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# FLOATS, PEGS AND THE TRANSMISSION OF FISCAL POLICY

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**Abstract**
According to conventional wisdom, fiscal policy is more effective under a fixed exchange rate regime than under a flexible one. In this paper we reconsider the transmission of shocks to government spending across these regimes within a standard new-Keynesian model of a small open economy. Because of the stronger emphasis on intertemporal optimization, the new-Keynesian framework requires a precise specification of fiscal and monetary policies, and their interaction, at both short and long horizons. We derive an analytical characterization of the transmission mechanism of expansionary spending policies under a peg, showing that the long-term real interest rate necessarily rises if inflation rises on impact, in response to an increase in government spending. This drives down private demand even though short-term real rates fall. As this need not be the case under floating exchange rates, the conventional wisdom needs to be qualified. Under plausible medium-term fiscal policies, government spending is not necessarily less expansionary in a floating regime.

**Resumen**
De acuerdo con el paradigma convencional, la política fiscal es más efectiva bajo un régimen cambiario fijo que con tipo de cambio flexible. En este trabajo se reconsidera la transmisión de shocks del gasto de gobierno a través de estos regímenes dentro de un modelo neokeynesiano para una economía pequeña y abierta. Dado el especial énfasis en la optimización intertemporal, el marco neokeynesiano requiere de una especificación precisa de las políticas tanto monetaria como fiscal, y su interacción tanto a corto como a largo plazo. Se deriva analíticamente una caracterización del mecanismo de trasmisión de políticas de gasto expansivo bajo tipo de cambio fijo, mostrando que la tasa de interés real de largo plazo necesariamente aumenta si la inflación aumenta sobre el impacto, en respuesta a un incremento del gasto de gobierno. Esto motiva una caída de la demanda privada aunque las tasas de interés real de corto plazo disminuyan. Como este no tiene por qué ser el caso bajo tipo de cambio flotante, el paradigma convencional requiere matizarse. Bajo políticas fiscales plausibles de mediano plazo, el gasto de gobierno no es necesariamente menos expansivo bajo tipo de cambio flotante.

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# 1 Introduction

One of the most popular pieces of wisdom in economic policy is the idea that fiscal policy is more effective in a fixed exchange rate regime or a currency union, relative to a regime of flexible exchange rates. In this paper, we revisit the theoretical foundations of the conventional wisdom on the relative effectiveness of fiscal policy under alternative exchange rate regimes, using a standard new-Keynesian model of a small open economy. We do so by focusing our analysis on the inherent link between the macroeconomic effects of short-run stimulus and private expectations about medium-run monetary and fiscal policy developments. We do not, however, deviate from the assumption of perfect credibility of the peg, and we do not consider the case of prospective deficit monetization, discussed in an important contribution by Dornbusch (1980).[1] Rather, we consider plausible monetary and fiscal policy regimes credibly in place over the medium run.

Specifically, the new-Keynesian model calls attention to the real long-term rate as a core indicator of the overall stance of stabilization policy: for private demand to increase in response to a shock, this rate must fall, see Woodford (2003). Then, as stressed by Corsetti, Meier, and Müller (2009), under the expectation hypothesis, long-term rates reflect the entire path of (current and future anticipated) monetary and fiscal decisions, via the effects of the latter on short-term rates over time. Based on this consideration, in this paper we are able to derive sharp predictions regarding the macroeconomic dynamics following any given fiscal expansion, as a function of the regimes governing the evolution of fiscal policy and monetary/exchange rate policy.

The main conclusion of our analysis is that fiscal policy is not necessarily less effective under flexible exchange rates. With the central bank behavior approximated by a Taylor rule, a plausible regime of medium-run fiscal consolidation in which, after the initial stimulus, both spending and taxes are adjusted so as to stabilize debt, can easily undermine the ranking according to the conventional wisdom. The transmission mechanism for the case of a float is analyzed in detail by Corsetti et al. (2009), henceforth CMM. Everything else equal, the long-term real interest rate tends to fall if agents anticipate a contraction in government spending in the near future. As this is expected to cause a slowdown of inflation, under floating rates private agents also expect the central bank to cut policy rates. At the same time, with nominal rigidities, anticipation of falling inflation in the near future affects price setting much in advance, translating into lower inflation (and thus lower policy rates) already today. When today's stimulus is expected to be matched by future spending cuts, it may then well be possible that long-term real interest rates actually fall at the time of the fiscal expansion, instead of increasing.

[1] According to Dornbusch, the prediction that a fiscal expansion appreciates the exchange rate is an unappealing feature of the Mundell-Fleming model, in apparent contrast with the practical experience in policymaking. To address this issue, Dornbusch encompasses medium-term monetary developments in the model, focusing on the case in which government expansions in the short run foreshadow deficit monetization over the medium run. The anticipation of a future monetary expansion weakens the exchange rate already in the short run.

This would drive up private demand on impact.

A specific contribution of this paper is to show that a fall in long real rates in response to a fiscal expansion is not possible under a peg, whether or not agents anticipate spending cuts in the medium term. Indeed, we provide a simple analytical characterization of the impact effect of temporary shocks (including fiscal ones) on the long-term rate in a regime of limited exchange rate flexibility. Namely, assuming complete financial markets and additively-separable utility for simplicity, we show that, up to a first-order approximation, under a peg the long-term real rate moves one-to-one with the initial (unexpected) change in the CPI. In other words, the initial bout of inflation in response to a fiscal expansion approximates the rise in long-term real rates on impact. In turn, this rise in long-term real rates drives down consumption demand proportionately.[2] The crowding out of consumption thus reduces the multiplier. Different outcomes, instead, are possible under a float, depending on the interaction of monetary and fiscal policy in the medium run.

A corollary of our analysis is that, under a peg, short-term and long-term real rates co-move negatively in response to a fiscal shock: the latter necessarily rise on impact, even if the former fall one-to-one with the rate of inflation. This characterization of the transmission mechanism casts doubts on the argument underlying the so-called Walter's critique. According to this critique, under a fixed exchange rate regime, exogenous cyclical shocks (including fiscal shocks) that cause inflation, are bound to be amplified by the implied endogenous pro-cyclical movements in the real interest rate. A fixed exchange rate regime, so the argument goes, is therefore inherently destabilizing. It is apparent that this argument relies on the maintained (but incorrect) assumption that real rates move necessarily in the same direction over the whole maturity structure.

We carry out robustness analysis by enriching the baseline new-Keynesian framework with features capturing financial imperfections and frictions. After establishing that our main conclusions go through under incomplete financial markets, we study the case of economies with limited asset market participation—a fraction of households are excluded from financial markets, possibly because of (non-modeled) costs of access to them. Fiscal stabilization is typically motivated by pointing out that a significant fraction of households may face financial constraints, making monetary policy less potent. We show that our main results carry over in this environment as well, where fiscal policy becomes overall more effective.

This paper is organized as follows. Section 2 reviews the conventional wisdom based on the traditional Mundell-Fleming model. Section 3 presents our new-Keynesian (NK) model. Section 4 provides a brief overview of the linearized equilibrium conditions. Section 5 reconsiders the conventional wisdom in the NK framework, focusing on the special case of an exogenous autoregressive

[2] The constant of proportionality depends on the curvature of the utility function. While this condition does not hold exactly if markets are incomplete, or preferences are not additive separable, the main insight of a positive relation between initial unexpected inflation and the movement in the long-term rate remains valid in more general model specifications.

fiscal disturbance. Section 6 derives analytical results regarding the fiscal transmission mechanism. Section 7 carries out experiments for a general specification of fiscal policy with endogenous correction of both taxes and spending. Section 8 explores the robustness of our results in the presence of financial frictions. Section 9 concludes.

## 2 The conventional wisdom

The conventional wisdom typically refers to the textbook version of the Mundell-Fleming model as illustrated graphically by Figure 1. Aggregate demand, $Y$, is measured against the horizontal axis, the nominal interest rate is measured against the vertical axis. The downward sloping line is the IS curve, derived from the equilibrium condition that investment equals savings, and expressing output as a declining function of the interest rate. The position of the IS curve depends on the level of the exchange rate: with preset prices, a nominal (=real) depreciation moves the IS to the right, through a positive competitiveness effect on real export. In the background of this curve, the exchange rate is determined by the uncovered interest parity condition—so that a fixed exchange rate requires equality between the domestic and the foreign interest rate in nominal terms. Under a floating rate, one needs to make an assumption about agents expectations of future exchange rates. Without loss of generality, for our purpose it is analytically convenient to assume that the exchange rate follows a random walk.[3] Money demand is a positive function of output, and a negative function of the nominal interest rate.

In a small open economy (foreign interest rate and prices are given), a spending expansion has a large multiplier effect on output under fixed exchange rates, while it just crowds out net exports one-to-one under flexible exchange rates. The reason for these differential results is a different degree of monetary accommodation across the two regimes. Under a peg, the central bank is committed to stem any change in the demand for money which may compromise the sustainability of the official exchange rate parity. Hence there must be full monetary accommodation: if government interventions drive up employment and income, households and firms raise their demand for cash, and the central bank has to raise its money supply by the same amount. If it did not, the interest rate would rise, and a higher interest rate would tend to appreciate the currency (via the uncovered interest parity condition), contradicting its commitment to maintain the currency peg. This implies a multiplier larger than one for the case of a peg.

Under a flexible rate regime, instead, the central bank is not committed to any particular exchange rate parity. If a spending expansion were successful to raise employment, incomes and therefore the demand for money, there would be an upward pressure on interest rates which would in turn appreciate the currency. But a stronger currency reduces aggregate demand and income, by crowding

[3] Many textbook models assume stationary expectations instead: the exchange rate in the future is expected to revert to some given value.

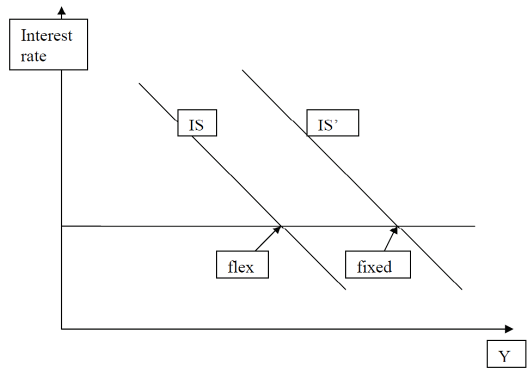


Figure 1: Expansion of government spending in Mundell-Fleming model (textbook version).

out net exports, and therefore counteracts the effects of the initial stimulus on interest rates. Since in equilibrium there cannot be any upward pressure on the interest rate or the exchange rate, on impact the latter must appreciate by enough to rule out any change in the level of aggregate demand, output, and money demand. So, a government expansion results exclusively in nominal and real appreciation, and a different composition of final demand, with more public demand and fewer exports.[4]

Such sharp results are of course sensitive to the parameterization of expectations. Assuming a stationary exchange rate, for instance, the impact appreciation of the exchange rate under a floating regime would create expectations of depreciation in the future. In equilibrium, the domestic interest rate would rise above the foreign one, with crowding out effects on domestic investment. The substance of the analysis above would not be affected, but there would be some response in equilibrium policy rates, and the composition of final demand, whereby more government spending would imply both lower net exports and lower investment. A further observation is that, encompassing price dynamics in the model, the inflationary consequences of a spending expansion should be more pronounced under a fixed exchange rate.

The presumption that the degree of monetary accommodation is necessarily higher under a peg is nonetheless controversial, even in the traditional literature. Implicit in the analysis by Dornbusch (1980), for instance, is the notion that, in practice, monetary accommodation tends to be quite pronounced under a floating regime—a position motivated by the empirical observation that the nominal exchange rate tends to depreciate with fiscal expansions.[5]

[4]Note that in this simple exercise monetary accommodation works through changes in the money supply: the interest rate actually remains constant in both regimes. The analysis of the flexible exchange rate regime is indeed typically carried out under the assumption of a constant money supply.

[5]See Corsetti, Meier, and Müller (2010) for recent evidence.

# 3 A small open economy model

In the following we outline a new-Keynesian small open economy model similar to Galí and Monacelli (2005) and Ghironi (2000). Our exposition follows CMM, except that, for clarity of exposition, in our baseline scenario we assume complete international financial markets. In a later section, we consider alternative assumptions regarding the set of internationally traded assets and the fraction of households which participate in domestic asset markets. Our exposition focuses on the domestic economy and its interaction with the rest of the world, ROW, for short.[6]

## 3.1 Final Good Firms

The final consumption good, $C_t$, is a composite of intermediate goods produced by a continuum of monopolistically competitive firms both at home and abroad. We use $j \in [0,1]$ to index intermediate good firms as well as their products and prices. Final good firms operate under perfect competition and purchase domestically produced intermediate goods, $Y_{H,t}(j)$, as well as imported intermediate goods, $Y_{F,t}(j)$. Final good firms minimize expenditures subject to the following aggregation technology

$$C_t = \left[ (1-\omega)^{\frac{1}{\sigma}} \left( \left[ \int_0^1 Y_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}} \right)^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left( \left[ \int_0^1 Y_{F,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad (3.1)$$

where $\sigma$ measures the trade price elasticity, i.e., the extent of substitution between domestically produced goods and imports for a given change in the terms of trade. The parameter $\epsilon > 1$ measures the price elasticity across intermediate goods produced within the same country, while $\omega$ measures the weight of imports in the production of final consumption goods—a value lower than 1/2 corresponds to home bias in consumption, and is therefore associated with deviations from PPP.

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

$$P_{H,t} = \left( \int_0^1 P_{H,t}(j)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}, \qquad P_{F,t} = \left( \int_0^1 P_{F,t}(j)^{1-\epsilon} di \right)^{\frac{1}{1-\epsilon}}. \quad (3.2)$$

By the same token, the consumption price index is

$$P_t = \left( (1-\omega) P_{H,t}^{1-\sigma} + \omega P_{F,t}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}. \quad (3.3)$$

Regarding the ROW, we assume an isomorphic aggregation technology. Further, the law of one price is assumed to hold at the level of intermediate goods such that

$$P_{F,t} \mathcal{E}_t = P_t^*, \quad (3.4)$$

[6] Our small open economy can be interpreted as the limiting case within a two-country world of an economy that has a relative size of zero, see De Paoli (2009).

where $\mathcal{E}_t$ is the nominal exchange rate (the price of domestic currency in terms of foreign currency) and $P_t^*$ denotes the price index of imports measured in foreign currency. It corresponds to the foreign price level, as imports account for a negligible fraction of ROW consumption. For future reference we define the terms of trade and the real exchange rate as

$$S_t = \frac{P_{H,t}}{P_{F,t}},\ Q_t = \frac{P_t \mathcal{E}_t}{P_t^*} \tag{3.5}$$

respectively.

### 3.2 Intermediate Good Firms

Intermediate goods are produced on the basis of the following production function: $Y_t(j) = H_t(j)$, where $H_t(j)$ measures the amount of labor employed by firm $j$.
Intermediate good firms operate under imperfect competition. We assume that price setting is constrained exogenously by a discrete time version of the mechanism suggested by Calvo (1983). Each firm has the opportunity to change its price with a given probability $1 - \xi$. Given this possibility, a generic firm $j$ will set $P_{H,t}(j)$ in order to solve

$$\max E_t \sum_{k=0}^{\infty} \xi^k \rho_{t,t+k} \left[ Y_{t,t+k}(j) P_{H,t}(j) - W_{t+k} H_{t+k}(j) \right], \tag{3.6}$$

where $\rho_{t,t+k}$ denotes the stochastic discount factor and $Y_{t,t+k}(j)$ denotes demand in period $t + k$, given that prices have been set optimally in period $t$. $E_t$ denotes the expectations operator.

### 3.3 Households

For our baseline scenario we assume that there is a representative household which ranks sequences of consumption and labor effort, $H_t = \int_0^1 H_t(j)$, according to the following criterion

$$E_t \sum_{k=0}^{\infty} \beta^k \left( \frac{C_{t+k}^{1-\gamma}}{1-\gamma} - \frac{H_{t+k}^{1+\varphi}}{1+\varphi} \right). \tag{3.7}$$

We assume that the household trades a complete set of state-contingent securities with the rest of the world. Letting $\Xi_{t+1}$ denote the payoff in units of domestic currency in period $t + 1$ of the portfolio held at the end of period $t$, the budget constraint of the household is given by

$$W_t H_t + \Upsilon_t - T_t - P_t C_t = E_t \left\{ \rho_{t,t+1} \Xi_{t+1} \right\} - \Xi_t, \tag{3.8}$$

where $T_t$ and $\Upsilon_t$ denotes lump-sum taxes and profits of intermediate good firms, respectively.

## 3.4 Monetary and fiscal policy

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

$$\log(R_t) = \phi_\pi(\Pi_{H,t} - \Pi_H), \tag{3.9}$$

where $\Pi_{H,t} = P_{H,t}/P_{H,t-1}$ measures domestic inflation and (here as well as in the following) variables without time subscript refer to the steady-state value of a variable. In this case, the nominal exchange rate is free to adjust in accordance with the equilibrium conditions implied by the model. Note that under a float, there are several monetary regimes possible and the specification of monetary policy is key for our comparison of fiscal policy transmission under pegs and floats.

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

$$\log(R_t) = \log(R_t^*) + \phi_{\mathcal{E}} \log(\mathcal{E}_t), \text{ with } \phi_{\mathcal{E}} > 0, \tag{3.10}$$

see Ghironi (2000) and Benigno, Benigno, and Ghironi (2007).

As regards fiscal and budget policy, we assume that government spending falls on an aggregate of domestic intermediate goods only:

$$G_t = \left( \int_0^1 Y_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}. \tag{3.11}$$

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

$$R_t^{-1} D_{t+1} = D_t + P_{H,t} G_t - T_t. \tag{3.12}$$

Defining $D_t^r = D_t/P_{t-1}$ as a measure for real, beginning-of-period, debt, and $T_t^r = T_t/P_t$ as taxes in real terms, we posit that fiscal policy is described by the following feedback rules from debt accumulation to the level of spending and taxes:

$$G_t = (1-\rho)G + \rho G_{t-1} - \psi_G D_{Rt} + \varepsilon_t, \;\; T_{Rt} = \psi_T D_{Rt}, \tag{3.13}$$

where $\varepsilon_t$ measures an exogenous iid shock to government spending. The $\psi$-parameters capture the responsiveness of spending and taxes to government spending and debt. Note that standard analyses of the fiscal transmission typically assume that $\psi_G = 0$. When taxes are lump-sum, Ricardian equivalence obtains in this case, as the path of government spending is exogenously given, and the time path of debt and taxes becomes irrelevant for the real allocation. Compared to this benchmark, allowing for $\psi_G > 0$ fundamentally alters the fiscal transmission mechanism—see CMM. For once, strictly speaking, Ricardian equivalence fails in this case, even when taxes are lump sum. A debt financed cut in taxes dynamically leads to adjustment in real spending, affecting the real allocation. Moreover, the time profile of adjustment affects the intertemporal price of consumption, with sharp implications for macroeconomic dynamics. Below we analyze the fiscal transmission mechanism in light of these considerations, contrasting results under a floating exchange rate regime with those obtained under a pegged exchange rate regime.

### 3.5 Equilibrium

Equilibrium requires that firms and households behave optimally for given initial conditions, exogenously given developments in the ROW, and government policies. Moreover, market clearing conditions need to be satisfied. At the level of each intermediate good, supply must equal total demand stemming from final good firms, the ROW, and the government:

$$Y_t(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon} \left((1-\omega)\left(\frac{P_{H,t}}{P_t}\right)^{-\sigma} C_t + \omega \left(\frac{P^*_{H,t}}{P^*_t}\right)^{-\sigma} C^*_t + G_t\right), \tag{3.14}$$

where $P^*_{H,t}$ and $C^*_t$ denote the price index of domestic goods expressed in foreign currency and ROW consumption, respectively. It is convenient to define an index for aggregate domestic output: $Y_t = \left(\int_0^1 Y_t^{\frac{\epsilon-1}{\epsilon}}(j)dj\right)^{\frac{\epsilon}{\epsilon-1}}$. Substituting for $Y_t(j)$ using (3.14) gives the aggregate relationship

$$Y_t = (1-\omega)\left(\frac{P_{H,t}}{P_t}\right)^{-\sigma} C_t + \omega \left(\frac{P^*_{H,t}}{P^*_t}\right)^{-\sigma} C^*_t + G_t. \tag{3.15}$$

We also define the trade balance in terms of steady-state output

$$TB_t = \frac{1}{Y}\left(Y_t - \frac{P_t}{P_{H,t}}C_t - G_t\right). \tag{3.16}$$

In what follows, we will consider a first-order approximation of the equilibrium conditions of the model around a deterministic steady state with balanced trade, zero debt, zero inflation, and purchasing power parity. Further, we consider only shocks which originate in the domestic economy and thus do not impact the ROW.

## 4 Linearized equilibrium conditions

In this section we present a set of equilibrium conditions which can be used to approximate the equilibrium allocation in response to government spending shocks in the neighborhood of the steady state. In what follows, small-case letters indicate percentage deviations from steady state, while a hat indicates that such deviations are measured in percent of steady-state output. Details of the derivation can be found in the appendix. Observe that under a float and for an exogenously given path of government spending, three equations are sufficient to characterize the equilibrium: a dynamic IS equation, the new-Keynesian Phillips curve and a characterization of monetary policy.[7] A three-equation representation of the equilibrium is not possible for a richer specification of fiscal policy featuring an endogenous feedback effect from debt to spending and/or in case of an exchange rate peg, however.

The dynamic IS equation is given by:

$$y_t = E_t y_{t+1} - \frac{(1-\chi)\varpi}{\gamma}(r_t - E_t \pi_{H,t+1}) - E_t \Delta \hat{g}_{t+1}, \tag{4.1}$$

where $\pi_{H,t}$ denotes domestic (producer price) inflation and, according to our definition, $\hat{g}_t$ denotes the deviation of government spending from steady state measured in percent of steady state output. $\chi$ measures the government spending-to-output ratio in steady state and $\varpi = 1 + \omega(2-\omega)(\sigma\gamma - 1)$.

The open-economy new-Keynesian Phillips curve is given by

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa \left( \varphi + \frac{\gamma}{(1-\chi)\varpi} \right) y_t - \kappa \frac{\gamma}{(1-\chi)\varpi} \hat{g}_t, \tag{4.2}$$

where $\kappa = (1-\beta\xi)(1-\xi)/\xi$.

Either monetary policy is characterized by an interest rate feedback rule (in which case the nominal exchange rate is free to adjust) or monetary authorities adjust the policy rate so as to peg the exchange rate to its steady state level. Formally, we have:

$$r_t = \phi_\pi \pi_{H,t}, \quad \text{or} \quad r_t = \phi_\mathcal{E} e_t. \tag{4.3}$$

Note that variables pertaining to ROW are zero in terms of deviations from steady state, as we only consider shocks in the domestic economy.

The evolution of public debt, government spending and taxes are given by

$$\beta \hat{d}^r_{t+1} = \hat{d}^r_t + \chi\omega s_t + \hat{g}_t - \hat{t}^r_t, \tag{4.4}$$

$$\hat{g}_t = \rho \hat{g}_{t-1} - \psi_G \hat{d}^r_t + \varepsilon_t, \tag{4.5}$$

$$\hat{t}^r_t = \psi_T \hat{d}^r_t. \tag{4.6}$$

In order to fully specify the equilibrium dynamics, we relate the nominal exchange rate to the dynamics of output and inflation as follows. The definition of the terms of trade $s_t = p_{H,t} - p_{F,t}$ and the

[7] This is often referred to as the canonical representation of the the new-Keynesian model (see e.g. Galí and Monacelli 2005). As Galí and Monacelli (2005) abstract from government spending, our representation differs from theirs. Importantly, we prefer to represent the canonical form using output, rather than the output gap, in view of the fact that changes in government spending also alter the natural level of output. Galí and Monacelli (2008) consider a very similar setup, but focus on the special case where the intertemporal elasticity of substitution and the trade price elasticity are equal to one.

law of one price imply

$$s_t = p_{H,t} + e_t. \tag{4.7}$$

Using the good market clearing condition and the risk sharing condition, we can express the terms of trade in terms of output net of government spending:

$$\frac{1-\chi}{\gamma}\varpi s_t = -(y_t - \hat{g}_t). \tag{4.8}$$

Given initial conditions and a sequence for innovations to government spending $\{\varepsilon_t\}_{t=0}^{\infty}$, equations (4.1) to (4.8) pin down a sequence for nine variables $\{y_t, r_t, \pi_{H,t}, p_{H,t}, \hat{g}_t, e_t, s_t, \hat{t}_t^r, d_{t+1}\}_{t=0}^{\infty}$, where $\pi_{H,t} = p_{H,t} - p_{H,t-1}$.

# 5 Revisiting the conventional wisdom: exchange rate regime and monetary accommodation

In theoretical studies of the macroeconomic effects of fiscal policy, government spending is typically assumed to follow an exogenously given AR(1) process. In our framework, this assumption corresponds to the case of no feedback from debt accumulation to spending, $\psi_G = 0$, which, as already mentioned, implies Ricardian equivalence. While restrictive, this conventional parameterization provides a useful starting point to our analysis. Specifically, we take up the issue how and why the exchange rate regime may alter the transmission of an autoregressive spending shock matched by higher lump-sum taxes. Using model simulations, we show that under standard assumptions on parameter values this basic exercise supports a particular aspect of the conventional wisdom, namely, that fiscal policy is more effective in stimulating economic activity under a regime of fixed exchange rates than under floating exchange rates (and in which the central bank follows a Taylor rule).

For our numerical experiments we adopt the following parameter values: a period in the model corresponds to one quarter. The discount factor $\beta$ is set to $0.99$. We assume that the coefficient of relative risk aversion, $\gamma$, and the inverse of the Frisch elasticity of labor supply, $\varphi$, take the value of one. The trade price elasticity $\sigma$ is set equal to unity as well. Regarding openness, we assume $\omega = 0.3$. As price rigidities are bound to play an important role in the transmission of government spending shocks, we assume a fairly flat Phillips curve. We do so by setting $\xi = 0.9$, a value that implies an average price duration of 10 quarters. Note that such a parameterization *prima facie* is in conflict with evidence from microeconomic studies such as Nakamura and Steinsson (2008). Nonetheless, the choice of a relatively high degree of price rigidities seems appropriate in the context of our framework, as we abstract from several model features which would imply a flatter Philips curve for any given value of $\xi$, e.g., non-constant returns to scale in the variable factor of production or non-constant elasticities of

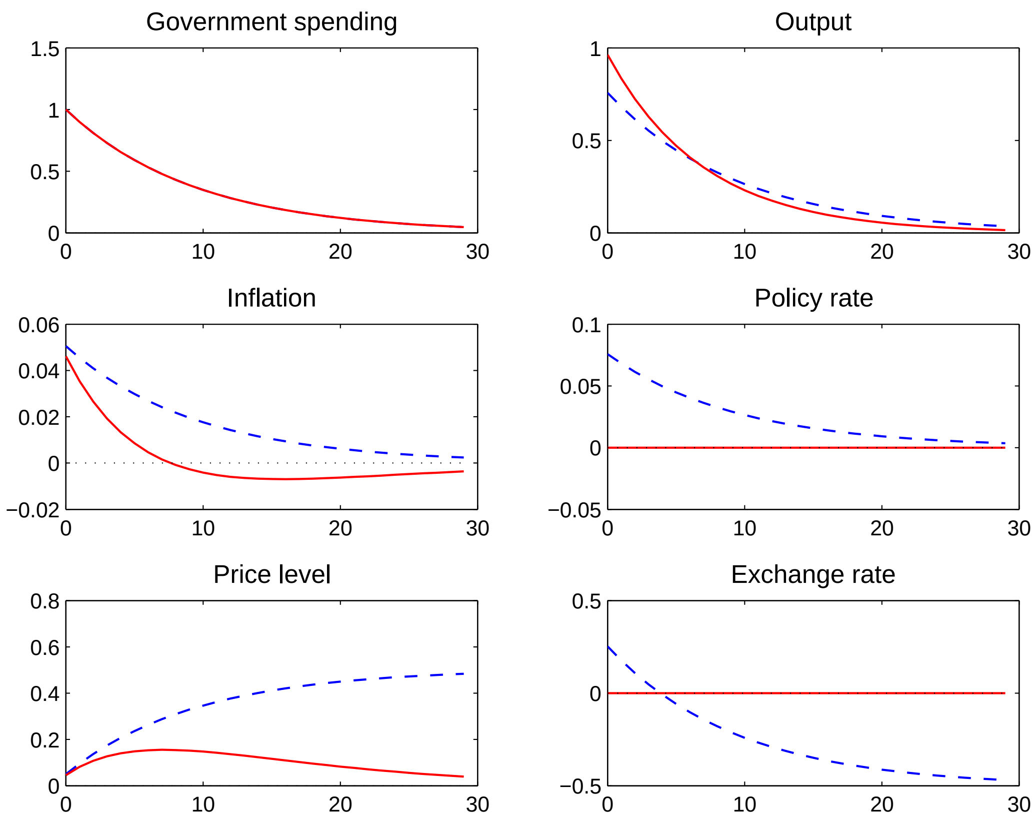


Figure 2: Effect of government spending shock under peg and float. Notes: dashed lines display responses under floating exchange rates assuming $\phi_\pi = 1.5$; solid lines display responses under pegged exchange rates. Output and government spending are measured in percent of steady-state output. Other variables are measured in percentage deviations from steady state (quarterly frequency). Horizontal axes indicate quarters. Inflation and price level pertain to the price of domestically produced goods.

demand.[8] We also abstract from wage rigidities. We set $\epsilon = 11$, such that the steady-state markup is equal to 10 percent. In specifying monetary policy, we set $\phi_\pi = 1.5$. As discussed below, this parameter plays a central role in the transmission of fiscal shocks. Finally, the average share of government spending in GDP is set to 20 percent, and we assume that the persistence of government spending is $\rho = 0.9$.

Figure 2 displays the impulse response to an exogenous increase in government spending by one percent of GDP, for two economies that are identical in all respects but for the exchange rate (and thus the monetary) regime. The responses of output and government spending are measured in percent of steady-state output. The responses of the other variables are measured in percentage deviations from steady state. The horizontal axes indicate quarters. The solid line refers to the exchange rate peg,

[8] See Galí, Gertler, and López-Salido (2001) or Eichenbaum and Fisher (2007) for further discussion of how real rigidities interact with nominal price rigidities in the context of the new Keynesian model. Note that the latter study also considers a non-constant price elasticity of demand, which further increases the degree of real rigidities.

while a dashed line marks the floating regime. The AR(1) process of government spending, identical across exchange rate regimes, is shown in the upper left panel.

A first notable result is that, in both regimes, the response of output (upper right panel) is positive, but smaller than unity throughout. This is quite different from the predictions of the Mundell-Fleming model for a small open economy with perfect capital mobility. As already discussed above, according to this model, government spending multipliers on output should be larger than one under a peg, zero under a float. Nonetheless, our results do agree with the conventional theory in relative terms: in response to a positive (autoregressive) fiscal shock, GDP under the peg exceeds that under the float by approximately 25 percent on impact and the response of GDP remains stronger under the peg for the first couple of quarters after the initial impulse.

Further notable results shown in Figure 2 concern the response of inflation and the price level. On impact, the response of domestic inflation (middle left panel) is positive irrespective of the exchange rate regime. Yet, over time, inflation follows divergent paths. Under a peg, inflation falls below its steady state value after about 2 years. Under a float, it remains positive throughout. This has direct implications for the policy rate. Under a float, the Taylor rule implies that the policy rate rises sharply on impact, and only gradually reverts back to its steady-state level. In nominal terms, the policy rate under a float thus remains above the constant nominal rate, dictated by the need to maintain the peg. Moreover, as the Taylor principle is satisfied under a float, real short-term interest rates (not shown) rise above steady-state levels throughout the expansionary fiscal stance such that the long-term real interest rate rises as well.

The differential behavior of inflation also maps into an apparent long-run divergence in the price level for domestically produced goods ($p_{H,t}$), and thus in the nominal exchange rate. With the central bank following a Taylor rule under a float, monetary authorities adjust the policy rate in response to the rate of growth in prices, and nominal prices drift to a permanently higher level. Since purchasing power parity (henceforth PPP) must be satisfied in the long-run, the nominal exchange rate depreciates proportionally over time. So, under a float, both the level of domestic prices and the nominal exchange rate display a unit root behavior.

When the exchange rate remains (credibly) pegged to its initial level, instead, long-run PPP requires domestic prices to revert back to their initial steady-state level. After an initial positive bout, inflation must therefore fall below its steady-state rate. Intuitively, in the short run firms respond to the additional demand from the government by raising prices. This makes them less competitive in the world market. As government spending progressively reverts back to its initial level, domestic firms need to re-gain competitiveness: when re-optimizing prices, they do so by setting lower prices along with a falling government demand.

Since in Figure 2 the government spending is exogenously determined and identical across exchange

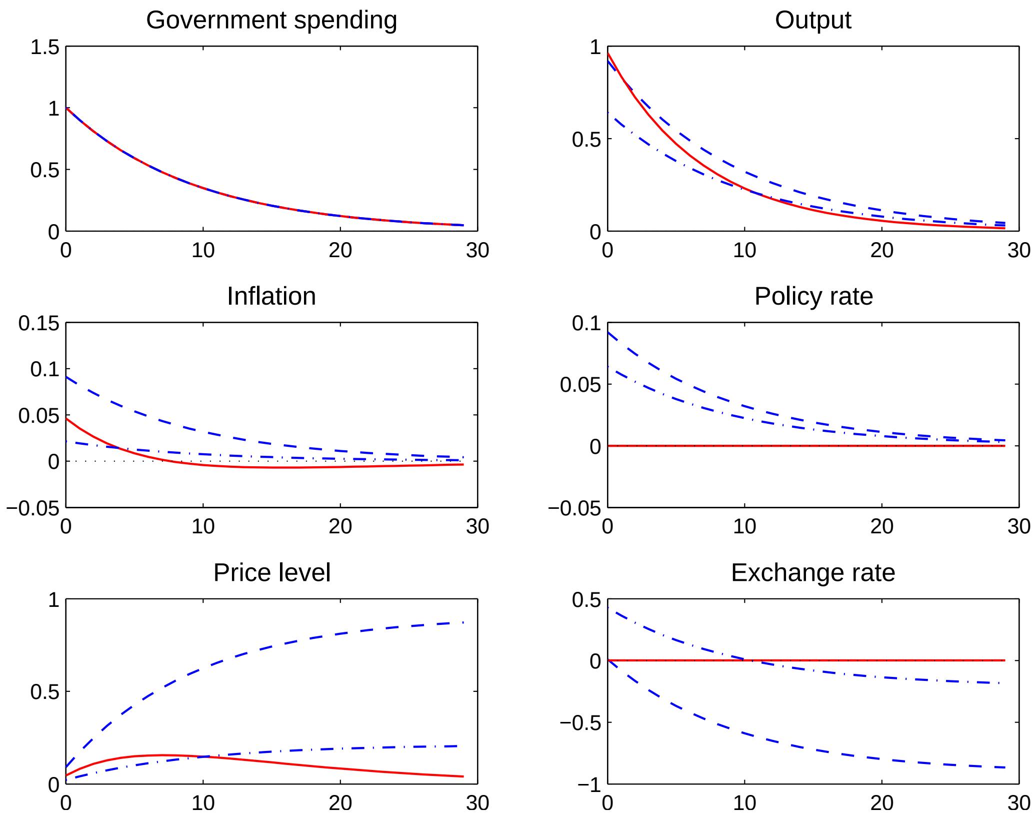


Figure 3: Effect of government spending shock under peg, and under a float for alternative values of $\phi_\pi$. Notes: dashed (dashed-dotted) lines display responses under floating exchange rates assuming $\phi_\pi = 1.01$ ($\phi_\pi = 3$). Solid lines display responses under pegged exchange rates (these responses are the same as in Figure 2), see Figure 2.

rate regimes, larger output effects under a peg reflect a relative more accommodative monetary policy—as maintained by conventional wisdom. Given the role that monetary accommodation plays for the transmission mechanism, our results are somewhat sensitive to the parameterization of the monetary policy rule under a float, a point illustrated by Figure 3. In this figure, we contrast results for a high and a low value of the coefficient $\phi_\pi$. With a coefficient as high as $\phi_\pi = 3$, implying that the central bank targets near price stability, the impact multiplier is about 0.6 (dashed-dotted line)—a result more in line with the traditional Mundell-Fleming view of relatively weak output effects of government spending under a float. Conversely, with a lower coefficient $\phi_\pi = 1.01$, indexing a mild reactivity of the central bank to current inflation, the impact multiplier under a float is very close to that under a peg (cumulative multipliers, obtained by summing up the output effects over time, are actually larger).

In light of the above results, we can rephrase the key lesson from the conventional wisdom: since the effectiveness of fiscal policy depends on the degree of monetary accommodation, comparing fiscal transmission across exchange rate regimes requires a precise specification of how monetary policy is and will be conducted. In this respect, the new-Keynesian model provides a clear and transparent framework for doing so.

## 6 Inspecting the transmission mechanism

To analyze more closely how the transmission of fiscal shocks is bound to depend on the interaction of fiscal and monetary policy over different time horizons, we now turn to a simple analytical characterization of fiscal transmission under a float (cum Taylor rule) and under a peg. The main insight is that fiscal policy cannot be modeled without specifying a medium and long-term policy framework. Relative to the Mundell-Fleming world, new-Keynesian analysis provides a more suitable framework for this purpose, as it assigns a much greater role to optimal intertemporal allocation by households in response to changes in relative prices, and most notably to the path of real interest rates.

In the baseline NK model, the optimal path of consumption is characterized by the consumption Euler equation. Using a linearized version of the model (see appendix) and solving forward, this equation yields

$$c_t = -\frac{1}{\gamma} \underbrace{E_t \sum_{s=0}^{\infty} (r_{t+s} - \pi_{t+1+s})}_{\equiv \bar{r}_t}, \tag{6.1}$$

where we have used the fact that the economy is stationary, and thus always reverts back to steady state (i.e. $\lim_{s\to\infty} c_{t+s} = 0$). Equation (6.1) shows that, in terms of deviations from steady state, current consumption is determined by expectations over the entire path of future ex-ante real interest rates. Since the expectation hypothesis holds in the model, the latter can be interpreted as a measure for the real return on a bond of infinite duration, i.e., as a measure for the long-term real interest rate.[9] It is easy to see how the long-term real rate synthesizes fiscal and monetary interactions across all time horizons, in response to fiscal (as well as to any other types of) shocks (see CMM). As already mentioned, under a float, monetary policy is not constrained by the need to bring the price level back to its initial steady state level in the long run. With a Taylor rule in place, the monetary stance in response to a fiscal expansion is contractionary in both the short and the long run, to a degree that depends on the parameterization of the coefficient $\phi_\pi$. Since the increase in spending causes inflation to remain persistently positive, short-term rates are expected to remain above or at their steady state value over time, implying a rise in long rates on impact. In Appendix C we show formally that under a float long term rates always increase for plausible parameter values, as long as $\psi_G = 0$.

Consider now the case of a peg. As shown in our first figure, under a currency peg, monetary policy appears to be more accommodative in the short run, since in real terms short-term interest rates fall one-to-one with the rise in inflation. By the same token, however, short real rates rise in the medium and the long-run, when, for an unchanged nominal exchange rate, purchasing power parity drives inflation into negative territory (in deviations from steady state). In our first exercise above, for instance, real short-term rates initially fall below steady state, but become positive after about 8 quarters.

This observation raises the issue of determining in which direction the long-term rate moves on impact. Under our simplifying assumptions (a small open economy, constant foreign variables), it is possible to provide a simple analytical insight on this question. Recall that under complete financial markets, the economy is stationary and always reverts back to steady state after a temporary increase in domestic government spending. As PPP holds in the long run, $\lim_{t\to\infty} P_t = P^*$ under an exchange rate peg: in the long run, the domestic price level is pinned down by the foreign price level. It follows that $\sum_{t=0}^{\infty} \pi_t = 0$ so that, with the domestic interest rate pegged to the foreign one, constant by assumption:

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

Hence, on impact the response of the real long-term interest rate is equal to the initial, unanticipated, change in CPI inflation (the future evolution of inflation is not relevant). As the initial effect of an increase in government spending on inflation is positive, the long-term rate increases, and consumption cannot but decline. Moreover, a positive differential between domestic and foreign long-term

[9]The long-term real interest rate is also—via the risk sharing condition—tightly linked to the real exchange rate: $-\gamma c_t = q_t = \bar{r}_t$ (see appendix). Hence, movements in the long-term interest rate may simultaneously rationalize changes in consumption and the real exchange rate. Specifically, CMM discuss how the expected path of future government spending alters the behavior of long-term real interest rates and thus the short-run adjustment to an exogenous innovation in government spending.

real rates causes the exchange rate to appreciate in real terms.

It is worth stressing that the above result has a number of implications for the literature on macroeconomic adjustment and stabilization policy under a fixed exchange rate regime. A point in case concerns the so-called Walter's critique. This starts from the observation that, holding the nominal interest rate constant, the inflationary effects of a positive demand shock translate into a fall in the short-term real interest rate. The endogenous movement in the real interest rate, the argument goes, is expansionary: it boosts demand further, rather than stabilizing it. In its extreme (perhaps caricature-like) form, the Walter's critique states that, a small open economy pursuing a currency peg or participating in a currency union, becomes unstable, since shocks are amplified by procyclical movements in the monetary stance.

The traditional counterargument points out that, with positive domestic inflation, rising prices would eventually crowd out exports, naturally stabilizing demand through the real exchange rate channel. The modern paradigm clarifies a deeper issue. As shown above, under a peg, the long-run real rates, which drive private demand, actually rise one-to-one with the initial bout of inflation. While the short-run inflationary consequences of a positive demand shock simultaneously reduce short-term rates in real terms, these are not directly relevant for private spending decisions.

Note that a reference to the effects of rising prices on competitiveness is still appropriate in the modern framework: competitiveness is the economic force behind PPP. What the new-Keynesian model emphasizes is that one cannot contrast the real exchange rate channel and the interest rate channel, treating them as independent of each other. In equilibrium, they both shape the intertemporal price relevant for private consumption/saving decisions.

## 7 Overturning the conventional wisdom: the medium-term fiscal framework

The role of intertemporal prices in the transmission of fiscal policy stressed above, naturally points to the importance of broadening the analysis so as to encompass general specifications of the medium-term framework—beyond the case $\psi_G = 0$. To explore this new direction of the analysis, in what follows we refer to CMM and contrast results for $\psi_G = 0$ and $\psi_G = 0.02$, while setting $\psi_T = 0.02$; compare equation (3.13). Note that with a positive $\psi_G$, an expansion of government spending leads to a further, endogenous adjustment of spending over time. From a quantitative point of view, our assumptions imply that government spending is cut, and taxes are increased, by 0.02 basis points for every increase of government debt by one percent (all measured in units of steady-state output).

For economies with floating exchange rates, the relevance of debt stabilization for the effectiveness of fiscal stimulus cannot be overstated. CMM analyze in detail the implications of endogenous dynamic cuts in spending, dubbed "spending reversals" and show that the spending multiplier on consumption

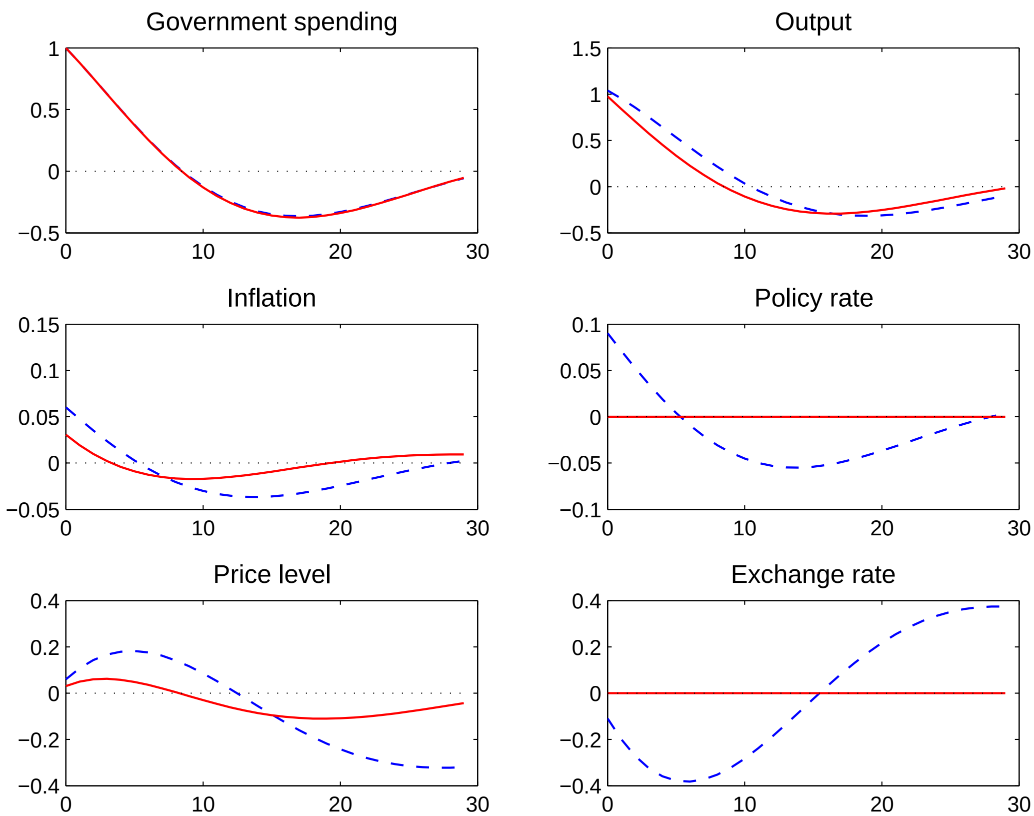


Figure 4: Effect of government spending shock with spending reversals: peg vs float. Notes: solid (dashed) lines display responses for peg (float); output, consumption and government spending are measured in percent of steady state output. Other variables are measured in percentage deviations from steady state. Horizontal axes indicate quarters. Inflation and price level pertain to the price of domestically produced goods.

may be positive on impact: consumption demand is actually crowded in; the response of output is therefore larger. The transmission mechanism is analogous to the one discussed under the peg in the previous section. Following the same logic as before, focus on the response of inflation. The rate of inflation, positive in the short run, turns negative over time (relative to steady state), in anticipation of spending cuts, thus even before these cuts are actually implemented. This is because, with sticky prices, forward-looking firms optimally adjust prices downward ahead of the fall in demand. Since lower inflation means lower policy rates, relative to the case of $\psi_G = 0$, a spending expansion in the short run may actually be accompanied by a fall (not a rise) in the long-term interest rate, crowding in private demand and boosting output more than one-for-one on impact. As an implication, the exchange rate depreciates, instead of appreciating. This is consistent with a recent body of evidence for economies that have adopted floating exchange rates (see the discussion in Corsetti et al. 2010).

For our purposes, the CMM case of a spending reversal is especially relevant because their transmission mechanism sharply differs across exchange rate regimes. Figure 4 reports impulse responses for the float (dashed lines) and the peg (solid lines), for government spending shocks characterized by reversals (the endogenous behavior of spending over time is shown in the upper left panel of the figure). The results contrast sharply with those shown in Figure 2, computed in the absence of spending reversals. In particular, the output response, shown in the upper right panel, is apparently at odds with the conventional wisdom: for the first two years the output response is now larger under a float than under a peg.

While the regime of debt consolidation (with reversals) is quite consequential for the short-run output effects under a float, it plays little or no role under a peg. This is consistent with our analytical characterization of the transmission under a peg, according to which—on impact—the long-term real rate always rises with impact inflation—irrespectively of the exact path of future short-term real rates, and thus irrespective of the type and intensity of debt consolidation.

These results add an important dimension to the conventional wisdom on fiscal transmission across exchange rate regimes. Not only does the relative effectiveness of fiscal policy vary with the relative degree of monetary accommodation across regimes. But holding the degree of monetary accommodation constant, the ranking is also sensitive to the specification of the medium-term fiscal outlook.

# 8 Incomplete financial markets

So far, we have developed our analysis under the assumption of complete financial markets. We now take up the question to what extent our results are sensitive to financial frictions. In this section, we explore this issue under two alternative assumptions regarding the structure of financial markets. First, we relax the assumption that financial markets are complete at the international level and allow for trade in nominally non-contingent bonds only. Second, we assume that, in addition, access to domestic financial markets is restricted. Specifically, we assume that only a subset of the population has access to asset markets. Households without access consume their disposable income in each period. That setup is similar to the closed-economy variants of Galí, López-Salido, and Vallés (2007) and Bilbiie, Meier, and Müller (2008).

## 8.1 Model setup

Our model is amended by positing that, out of a continuum of households in $[0, 1]$ residing in our small open economy, a fraction $1 - \lambda$ are asset holders, indexed by a subscript 'A'. These households own the firms, and may trade one-period bonds both domestically and internationally. The remaining households (a fraction $\lambda$ of the total) do not participate at all in asset markets, i.e., they are 'non-asset holders.' They are indexed by subscript 'N'.

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

$$E_t \sum_{k=0}^{\infty} \beta^k \left( \frac{C_{A,t+k}^{1-\gamma}}{1-\gamma} - \frac{H_{A,t+k}^{1+\varphi}}{1+\varphi} \right) \tag{8.1}$$

subject to the period budget constraint

$$R_t^{-1} A_{t+1} + R_{F,t}^{-1} B_{t+1}/\mathcal{E}_t + P_t C_{A,t} = A_t + B_t/\mathcal{E}_t + W_t H_{A,t} - T_t + \Upsilon_t. \tag{8.2}$$

where $A_t$ and $B_t$ are one-period bonds denominated in domestic and foreign currency, respectively. $R_t$ and $R_{F,t}$ denote the gross nominal interest rates on both bonds. Ponzi schemes are ruled out by assumption.

We assume that the interest rate paid or earned on foreign bonds by domestic households is determined by the exogenous world interest rate, $R_t^*$, plus a 'spread' which decreases in the real value of bond holdings scaled by output, that is:

$$R_{F,t} = R_t^* - \alpha \frac{B_{t+1}}{\mathcal{E}_t Y_t P_t}. \tag{8.3}$$

This assumption ensures the stationarity of bond holdings (even for very small values of $\alpha$) and thus allows us to study the behavior of the economy in the neighborhood of a deterministic steady state.[10]

A representative non-asset holding household chooses consumption, $C_{N,t}$, and supplies labor, $H_{N,t}$, to intermediate good firms in order to maximize its utility flow on a period-by-period basis

$$\frac{C_{N,t}^{1-\gamma}}{1-\gamma} - \frac{H_{N,t}^{1+\varphi}}{1+\varphi}, \tag{8.4}$$

subject to the constraint that consumption expenditure equals net income

$$P_t C_{N,t} = W_t H_{N,t} - T_t. \tag{8.5}$$

For non-asset holders, consumption equals disposable income in each period; hence they are also referred to as 'hand-to-mouth consumers'.

Aggregate consumption and labor supply are given by

$$C_t = \lambda C_{N,t} + (1-\lambda) C_{A,t} \tag{8.6}$$

$$H_t = \lambda H_{N,t} + (1-\lambda) H_{A,t}, \tag{8.7}$$

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

Regarding asset markets, we assume that foreigners do not hold domestic bonds. Market clearing for domestic currency bonds therefore requires

$$(1-\lambda) A_t - D_t = 0. \tag{8.8}$$

The market for foreign currency bonds clears by Walras' law.

[10] Our particular specification draws on Kollmann (2002), who studies a model similar to ours. Schmitt-Grohé and Uribe (2003) consider a real model of a small open economy and suggest the above mechanism of a debt-elastic interest rate as one among several ways of 'closing small open economy models' (that is, inducing stationarity) with incomplete markets.

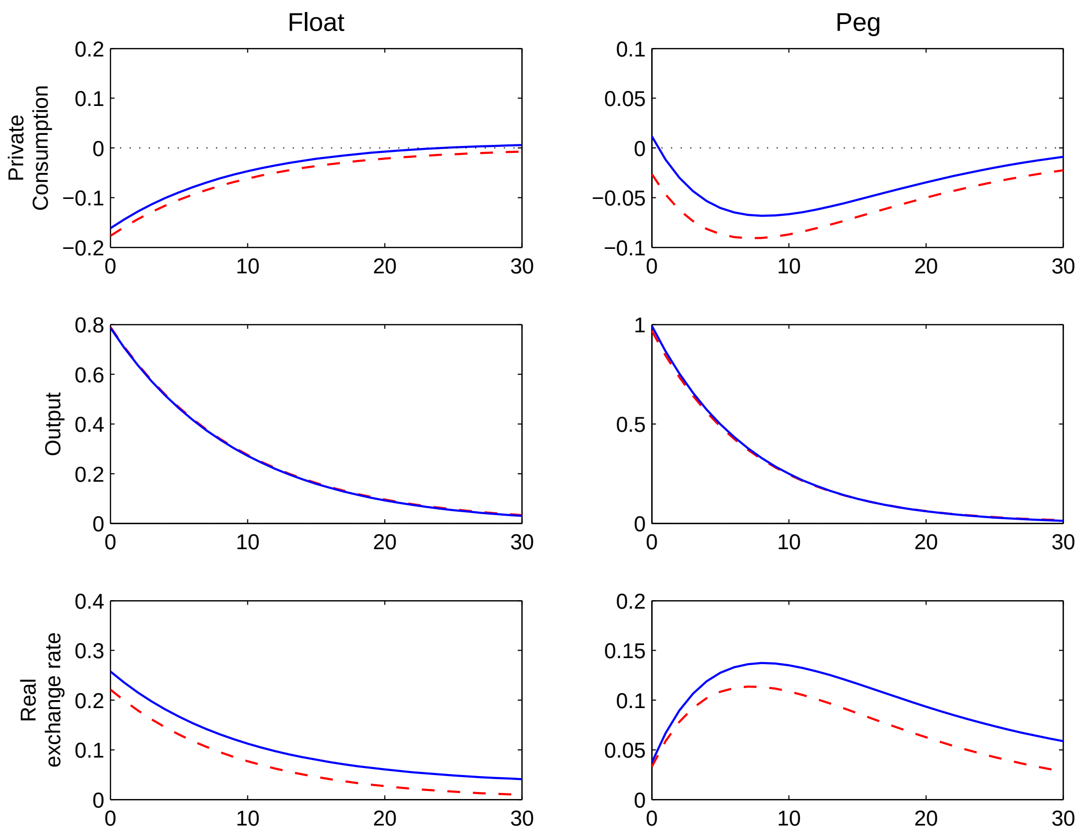


Figure 5: Effect of government spending shock under complete and incomplete international financial markets. Notes: solid (dashed) lines display responses assuming incomplete (complete) financial markets; output and consumption are measured in percent of steady-state output, real exchnage rate is measured in percentage deviations from steady state. Horizontal axes indicate quarters.

## 8.2 Transmission with imperfect risk sharing

This section presents model simulations under either incomplete markets, or both incomplete markets and limited market participation, as specified above. In Appendix A, we provide a detailed list of the equilibrium conditions used in the simulations. We maintain the same parameter values as in Section 5, except for the trade price elasticity $\sigma$. At a value of one for this elasticity (assumed above), relative prices move in such a way that they ensure complete risk sharing even under incomplete international asset markets, see Cole and Obstfeld (1991). Since we are interested in the sensitivity of our results to environments with imperfect risk sharing, we set $\sigma = 2/3$. For the sake of brevity, we focus only on the case of exogenous autoregressive spending shocks with $\psi_G = 0$ and do not examine the case of spending reversals here.

Figure 5 contrasts the results for the baseline scenario (complete financial markets) with those obtained under the assumption that international financial markets are incomplete. As before, we posit an exogenous increase in government spending by one percent of steady-state output (not shown).

The left column shows the results for the float, while the right column shows the results for the peg. The solid lines display the results obtained under the assumption that there is only trade in nominally non-contingent bonds at the international level. The dashed lines display responses obtained under the baseline scenario of complete financial markets. Observe that the response of consumption (top row) is somewhat higher with incomplete markets, in both exchange rate regimes, corresponding to a different dynamics of long-term real interest rates. However, from a quantitative point of view, differences in the response of consumption and output are modest.[11]

### 8.3 Limited asset-market participation

Figure 6 contrasts results for the baseline scenario (complete financial markets, dashed lines) with the case of limited participation (solid lines). In this case, we assume both that the set of assets traded across countries is restricted to trade in non-contingent bonds, and that—within a country—access to trade in bonds is restricted, so that only a fraction $1 - \lambda$ has access to trade in bonds. Specifically, we assume that $\lambda = 1/3$. Results for this case are displayed by the solid lines (as before dashed lines pertain to the baseline scenario of complete financial markets). We report the responses of consumption, long-term real interest rates and output to an exogenous increase in government spending by one percent of GDP.

With limited asset market participation, the dynamic adjustment of consumption is quite different compared to our results in Section 5. On impact, consumption now increases, both under the float and under the peg. Importantly, this is so despite the fact that the response of long-term real rates is actually positive throughout. The reason is straightforward: in our specification, a considerable fraction of households does not have access to asset markets. Their consumption is a function of current income, and not directly linked to changes in long-term interest rates. Because of the strong consumption response, we also find a considerably stronger effect of government spending on output. Absent a reversal of spending (with $\psi_G = 0$) also with these features the model thus lends support to the conventional wisdom: the macroeconomic transmission of fiscal shocks is somewhat stronger under the peg, with an impact multiplier above one.

[11]This finding is in line with earlier research, which found that the allocation under incomplete financial markets is quite close to the allocation under complete markets, unless the trade price elasticity is substantially different from one on either side, and, for the case of a high elasticity, shocks are persistent or follow a diffusion process, see Corsetti, Dedola, and Leduc (2008).

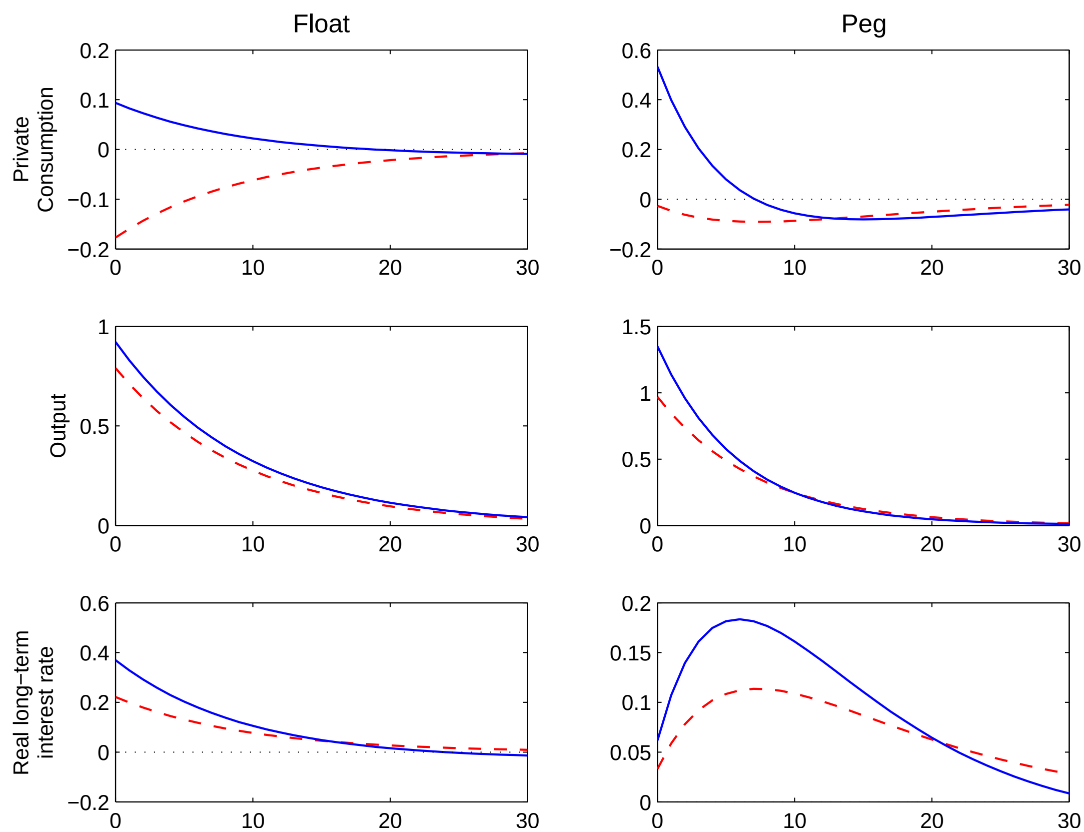


Figure 6: Effect of government spending shock under unrestricted and restricted financial markets. Notes: solid and dashed lines display responses assuming restricted (only bonds traded at international level and $\lambda = 1/3$) and unrestricted (complete financial markets), respectively; output and consumption are measured in percent of steady state output, long term interest rates are measured in percentage deviations from steady state. Horizontal axes indicate quarters.

## 9 Conclusions

Does a fixed exchange rate regime enhance the ability of fiscal policies to determine economic activity? Can small countries in the euro area expect more from fiscal stabilization than countries outside the area? Decades of practice in economic policy have already qualified the affirmative answers that textbook treatments of the Mundell-Fleming model provide to these questions. In this paper we have explored theoretical reasons for reframing the conventional wisdom in a still richer way.

Building on Corsetti et al. (2009), our analysis brings a simple insight to bear on the role of the exchange rate regime for fiscal policy transmission: the effectiveness of fiscal stimulus depends on the medium-term policy framework, that is on both monetary and fiscal policies over the medium term. In particular, the short-run effect of fiscal measures does not only depend on the exchange rate regime and the monetary strategy more generally, but hinges also on the future fiscal mix. In other words, according to conventional wisdom, one cannot assess fiscal stimulus independently of the exchange rate regime. In our generalization, the same should be said for medium-term fiscal regime. As a result of fiscal and monetary interactions, the textbook rendition of the conventional wisdom can therefore not be taken at face value. To the extent that budget adjustments are implemented through spending cuts in addition to tax hikes (the case stressed by Corsetti et al. 2009), the anticipation of future retrenchment of government spending tends to magnify the output effects of fiscal expansions under flexible exchange rates, but has limited or no effects under a peg (as shown in this paper). These results raise a number of analytical, empirical and policy issues, which, properly addressed, should help define the preconditions for successful fiscal stabilization.

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# A Equilibrium conditions of linearized model

In the following we outline the linearization of the model and state the equilibrium conditions used in the simulations. Small letters denote percentage deviations from steady state values, 'hats' denote deviations from steady state values scaled by steady-state output. Throughout we assume that variables in the rest of the world are constant. We consider the model which allows for a fraction of households without access to asset markets (see section 8.2) which nests the model with full asset market participation for $\lambda = 0$.

## A.1 Definitions and derivations

**Price indices** The law of one price, the terms of trade, the consumption price index, and, hence CPI inflation can be written as

$$\begin{aligned} p_{F,t} &= p_t^* - e_t && \text{(A.1)} \\ s_t &= p_{H,t} - p_{F,t} && \text{(A.2)} \\ p_t &= (1-\omega)p_{H,t} + \omega p_{F,t} = p_{H,t} - \omega s_t && \text{(A.3)} \\ \pi_t &= \pi_{H,t} - \omega \Delta s_t && \text{(A.4)} \\ q_t &= (1-\omega)s_t, && \text{(A.5)} \end{aligned}$$

where $q_t$ measures the real exchange rate.

**Intermediate good firms** The production function of intermediate goods is given by $Y_t(j) = H_t(j)$. Using (3.15) in (3.14) gives the demand function for a generic good $j$

$$Y_t(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon} Y_t, \tag{A.6}$$

So that

$$\int_0^1 Y_t(j)dj = \zeta_t Y_t, \tag{A.7}$$

where $\zeta_t = \int_0^1 \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon} dj$ measures price dispersion. Aggregating gives

$$\zeta_t Y_t = \int_0^1 H(j)_t dj = H_t. \tag{A.8}$$

A first order approximation is given by $y_t = h_t$.

The first order condition to the price setting problem is given by

$$E_t \sum_{k=0}^{\infty} \xi^k \rho_{t,t+k} \left[ Y_{t,t+k}(j) P_{H,t}(j) - \frac{\epsilon}{\epsilon - 1} W_{t+k} H_{t+k} \right] = 0 \tag{A.9}$$

In steady state, we have a symmetric equilibrium:

$$P_H = \frac{\epsilon}{\epsilon - 1}\frac{WH}{Y} = \frac{\epsilon}{\epsilon - 1}MC^n, \tag{A.10}$$

where the second equation defines nominal marginal costs.

Linearizing (A.9) and using the definition of price indices, one obtains a variant of the new-Keynesian Phillips curve (see, e.g., Galí and Monacelli 2005):

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa mc_t^r, \tag{A.11}$$

where $\kappa = (1-\xi)(1-\beta\xi)/\xi$ and marginal costs are defined in real terms, deflated with the domestic price index

$$mc_t^r = w_t - p_{H,t} = w_t^r - \omega s_t. \tag{A.12}$$

Here $w_t^r = w_t - p_t$ is the real wage (deflated with the CPI).

Profits per capita are defined as follows

$$\Upsilon_t^{pc} = P_{H,t}Y_t - W_t H_t \tag{A.13}$$

Linearized we have (deflate with the CPI)

$$\hat{\Upsilon}_t^{r,pc} = \omega s_t + y_t - \frac{\epsilon - 1}{\epsilon}(w_t^r + h_t). \tag{A.14}$$

**Households** The first order conditions in deviations from steady state are familiar:

$$w_t - p_t = \gamma c_{A,t} + \varphi h_{A,t} \tag{A.15}$$

$$c_{A,t} = E_t c_{A,t+1} - \frac{1}{\gamma}(r_t - E_t \pi_{t+1}) \tag{A.16}$$

Or, in terms of output units (defining $\chi \equiv G/Y$):

$$(1-\chi)w_t^r = \gamma \hat{c}_{A,t} + (1-\chi)\varphi h_{A,t} \tag{A.17}$$

$$\hat{c}_{A,t} = E_t \hat{c}_{A,t+1} - \frac{(1-\chi)}{\gamma}(r_t - E_t \pi_{t+1}) \tag{A.18}$$

The first order conditions for non-asset holders are

$$P_t C_{N,t} = W_t H_{N,t} - T_t \tag{A.19}$$

$$C_{N,t} = \frac{W_t}{P_t} H_{N,t} - T_t^R \tag{A.20}$$

First order approx:

$$Y\hat{c}_{N,t} = \frac{WH}{P}(w_t^r + h_{N,t}) - Y\hat{t}_t^r \tag{A.21}$$

Or, after rearranging

$$\hat{c}_{N,t} = \frac{\epsilon - 1}{\epsilon}(w_t^r + h_{N,t}) - \hat{t}_t^r. \tag{A.22}$$

The first order condition for labor supply is given by

$$(1-\chi)w_t^r = \gamma \hat{c}_{N,t} + (1-\chi)\varphi h_{N,t}. \tag{A.23}$$

Regarding international financial market, we consider as baseline scenario a complete set of assets. In this case, consumption is tightly linked to the real exchange rate (see, e.g., Galí and Monacelli 2005)

$$\gamma c_{A,t} = -q_t. \tag{A.24}$$

Alternatively, we assume that there is trade in nominally risk-less bonds only. In this case, we have to keep track of the net foreign asset position, using the flow budget constraint of asset holders

$$R_t^{-1}A_{t+1} + R_{F,t}^{-1}B_{t+1}^*/\mathsf{E}_t + P_tC_{A,t} = A_t + B_t^*/\mathsf{E}_t + W_tH_{A,t} - T_t + \Upsilon_t. \tag{A.25}$$

Recall that $D_t = (1-\lambda)A_t$, i.e. government debt is held by domestic asset holders, and that profits go to asset holders only: $(1-\lambda)\Psi_t = \Psi_t^{pc}$. Linearization around zero debt steady state gives

$$\beta\hat{d}_{t+1}^r/(1-\lambda) + \beta\hat{b}_{t+1}^r + \hat{c}_{A,t} = \hat{d}_t^r/(1-\lambda) + \hat{b}_t^r + \frac{\epsilon-1}{\epsilon}(w_t + h_{A,t}) - \hat{t}_t^r + \hat{\Upsilon}_t^{r,pc}/(1-\lambda), \tag{A.26}$$

UIP would imply: $r_t - r_{F,t} = -\Delta E_t e_{t+1}$; yet recall that interest rates on foreign currency bonds (assuming constant world interest rates) are given by $r_{F,t} = -\alpha\frac{B_{t+1}}{\beta Y \mathcal{E}_t P_t}$ such that

$$r_t + \alpha\beta\hat{b}_{t+1}^r = -\Delta E_t e_{t+1}. \tag{A.27}$$

**Government** Rewriting the interest rate feedback rule in terms of deviations from steady state (with zero inflation), we have under a float

$$r_t = \phi\pi_{H,t}, \tag{A.28}$$

recall that $r_t = (R_t - R)/R$. Rewriting the fiscal rules gives

$$\begin{aligned} \frac{G_t - G}{Y} &= \rho\frac{G_{t-1} - G}{Y} - \psi_G\frac{D_t}{YP_{t-1}} + \varepsilon_{g,t} \\ T_{r,t} &= \phi_T\frac{D_t}{P_{t-1}}, \end{aligned}$$

or

$$\hat{g}_t = \rho\hat{g}_{t-1} - \psi_G\hat{d}_t^r + \varepsilon_t \tag{A.29}$$

$$\hat{t}_t^r = \psi_T\hat{d}_t^r \tag{A.30}$$

Finally, the government budget constraint is given by

$$\beta\hat{d}_{t+1}^r = \hat{d}_t^r + \chi\omega s_t + \hat{g}_t - \hat{t}_t^r. \tag{A.31}$$

**Equilibrium and additional definitions** Good market clearing (3.15) in terms of deviations from steady state is given by

$$y_t = -\sigma(1-\omega)\omega(1-\chi)s_t + (1-\omega)\hat{c}_t - \omega\sigma(1-\chi)s_t + \omega\hat{c}_t^* + \hat{g}_t. \tag{A.32}$$

Rearranging under the assumption that ROW variables are constant:

$$y_t = -(2-\omega)\sigma\omega(1-\chi)s_t + (1-\omega)\hat{c}_t + \hat{g}_t. \tag{A.33}$$

Define trade balance in percent of steady state output:

$$TB_t = \frac{P_{H,t}Y_t - P_tC_t - P_{H,t}G_t}{P_{H,t}Y} = \frac{Y_t - C_t\frac{P_t}{P_{H,t}} - G_t}{Y}. \tag{A.34}$$

Approximatively, in around steady state we have:

$$\widehat{tb}_t = y_t - \hat{c}_t + (1-\chi)\omega s_t - \hat{g}_t. \tag{A.35}$$

## A.2 Equilibrium conditions used in model simulation

Optimality of household behavior implies

$$\begin{aligned}
\gamma\hat{c}_{A,t} &= \gamma E_t\hat{c}_{A,t+1} - (1-\chi)(r_t - E_t\pi_{t+1}) && \text{(L.1)}\\
\hat{c}_{N,t} &= \frac{(\epsilon-1)}{\epsilon}(w_t^r + h_{N,t}) - \hat{t}_t^r && \text{(L.2)}\\
\hat{c}_t &= \lambda\hat{c}_{N,t} + (1-\lambda)\hat{c}_{A,t} && \text{(L.3)}\\
(1-g_y)w_t^r &= \gamma\hat{c}_{A,t} + (1-\chi)\varphi h_{A,t} && \text{(L.4)}\\
(1-g_y)w_t^r &= \gamma\hat{c}_{N,t} + (1-\chi)\varphi h_{N,t} && \text{(L.5)}\\
h_t &= \lambda h_{N,t} + (1-\lambda)h_{A,t} && \text{(L.6)}
\end{aligned}$$

Asset market structures differ across simulations. First, incomplete financial markets: we need the budget constraint of asset-holders (A.26) and the UIP condition (A.27)

$$\begin{aligned}
\beta\hat{d}_{t+1}^r/(1-\lambda) + \beta\hat{b}_{t+1}^r + \hat{c}_{A,t} &= \hat{d}_t^r/(1-\lambda) + \hat{b}_t^r + \frac{\epsilon-1}{\epsilon}(w_t^r + h_{A,t}) - \hat{t}_t^r + \frac{\hat{\Psi}_t^{r,pc}}{1-\lambda} && \text{(L.7)}\\
r_t + \alpha\beta\hat{b}_{t+1}^r &= -\Delta E_t e_{t+1}. && \text{(L.8)}
\end{aligned}$$

Instead, under complete markets we use the risk-sharing condition (A.24) and zero foreign bonds holdings

$$\begin{aligned}
\gamma\hat{c}_{A,t} &= -(1-\chi)q_t && \text{(L.7')}\\
\hat{b}_{t+1} &= 0. && \text{(L.8')}
\end{aligned}$$

Intermediate good firms' behavior is governed by marginal costs (A.12), the Philips curve (A.11) and the production function:

$$mc_t^r = w_t^r - \omega s_t + \tag{L.9}$$

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa mc_t^r \tag{L.10}$$

$$y_t = h_t \tag{L.11}$$

Government policies (A.28), (A.29), (A.30), government budget constraint (A.31) and market clearing (A.33) are given by:

$$r_t = \phi \pi_{H,t} \text{ or } \Delta e_t = 0 \tag{L.12}$$

$$\hat{t}_t^r = \psi_T \hat{d}_t^r \tag{L.13}$$

$$\hat{g}_t = \rho \hat{g}_{t-1} - \psi_G \hat{d}_t^r + \varepsilon_t \tag{L.14}$$

$$\beta \hat{d}_{t+1}^r = \hat{d}_t^r + \chi \omega s_t + \hat{g}_t - \hat{t}_t^r \tag{L.15}$$

$$y_t = -(1-\chi)(2-\omega)\sigma\omega s_t + (1-\omega)\hat{c}_t + \hat{g}_t. \tag{L.16}$$

Definitions for the trade balance, relative prices, inflation and profits are given by:

$$tb_t = y_t - \hat{c}_t + (1-\chi)\omega s_t - \hat{g}_t \tag{L.17}$$

$$\pi_t = \pi_{H,t} - \omega \Delta s_t \tag{L.18}$$

$$\Delta e_t = (1-\omega)\Delta s_t - \pi_t \tag{L.19}$$

$$q_t = (1-\omega)s_t \tag{L.20}$$

$$\hat{\Psi}_t^{pc,r} = \omega s_t + y_t - \frac{\epsilon - 1}{\epsilon}(w_t^r + h_t). \tag{L.21}$$

# B Key equations of simple model

In the following we reduce the number of equations which characterize the equilibrium in order to obtain the canonical representation which is used in section 3. We only consider the case $\lambda = 0$.

## B.1 Dynamic IS

Combining good market clearing and risk sharing condition $\gamma c_t = -(1-\omega)s_t$ gives

$$y_t = -\frac{1-\chi}{\gamma}\underbrace{(1+\omega(2-\omega)(\sigma\gamma-1))}_{\equiv\varpi}s_t + \hat{g}_t$$

Hence, we have

$$s_t = -\frac{\gamma}{(1-\chi)\varpi}(y_t - \hat{g}_t), \tag{B.1}$$

which is equation (A.24) in the main text.
Alternatively, we substitute for the terms of trade in order to obtain:

$$c_t = \frac{1-\omega}{\varpi(1-\chi)}(y_t - \hat{g}_t).$$

This is helpful in rewriting the Euler equation

$$\begin{aligned} c_t &= E_t c_{t+1} - \frac{1}{\gamma}(r_t - E_t(\pi_{H,t+1} - \omega\Delta s_{t+1})) & \text{(B.2)} \\ &= E_t c_{t+1} - \frac{1}{\gamma}(r_t - E_t\pi_{H,t+1} - \frac{\omega\gamma}{(1-\chi)\varpi}E_t(\Delta y_{t+1} - \Delta\hat{g}_{t+1}), & \text{(B.3)} \end{aligned}$$

where we use $\pi_t = \pi_{H,t} - \omega\Delta s_t$ in the first equation.
Substituting for consumption gives

$$y_t = E_t y_{t+1} - E_t\Delta\hat{g}_{t+1} - \frac{(1-\chi)\varpi}{\gamma}(r_t - E_t\pi_{H,t+1}),$$

which is (4.1) in the main text.

## B.2 Phillips curve

Consider once more marginal costs

$$\begin{aligned} mc_t^r &= w_t^r - \omega s_t = -s_t + \varphi y_t \\ &= \frac{\gamma}{(1-\chi)\varpi}(y_t - \hat{g}_t) + \varphi y_t \end{aligned}$$

Substituting in (A.11) gives (4.2) in the main text.

# C Long-term interest rates under floating exchange rates

Here we focus on the response of long-term real interest rates in case of exogenous government spending. Under a float the allocation is characterized by (4.1), (4.2) and the Taylor rule (4.3). Assuming $\psi_G = 0$, we solve the model using method of undetermined coefficients. Assuming that $y_t = \phi_{yg}\hat{g}_t$ and $\pi_{H,t} = \phi_{\pi g}\hat{g}_t$ and substituting in (4.1) gives

$$\hat{\sigma}(1-\rho)\phi_{yg} = -(\phi_\pi - \rho)\phi_{\pi g} + \hat{\sigma}(1-\rho),$$

where $\hat{\sigma} \equiv \gamma/((1-\chi)\varpi)$. This will be positive if $\varpi > 0$, which in turn requires $1 > \omega(2-\omega)(1-\sigma\gamma)$ (which we assume to be satisfied).

Substituting in (4.2) gives

$$\phi_{yg} = \frac{(1-\beta\rho)\phi_{\pi g} + \kappa\hat{\sigma}}{\kappa(\hat{\sigma}+\varphi)}.$$

Combining the two expressions yields the result

$$\phi_{\pi g} = \frac{\hat{\sigma}(1-\rho)\varphi\kappa}{\hat{\sigma}(1-\rho)(1-\beta\rho) + \kappa(\varphi+\hat{\sigma})(\phi_\pi - \rho)} > 0,$$

as long as $\rho < 1$ and $\phi_\pi > 0$ (which we assume throughout).

As shown in the main text (see (6.1)), an expression long-term real interest rates is given by:

$$\bar{r}_t = E_t \sum_{s=0}^{\infty} (r_{t+s} - \pi_{t+1+s}) = E_t \sum_{s=0}^{\infty} (r_{t+s} - (\pi_{H,t+s+1} - \omega\Delta s_{t+s+1})) \tag{C.1}$$

where the second equality follows from (B.2).

Given the solution of the model we have

$$\begin{aligned} E_t r_{t+s} &= \phi_\pi \phi_{\pi g}\rho^s \hat{g}_t \\ E_t \pi_{H,t+s+1} &= \phi_{\pi g}\rho^{s+1}\hat{g}_t \\ E_t \Delta s_{t+s+1} &= \hat{\sigma}(1-\phi_{yg})(\rho-1))\rho^s \hat{g}_t, \end{aligned}$$

where the last relationship follows from (B.1). Substituting in (C.1) gives (after some algebra)

$$\bar{r}_t = \underbrace{\frac{(1-\omega)(\phi_\pi-\rho)\phi_{\pi g}}{1-\rho}}_{>0}\hat{g}_t, \tag{C.2}$$

i.e. long-term rates always increase in response to government spending innovations under a float (as long as $\psi_G = 0$).

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