, such that $P_{H,t} = e_t P^*_{H,t}$ and $P_{F,t} = e_t P^*_{F,t}$. Since Home is a small country, its weight in Foreign's CPI is negligible and so $P^*_{F,t} = P^*_t$.

In equilibrium, the government bond market clears, which implies

$$B_t = B_{H,t} + B_{F,t}. \tag{3.16}$$

Also, we assume that the relative shares of foreign and domestic bond holdings are constant, i.e.

$$B_{F,t} = \frac{B_F}{B} B_t. \tag{3.17}$$

Goods market clearing implies $y_t = c_{H,t} + g_{H,t} + c^*_{H,t}$. After substituting in the private and public demand schedules derived in Appendix 3.A.1, we obtain

$$y_t = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} c_t + g_t + \alpha^* q_t^{\eta^*}\left(\frac{P_{H,t}}{P_t}\right)^{-\eta^*} c^*_t, \tag{3.18}$$

where $\eta > 0$ denotes the intratemporal elasticity of substitution between Home and Foreign goods, and where $\alpha \in [0,1)$ denotes the import share in the basket of household consumption.

Furthermore, labour market clearing implies $N_t = \int_0^1 N_t(i)di$. Using the production function of the intermediate goods firm, given by (3.14), and the optimal demand schedule of the final good firm, we can write this conditions as

$$n_t = y_t \mathcal{D}_t, \tag{3.19}$$

where $\mathcal{D}_t \equiv \int_0^1 \left(P_{H,t}(i)/P_{H,t}\right)^{-\epsilon}$ is a measure of price dispersion.

Finally, the balance of payments condition follows from consolidating the government's and household's budget constraints, while substituting for aggregate firm profits, $P_{H,t}\psi_t = P_{H,t}y_t - W_t n_t$:

$$\frac{P_{H,t}}{P_t}(y_t - g_t) - c_t = q_t r^*_{t-1}\Xi^*_{h,t-1} f^*_{t-1} + (1-\Delta_t)\, r_{t-1} b_{F,t-1} - (q_t f^*_t + b_{F,t})\,. \quad (3.20)$$

Equation (3.20) shows that national savings must equal net capital outflows. Also, for future use, we derive the following expression for Home net exports, denoted by nx_t (see Appendix 3.A.2):

$$nx_t = \alpha^* \left(\frac{q_t^{\eta-1} - \alpha}{1-\alpha} \right)^{\frac{\eta^*}{\eta-1}} c^*_t - \alpha q_t^{-\eta} c_t. \quad (3.21)$$

3.1.4 Steady state and equilibrium

Given constant private consumption in steady state, i.e. $c_t = c$, Equation (3.12) implies that the steady-state gross real interest rate is determined by $r = 1/\left[\beta\left(1-\delta\right)\right]$. Also, in steady state, $\theta \to 0$ and $\overline{P}_{H,t} = P_{H,t}$. Finally, we assume that Foreign and Home prices are the same in steady state, such that $e = q = 1$.

Equilibrium is then given by a sequence of c_{t+k}, n_{t+k}, y_{t+k}, nx_{t+k}, w_{t+k}, b_{t+k}, $b_{H,t+k}$, $b_{F,t+k}$, f^*_{t+k}, π_{t+k}, $\pi_{H,t+k}$, q_{t+k}, e_{t+k}, R_{t+k}, $\Xi^*_{h,t+k}$, δ_{t+k} and T_{t+k} that satisfies the public's budget constraint (3.2), the default scheme (3.1), an exogenous sequence for government spending (3.3), the fiscal policy rule (3.4), the monetary policy rule (3.5) or (3.6), the household's budget constraint (3.9), and first-order conditions (3.10), (3.11) and (3.12), the private risk premium function (3.7), the UIP condition (3.13), the price indices and producer price-setting decision in Appendix 3.A, and the market clearing conditions (3.16), (3.17), (3.18), (3.19) and (3.20), given sequences for $\mathcal{B}$, c^*_{t+k}, R^*_{t+k} and π^*_{t+k}, for all $k \geq 0$.

3.2 Exploring the mechanism

The presence of the fiscal limit in the New Keynesian model alters the fiscal transmission mechanism in two important ways. First of all, the response of the exchange rate to a government spending shock changes under sovereign risk, which affects the response of net exports. This implication of sovereign risk is referred to as the *exchange rate effect*. Second, the presence of sovereign risk pass-through generates a new *crowding-out effect* on aggregate private consumption. We shall explain these two effects separately in the following two sub-sections using a reduced version of the model presented in the previous section. Subsequently, in Section 3.3, we show the implications of sovereign risk as implied by the full-fledged model.

All results originate from a linear approximation around the deterministic steady state, which is derived in Appendix 3.B. In what follows, variables with a hat express the percentage deviation of that variable from its steady-state level, while variables without a time-index denote the steady-state level of the corresponding variable, such that $\hat{x}_t = (x_t - x)/x$, for any generic variable x_t. For simplicity, we assume that Foreign consumption, inflation and the nominal interest rate remain constant, i.e. $c_t^* = c^*$, $\pi_t^* = \pi^*$ and $R_t^* = R^*$ for all t.

3.2.1 The exchange rate effect of sovereign risk

We start by explaining the exchange rate effect, for which we make two simplifying assumptions. First, we assume full international risk sharing, which implies $\hat{q}_t = \sigma \hat{c}_t$. Full international risk sharing eliminates the effects of sovereign risk on private borrowing conditions, which allows us to ignore the crowding-out effect for now. Second, bond holdings in equilibrium are assumed as follows: all government bonds are held by foreigners (such that $b_H = 0$) and net private bond holdings are zero ($f^* = 0$). The assumptions on bond holdings facilitate notation and have no qualitative effects.

Using these assumptions, only three linearised equations subject to sovereign risk remain: the UIP condition, the balance of payments equation and the government budget constraint, i.e.

$$\hat{q}_t = E_t\hat{q}_{t+1} - (1-\Phi)\left(\hat{R}_t - E_t\hat{\pi}_{t+1}\right) + \Phi\hat{b}_t, \quad (3.22)$$

$$\hat{b}_t = \left(\frac{1-\Phi}{\beta}\right)\left(\hat{R}_{t-1} - \hat{\pi}_t + \hat{b}_{t-1}\right) + \left(\frac{b}{Y}\right)^{-1}\left[\left(\frac{\alpha}{1-\alpha} + \frac{1}{\sigma}\frac{c}{y}\right)\hat{q}_t - \hat{y}_t + \frac{g}{y}\hat{g}_t\right], \quad (3.23)$$

$$\hat{b}_t = \left(\frac{1-\Phi}{\beta}\right)\left(\hat{R}_{t-1} - \hat{\pi}_t + \hat{b}_{t-1}\right) - \gamma_b\frac{T}{b}\hat{b}_{t-1} + \frac{g}{b}\hat{g}_t. \quad (3.24)$$

Under a fixed exchange rate regime, a government spending shock is met by a counteracting monetary response of the central bank in order to prevent movements in the nominal exchange rate. In particular, when government spending rises, the public's budget deficit rises as well, which pushes the stock of government debt towards the fiscal limit. The subsequent increase in sovereign risk reduces the real *effective* return on government bonds, which creates tensions on international capital markets. In order to prevent an outflow of capital and a change in the exchange rate, the central bank then intervenes by fully offsetting the effects of sovereign risk through an appropriate adjustment in the policy rate. By maintaining a constant return on government bonds, the central bank prevents changes in cross-border capital flows, which implies a constant nominal exchange rate. Hence, sovereign risk does not affect the traditional fiscal transmission mechanism under a fixed exchange rate regime (and without sovereign risk pass-through). To see this more clearly, note that a fixed nominal exchange rate implies $\hat{e}_t = 0$ and therefore $E_t\hat{q}_{t+1} - \hat{q}_t = -E_t\hat{\pi}_{t+1}$. The following new interest rate rule then follows from the UIP condition (3.22):

$$\hat{R}_t = \frac{\Phi}{1-\Phi}\left(\hat{b}_t - E_t\hat{\pi}_{t+1}\right).$$

Using this rule to substitute out $\hat{R}_t$ from (3.23) and (3.24) eliminates the sovereign default elasticity Φ from the model.[4]

[4] Under fixed exchange rates, the effects of sovereign risk can be eliminated in the full-fledged model as well, provided that sovereign risk pass-through is ruled out. This can be shown as follows: for $e_t = e$ for all t, the UIP condition (3.13) becomes $(1 - E_t\delta_{t+1})\, r_t = r_t^*$. Using this expression to substitute for R_t in the public's budget constraint (3.2), the household's Euler equation (3.12), and the balance of payments condition (3.20), the sovereign default probability, δ_t, can be eliminated from the model.

Sovereign risk *does* enter the model under a flexible exchange rate regime, because the central bank targets inflation, rather than the exchange rate, and therefore does not fully neutralise the impact of sovereign risk on the exchange rate. To assess the implications of sovereign risk for the transmission of fiscal shocks under a regime of flexible exchange rates, we use a simple IS-BOP model as in Bouakez and Eyquem (2015). For convenience, we assume that the policy rate moves one-for-one with expected inflation, i.e. $\hat{R}_t = E_t\hat{\pi}_{t+1}$, which corresponds to setting $\alpha_\pi = 1$ and $\rho_R = 0$ in Equation (3.5). The IS and BOP curves are then given by

$$\hat{y}_t = \Psi_1\hat{q}_t + \frac{g}{y}\hat{g}_t, \tag{3.25}$$

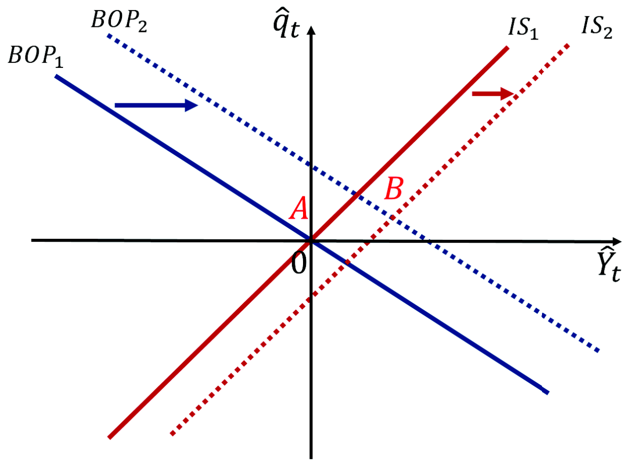
$$\hat{y}_t = \frac{b}{y}\left(\frac{1-\Phi}{\beta}\right)\hat{b}_{t-1} + \Psi_2\hat{q}_t + \left(\Phi\Psi_3 + \frac{g}{y}\right)\hat{g}_t, \tag{3.26}$$

where $\Psi_1 > 0$, $\Psi_2 < \Psi_1$ and $\Psi_3 > 0$ are derived in Appendix 3.C. Figure 3.2 gives a graphical representation of the IS and BOP curves. The IS curve is upward sloping and shifts to the right upon a government spending shock. The BOP curve is downward sloping for most parameter choices (and if it is upward sloping, it will be less steep than the IS curve) and also shifts to the right upon a government spending shock.

In equilibrium, the two curves cross at point A, where $\hat{q}_t = \hat{y}_t = 0$. An increase in government spending then yields a new equilibrium with a higher level of output, as indicated by point B. On the vertical axis, point B is located at $\Phi\Psi_3/(\Psi_1 - \Psi_2)$ and hence the real exchange rate rises, i.e. *depreciates*, upon a government spending shock. In the absence of sovereign risk, $\Phi = 0$ and so the real exchange rate remains constant.

According to Figure 3.2, a rise in government spending is followed by a depreciation of the exchange rate, which stands in contrast to the traditional Mundell-Fleming model. To understand why, note that an increase in government spending raises the budget deficit and thereby the stock of public debt. In times of sovereign default risk, the rise in public debt generates concerns regarding fiscal insolvency, making sovereign bonds a more risky asset. Foreign investors respond by reducing their demand for bonds, while increasing their demand for Foreign (and relatively safer) assets. The ensuing capital outflow then necessitates an exchange rate depreciation in order to restore equilibrium

Figure 3.2: The effects of a positive government spending shock under sovereign risk and flexible exchange rates



in the balance of payments. We refer to this effect as the 'exchange rate effect' of sovereign risk.[5]

The exchange rate effect tends to increase the size of the government spending multiplier through a depreciation of the real exchange rate and an increase in net exports (see Equation [3.21]). This result stands in contrast to the Mundell-Fleming model which predicts an appreciation of the real exchange rate and a fall in net exports upon an increase in government spending. Under fixed exchange rates, the effects of sovereign risk are completely offset by the central bank and the exchange rate effect is not present, suggesting that the effects of government spending on output can be larger under flexible than fixed exchange rates. In the next section, we explore this possibility further by examining the effect of sovereign risk pass-through.

3.2.2 The crowding-out effect of sovereign risk

Here, we assess the impact of a government spending shock when private borrowing conditions are affected by a worsening of public finances. To facilitate interpretation, we shut down the exchange rate effect described earlier and focus on a shock in the private risk premium without portfolio adjustment effects (i.e. $\hat{b}_t = 0$). For simplicity, we assume the private risk premium evolves

[5]These results are closely related to Bouakez and Eyquem (2015), who show that an increase in government spending raises the real exchange rate due to an increase in the risk premium on household external liabilities.

according to $\hat{\Xi}^*_{h,t} = \rho_\Xi \hat{\Xi}^*_{h,t-1} + \varepsilon_{\Xi,t}$, with $\rho_\Xi \in (0,1)$ and $\varepsilon_{\Xi,t} \sim N(0, \sigma_\Xi)$ a random i.i.d. risk premium shock (we can therefore ignore Φ). Finally, since the exchange rate effect is absent also in an economy without foreign trade, we set $\alpha = \alpha^* = 0$. Given these assumptions, the dynamic equations of the model become

$$\sigma \hat{c}_t = \sigma E_t \hat{c}_{t+1} - (1-\Phi)\left(\hat{R}_t - E_t \hat{\pi}_{t+1}\right), \quad (3.27)$$

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \Omega \hat{c}_t, \quad (3.28)$$

where $\Omega \equiv (1-\theta)(1-\theta\beta)/\theta(\varphi c/y + \sigma)$. $\hat{R}_t$, which is now the interest rate against which households can borrow, equals the policy rate plus the risk premium, i.e. $\alpha_\pi E_t \hat{\pi}_{t+1} + \hat{\Xi}^*_{h,t}$, with $\alpha_\pi = 0$ under fixed exchange rates and $\alpha_\pi > 0$ under flexible exchange rates.

Solving the system of (3.27)-(3.28) using the method of undetermined coefficients yields the following solution for consumption:

$$\hat{c}_t = -\frac{1}{\sigma\left(\frac{1-\rho_\Xi}{1-\Phi}\right) + \rho_\Xi(\alpha_\pi - 1)\left(\frac{\Omega}{1-\rho_\Xi\beta}\right)} \hat{\Xi}^*_{h,t}. \quad (3.29)$$

Since $\sigma(1-\rho_\Xi) - \rho_\Xi\Omega/(1-\rho_\Xi\beta) > 0$, an increase in the risk premium reduces household consumption. We call this effect the 'crowding-out effect' of sovereign risk.

Note that the crowding-out effect is smaller under a flexible exchange rate regime, as the central bank sets $\alpha_\pi > 0$ which raises the denominator in (3.29). Specifically, under flexible exchange rates, the central bank responds to any reduction in inflation that might arise following a drop in consumption by lowering $\hat{R}_t$, which partially offsets the adverse effects of the rise in $\hat{\Xi}^*_{h,t}$. In contrast, under fixed exchange rates, the central bank is unable to counteract any change in $\hat{\Xi}^*_{h,t}$, since it needs to maintain $\alpha_\pi = 0$. Hence, when a rise in government spending leads to sovereign default expectations, the associated crowding-out effects reduce the size of the fiscal multiplier, yet the reduction is generally less pronounced under flexible exchange rates.

The analytical results from the reduced version of the model presented in this section indicate that sovereign risk gives rise to two counteracting effects that alter the traditional Keynesian transmission mechanism of fiscal policy: an exchange rate effect, which raises the government spending multiplier due to a positive effect on net exports through the exchange rate, and a crowding-out effect, which reduces the multiplier due to adverse effects on household consumption through the private risk premium. The former arises only under a flexible exchange rate regime and the latter arises under both regimes, yet is less pronounced under flexible exchange rates. The latter suggests that the multiplier can be higher under floating than under fixed exchange rates. In the next section, we provide numerical simulations using the full-fledged linearised model.

3.3 The effects of government spending shocks

The full version of the model shows how the exchange rate effect and the crowding-out effect of sovereign risk behave and interact without the limiting assumptions made in the previous section. After calibrating the model, we discuss the effects of a government spending shock on the economy in the absence of sovereign risk. This exercise allows us to reconcile our results with conventional Keynesian predictions about the effects of fiscal policy and is used as a benchmark. We then proceed by showing how the results change in the presence of sovereign risk (Section 3.3.3) and when sovereign risk passes through to the private sector (Section 3.3.4).

3.3.1 Calibration

We calibrate the model on a quarterly frequency. For an overview of the parameterisation, see Table 3.1. The parameters σ, φ, β, η and θ are assigned values most commonly found in the literature, since their iterations have no qualitative effects on our results. In what follows, we elaborate on the calibration of those parameters that can be expected to influence our main results and the equilibrium properties of the linearised model.

The essential parameters for the strength of the exchange rate effect are η^*, which measures Foreign's elasticity of substitution between consumption on Home and Foreign goods, and α, which measures Home's import share and thus reflects the degree of country openness. As a benchmark, we set $\eta^* = 1.25$ and $\alpha = 0.6$ (the latter corresponds to the average import-to-consumption ratio of OECD countries). We shall experiment with alternative values for η^* and

Table 3.1: Benchmark calibration

	Preference and production parameters	
$1/\sigma$	Intertemporal elasticity of substitution	1
$1/\varphi$	Frisch elasticity of labour supply	1
β	Subjective discount factor	0.99
η, η^*	Elasticity of substitution between Foreign and Home goods	1.25
α	Country openness	0.6
α^*	Foreign's openness with respect to Home	0.01
θ	Probability of non-price adjustment	0.85
	Steady states	
g/y	Government consumption as a share of output	0.2
c/y	Household consumption as a share of output	0.79
nx/y	Home net exports as a share of output	0.01
b/y	Real government debt as a share of output (annualised)	0.6
b_F/y	Real government debt held by Foreign as a share of output (annualised)	0.3
f^*/y	Real household external debt as a share of output (annualised)	0.6
T/y	Taxes as a share of output	0.2
	Policy parameters	
α_π	Monetary policy rule coefficient	1.5
ρ_R	Policy interest rate smoothing parameter	0.8
γ_b	Fiscal policy rule coefficient	0.15
ρ_g	Persistence in government spending shocks	0.9
	Sovereign risk and capital market imperfection	
δ	Sovereign default probability	0.0025
Φ	Sovereign default elasticity	0.03
$\chi_{h,1}$	Risk premium elasticity w.r.t. household net foreign debt	0.0017
$\chi_{h,2}$	Degree of sovereign risk pass-through	0.17

α in order to highlight the transmission mechanism of fiscal policy.

The steady-state parameters are set to match long-run averages from OECD countries. Specifically, we set the annual steady-state public and private debt-to-output ratio's equal to 0.6, the share of government debt held by Foreign investors to 50% (in line with Andritzky, 2012) and $g/y = 0.2$. We set $\alpha^* = 0.01$ to reflect the small size of the Home country and obtain the share of household consumption in steady state output by the balance of payments condition (3.20) as $c/y = 0.79$. The public's budget constraint (3.2) implies a steady-state tax-to-output ratio of $T/y = 0.2$. Further, using the goods market clearing condition (3.18) to calculate $c^*/y = 48$, we obtain a net exports ratio of around 0.01 (which is around the long-run average in the euro area).

Regarding the policy parameters, we set $\alpha_\pi = 1.5$ (such that the central bank obeys the Taylor-principle) and $\rho_R = 0.8$. The feedback coefficient between taxes and real government debt is set to $\gamma_b = 0.15$, roughly in line with estimates of Ballabriga and Martinez-Mongay (2010) for euro area countries and ensuring that the debt level remains bounded (see Bohn, 1998). As in Galí and Gertler (2007), we set the autocorrelation coefficient of government consumption to $\rho_g = 0.9$.

The central parameters in our model are those governing sovereign risk, δ and Φ, and capital market imperfections, $\chi_{h,1}$ and $\chi_{h,2}$. We assume that, when the level of government debt is near the fiscal limit, the Home economy faces an annual government bond spread of 1%, which implies a steady-state sovereign default probability of $\delta = 0.0025$. The default elasticity, Φ, measures the response of the sovereign default probability to changes in the outstanding stock of real gross public debt. We rely on estimates reported by Cottarelli and Jaramillo (2012), who examine the effects of gross public debt on sovereign CDS spreads for a number of advanced economies. Based on their estimation of $\delta' \equiv d\delta/d\,(rb) = 0.01$, we obtain $\Phi = 0.03$. Since estimates of δ' differ somewhat across studies (see e.g. Ardagna et al., 2007, and Laubach, 2009), we experiment with alternative values for Φ to check for robustness. Furthermore, following Bouakez and Eyquem (2015), who rely on estimates of Lane and Milesi-Ferretti (2002), we set the elasticity of the private risk premium with respect to changes in household net external debt to $\chi_{h,1} = 0.0017$. Finally, we assume that sovereign risk pass-through is 20%, which means that a 1% increase in the sovereign default probability raises the private risk premium by

20 basis points. Using Equation (3.7), we obtain $\chi_{h,2} = 0.17$. As in the case of the default elasticity parameter, we check for robustness of our results by varying the degree of sovereign risk pass-through.

3.3.2 Benchmark case: no sovereign risk

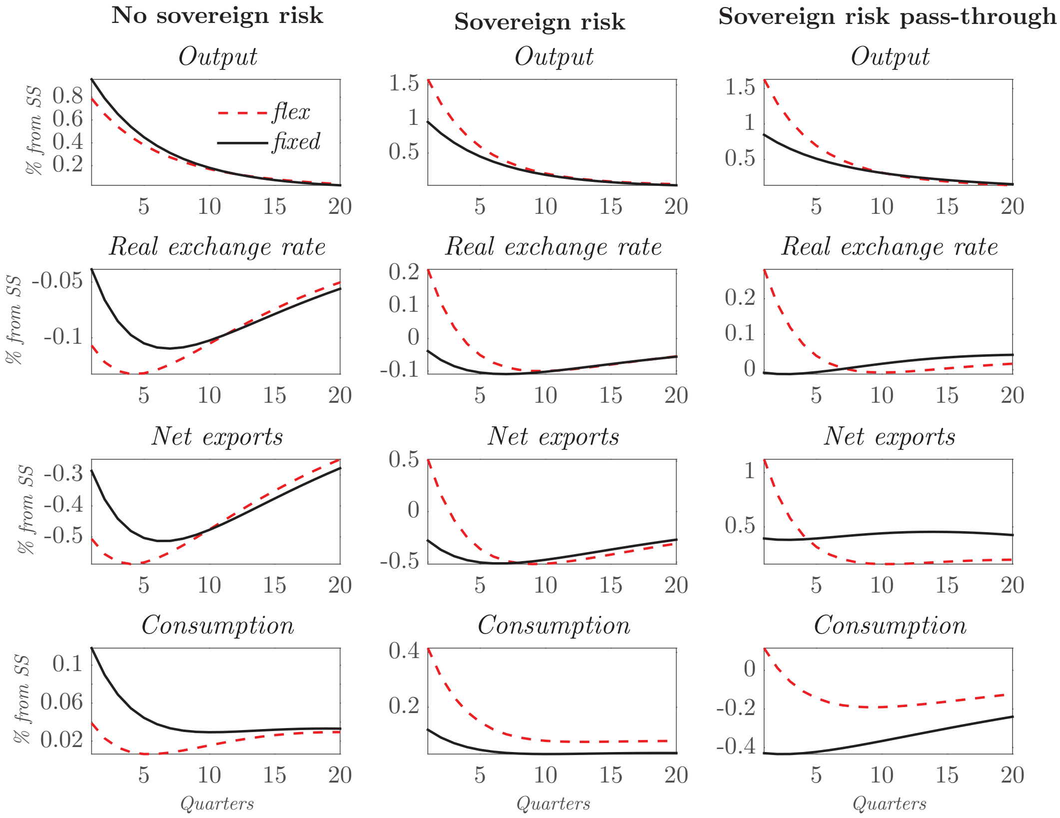
The responses to an exogenous government spending shock of output, the real exchange rate, net exports and consumption are shown in Figure 3.3, and the responses of the nominal exchange rate, the nominal interest rate, the (effective) real rate of return on government bonds, and the private risk premium are shown in Figure 3.4.[6] The responses without sovereign risk, where $\delta = \Phi = \chi_{h,2} = 0$, are presented in the left column of both figures and constitute as our benchmark. We find that an increase in government spending has a positive effect on output under both flexible and fixed exchange rates, yet, in line with the conclusions of the Mundell-Fleming model, the output response is larger under fixed exchange rates.

Driving these results are the responses of the exchange rate, net exports and consumption. Particularly, the rise in government spending raises CPI inflation, which, under flexible exchange rates, induces the central bank to raise the nominal interest rate. The higher interest rate leads to an appreciation (i.e. fall) of both the nominal and real exchange rate, which has an adverse effect on net exports. When the nominal exchange rate is held constant, however, the rise in CPI inflation is followed by a more gradual appreciation of the real exchange rate and a smaller reduction in net exports.

The consumption response is determined by substitution and income effects, which go in opposite directions. The appreciation of the real exchange rate following the fiscal expansion causes foreign goods to be relatively cheaper, thereby prompting households to raise consumption on foreign goods. Further, the rise in inflation reduces the real interest rate, yet only under fixed exchange rates, causing households to intertemporally substitute current for future consumption. These two substitution effects both tend to raise consumption. On the other hand, the increase in government spending induces a negative wealth effect through an increase in expected future taxes, which reduces consumption. As the response of consumption is positive, the substitution effects

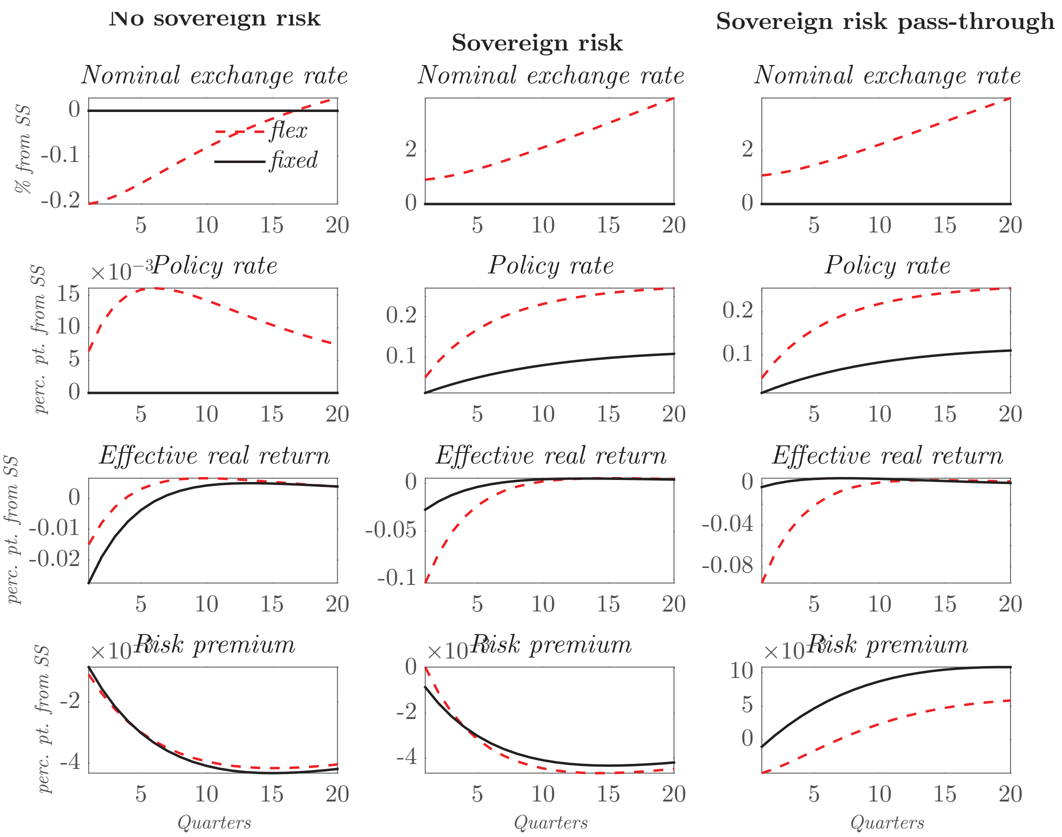
[6] The responses of the remaining variables are available upon request.

Figure 3.3: Effects of a positive government spending shock



Notes: Figures show the impulse responses upon an exogenous increase in government spending from steady state of 1% of output.

Figure 3.4: Effects of a positive government spending shock



Notes: See notes under Figure 3.3.

dominate the income effect. And, as the substitution effects are larger under fixed exchange rates, the consumption response is higher under fixed than under flexible exchange rates.

The different responses of net exports and household consumption to the government spending shock across monetary regimes explains why the output response is higher under fixed than under flexible exchange rates. These findings are in line with conventional Keynesian wisdom. Note, however, that the differences in output responses across monetary regimes are smaller than predicted by the traditional Mundell-Fleming model, yet correspond to the theoretical results of Corsetti et al. (2013d) and empirical findings reported by Corsetti et al. (2012b), Ilzetzki et al. (2012) and Born et al. (2013).

3.3.3 Introducing sovereign risk

The middle columns of Figures 3.3 and 3.4 show the effects of a government spending shock when the economy is near its fiscal limit and an increase in government debt raises the sovereign default probability. These figures are generated for $\delta = 0.0025$, $\Phi = 0.03$ and $\chi_{h,2} = 0$. As explained in Section 3.2.1, introducing sovereign risk without pass-through does not alter the fiscal policy transmission mechanism under fixed exchange rates, because the central bank raises the policy interest rate to fully offset the effects of changes in sovereign risk. Hence, the effective real rate of return is unchanged and the responses of the other endogenous variables are the same as in the benchmark case.

Under flexible exchange rates, however, the dynamics following a government spending shock differ from the benchmark case due to the exchange rate effect. The output response is higher than in the benchmark case and exceeds the output response under the fixed exchange rate regime. This result is driven by a *depreciation* of the real exchange rate and the consequent *rise* in net exports. Particularly, as the fiscal expansion worsens the fiscal position, sovereign default expectations, $E_t\delta_{t+1}$, rise which reduce the effective real rate of return on government bonds, $(1 - E_t\delta_{t+1})\, r_t$. Consequently, Foreign investors reduce their holdings of bonds, which leads to a depreciation of the exchange rate and, subsequently, a rise in net exports. This result stands in sharp contrast to the traditional Mundell-Fleming model.

The strength of the exchange rate effect is increasing in the parameters

η^*, α and Φ. In particular, η^* governs the responsiveness of Foreign demand for Home goods to changes in relative international prices. Thus, for a given depreciation of the real exchange rate, net exports will rise by more for higher values of η^*. Furthermore, the greater is α, the more open is the economy to foreign trade, and thus the more the production sector benefits from a depreciation of the real exchange rate. In Figure 3.7 of Appendix 3.D, we show that indeed the differences in the output responses between flexible and fixed exchange rates is increasing in both η^* and α under sovereign risk. Also, if the economy faces a higher sovereign default elasticity, Φ, a government spending shock exerts a stronger effect on Foreign demand for Home government bonds, and therefore also on the real exchange rate, net exports and output. Figure 3.8 in Appendix 3.D shows that raising Φ, while keeping the other parameters fixed at their benchmark values, indeed raises the difference in output responses upon a government spending shock between flexible and fixed exchange rates.

Finally, note that the response of consumption under flexible exchange rates is higher in the presence of sovereign risk than in the benchmark case without sovereign risk. This is due to the fall in the effective real rate of return on bonds, which, according to the household's Euler equation (3.12), induces households to reduce their holdings of government bonds and raise consumption. An increase in sovereign risk therefore has an expansionary effect on consumption, which is rather counter-intuitive. As shown in the next section, this result changes in the presence of sovereign risk pass-through.

3.3.4 Introducing sovereign risk pass-through

The right columns of Figures 3.3 and 3.4 present the responses to a government spending shock when sovereign risk leads to an increase in the private risk premium. Here, the private risk premium increases by 20 basis points for every 100 basis points increase in the sovereign default probability. We set $\chi_{h,2} = 0.17$ and keep $\delta = 0.0025$ and $\Phi = 0.03$. Under this assumption, the increase in government spending raises the risk premium, which in turn worsens private borrowing conditions and reduces household consumption. This is the crowding-out effect discussed in Section 3.2.2.

The output response to the government spending shock remains positive under both monetary regimes, despite the crowding-out effect. However, the difference between the government spending multiplier under flexible and fixed exchange rates is now larger than it was in the absence of sovereign risk pass-through, especially if the sovereign default elasticity Φ is high (see Figure 3.9 in Appendix 3.D). This is because the negative crowding-out effect is larger under fixed exchange rates than under flexible exchange rates, as explained in Section 3.2.2.

Figure 3.10 in Appendix 3.D shows that a higher degree of sovereign risk pass-through raises the government spending multiplier under flexible exchange rates, indicating that the exchange rate effect dominates. However, the multiplier falls under fixed exchange rates as sovereign risk pass-through becomes more pronounced, which suggests that the crowding-out effect dominates.

3.3.5 Robustness

We conclude this section by two robustness checks on our assumptions. First, we deny capital market access to some of the households. Without the ability to save or borrow, these households maximise utility simply by consuming their entire disposable income for that period. We refer to these households as *Non-Ricardian* as they are not subject to wealth effects generated by fiscal policy. Appendix 3.E derives the model in the presence of Non-Ricardian households and finds that the crowding-out effects of sovereign risk are slightly muted, due to a smaller decline in aggregate consumption. Nevertheless, the presence of Non-Ricardian households does not alter our main results: a positive shock to government spending still raises output by more under flexible than fixed exchange rates, because the exchange rate effect of sovereign risk remains present.

Second, we consider the case in which the government bond rate is no longer equal to the policy rate of the central bank. Recall that in our current set-up, the central bank controls the interest rate on government bonds, such that investors are unable to respond to changes in sovereign risk by adjusting the bonds price; instead, they must respond by changing their demand for bonds. Changes in foreign demand for government bonds give rise to the exchange rate effect, which underlies our main results. If bond holders were insured against the risk of sovereign default, the direct effect on the exchange rate would be mitigated. However, the indirect effects of sovereign risk through private credit risk are still present. Hence, in the presence of sovereign risk pass-through, we still see a depreciation of the exchange rate (and therefore a rise in net exports) following a fiscal expansion. Appendix 3.F derives the model under the assumption that holders of government bonds are *completely* insured against the direct effects of sovereign risk, yet not against the indirect effects, and shows that the effects of a government spending shock are still higher under floating than fixed exchange rates when sovereign risk passes through to private credit conditions.

3.4 Empirical assessment

In this section, we confront the predictions from our New Keynesian model to the data. First we show some stylized statistics. Next, we estimate the effects of a government spending shock on output as a function of both the exchange rate regime and the state of public finances.

3.4.1 Stylized statistics

The results from the previous section indicate that the interaction between the exchange rate regime and the state of public finances should not be ignored. A similar argument is made by De Grauwe (2012), who compares substantial increases in government debt in the UK and Spain, and who finds that the subsequent economic experiences in these two countries have been very different. In the UK, the rise in public debt was met by a depreciation of the nominal exchange rate, which supported net exports and thus facilitated economic growth, whereas in Spain, no such depreciation could take place and the rise in government debt was associated by a decline in output growth.

Here, we compare key stylized statistics of those countries that have experienced an increase in sovereign risk during the crisis to those who have not and condition on the exchange rate regime in place. We identify sovereign risk using CDS rates. For those OECD countries that have experienced sovereign risk during 2007-11, we calculate the average change in output, and other key macroeconomic aggregates, over this time period and compare them to (unweighted) averages of all OECD members.

The statistics confirm De Grauwe's story: in countries with flexible ex-

Table 3.3: Stylized statistics for the OECD: average change in the group vis-á-vis the OECD average between 2007 and 2011

Output

	flex	fixed
No SR	-0.7	1.5
SR	1.5	-2.0

Consumption

	flex	fixed
No SR	1.3	1.8
SR	-2.5	-2.4

Exports

	flex	fixed
No SR	-2.6	1.8
SR	5.2	-2.3

Nominal exchange rate

	flex	fixed
No SR	-7.9	-
SR	15.7	-

Real exchange rate

	flex	fixed
No SR	-3.3	-0.5
SR	6.7	0.7

CPI

	flex	fixed
No SR	-4.2	0.6
SR	8.4	-0.8

Notes: All figures are in percent changes and annualized; a positive change in the nominal and real exchange rate indicates a depreciation; a positive change in CPI indicates inflation. Flex denotes countries with a flexible exchange rate, fixed with a fixed exchange rate, no SR countries that have not faced sovereign risk, SR countries that have experienced sovereign risk. Exchange rate regime classifications from Ilzetzki et al. (2010). Experiencing sovereign risk is defined as having a CDS rate on 10 year bonds larger than 100 bp on average during 2007-2011. *Source*: OECD National Accounts Statistics.

change rates that faced sovereign risk, the nominal and real exchange rate depreciated compared to the OECD mean by 16% and 7%, respectively, and net exports and output rose by 5% and 2%, respectively. On the other hand, in countries with fixed exchange rates, the real exchange rate barely changed during episodes of sovereign risk, while net exports and output both *fell* by 2% compared to the OECD average. While these observations do not establish a link with government spending, they do corroborate with the exchange rate effect of sovereign risk explained in Section 3.2.1, i.e. an increase in sovereign risk coincides with an exchange rate depreciation and an increase in exports under flexible exchange rates.

3.4.2 Estimating government spending multipliers

Our empirical investigation on the effects of government spending shocks extends the work of Corsetti et al. (2012b). Corsetti et al. report larger fiscal multipliers under fixed exchange rates than under flexible exchange rates, which is in line with the predictions of the Mundell-Fleming model. Also, they find that the effects of government spending on output are lower when there is fiscal strain.[7] We extend their work by examining whether the effects of the exchange rate regime on the efficacy of fiscal policy are different in countries with weak public finances. To this end, we condition on the state of public finances and the exchange rate regime *jointly*, whereas Corsetti et al. do so separately.

We follow the two-step methodology suggested by Corsetti et al. (2012b). In the first step, we estimate a government spending rule for each country i:

$$\begin{aligned} \text{GOVT}_{it} &= \text{CONST}_i + \gamma_{i1}\text{GOVT}_{it-1} + \gamma_{i2}\text{OUTPUT}_{it-1} + \gamma_{i3}\text{CLI}_{it-1} \\ &\quad + \gamma_{i4}\text{DEBT}_{it} + \gamma_{i5}\text{RISK}_{it-1} + \gamma_{i6}\text{REGIME}_{it-1} + \text{INNOVATIONS}_{it} \end{aligned} \tag{3.30}$$

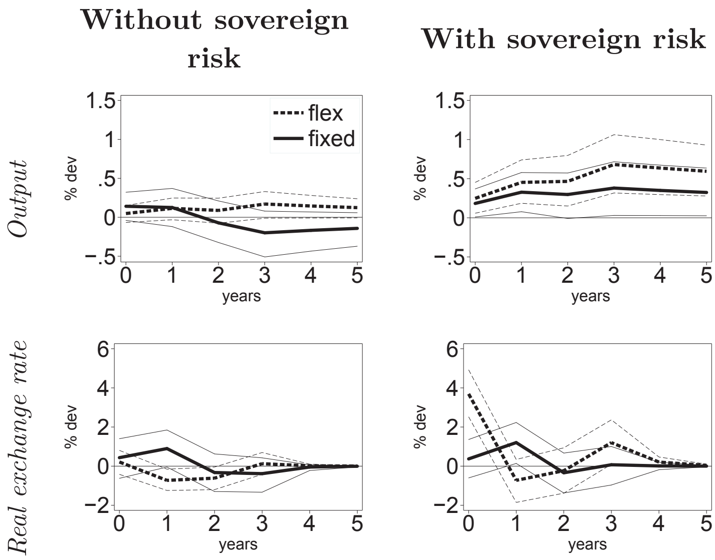
where GOVT_{it} denotes the log of government consumption per capita at t, OUTPUT_{it} the log of gross domestic product (GDP) per capita, CLI_{it-1} the composite leading indicator, DEBT_{it} the debt-to-GDP ratio at the beginning of the period, RISK_{it} is a dummy variable which indicates whether the corresponding country is facing sovereign risk, and REGIME_{it} is a dummy indicating the monetary regime. Following Corsetti et al. (2012b), sovereign risk is assumed to be present whenever the debt-to-GDP ratio is larger than 100% and/or the budget deficit exceeds 6% of GDP in the previous year. The exchange rate regime classification follows Ilzetzki et al. (2010).[8] The variable INNOVATIONS_{it} is the estimation residual and serves as a proxy for the exogenous discretionary change in government spending.

In the second step, we perform a fixed-effects panel regression on a number of macroeconomic variables using the residuals from the previous step as explanatory variables. To gauge the role of sovereign risk, we split the sample into a sub-sample of countries that faced sovereign risk and a sub-sample of countries that did not. Then, for VAR_{it} being the variable of interest, we

[7] Other recent empirical contributions that study the influence of the economic environment on the effects of fiscal shocks on output are Auerbach and Gorodnichenko (2012) and Ilzetzki et al. (2012).

[8] See Appendix 3.G for a list of sovereign risk episodes and the exchange rate regime classifications used in this chapter.

Figure 3.5: Effects of a government spending shock: empirical estimates



Notes: 'Output' denotes the log of GDP per capita; 'Real exchange rate' denotes the change in the real exchange rate; a positive (negative) change in the real exchange rate refers to a depreciation (appreciation).

estimate for each sub-sample the following regression:

$$\begin{aligned} \text{VAR}_{it} &= \text{CONST}_i + \beta_{i1}\text{VAR}_{it-1} + \sum_{s=0}^{k} \beta_{2s}\text{INNOVATIONS}_{it-s} \\ &+ \sum_{s=0}^{k} \beta_{3s}\text{INNOVATIONS}_{it-s} \times \text{REGIME}_{it-1} + \text{ERROR}_{it} \end{aligned} \tag{3.31}$$

As in Corsetti et al. (2012b), we set $k = 3$. In Equation (3.31), the coefficient β_{2s} measures the unconditional fiscal multiplier of a government spending shock s periods ago, whereas $\beta_{2s} + \beta_{3s}$ is the fiscal multiplier conditional on the type of monetary regime. Our panel contains 17 countries, covers 1970-2012 and is unbalanced. Data is from the OECD National Accounts Statistics and the IMF WEO Database and summary statistics are provided in Appendix 3.G.

Using the estimated coefficients, we simulate the impulse responses of output and the real exchange rate upon a shock to government spending of 1% of output. The results are shown in Figure 3.5. The figures in the left column show the responses for the sub-sample in which sovereign risk is absent and serve as a benchmark. In line with the findings of Corsetti et al. (2012b), the impact response of output is higher under fixed exchange rates than under flexible exchange rates.[9] The figures in the right column show the responses for the sub-sample in which sovereign risk is present. In this case, the output response is higher under *flexible* exchange rates than under fixed exchange rates, contrasting traditional Keynesian wisdom. The results also show that the rise in government consumption in the presence of sovereign risk is accompanied by a significant depreciation (i.e. increase) of the real exchange rate under the flexible exchange rate regime, whereas the real exchange rate depreciates only marginally under the fixed exchange rate regime. These contrasting output and exchange rate dynamics match our theoretical results shown in the right column of Figure 3.3.

3.5 Expansionary fiscal contractions?

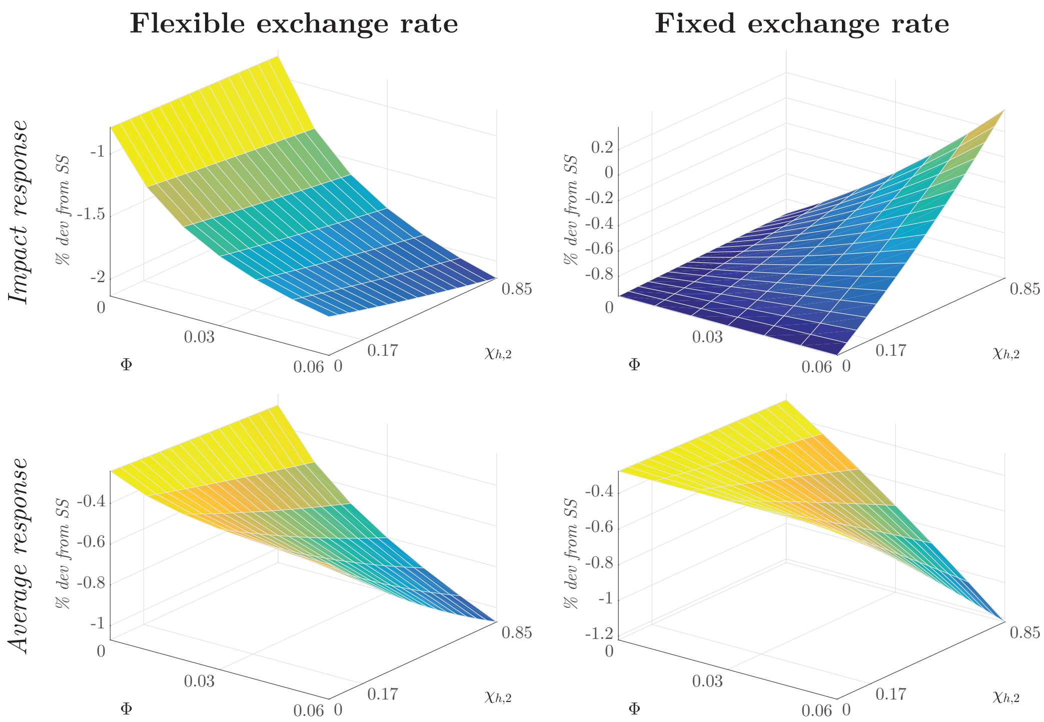
Can fiscal contractions be expansionary? This question, originally raised by Giavazzi and Pagano (1990), has prompted a large debate in the academic literature as well as in policy circles.[10] In their paper, Giavazzi and Pagano make an excellent account of an increase in private consumption that occurred during substantive fiscal contractions in Denmark and Ireland during the 1980s. These 'Non-Keynesian' effects of fiscal policy may arise when a credible fiscal retrenchment reduces expected future tax liabilities, thereby generating a positive wealth effect and inducing households to raise current consumption (see Sutherland, 1997). In our model, a fiscal contraction may also lead to higher household consumption by mitigating the crowding-out effect of sovereign risk. In particular, when the government raises taxes, or reduces spending, the level of public debt moves away from the fiscal limit and sovereign default expectations fall. Consequently, the private risk premium falls as well, which allows households to raise consumption.

In this section, we assess the 'expansionary fiscal contraction hypothesis' by simulating the response of output upon a temporary reduction in government spending. Because we expect the effects of a fiscal contraction to depend on

[9] Our benchmark results differ slightly from those of Corsetti et al. (2012b), as we use a larger sample and our classification of the exchange rate regime follows Ilzetzki et al. (2010) more strictly.

[10] Sutherland (1997), Alesina and Ardagna (1998) and Perotti (1999) are significant contributions. Recently, the debate has resurfaced with contributions from Alesina and Ardagna (2010), Leigh et al. (2011) and Jordà and Taylor (2013), among others.

Figure 3.6: Effects of a fiscal contraction on output



Notes: Figures show the responses upon impact and the average responses over time of output following a fall in government spending of 1% of output as a function of the sovereign default elasticity, $\Phi \in [0, 0.06]$, and the degree of sovereign risk pass-through, $\chi_{h,2} \in [0, 0.85]$, under flexible exchange rates (left column) and fixed exchange rates (right column).

the strength of the crowding-out effect of sovereign risk, we will consider a wide range of values for the sovereign default elasticity Φ and sovereign risk pass-through parameter $\chi_{h,2}$ (the remaining parameters are as given in Table 3.1). In particular, we ask: how much sovereign risk and pass-through of sovereign risk to private credit conditions is required for a fiscal consolidation to be expansionary? Also, what is the role of the exchange rate regime?

The top-left quadrant of Figure 3.6 suggests that, under flexible exchange rates, a reduction in government consumption leads to output losses for any degree of sovereign risk and sovereign risk pass-through. In fact, the larger are Φ and $\chi_{h,2}$, the stronger is the output loss upon a fiscal contraction. This result follows directly from our discussion in Section 3.3.3, in which we showed that the real exchange rate response to a government spending shock is positively related to the amount of sovereign risk. Specifically, as the fiscal contraction reduces the stock of debt, sovereign risk falls such that foreign investors are induced to increase their holdings of Home assets. Re-shifting of Foreign's asset portfolio towards assets denominated in Home currency puts downward pressure on the real exchange rate, i.e. the real exchange rate appreciates, which in turn has a negative effect on output. The larger is the default elasticity with respect to public debt (Φ), the stronger is the response of Foreign investors to an improvement of the fiscal balance and the greater is the pressure on the exchange rate and aggregate production.

Under fixed exchange rates, however, a fiscal consolidation can generate *positive* output responses when both the default elasticity and the degree of sovereign risk pass-through are substantial (see top-right quadrant of Figure 3.6). Again, the reduction in public debt restores confidence in financial markets and raises demand for government bonds by foreign investors. However, unlike under flexible exchange rates, the rise in foreign demand for government debt does not lead to an appreciation of the exchange rate. Hence, the response of output following the fiscal consolidation is driven by the response of household consumption. The latter *rises* upon a fall in public spending due to a reduction in the risk premium on household loans. Therefore, if the pass-through from sovereign risk to the private risk premium is large enough, i.e. if $\chi_{h,2}$ is sufficiently high, the net effect on output following a fiscal consolidation can become positive.

The impact responses of output upon a fall in government consumption conceal potentially important long-run effects. The bottom row of Figure 3.6 therefore shows the average output response, defined as the cumulative response divided by the number of periods under consideration (i.e. 5 years). Under flexible exchange rates, the average effects on output are again dictated by the sovereign default elasticity and its interaction with the real exchange rate. Higher measures of Φ result in greater output losses for a given reduction in government spending (see bottom-left quadrant of Figure 3.6). Under fixed exchange rates, we observe that the average output response to a government spending cut is also negative for all combinations of Φ and $\chi_{h,2}$ due to a fall in output in the long run, which completely offsets the potential positive effects of the fiscal contraction in the short run.

Summarizing, it is possible for a fiscal consolidation to generate a positive output response, yet only in the presence of *considerable* fiscal strain and sovereign risk pass-through. In addition, a fiscal contraction is only favourable in terms of output gains under *fixed* exchange rates and only in the *short run*.

3.6 Conclusion

Recent sovereign debt crises in a number of advanced economies have highlighted the importance of public debt sustainability for fiscal policy outcomes. In this chapter, we examined the implications of sovereign risk for the economic effects of fiscal policy under different monetary regimes. Specifically, we have shown, both theoretically and empirically, that in the presence of sovereign risk, a government spending shock can generate higher output responses under flexible than under fixed exchange rates. This stands in contrast to both the traditional Mundell-Fleming model and conventional New Keynesian models.

Intuitively, an increase in the probability of sovereign default, following a rise in government spending, leads to a fall in foreign demand for domestic assets. The consequent nominal exchange rate depreciation under a float supports aggregate output through an increase in net exports, especially when the elasticity of substitution between foreign and domestic goods and the degree of country openness are large. Under fixed exchange rates, however, the favourable relative price change is eliminated through central bank intervention. Instead, the crowding-out effects of sovereign risk that are associated with the fiscal expansion dominate and so the output response is lower than under flexible exchange rates.

Our model and empirical exercise formalise the discussion in De Grauwe (2012), in which it is argued that a rise in sovereign default beliefs can have positive externalities provided sovereign debt is largely denominated in domestic currency and the exchange rate is allowed to act as a natural adjustment mechanism. Countries experiencing a relatively high degree of sovereign risk and whose external debt is denominated in foreign currency, however, face a higher probability of falling into unstable equilibria, characterised by explosive debt developments. Our results are therefore particularly relevant for countries that are struggling with weak public finances, while contemplating to anchor their exchange rate or adopt a common currency.

Finally, we have shown that it is possible for a fiscal contraction to generate a positive output response, yet only in the presence of a considerable degree of sovereign risk pass-through. In addition, a fiscal contraction is favourable in terms of output gains only under fixed exchange rates and only in the short run. The average effects of fiscal contractions over the long run are contractionary, irrespective of the exchange rate regime. Whether these results can be confirmed empirically, and what they might imply for the design of optimal fiscal policy, is a venue we leave for future work.

3.A Equilibrium conditions

In this section, we present the equilibrium conditions that were omitted from the main text for the sake of exposition.

3.A.1 Optimal demand and price indices

Household consumption

Total household consumption, c_t, is a composite index determined by consumption on domestically produced goods, $c_{H,t}$, and imported goods, $c_{F,t}$, defined by the following CES aggregator:

$$c_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} \left(c_{H,t}\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(c_{F,t}\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}. \tag{3.32}$$

The household optimally allocates consumption between $c_{H,t}$ and $c_{F,t}$ by maximising (3.32) subject to the expenditure constraint $P_t c_t \geq P_{H,t} c_{H,t} + P_{F,t} c_{F,t}$. The optimal demand schedules and CPI equation that follow are given by

$$c_{H,t} = (1-\alpha) \left(\frac{P_{H,t}}{P_t} \right)^{-\eta} c_t, \tag{3.33}$$

$$c_{F,t} = \alpha \left(\frac{P_{F,t}}{P_t} \right)^{-\eta} c_t, \tag{3.34}$$

$$P_t = \left[(1-\alpha) P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta} \right]^{\frac{1}{1-\eta}}. \tag{3.35}$$

Similarly, optimal demand by Foreign households for Foreign goods, $c^*_{F,t}$, and Home goods, $c^*_{H,t}$, is given by

$$c^*_{H,t} = \alpha^* \left(\frac{P^*_{H,t}}{P^*_t}\right)^{-\eta^*} c^*_t, \qquad c^*_{F,t} = (1-\alpha^*) \left(\frac{P^*_{F,t}}{P^*_t}\right)^{-\eta^*} c^*_t. \tag{3.36}$$

Firm demand and price setting

The final good firm combines intermediate goods to produce the final good, y_t, using a standard CES production technology, i.e.

$$y_t = \left(\int_0^1 y_t(i)^{\frac{\epsilon-1}{\epsilon}} di\right)^{\frac{\epsilon}{\epsilon-1}}, \tag{3.37}$$

where $\epsilon > 1$ is the constant elasticity of substitution between intermediate goods. Minimisation of the costs of assembling y_t, subject to (3.37), results in the following optimal demand schedule for goods produced by intermediate goods firm i and the Home aggregate domestic price level:

$$y_t(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} y_t, \tag{3.38}$$

$$P_{H,t} = \left(\int_0^1 P_{H,t}(i)^{1-\epsilon} di\right)^{\frac{1}{1-\epsilon}}. \tag{3.39}$$

The intermediate goods firm, on the other hand, uses the linear production function (3.14) and aims to maximise current and expected future profits, subject to (3.38) and (3.14), while taking the nominal wage rate, W_t, and the probability of non-price adjustment in the future as given:

$$\max_{\overline{P}_{H,t}} E_t \sum_{k=0}^{\infty} \theta^k Q_{t,t+k} \left(\overline{P}_{H,t} y_{t,t+k}(i) - W_{t+k} n_{t,t+k}(i)\right),$$

where $\overline{P}_{H,t}$ is the optimal reset price[11], $Q_{t,t+k} \equiv \beta^k (1-\delta_{t+k}) (c_{t+k}/c_t)^{-\sigma} / \pi_{t+k}$ is the stochastic discount factor for nominal pay-offs in period $t+k$ (see [3.12]), and $y_{t,t+k}(i)$ is the amount of output produced by firm i who last reset its price in period t. The optimal reset price that follows is a mark-up $\mathcal{M} \equiv \epsilon/(\epsilon-1)$

[11] Note that the optimal reset price is not firm-specific, due to symmetry among firms.

over current and expected real marginal costs, given by

$$\overline{P}_{H,t} = \mathcal{M}\frac{E_t \sum_{k=0}^{\infty} (\theta\beta)^k (1-\delta_{t+k}) P_{t+k}^{-1} P_{H,t+k}^{1+\epsilon} c_{t+k}^{-\sigma} y_{t+k} mc_{t+k}}{E_t \sum_{k=0}^{\infty} (\theta\beta)^k (1-\delta_{t+k}) P_{t+k}^{-1} P_{H,t+k}^{\epsilon} c_{t+k}^{-\sigma} y_{t+k}}. \tag{3.40}$$

Note that, under flexible prices, $\theta \to 0$ and $\overline{P}_{H,t} = P_{H,t}$ for all t, such that (3.40) reduces to $mc_t = 1/\mathcal{M}$.

3.A.2 Net exports

The expression for Home net exports given by (3.21) is derived as follows. First, rewrite the CPI equation, (3.35), using the law of one price, $P_{F,t} = e_t P_{F,t}^* = e_t P_t^*$, and the definition of the real exchange rate, $q_t = e_t P_t^*/P_t$:

$$P_t = \left[(1-\alpha) P_{H,t}^{1-\eta} + \alpha (q_t P_t)^{1-\eta}\right]^{\frac{1}{1-\eta}}.$$

Then, divide by P_t and solve for $P_{H,t}/P_t$:

$$\begin{aligned} 1 &= \left[(1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{1-\eta} + \alpha q_t^{1-\eta}\right]^{\frac{1}{1-\eta}}, \\ \frac{P_{H,t}}{P_t} &= \left(\frac{1-\alpha q_t^{1-\eta}}{1-\alpha}\right)^{\frac{1}{1-\eta}}. \end{aligned}$$

Rewrite the Foreign demand schedule for Home goods, (3.36), by substituting $P_{H,t}/P_t$:

$$\begin{aligned} c_{H,t}^* &= \alpha^* \left(\frac{P_{H,t}^*}{P_t^*}\right)^{-\eta^*} c_t^* = \alpha^* q_t^{\eta^*} \left(\frac{P_{H,t}}{P_t}\right)^{-\eta^*} c_t^* \\ &= \alpha^* \left(\frac{q_t^{\eta-1} - \alpha}{1-\alpha}\right)^{\frac{\eta^*}{\eta-1}} c_t^*. \end{aligned}$$

Rewrite the Home demand schedule for Foreign goods, (3.34):

$$\begin{aligned} c_{F,t} &= \alpha \left(\frac{P_{F,t}}{P_t}\right)^{-\eta} c_t = \alpha \left(\frac{e_t P_{F,t}^*}{P_t}\right)^{-\eta} c_t = \alpha \left(\frac{e_t P_t^*}{P_t}\right)^{-\eta} c_t \\ &= \alpha q_t^{-\eta} c_t. \end{aligned}$$

Net exports is then defined as the difference between $c^*_{H,t}$ and $c_{F,t}$:

$$nx_t \equiv c^*_{H,t} - c_{F,t} = \alpha^* \left(\frac{q_t^{\eta-1} - \alpha}{1-\alpha} \right)^{\frac{\eta^*}{\eta-1}} c^*_t - \alpha q_t^{-\eta} c_t.$$

3.B Linearisation

The linearised versions of the equilibrium conditions (3.2), (3.7), (3.12), (3.13) and (3.20) follow once we have linearised $1-\delta_t$:

$$\begin{aligned} 1-\delta_t &\approx (1-\delta) - \delta' \left(\frac{R_{t-1}}{\pi_t} b_{t-1} - \frac{R}{\pi} b \right), \qquad (3.41) \\ \frac{(1-\delta_t)-(1-\delta)}{1-\delta} &\approx -\delta' \left(\frac{\frac{R}{\pi} b}{1-\delta} \right) \left(\frac{\frac{R_{t-1}}{\pi_t} b_{t-1} - \frac{R}{\pi} b}{\frac{R}{\pi} b} \right) \\ &= -\Phi \left(\hat{R}_{t-1} - \hat{\pi}_t + \hat{b}_{t-1} \right). \end{aligned}$$

Using (3.41), we obtain the following linear equations:

$$\begin{aligned} \sigma \hat{c}_t &= \sigma E_t \hat{c}_{t+1} - (1-\Phi) \left(\hat{R}_t - E_t \hat{\pi}_{t+1} \right) + \Phi \hat{b}_t, \qquad (3.42) \\ \hat{b}_t &= \left(\frac{1-\Phi}{\beta} \right) \left(\hat{R}_t - \hat{\pi}_t + \hat{b}_{t-1} \right) \qquad (3.43) \\ &\quad + \frac{\alpha}{1-\alpha} \left(\frac{T-g}{b} \right) \hat{q}_t - \frac{T}{b} \hat{T}_t + \frac{g}{b} \hat{g}_t, \\ \hat{y}_t - \frac{c}{y} \hat{c}_t - \frac{g}{y} \hat{g}_t &= \frac{f^*}{y} \left[\frac{1}{\beta} \left(\hat{f}^*_{t-1} + \hat{\Xi}^*_{h,t-1} \right) - \hat{f}^*_t \right] \qquad (3.44) \\ &\quad + \left[\left(\frac{1}{\beta} - 1 \right) \frac{f^*}{y} + \frac{\alpha}{1-\alpha} \left(1 - \frac{g}{y} \right) \right] \hat{q}_t - \frac{b_F}{y} \hat{b}_{F,t} \\ &\quad + \frac{1}{\beta} \frac{b_F}{y} \left[(1-\Phi) \left(\hat{R}_{t-1} - \hat{\pi}_t \right) - \left(\Phi \hat{b}_{t-1} - \hat{b}_{F,t-1} \right) \right], \\ \hat{\Xi}^*_{h,t} &= \chi_{h,1} \frac{f^*}{y} \left(\hat{f}^*_t + \hat{q}_t \right) \qquad (3.45) \\ &\quad + \chi_{h,2} \frac{b_F}{y} \left[(1-\delta) \Phi \left(\hat{R}_{t-1} - \hat{\pi}_t + \hat{b}_{t-1} \right) + \delta \hat{b}_{F,t} \right], \\ \hat{q}_t &= E_t \hat{q}_{t+1} - \left[(1-\Phi) \left(\hat{R}_t - E_t \hat{\pi}_{t+1} \right) - \Phi \hat{b}_t \right]. \qquad (3.46) \end{aligned}$$

The linearised versions of the remaining equilibrium conditions are given by

$$\varphi\hat{y}_t = \hat{w}_t - \sigma\hat{c}_t, \quad (3.47)$$
$$\sigma\hat{c}_t = \sigma E_t\hat{c}_{t+1} - (E_t\hat{q}_{t+1} - \hat{q}_t) - \hat{\Xi}^*_{h,t}, \quad (3.48)$$
$$\hat{T}_t = \gamma_b\hat{b}_{t-1}, \quad (3.49)$$
$$\hat{y}_t = \left(\eta\alpha\frac{c}{y} + \eta^*\frac{\alpha^*}{1-\alpha}\frac{c^*}{y}\right)\hat{q}_t + (1-\alpha)\frac{c}{y}\hat{c}_t + \frac{g}{y}\hat{g}_t, \quad (3.50)$$
$$\hat{b}_t = \frac{b_H}{b}\hat{b}_{H,t} + \frac{b_F}{b}\hat{b}_{F,t}, \quad (3.51)$$
$$\hat{b}_{F,t} = \hat{b}_t, \quad (3.52)$$
$$\hat{g}_t = \rho_g\hat{g}_{t-1} + \varepsilon_{g,t}, \quad (3.53)$$
$$\hat{nx}_t = \left(\frac{\eta^*}{1-\alpha} + \eta\right)\hat{q}_t - \hat{c}_t. \quad (3.54)$$

Finally, linearisation of the monetary policy rule under flexible exchange rates, given by (3.5), yields

$$\hat{R}_t = \rho_R\hat{R}_{t-1} + (1-\rho_R)\,\alpha_\pi E_t\hat{\pi}_{t+1}. \quad (3.55)$$

Under fixed exchange rates, the linear monetary policy rule is given by

$$\hat{e}_t = 0. \quad (3.56)$$

3.C Derivation of the IS and BOP curve

The IS curve is given by the goods market clearing condition using $\hat{q}_t = \sigma\hat{c}_t$:

$$\hat{y}_t = \Psi_1\hat{q}_t + \frac{g}{y}\hat{g}_t, \quad (3.57)$$

Since $\Psi_1 \equiv [\eta\alpha + (1-\alpha)/\sigma]\,c/y + \eta^*\alpha^*/(1-\alpha)\,c^*/y > 0$, the IS curve is upward sloping.

To derive the BOP curve, we first establish a relationship between the debt level and the real exchange rate. We substitute the monetary policy rule in equations (3.22) to (3.24), the government budget constraint in the UIP condition and the IS curve in the BOP equation. This yields the following system of two equations:

$$\hat{q}_t = E_t\hat{q}_{t+1} + \Phi\Pi_1\hat{b}_{t-1} + \Phi\frac{g}{b}\hat{g}_t, \tag{3.58}$$

$$\hat{b}_t = \left(\frac{1-\Phi}{\beta}\right)\hat{b}_{t-1} + \Pi_2\hat{q}_t, \tag{3.59}$$

where

$$\Pi_1 \equiv \frac{1-\Phi}{\beta} - \gamma_b\frac{T}{b}, \qquad \Pi_2 \equiv \left(\frac{b}{y}\right)^{-1}\left(\frac{\alpha}{1-\alpha} + \frac{1}{\sigma}\frac{c}{y} - \Psi_1\right).$$

These two equations describe the dynamics for the real exchange rate, $\hat{q}_t$, and government debt, $\hat{b}_t$, and can be decoupled from the rest of the model. We use the method of undetermined coefficients to find a stable solution to the system above and conjecture

$$\hat{q}_t = \psi_1\hat{b}_{t-1} + \Phi\psi_2\hat{g}_t, \tag{3.60}$$

where the ψ coefficients are functions of the model's structural parameters. Rewrite (3.58) using (3.60):

$$\hat{b}_t = \left(\frac{\psi_1 - \Phi\Pi_1}{\psi_1}\right)\hat{b}_{t-1} + \left[\frac{\psi_2\left(1-\rho_g\right) - \Phi\frac{g}{b}}{\psi_1}\right]\hat{g}_t.$$

Also, rewrite (3.59) using (3.60) and combine the result with the equation above to yield

$$\left[\frac{1-\Phi}{\beta} + \psi_1\Pi_2 - \left(\frac{\psi_1 - \Phi\Pi_1}{\psi_1}\right)\right]\hat{b}_{t-1} + \left\{\psi_2\Pi_2 - \left[\frac{\psi_2\left(1-\rho_g\right) - \Phi\frac{g}{b}}{\psi_1}\right]\right\}\hat{g}_t = 0.$$

This implies that for (3.60) to actually be a solution to (3.58)-(3.59), the following conditions must hold:

$$\psi_1 = \frac{(1-\Phi-\beta) + \sqrt{(1-\Phi-\beta)^2 - 4\Phi\Pi_2\Pi_1\beta^2}}{-2\Pi_2\beta}, \qquad \psi_2 = \frac{\frac{g}{b}}{1-\rho_g-\psi_1\Pi_2}.$$

The second solution for ψ_1 is excluded as it is not a stable solution.

Second, we use (3.60) to substitute out $E_t\hat{q}_{t+1}$ from the UIP condition (3.22), solve for $\hat{b}_t$ and insert in the balance of payments condition (3.23), and finally solve for $\hat{y}_t$:

$$\hat{y}_t = \frac{b}{y}\left(\frac{1-\Phi}{\beta}\right)\hat{b}_{t-1} + \Psi_2\hat{q}_t + \left(\Phi\Psi_3 + \frac{g}{y}\right)\hat{g}_t. \tag{3.61}$$

where

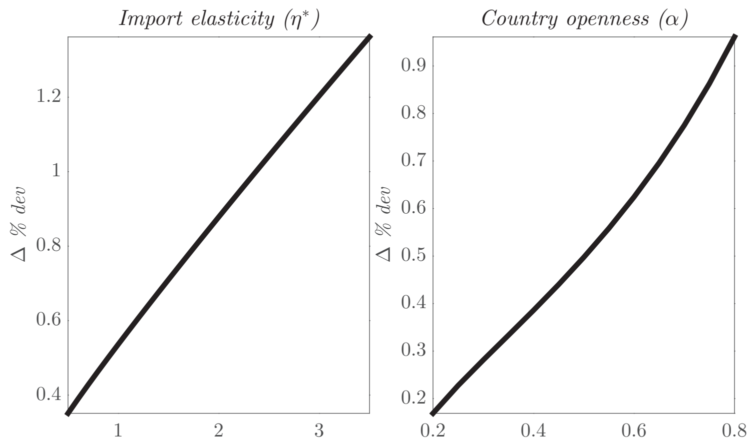
$$\Psi_2 \equiv \frac{\alpha}{1-\alpha} + \frac{1}{\sigma}\frac{c}{y} - \frac{b}{y}\frac{1}{\psi_1+\Phi}, \qquad \Psi_3 \equiv \frac{\frac{b}{y}\psi_2}{\psi_1+\Phi}.$$

$\Pi_1 > 0$ and $\Pi_2 < 0$ imply $\psi_1 > 0$. $\psi_1 > 0$ and $\psi_2 > 0$ imply $\Psi_3 > 0$. The condition $\Psi_1 > \Psi_2$ can be rewritten into $(1-\Phi)+\Phi^2\beta\Pi_2^2-\Phi\Pi_2\left[(1-\Phi)+\beta(1-\Pi_1)\right] > 0$, which holds as $0 \leq \Phi < 1$, $\beta > 0$, $\Pi_2 < 0$ and $0 < \Pi_1 < 1$ (for $\Pi_1 \geq 1$, the debt level would be non-stationary and such that a unique solution to the model would not exist).

From (3.60), we find that a higher debt level leads to a depreciation of the real exchange rate. Also, an increase in government spending leads to a depreciation of the real exchange rate under sovereign risk since $\psi_2 > 0$. This result is stronger for a higher default elasticity, Φ. The greater is the persistence of the government spending shock, i.e. the higher is ρ_g, and the greater is the share of government spending to output, g/y, the stronger is the response of the real exchange rate to changes in government spending.

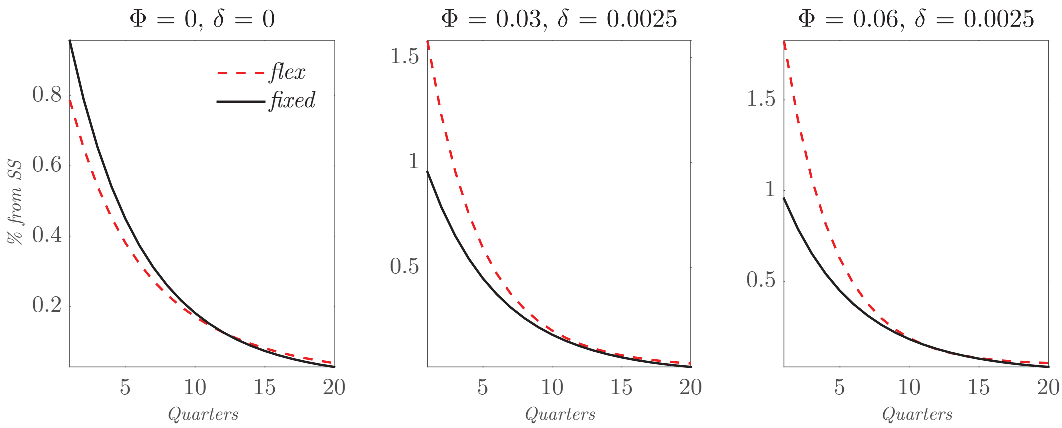
3.D Additional graphs

Figure 3.7: Differences in output responses upon impact across monetary regimes



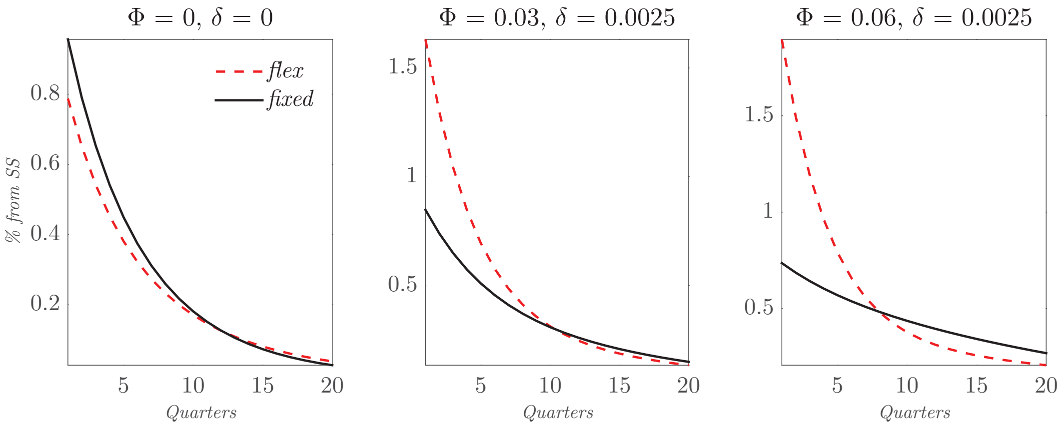
Notes: Figures show differences in output responses upon impact (in percentage deviation from steady state) across monetary regimes, denoted by $\Delta\%dev = \%dev_{\text{flex}} - \%dev_{\text{fixed}}$, for different values of η^* and α, in the presence of sovereign risk, i.e. for $\delta = 0.0025$ and $\Phi = 0.03$ (here, we assume that $\chi_{h,2} = 0$, which means that there is no sovereign risk pass-through).

Figure 3.8: The effect of Φ: output responses to a government spending shock under sovereign risk and without sovereign risk pass-through



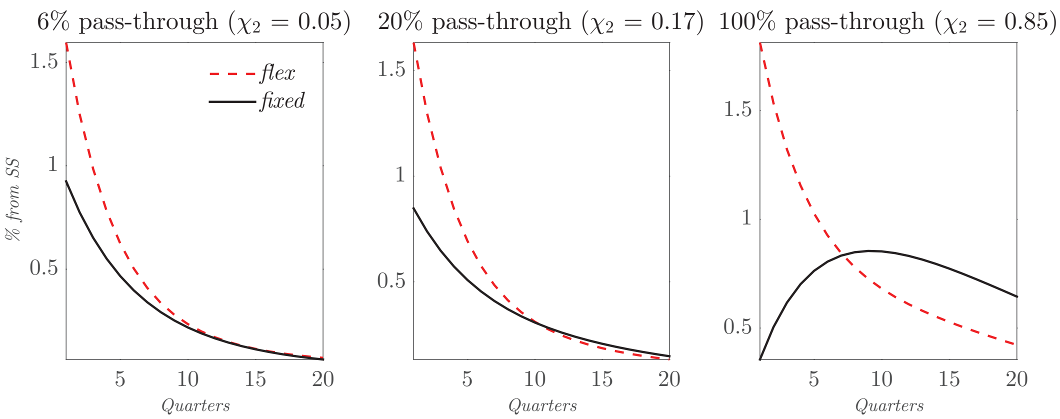
Notes: Figures are generated based on the calibration reported in Table 3.1, yet assuming $\chi_{h,2} = 0$.

Figure 3.9: The effect of Φ: output responses to a government spending shock under sovereign risk and 20% sovereign risk pass-through



Notes: Figures are generated based on the calibration reported in Table 3.1.

Figure 3.10: The effect of $\chi_{h,2}$: output responses to a government spending shock under different degrees of sovereign risk pass-through



Notes: See notes under Figure 3.9.

3.E Non-Ricardian households

In this section, we modify the model outlined in Section 3.1 by assuming that not all households have access to financial markets and are thus prohibited from investing and borrowing. Since savings and borrowing decisions no longer enter the optimisation problem, these types of households maximise utility by simply consuming all of their disposable income in every period. In that sense, Ricardian equivalence fails, as changes in government spending, that affect the government's intertemporal budget constraint, no longer induce private wealth effects through expected changes in future taxes. Such households are therefore often referred to as *Non-Ricardian*. Non-Ricardian households have become a standard feature in many contemporary New Keynesian models.

We introduce Non-Ricardian households to the model and index them by NR. The remaining (Ricardian) households are indexed by R. Accordingly, the first-order conditions of a representative Ricardian household, derived in Section 3.1.2, are changed to

$$n_t^{\varphi} = c_{R,t}^{-\sigma} w_t, \tag{3.62}$$

$$q_t c_{R,t}^{-\sigma} = \beta E_t \left[c_{R,t+1}^{-\sigma} q_{t+1} \Xi_{h,t}^* r_t^* \right], \tag{3.63}$$

$$c_{R,t}^{-\sigma} = \beta E_t \left[c_{R,t+1}^{-\sigma} \left(1 - \delta_{t+1}\right) r_t \right]. \tag{3.64}$$

The consumption function of a representative Non-Ricardian household is given by

$$P_t c_{NR,t} = W_t n_{NR,t} - P_{H,t} T_{NR,t}. \tag{3.65}$$

We assume that Non-Ricardian households do not own any shares of intermediate goods firms. Subject to (3.65), the Non-Ricardian household chooses consumption and labour supply to maximise its current utility, i.e.

$$\frac{c_{NR,t}^{1-\sigma}}{1-\sigma} - \frac{n_{NR,t}^{1+\varphi}}{1+\varphi}.$$

Let s_{NR} denote the share of Non-Ricardian households. Then, aggregate consumption is defined as

$$c_t \equiv s_{NR} c_{NR,t} + \left(1 - s_{NR}\right) c_{R,t}. \tag{3.66}$$

Since both types of households supply the same quality of labour, labour demand is distributed equally across households. Hence $n_t = n_{NR,t} = n_{R,t}$, for all t. The same holds for lump-sum taxes, i.e. $T_t = T_{NR,t} = T_{R,t}$. Moreover, bonds market clearing now requires

$$B_t = (1 - s_{NR})\, B_{H,t} + B_{F,t}. \tag{3.67}$$

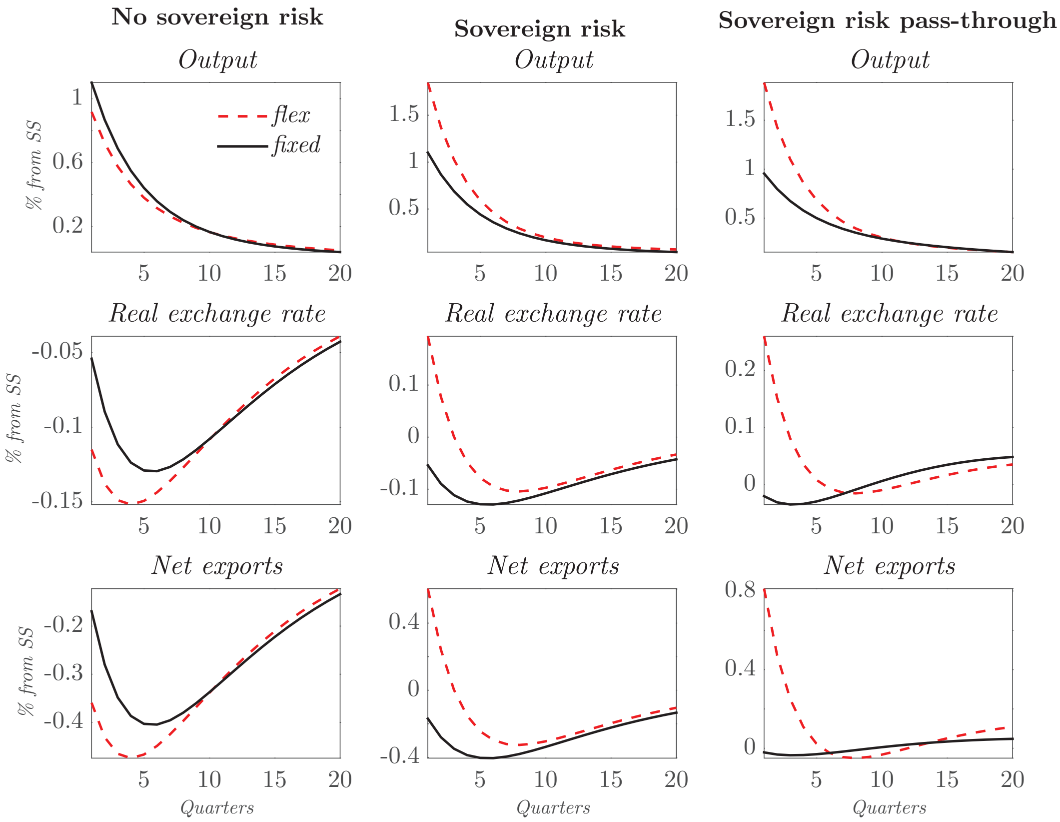
All other market clearing conditions, the first-order conditions of the firms, the public budget constraint and the policy rules remain the same.

We linearise equations (3.62)-(3.64) and replace them for (3.47), (3.42) and (3.46), respectively. Additionally, we linearise (3.65)-(3.67) and add them to the model. We set the share of Non-Ricardian households equal to $s_{NR} = 0.2$. Also, assuming consumption by Ricardian households is 80% of aggregate output in steady state, i.e. $c_R/y = 0.8$, and using (3.66) yields $c_{NR}/y = 0.75$. We proceed by simulating the responses of the endogenous variables to a government spending shock for alternative assumptions regarding sovereign risk. The results are shown in Figures 3.11 and 3.12.

The inclusion of Non-Ricardian households does not affect the results presented in Section 3.3: following a positive shock to government consumption, and in the absence of sovereign risk, output rises and the response is larger under fixed than flexible exchange rates. This result is reversed when sovereign risk is introduced, with the difference between output responses under the two monetary regimes being larger in the presence of sovereign risk spillovers to private credit conditions.

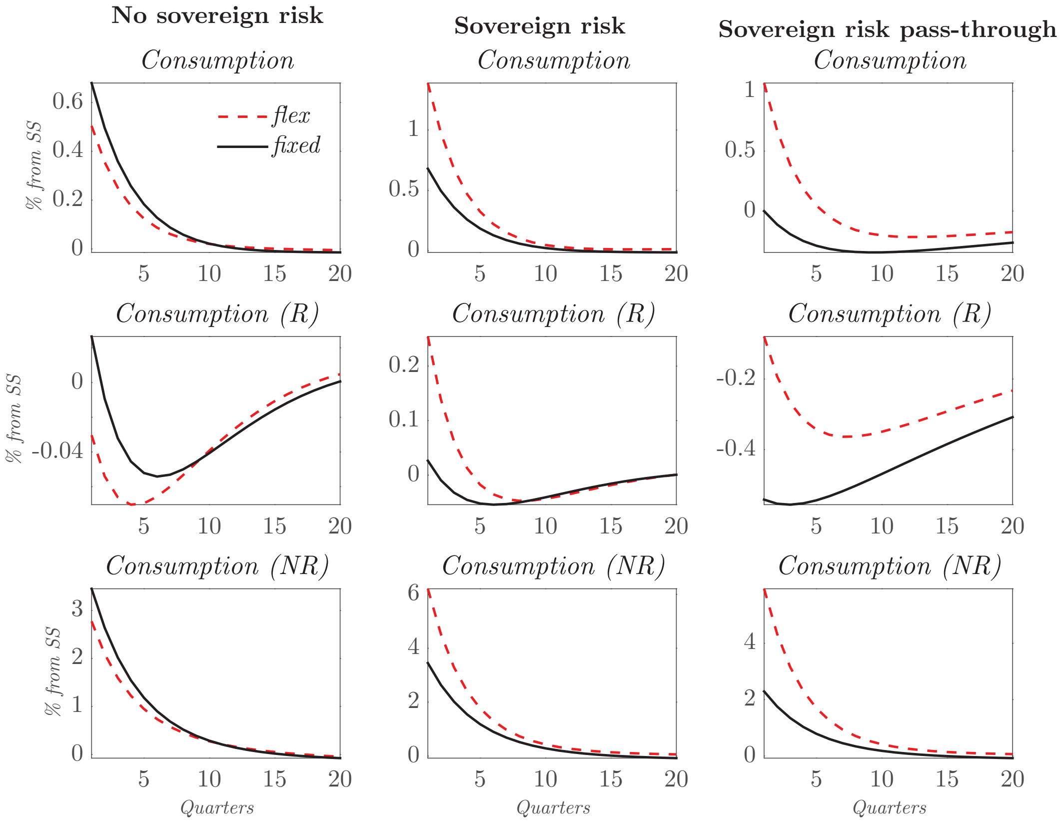
While qualitatively very much similar, the adverse crowding-out effects of sovereign risk on aggregate consumption are somewhat muted as compared to the case without Non-Ricardian households. This is because sovereign risk only affects the optimal path of consumption for Ricardian households, but not for Non-Ricardian households. Specifically, upon an increase in sovereign risk, Ricardian households face higher borrowing costs, due to sovereign risk pass-through, and therefore reduce consumption (as before), yet Non-Ricardian households only adjust their level of consumption insofar there are changes in their disposable income. Since the fiscal expansion raises output and disposable income immediately, through an increase in government spending, and indirectly, through an increase in net exports owing to the exchange

Figure 3.11: Responses to a government spending shock in the presence of Non-Ricardian households



Notes: Figures are generated based on the calibration reported in Table 3.1 and a 20% share of Non-Ricardian households.

Figure 3.12: Responses to a government spending shock in the presence of Non-Ricardian households



Notes: See notes under Figure 3.11.

rate effect (explained in Section 3.2.1), Non-Ricardian households *raise* consumption. Therefore, the reduction in aggregate consumption is lower than in the case where Non-Ricardian households were absent. In fact, for higher values of s_{NR}, aggregate consumption may even respond positively under both monetary regimes.

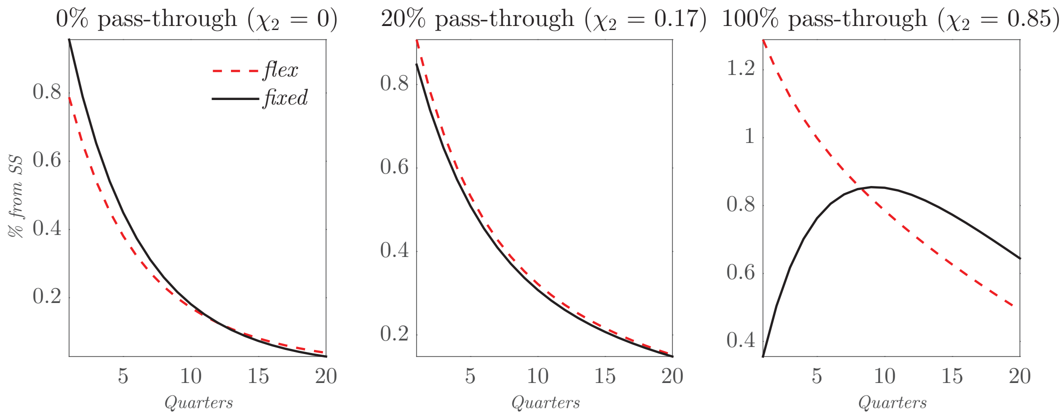
Since the presence of Non-Ricardian households mutes the adverse effects of sovereign risk, the government spending multiplier becomes larger, yet more so under flexible than fixed exchange rates. This is because the exchange rate effect is still driving most of the results: without sovereign risk, the government spending shock leads to an appreciation of the real exchange rate and a fall in net exports under both monetary regimes. When sovereign risk is present, however, the exchange rate depreciates, which supports net exports and output, and more so when exchange rates are allowed to float. Therefore, and in accordance with our previous results, the response of output to a government spending shock is larger under flexible than fixed exchange rates in the presence of sovereign risk.

3.F Insurance against sovereign default

Thus far, we have assumed that the central bank controls the interest rate on government bonds, R_t, which implies that bondholders cannot respond to changes in the risk of sovereign default by adjusting the bond *price*. Instead, they must respond by changing their *demand* for bonds. Thus, when a fiscal expansion raises sovereign risk, bond holders sell domestic government bonds in exchange for (relatively safer) foreign assets, which gives rise to the exchange rate effect that underlies our main results. If, on the other hand, bond holders were able to partially insure against the risk of sovereign default, the exchange rate effect would be mitigated.

However, our results would still hold even if government bond holders were *completely* insured against sovereign risk. This is because of the presence of sovereign risk pass-through, which establishes a link between public and private credit risk. Since foreign lenders cannot perfectly control for changes in the riskiness of private borrowers induced by sovereign risk, an increase in the sovereign default probability would still put upward pressure on the exchange rate, at least in the floating exchange rate regime. An increase in government

Figure 3.13: Output responses to a government spending shock under complete sovereign risk insurance for different values of $\chi_{h,2}$



Notes: Figures are generated based on the calibration reported in Table 3.1.

spending would therefore generate qualitatively the same results as shown in Section 3.3.4.

In this section, we illustrate this result, and thereby also demonstrate the robustness of our previous results, by considering the case in which holders of government bonds are completely insured against the direct effects of sovereign risk, while still allowing for the presence of sovereign risk pass-through. In particular, we assume that the central bank sets the risk-free rate, $R_{f,t}$, rather than the bond rate, whereas the bond rate is determined in equilibrium by the following condition:

$$R_t = \frac{1}{1 - E_t \delta_{t+1}} R_{f,t}. \tag{3.68}$$

According to (3.68), a change in the sovereign default probability must be offset by a change in the bond rate. Thus, bond holders are completely insured against the direct effects of sovereign risk. We also make the appropriate changes to the monetary policy rule, given by (3.5):

$$\frac{R_{f,t}}{R_f} = \left(\frac{R_{f,t-1}}{R_f}\right)^{\rho_r} \left(\frac{E_t \pi_{t+1}}{\pi}\right)^{(1-\rho_R)\phi_\pi},$$

and add the linearised version of (3.68) to the model.

The output responses following a government spending shock generated by the new model are shown by Figure 3.13. The figures are all generated under the assumption that $\delta = 0.0025$ and $\Phi = 0.03$. Therefore, sovereign risk is present in *all* cases. If there is no pass-through from public to private credit risk, i.e. $\chi_{h,2} = 0$, the output responses are higher under fixed exchange rates than under flexible exchange rates, despite the presence of sovereign risk (left column of Figure 3.13). This result arises because investors can perfectly insure themselves against changes in sovereign risk: without a response of foreign bond holders to a change in sovereign risk, the exchange rate effect is no longer present and the effects of an increase in government spending are in line with traditional Keynesian theory. However, when we allow for sovereign risk pass-through and set $\chi_{h,2} = 0.17$, we re-obtain the results from Section 3.3.4 and find that the output response is higher under flexible than fixed exchange rates.

3.G Additional tables

Table 3.4: Exchange rate regime classification

	Fixed		Flexible	
Australia	1975-1983		1984-2012	
Austria	1975-2012			
Belgium	1975-2012			
Canada			1975-2012	
Denmark	1975-2012			
Finland	1989-1991	1996-2012	1992-1995	
France	1975	1979-2012	1976-1978	
Ireland	1996-2012			
Italy	1979-1991	1996-2012	1975-1978	1992-1995
Japan			1980-1989	
Netherlands	1975-1979	1990-2012	1975-2012	
Norway	1978-1991		1992-2012	
Portugal	1992-2012		1981-1991	
Spain	1989-2012		1980-1988	
Sweden	1975-1976	1978-1993	1977	1994-2012
UK			1975-2012	
US			1975-2012	

Table 3.5: Episodes of weak public finances

	Weak public finances		
Belgium	1976-2004	2012	
Canada	1983-1987	1992-1995	
Denmark	1982-1984		
Finland	1994-1996		
France	1994	2010-2011	
Ireland	2009-2012		
Italy	1975-2012		
Japan	1988-2012		
Netherlands	1983	1996	
Portugal	1981-1983	1986-1988	1992
	1994-1995	2006	2010-2012
Spain	1983-1987	1994-1996	2010-2012
Sweden	1983	1993-1996	
UK	1993-1995	2010-2012	
US	2009-2012		

Table 3.6: Data description, summary statistics and correlation coefficients

	Name	**Source**	**#Obs**	**Mean**	**Min**	**Max**	**Std**	**Within**	**Between**
Log government consumption/capita	GOVT	OECD EO92	711	4.01	2.83	5.90	0.65	0.09	0.65
Log GDP/capita	OUTPUT	OECD EO92	711	4.68	3.78	6.61	0.64	0.10	0.64
Composite Leading Indicator	CLI	OECD EO92	692	0.00	-0.05	0.04	0.01	0.01	0.00
Debt/GDP	DEBT	**	731	0.59	0.00	2.14	0.33	0.20	0.22
Change in the REER	REER	OECD EO92	710	0.00	-0.18	0.30	0.05	0.05	0.01
Weak public finances	RISK	Corsetti et al (2012)	731	0.22	0	1	0.41	0.29	0.26
Peg	REGIME	Ilzetzki et al (2010)	731	0.59	0	1	0.49	0.26	0.37

Notes: 'Std' denotes overall standard deviation, within the within standard deviation and between the between standard deviation. For 'Debt/GDP', we used IMF GFS data whenever the data was not supplied by the OECD EO92.

Correlations	GOVT	OUTPUT	CLI	DEBT	REER	RISK
OUTPUT	0.97					
CLI	0.01	0.04				
DEBT	0.53	0.50	0.01			
REER	-0.04	0.00	-0.09	-0.12		
RISK	0.16	0.09	0.04	0.41	-0.13	
REGIME	-0.12	-0.10	0.05	-0.01	0.10	-0.05

Notes: Correlations are averages of the correlations per country.