Foreign currency denominated indebtedness and the fiscal multiplier*

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Abstract

This paper aims at explaining why the public spending multiplier is generally low, even close to zero, in emerging economies (EMEs). We claim that this can be related to the foreign currency denominated debt borne by private agents. Indeed, according to a recent literature, the real exchange rate can depreciate following an increase in public spending. In this case, the debt burden denominated in foreign currency increases. Thus, the domestic firms' balance sheet structure deteriorates, which raises their external finance premium and pushes private investment down. Finally, this may offset the stimulating impact of the initial public spending shock. In this paper, we first show that this explanation is empirically valid: the impulse response functions from a PCH-VAR indicate that the the higher the share of the external debt denominated in foreign currency, the lower the public spending multiplier. Then, we demonstrate that such an explanation and its underlying mechanisms are theoretically valid in a two-country DSGE model with incomplete and imperfect international financial markets, sticky prices, financial frictions and external indebtedness.

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1 Introduction

Empirical evidences indicate that fiscal multipliers are significantly smaller in Emerging Market Economies (EMEs), where they are usually found close to zero, than in Advanced Economies (AEs), where they are often found larger than one.[1]

Generally speaking, the literature shows that fiscal multipliers are larger when public debt is low (Cimadomo et al., 2010; Ilzetzki et al., 2013; Nickel and Tudyka, 2014), under fixed exchange rate regimes (Born et al., 2013; Corsetti et al., 2012a), during business cycle downturns (Baum et al., 2012; Corsetti et al., 2012a) and when interest rates are relatively low (Woodford, 2011; Christiano et al., 2011; Nakamura and Steinsson, 2014; Giambattista and Pennings, 2017). The degree of development is also considered as a determinant per se, albeit without explaining why fiscal multipliers are so small in EMEs. Actually, none of the aforementioned determinants can explain this result. For example, emerging countries often experiment lower public debt-to-GDP ratio than AEs[2] that should lead to larger multiplier effects.

The low fiscal multiplier in EMEs may be due to some particularities such as a less flexible supply-side and an inefficient management of public spending. However, we argue that another feature may be relevant to explain the difference between fiscal multipliers in EMEs and AEs: especially, this article focuses on the currency denomination of external debt. As shown in Figure 1, the share of foreign currency denominated external debt in EMEs is about three times higher than in AEs.[3] Combined with the reaction of the exchange rate following a public spending stimulus, this large difference may be a source of diverging multiplier effects.

Contrary to the textbook Mundell-Fleming-Dornbush model, many recent papers show that the domestic currency depreciates following a domestic increase in public spending[4]. By this way, a fiscal stimulus leads to an increase in the real value of private domestic debt denominated in foreign currency, and to a worsening of the balance sheets of private agents who consequently bear higher external financial premium. In turn, this pushes private investment down. Hence, because of currency mismatch and related balance sheet effects,

[1] See for example Chian Koh (2017); Hory (2016); Ilzetzki et al. (2013).

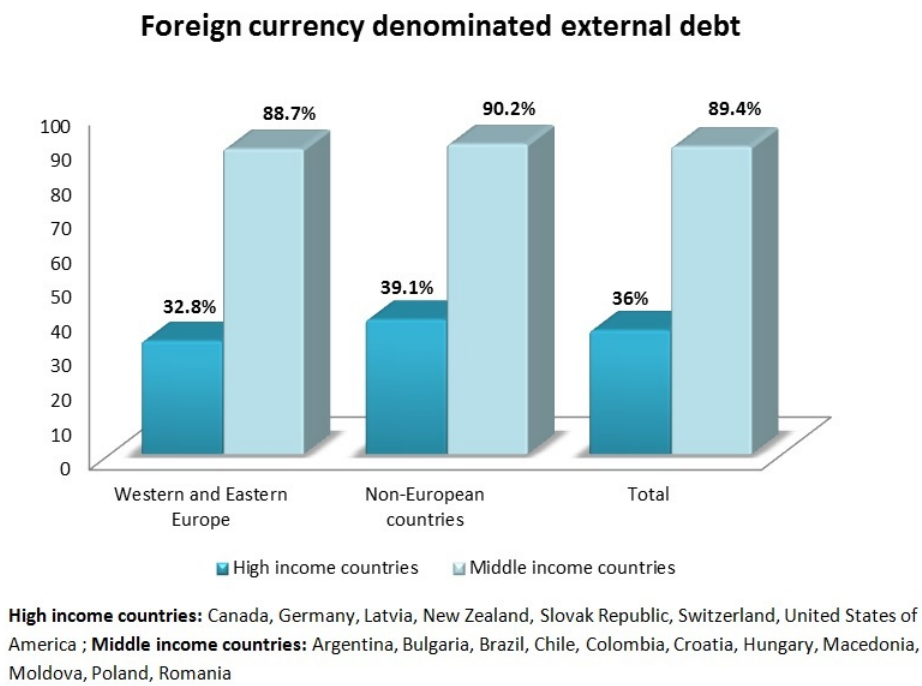
[2] Considering a panel of 41 countries from Europe and Central Asia between 2000 and 2013, the average debt-to-GDP ratio is 54% for high income countries, against 34% for middle income countries (Source: Historical Public Debt Database, International Monetary Funds).

[3] Due to a lack of financial accounts data at the national level in many EMEs, analyses on currency mismatch are scarce. For a recent assessment on risks related to - actually increasing - cross-border lending, see Chui et al. (2014), Avdjiev and Takats (2016) and Chow (2015), as well as Catão and Milesi-Ferretti (2014) for an investigation in terms of crises.

[4] See Kim and Roubini (2008); Betts and Devereux (2000); Ravn et al. (2007); Kollmann (2010); Corsetti et al. (2012a); Bouakez and Eyquem (2015).

depreciation may be contractionary (Céspedes et al., 2004),[5]. This may ultimately offset the stimulating impact of the initial public spending shock.

Figure 1: Share of foreign currency denominated external debt



Based on these intuitive mechanisms, our contribution is twofold. First, we provide an empirical evidence, based on a Panel Conditionally Homogeneous VAR (Georgiadis, 2012), of the negative impact of foreign currency denominated indebtedness on the public spending multiplier. Second, we demonstrate that this explanation is theoretically valid in a two-country Dynamic Stochastic General Equilibrium (DSGE) model with incomplete and imperfect international financial markets, sticky prices, external indebtedness and financial frictions. The latter are due to asymmetric information. In a Costly State Verification framework à la Townsend, firms have to bear an external financial premium that increases with their debt-to-wealth ratio. At the macroeconomic level, this gives rise to a financial accelerator mechanism à la Bernanke et al. (1999). Importantly, in our model, *a part* of domestic firms' debt is denominated in foreign currency, contrary to net wealth, which is denominated in domestic currency. Thus, any shock that makes local currency depreciate may in turn deteriorate the firms' balance sheet, increase their external financial premium, and decrease the aggregate investment. We precisely show that such an adverse scenario can result from a

[5]This is a reason why many central banks are reluctant to allow their currencies to devalue in response to external shocks. See for instance Hausmann et al. (2001) and Calvo and Reinhart (2002).

public spending stimulus, as this can lead to an exchange rate depreciation. This depreciation is due to the interest rate differential between the two countries, in a situation of imperfect financial markets, as in Bouakez and Eyquem (2015). We show that in such a context, the higher the share of foreign currency denominated debt, the lower the fiscal multiplier.

To the best of our knowledge, this is the first contribution that explains varying levels of fiscal multipliers by combining currency mismatch and exchange rate reactions to fiscal stimulus. In doing so, our analysis meets two strands of the literature.

On the one hand, this paper deals with the reaction of the exchange rate to a public spending shock. Several empirical studies find that the real exchange rate depreciates in response to an increase in public spending (see for example Kim and Roubini, 2008; Enders et al., 2011; Kim, 2015), contrary to the traditional Mundell-Fleming-Dornbush predictions. Some recent theoretical papers support this view. However, in these models, the assumptions underlying the characteristics and behaviors of public and private agents[6], as well as the hypothesis regarding the state of public finances[7], may also have direct effects on the fiscal multiplier (see for example Combes and Mustea, 2014). As a consequence, it may be difficult to clearly identify the effect of firms' indebtedness if several assumptions and transmission channels are jointly considered. That is why our model is closer to the theoretical framework of Bouakez and Eyquem (2015), which is more neutral in this respect. In this model with imperfect financial markets, a public spending stimulus causes a depreciation of the real exchange rate when the long term real interest rate increases less than the country premium. This depends in particular on external debt and on the stance of monetary policy. These two features are subject to an in-depth sensitivity analysis in our contribution. Last, we go further by introducing a financial accelerator mechanism in the domestic economy, where firms are (more or less) indebted in foreign currency.

On the other hand, by investigating the global effects of a currency depreciation through the deterioration of firms' balance sheet, our paper can be related to the so-called "third generation models of currency crisis" (Aghion et al., 2001, 2004; Christiano et al., 2004). Basically, this literature demonstrates how the global real effects of a currency depreciation

[6] Ravn et al. (2012) assume that the preferences of households and the government are characterized by deep habits; it is thus optimal for imperfectly competitive producers to lower markups and prices in the short run, in order to lock in higher demand for the future. Finally, the price of domestic consumption decreases relative to foreign consumption prices, i.e. the real exchange rate depreciates. See also Kollmann (2010) for a mechanism relying on supply-side effects.

[7] From a public debt consolidation view, Corsetti et al. (2012b) suggest that high public spending today induces expectations of future spending restraint. Thus, long-term real interest rates do not rise in response to a fiscal stimulus and the real exchange rate depreciates. Bonam and Lukkezen (2014) stress that foreign investors reduce their holding of government bonds when public debt is high and the sovereign risk is high. This makes the exchange rate depreciate. However, this argument is not relevant in our context as, as already mentioned, the public debt in usually lower in EMEs than in AEs.

are amplified, through lower profits and higher foreign currency debt burden. As a rule, countries that are most likely to go into a crisis are those in which firms held a lot of foreign currency denominated debt. Nonetheless, our contribution somewhat differs from these models in several respects. First, we only focus on the effects of fiscal shocks. Second, the mechanism that we focus on does not rely on public debt, but on private sector debt. Third, we consider the deterioration of balance sheets of private domestic firms not as a cause but as a consequence of the currency depreciation. Last, we are not interested in currency crisis.[8]

By this way, our model is close to the recent two-country DSGE models with nominal rigidities and financial frictions. However, in most of them, either firms' debt is denominated in local currency only, as in Gertler et al. (2007), or they are entirely indebted in foreign currency, such as in Sangaré (2016). Batini et al. (2007) is, to our best knowledge, the only contribution to assume that domestic firms can borrow in both home and foreign currencies. Nonetheless, this paper does not focus on the amplitude of the fiscal multiplier.

Thus, by mixing the main features and results of these two broad strands of the literature, we provide an original explanation of the amplitude of fiscal multiplier effects, based on the reaction of the exchange rate to a public spending shock and on the proportion of private debt denominated in foreign currency.

The rest of the paper is organized as follows. Section 2 presents an empirical evidence of the negative impact of foreign currency denominated external debt on the multiplier. Sections 3, 4 and 5 respectively show the theoretical model, the calibration used and the results we obtain. Section 6 discusses alternative calibrations of the model. Finally Section 7 concludes.

2 Empirical evidence

In the literature, the impact of some determinants of the fiscal multiplier has been estimated, as for example the degree of openness or the level of public debt but, to the best of our knowledge, nothing is said about the importance of the currency denomination of private debt. This section therefore presents estimates of the impact of foreign currency denominated debt on the fiscal multiplier.

2.1 Empirical Specification

How does foreign currency denomination of indebtedness affect the impact of public spending on GDP? To address this question, fiscal multipliers have to be estimated conditionally

[8] As a consequence, we deal with a unique equilibrium, as in Céspedes et al. (2004), Christiano et al. (2004), Gertler et al. (2007).

to the currency denomination of debt. Nevertheless, this involves some technical difficulties.

First, some assumptions are necessary to identify exogenous shocks in public spending since measuring the impact of public spending on GDP leads to reverse causality issues.

Following Blanchard and Perotti (2002), we assume that the economic context can contemporaneously respond to government spending, but government spending are not contemporaneously affected by the economic context. Especially, it is assumed that a government takes at least one quarter to change its fiscal policy regarding economic context variations. This assumption reflects, among others, the decision and implementation lags of fiscal policy. Therefore, we use a Panel Vector Autoregressive (PVAR) model with a Cholesky decomposition that allows to generate Orthogonalized Impulse Response Functions (OIRF), meaning that the shocks generated are identified.

Second, estimates have to be conditional to the currency denomination of indebtedness. Georgiadis (2012) provides a method which allows to estimate a dynamic, within a VAR, that can vary according to the level of a conditional variable. Using his Panel Conditionally Homogeneous VAR (PCH-VAR), the dynamic between public spending and GDP can be estimated conditionally to the currency denomination of external debt.

The following equation is estimated:[9]

$$X_{n,t} = \Sigma_{s=1}^{p} A_i(z_{n,t}) X_{n,t-s} + C_n + \varepsilon_{n,t} \tag{1}$$

with:

- $X_{n,t} = [G_{n,t}; Y_{n,t}]$, where G is the quarterly growth rate of public consumption, and Y is the quarterly growth rate of GDP;
- $z_{n,t}$ is a vector containing the conditioning variable: the share of external debt denominated in foreign currency;
- $C_{n,t}$ is a vector of country fixed effects;
- $\varepsilon_{n,t}$ is a vector of reduced form residuals with $var(\varepsilon_{n,t}) = \hat{\sigma}$.

2.2 Data

Data about currency denomination of private debt are not broadly available. This constrains to use data on currency denomination of total external debt, including both private

[9]See Georgiadis (2012) for detailed explanations about the methodology, and Hory (2016) for an application of the PCH-VAR to the estimation of the fiscal multiplier.

and public debt; this is the first limitation of our estimates. Moreover, it is well known that data on the currency denomination of debt at the country-level are really scarce, as explained in Chui et al. (2014). A sample limited to 13 countries[10] is considered, including both emerging and advanced economies, over the period 2005Q1-2013Q4, implying a total of 473 observations.

Public consumption and GDP are taken from Eurostat, CEPALstat and the Asian Bank of Development. The share of external debt denominated in foreign currency comes from the Quarterly External Debt Statistics database from the World Bank.

Public consumption and GDP are corrected for seasonality by using an X-11 process. They are introduced in growth rate in the regression because the series are non-stationary (the results of unit root tests are shown in Appendix, Table 2).

2.3 Empirical Results

Our results are presented in Figure 2 which shows the response of GDP to a one unit shock in public spending according to the share of external debt denominated in foreign currency.[11] The higher the share of external debt denominated in foreign currency is, the smaller the response of GDP to a public spending shock is. This result confirms that the currency denomination of external debt modifies the impact of public spending on GDP.

Generally, to measure the efficiency of fiscal policy, the fiscal multiplier is computed, that is the ratio of a change in output (ΔY) to a change in public spending (ΔG) (Spilimbergo et al., 2009). Here, the multiplier cannot be directly read on the IRF because the IRF in Figure 2 shows the response of the GDP growth rate to a change in public spending growth rate, that is not the proper definition of the fiscal multiplier.

Hence, the fiscal multiplier at time t is computed as follows:[12]

$$\Lambda_t = \frac{\Delta Y_t}{\Delta G_t} = \frac{y_T}{g_T} irf_t \tag{2}$$

Where $\frac{y_T}{g_T}$ is the average ratio of public spending to GDP, and irf_t is the coefficient read on the IRF.

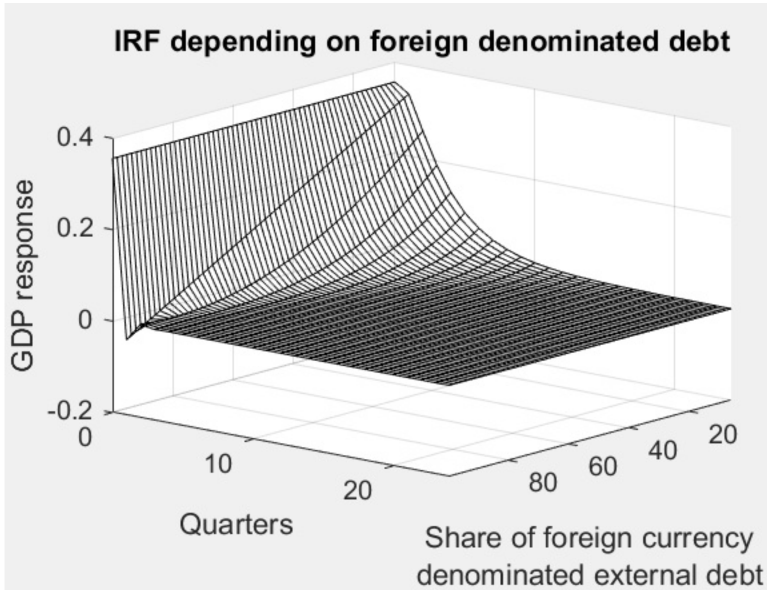
When the share of external debt denominated in foreign currency is less than 10%, the average fiscal multiplier is 1.6. However, it decreases when external debt increases. For share of external debt in foreign currency exceeding 90%, the average fiscal multiplier is about 0.

[10] Argentina, Bulgaria, Croatia, Germany, Hungary, Korea, Peru, Philippines, Slovak Republic, Sweden, Switzerland, Turkey, and Uruguay.

[11] The optimal lag-length is selected by minimizing the AIC criteria, which leads to introduce 1 lag, see Appendix, Table 3.

[12] See Hory (2016) for a demonstration.

Figure 2: GDP response to a one unit shock in public spending according to the share of external debt that is denominated in foreign currency



Moreover, the fiscal multiplier becomes zero at the first period for countries highly indebted in foreign currency, rather than it remains positive during more than 10 periods for countries mainly indebted in local currency.

This result shows that the currency denomination of external debt is an important determinant of public spending efficiency since it affects the value of the fiscal multiplier. Especially, a large share of external debt denominated in foreign currency reduces the fiscal multiplier.

As no formalization has been found in the existing literature, the next Section of the paper develops a theoretical framework which allows the impact of public spending to vary according to the currency denomination of external debt.

3 The model

In this section, we develop a DSGE model capable to reproduce the stylized facts found in the previous section. The theoretical mechanism that we want to underline relies on foreign currency denominated debt and exchange rate movements in response to a fiscal stimulus. We will show that a quite standard two-country DSGE model is able to reproduce the empirical facts of Section 2, without imposing strong assumptions, complex mechanisms, or unconventional behaviors. This will allow preserving clarity and parsimony, making the identification of the crucial mechanisms easier.[13]

We consider two countries of equal size: the Home economy (H), and the Foreign one (F). Both are populated by a continuum of identical households whose size is normalized to one. These households consume a composite good (C_t) including home ($C_{H,t}$) and foreign goods ($C_{F,t}$), and they also can buy home and foreign bonds ($B_{H,t}$ and $B_{F,t}$). In each bloc, there are two types of firms: the wholesalers and the retailers. The wholesale firms buy retail goods and turn them into capital, and they use capital to produce an homogeneous wholesale good. The crucial assumption is that home producers can borrow, both in local and foreign currencies, by paying an external finance premium, as in Bernanke et al. (1999). This premium affects firms' solvency, thus modifying investment decisions and, in this way, producing economic fluctuations. The retail sector is monopolistically competitive: retail firms purchase the wholesale goods, they differentiate them without any cost and then sell the retail goods to the households.

On the other side, in order to make the exposition as simple as possible, we assume that foreign wholesalers borrow only in foreign currency, and they do not have to pay any financial premium.

The other sectors of each economy are quite standard. Each country is populated by identical households, by a government following a balanced budget rule and by a central bank adjusting the nominal interest rate in response to inflation and output gaps. In what follows we present the equation describing the behavior of the home country sectors in details. Those of the foreign economy correspond to the standard equation of the basic DSGE model with price rigidities. The linearized version of the foreign economy is provided in Appendix 7.0.1.

3.1 Households

We consider an infinite horizon discrete time economy populated by a constant mass of agents whose size is normalized to one in each country. The representative household in the home country is characterized by the following preferences:

$$E_t \sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \tag{3}$$

[13]For instance, it would have been possible to add public debt or non-Ricardian behaviours, as in Galí et al. (2007). However, this would render the main effects more complex to identify, without analytical benefits regarding the aim of the paper.

Where E_t indicates the expectation operator at time t, $\beta \in (0,1)$ is the discount factor, C_t is the per capita consumption index, and L_t is the number of worked hours.

We assume that the utility function takes the following form:

$$U(C_t, L_t) = \frac{C_t^{1-\sigma_c}}{1-\sigma_c} - \frac{L_t^{1+\sigma_l}}{1+\sigma_l} \tag{4}$$

where $\sigma_c > 0$ is the inverse of the inter-temporal elasticity of substitution of consumption, and $\sigma_l > 0$ is the inter-temporal elasticity of substitution of labor. For sake of simplicity and in order to put in evidence the essential mechanisms, we assume that foreign households are characterized by the same preferences.

The home household faces the following budget constraint:

$$P_tC_t + B_{H,t} + S_tB_{F,t} + T_t = P_tW_tL_t + R_{n,t-1}B_{H,t-1} + \phi_{t-1}(d_{t-1})S_tR^*_{n,t-1}B_{F,t-1} + \Gamma_t \tag{5}$$

where W_t is the real wage rate, Γ_t represents the dividends received for the ownership of firms, S_t is the nominal exchange rate expressed as domestic currency units needed to have one unit of foreign currency, $B_{H,t}$ and $B_{F,t}$ are risk-free one-period nominal bonds from the home and the foreign countries, T_t is a lump-sum tax levied on households, P_t is the Consumer Price Index (CPI), $R_{n,t} = 1 + r_{n,t}$ and $R^*_{n,t} = 1 + r^*_{n,t}$ with $r_{n,t}$ and $r^*_{n,t}$ the domestic and foreign nominal interest rates.

The factor ϕ_t is a country premium received by the household who buys foreign bonds. It is an increasing function of the aggregate level of foreign debt d_t and it is defined as follows:

$$\phi_t(d_t) = exp\left(-\phi_d \frac{S_tB_{F,t}}{YP_t}\right) \tag{6}$$

where $d_t = \frac{S_tB_{F,t}}{YP_t}$ with $B_{F,t}$ being the total debt of country F, $\phi_d > 0$ is the country premium elasticity. Finally, it is assumed that $\phi'(.) < 0$, namely the country premium increases with the aggregate level of foreign debt $-B_{F,t}$ and at the steady state, when the net foreign asset position is zero, $\phi(0) = 1$.

The presence of a country premium, as specified by equation (6), ensures the stationarity of the model (Schmitt-Grohé and Uribe, 2003), and reflects frictions in international capital markets, as the price to pay to access them, agency costs or even the possibility of default. For analytical convenience, and without loss of generality, we suppose that home households can hold foreign bonds, but foreign households cannot hold home bonds (Benigno and Thoenissen, 2008).

The representative household chooses C_t, L_t, $B_{H,t}$ and $B_{F,t}$ in order to maximize her utility subject to the budget constraint, leading to the following first order conditions:

1. Consumption and leisure are chosen in order to equalize the marginal rate of substitution between consumption and leisure to the real wage:

$$\frac{L_t^{\sigma_l}}{C_t^{-\sigma_c}} = W_t \tag{7}$$

2. The Euler equation, representing household's taste for consumption smoothing:

$$R_{n,t} = \frac{1}{\beta} E_t \left[\frac{C_t^{-\sigma_c}}{C_{t+1}^{-\sigma_c}} \pi_{t+1} \right] \tag{8}$$

where $\pi_t = P_t / P_{t-1}$ is the inflation factor.

3. The arbitrage equation between national and foreign bonds:

$$E_t \left[\left(R_{n,t} - \phi_t \frac{rer_{t+1}}{rer_t} \frac{\pi_{t+1}}{\pi_{t+1}^*} R_{n,t}^* \right) \right] = 0 \tag{9}$$

where $\pi_{t+1}^* = P_{t+1}^* / P_t^*$ is the foreign inflation factor and $rer_t = \frac{S_t P_t^*}{P_t}$ is the real exchange rate. Finally, the standard transversality conditions must hold.

The per capita index of consumption, C_t, is an aggregate of consumption goods produced in the home country ($C_{H,t}$) and consumption goods produced in the foreign country ($C_{F,t}$). It is defined as follows:

$$C_t = \left[w^{1/\mu} C_{H,t}^{(\mu-1)/\mu} + (1-w)^{1/\mu} C_{F,t}^{(\mu-1)/\mu} \right]^{\mu/(\mu-1)} \tag{10}$$

where $\mu > 0$ is the elasticity of substitution between home and foreign goods, and $w \in (0,1)$ captures the degree of home bias in the home bloc, $(1-w)$ can therefore be viewed as the trade openness degree.

Consumption of final goods produced in each block is defined by:

$$C_{H,t} = \left[\int_0^1 C_{H,t}(v)^{(\zeta-1)/\zeta} dv \right]^{\zeta/(\zeta-1)} \; ; \quad C_{F,t} = \left[\int_0^1 C_{F,t}(v)^{(\zeta-1)/\zeta} dv \right]^{\zeta/(\zeta-1)} \tag{11}$$

where $\zeta > 0$ is the elasticity of substitution between the varieties v produced into each bloc.

The optimal intra-temporal allocations of consumption are:

$$C_{H,t}(v) = \left(\frac{P_{H,t}(v)}{P_{H,t}} \right)^{-\zeta} C_{H,t}; \quad C_{F,t}(v) = \left(\frac{P_{F,t}(v)}{P_{F,t}} \right)^{-\zeta} C_{F,t} \tag{12}$$

$$C_{H,t} = w \left(\frac{P_{H,t}}{P_t} \right)^{-\mu} C_t; \quad C_{F,t} = (1-w) \left(\frac{P_{F,t}}{P_t} \right)^{-\mu} C_t \tag{13}$$

The CPI associated with the consumption index (Equation 10) is given by:

$$P_t = \left[w(P_{H,t})^{1-\mu} + (1-w)(P_{F,t})^{1-\mu}\right]^{1/(1-\mu)} \tag{14}$$

where the price sub-indexes associated with $C_{H,t}$ and $C_{F,t}$ are defined as follows:

$$P_{H,t} = \left[\int_0^1 P_{H,t}(v)^{1-\zeta}dv\right]^{1/(1-\zeta)} ; \quad P_{F,t} = \left[\int_0^1 P_{F,t}(v)^{1-\zeta}dv\right]^{1/(1-\zeta)} \tag{15}$$

The Law of One Price (LOP) applies to differentiated goods, hence:

$$\frac{S_t P^*_{F,t}}{P_{F,t}} = \frac{S_t P^*_{H,t}}{P_{H,t}} = 1, \tag{16}$$

By using this relation combined with equation (14) and the corresponding definition of P^*_t,[14] it is possible to rewrite the real exchange rate at time t as:

$$rer_t = \frac{S_t P^*_t}{P_t} = \frac{\left[w^* + (1-w^*)\tau_t^{\mu^*-1}\right]^{1/(1-\mu^*)}}{\left[1 - w + w\tau_t^{\mu-1}\right]^{1/(1-\mu)}} \tag{17}$$

where $\tau = P_{F,t}/P_{H,t}$ represents the terms of trade (the domestic currency relative price of imports to exports).

Finally, using the household's first order condition (Equation 9), the (modified) Uncovered Interest rate Parity (UIP) condition is obtained:

$$E_t \frac{R_{n,t}}{\pi_{t+1}} = \phi_t E_t \frac{R^*_{n,t}}{\pi^*_{t+1}} \frac{rer_{t+1}}{rer_t} \tag{18}$$

The modified uncovered interest parity differs from the standard UIP because of the presence of the interest rate premium ϕ_t.

3.2 Firms

Both countries are populated by wholesale firms which buy the final good, both from H and from F, to convert it into new capital. Then they use capital to produce the wholesale good which is acquired and differentiated by monopolistically competitive firms, the retailers. The main difference between the productive sectors of the two economies is that home

[14] This last is given by $P^*_t = \left[(1-w^*)(P^*_{H,t})^{1-\mu^*} + w^*(P^*_{F,t})^{1-\mu^*}\right]^{1/(1-\mu^*)}$.

wholesalers borrow in home and foreign currencies to finance their activity and must pay an external financial premium, in the light of the financial accelerator of Bernanke et al. (1999); while foreign firms are not subject to this mechanism and are financed only by households of country F. The next Subsections describe the behavior of home wholesale and retail firms in details.

3.2.1 Wholesale Firms

Home country wholesale firms produce and sell an homogeneous good on a competitive market by using labor and capital. The production technology is characterized by constant returns to scale and is represented by a Cobb-Douglas function where technical progress is exogenous and captured by the factor A_t:

$$Y_t^W = A_t K_t^{\alpha} L_t^{1-\alpha} \tag{19}$$

where Y_t^W is the quantity of wholesale goods produced by the representative firm, K_t is the capital stock at the beginning of the period t, L_t is the labor input, and $0 < \alpha < 1$ measures the capital intensity.

To produce capital, the wholesale firm invests (I_t) by buying the final good sold by home and foreign retailers and uses the existing capital to transform it into new capital (K_t). The firm has also to support an internal adjustment cost of capital which is increasing and convex in I_t/K_t:

$$\Psi(I_t, K_t) = \frac{\Phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t \tag{20}$$

where $\delta \in (0,1)$ is the depreciation rate of capital, Φ is a positive parameter and I_t is a composite investment good from home and foreign retail firms constructed as follows:

$$I_t = \left[w_I^{1/\mu_I} I_{H,t}^{\frac{(\mu_I - 1)}{\mu_I}} + (1 - w_I)^{1/\mu_I} I_{F,t}^{\frac{(\mu_I - 1)}{\mu_I}} \right]^{\frac{\mu_I}{(\mu_I - 1)}} \tag{21}$$

where $w_I \in (0,1)$ measures the home bias of capital producers, and $\mu_I > 0$ the elasticity of substitution between home and foreign retail goods for capital producers. It is assumed that firms and households have the same preferences for home and foreign goods, so that $w = w_I$ and $\mu = \mu_I$. The price of I_t therefore is equal to the CPI:

$$P_t = \left[w(P_{H,t})^{1-\mu} + (1 - w)(P_{F,t})^{1-\mu} \right]^{1/(1-\mu)} \tag{22}$$

The optimal intra-temporal demands for domestic and foreign inputs are:

$$I_{H,t} = w \left(\frac{P_{H,t}}{P_t}\right)^{-\mu} I_t; \quad I_{F,t} = (1-w) \left(\frac{P_{F,t}}{P_t}\right)^{-\mu} I_t \tag{23}$$

Finally, the stock of capital evolves according to the following law:

$$K_{t+1} = I_t + (1-\delta)K_t \tag{24}$$

Wholesale firms choose the level of investment, the quantity of labor and capital that maximize their profits. Let $P^W_{H,t}$ be the price of the wholesale good at home, and $mc_t = \frac{P^W_{H,t}}{P_{H,t}}$ the marginal costs. The profit and the corresponding constraint of a representative wholesale firm can be written as follows:

$$\Pi^W_t = E_t \Sigma^{\infty}_{T=0} \beta^T_W \left[mc_{t+T} \frac{P_{H,t+T}}{P_{t+T}} A_{t+T} K^{\alpha}_{t+T} L^{1-\alpha}_{t+T} - W_{t+T} L_{t+T} - \frac{P_{t+T}}{P_{t+T}} I_{t+T} - \Psi(I_{t+T}, K_{t+T}) \right] \tag{25}$$

$$SC.\ K_{t+T+1} = I_{t+T} + (1-\delta)K_{t+T} \tag{26}$$

By solving this problem we obtain the value of the average real wage in the home economy:

$$W_t = mc_t \frac{P_{H,t}}{P_t}(1-\alpha)\frac{Y_t}{L_t} \tag{27}$$

the real price of capital, q_t:

$$q_t = 1 + \frac{\partial \Psi(I_t, K_t)}{\partial I_t} = 1 + \Phi\left(\frac{I_t}{K_t} - \delta\right) \tag{28}$$

and, finally, the real return on capital over the period t, R^k_t :

$$R^k_t = \left[\frac{\alpha mc_t \frac{P_{H,t}}{P_t}\frac{Y_t}{K_t} - \frac{\Phi}{2}\left[\delta^2 - \left(\frac{I_t}{K_t}\right)^2\right] + (1-\delta)q_t}{q_{t-1}} \right] \tag{29}$$

where $R^k_t = 1 + r^k_t$, with r^k_t the real rate of return of capital.

The first part of (29) is the marginal productivity of capital $\left(mpc_t = \alpha mc_t \frac{P_{H,t}}{P_t}\frac{Y_t}{K_t}\right)$. Equation (29) means that each additional unit of capital yields $\alpha mc_t \frac{P_{H,t}}{P_t}\frac{Y_t}{K_t}$ to the firm, minus the cost due to the adjustment of capital. The equation also takes into account the fact that capital can also be resold at its depreciated value $(1-\delta)q_t$.

Differently from foreign wholesale firms, home wholesalers borrow in local and foreign currency to finance their activity, and, as in Bernanke et al. (1999), they have to support an external finance premium, Θ_t, defined by:

$$\Theta_t = \Theta\left(\frac{q_{t-1}K_t}{N_t}\right) \tag{30}$$

with $\Theta'(.) > 0$, $\Theta(1) = 1$ and $\Theta(\infty) = \infty$; N_t is the net worth of a wholesale firm, which will be defined below.

The representative firm borrows in home currency with proportion κ, and in foreign currency with proportion $(1-\kappa)$, with $\kappa \in [0,1]$. Therefore, home and foreign interest rates are combined to obtain the expected marginal cost of borrowing:

$$\begin{aligned} E_t\left(R^k_{t+1}\right) &= \Theta_{t+1}\left[\kappa E_t\left(\frac{R_{n,t}}{\pi_{t+1}}\right) + (1-\kappa)\,\phi_t(d_t) E_t\left(\frac{R^*_{n,t}}{\pi^*_{t+1}}\frac{rer_{t+1}}{rer_t}\right)\right] \\ &= \Theta_{t+1}\left[\kappa E_t\left(R_t\right) + (1-\kappa)\,\phi_t(d_t) E_t\left(R^*_t \frac{rer_{t+1}}{rer_t}\right)\right] \end{aligned} \tag{31}$$

with R_t and R^*_t being the nominal exchange factors in the home and foreign economies. Equation (31) means that the real return of capital must be equal to the cost to acquire this capital. This cost is determined by the external finance premium, by the home interest rate in proportion κ, and by the foreign interest rate and the real exchange rate in proportion $1-\kappa$.

Wholesalers accumulate net worth according to the following dynamics:

$$N_{t+1} = \xi_e\left[R^k_t q_{t-1}K_t - \Theta_t\left[\kappa\frac{R_{n,t-1}}{\pi_t} + (1-\kappa)\phi_{t-1}\frac{R^*_{n,t-1}}{\pi^*_t}\frac{rer_t}{rer_{t-1}}\right](q_{t-1}K_t - N_t)\right] \tag{32}$$

where $1-\xi_e$ is the probability for a firm to exit the market. The net worth is equal to the real return on capital held by the firm minus the financing cost of the acquired capital.

Equation (32) shows that firms are exposed to exchange rate fluctuations when they are indebted in foreign currency. For small values of κ, a decrease in the RER (an appreciation) inflates the firm's net worth, and an increase in the RER (a depreciation) deflates their net worth.

Entrepreneurs that exit consume their remaining resources:

$$C^e_t = \frac{(1-\xi_e)}{\xi_e}N_t \tag{33}$$

As for households, the optimal consumption of exiting entrepreneurs is:

$$C^e_{H,t} = w\left(\frac{P_{H,t}}{P_t}\right)^{-\mu} C^e_t \ ; \ \ C^e_{F,t} = (1-w)\left(\frac{P_{F,t}}{P_t}\right)^{-\mu} C^e_t \tag{34}$$

3.2.2 Retail Firms

Each retail firm uses the wholesale good Y^W to produce a differentiated good $Y(v)$. The output of each firm is:

$$Y_t(v) = Y^W_t(v) \tag{35}$$

Each retailer maximizes his profit facing the following demand function:

$$Y_t(v) = \left(\frac{P_{H,t}(v)}{P_{H,t}}\right)^{-\zeta} Y_t \tag{36}$$

Home retailers set optimally the price of their goods $\widehat{P}_{H,t}(v)$ with a probability $1-\varrho_H$. If firms do not optimize the price at the period t, then $P_{H,t}(v) = P_{H,t-1}(v)$. This assumption allows to introduce sticky prices following Calvo (1983).

The inter-temporal profit of a retail firm can be written as follows:

$$E_t\Sigma^{\infty}_{k=0}\varrho^k_H\frac{\lambda_{t+k}}{\lambda_t}\left[\widehat{P}_{H,t}(v)Y_{t+k}(v) - P_{H,t+k}mc_{t+k}Y_{t+k}(v)\right] \tag{37}$$

where $mc_{t+k} = \frac{P^W_{H,t+k}}{P_{H,t+k}}$ represents marginal costs, $\frac{\lambda_{t+k}}{\lambda_t} = \beta^k\frac{U_{C_{t+k}}}{U_{C_t}}$ is the discount factor for future (real) profits.

The first order condition related to the maximization of inter-temporal profit implies:

$$\widehat{P}_{H,t}(v) = \frac{\zeta}{\zeta-1}\frac{\Sigma^{\infty}_{k=0}(\varrho_H\beta)^k mc_{t+k}P^{\zeta+1}_{H,t+k}Y_{t+k}}{\Sigma^{\infty}_{k=0}(\varrho_H\beta)^k P^{\zeta}_{H,t+k}Y_{t+k}} \tag{38}$$

The price index is therefore given by the combination of revised (and optimally set) prices and non-revised prices:

$$P_{H,t} = \left[(1-\varrho_H)(\widehat{P}_{H,t})^{1-\zeta} + \varrho_H(P_{H,t-1})^{1-\zeta}\right]^{\frac{1}{1-\zeta}} \tag{39}$$

Combining the log-linearization of Equations (38) and (39) leads to the following inflation dynamics, also called New-Keynesian Phillips curve:

$$\widehat{\pi}_{H,t} = \beta E_t\widehat{\pi}_{H,t+1} + \frac{(1-\varrho_H)(1-\beta\varrho_H)}{\varrho_H}\widehat{mc}_t \tag{40}$$

3.3 Fiscal Policy

Following, among others, Bouakez and Eyquem (2015), public spending is financed through lump-sum taxes:

$$P_t G_t = T_t \tag{41}$$

where G_t is the total amount of public spending. We assume that the government consumes both local and foreign final goods and that composite public spending is aggregated in the same way of the private demand.[15]

Public spending follows an autoregressive process of the type:

$$\widehat{G}_t = \rho_g \widehat{G}_{t-1} + \varepsilon_{g_t} \tag{42}$$

where $\widehat{G}_t = \frac{G_t - G}{G}$ is the log-deviation of G_t around its steady state value G, $\rho_g \in (0,1)$, and ε_t^g is a white noise.

3.4 Monetary Policy

The monetary authority sets the nominal interest rate according to the following Taylor rule a consumer price index inflation (π_{t+1}) targets:

$$\widehat{R}_{n,t} = \rho \widehat{R}_{n,t-1} + (1-\rho)\left(\gamma_\pi E_t \widehat{\pi}_{t+1}\right) \tag{43}$$

where ρ is the coefficient of autocorrelation of nominal interest rate, and γ_π is the weight given to inflation.

3.5 Market Clearing

The aggregated demand for the home economy is:

$$Y_t = w\left(\frac{P_{H,t}}{P_t}\right)^{-\mu}\left(C_t + C_t^e + I_t + G_t\right) + (1-w)\left(\frac{P_{H,t}^*}{P_t^*}\right)^{-\mu}\left(C_t^* + I_t^* + G_t^*\right) \tag{44}$$

The equilibrium between the current account and the financial account allows to define the trade balance (TB) as follows:

$$TB_t = P_{H,t} Y_t - P_t C_t - P_t C_t^e - P_t I_t - P_t G_t - P_t \Psi(I_t, K_t) \tag{45}$$

[15]As for I and C^e, this assumption means that government has the same preferences than households. It ensures that the reactions of firms, households and the government act in the same way without affecting the results.

The home economy accumulates net foreign assets according to the following dynamics:

$$d_t = \phi_{t-1} d_{t-1} \frac{RER_t}{RER_{t-1}} \frac{R^*_{n,t-1}}{\pi^*_t} + \frac{P_{H,t}}{P_t} \frac{Y_t}{Y} - \frac{C_t}{Y} - \frac{C^e_t}{Y} - \frac{G_t}{Y} - \frac{I_t}{Y} - \Psi_(I_t, K_t) \tag{46}$$

The Walras' law implies that the bond market equilibrium is reached when all the other markets clear.

4 Calibration

Our analysis is not a case study *per se*. It has a more general purpose. This is why, instead of estimating the model in reference to a given pair of countries, we have calibrated the parameters in reference to the values usually chosen in the literature. The calibration of the parameters and the steady state ratios are shown in the Appendix, Table 4. Nevertheless, alternative calibrations are tested, as presented in Section 6. Note that the parameters are similar in the two countries, excepted for monetary and fiscal policies. Moreover, for parsimony purpose and without loss of generality, the financial accelerator mechanism is only introduced in the home economy.[16]

4.1 Households

Following Bonam and Lukkezen (2014) or Elekdağ and Tchakarov (2007), the inverse of the inter-temporal elasticity of substitution (σ_c) is fixed at 2, and the inverse of the Frisch elasticity of labor supply (σ_l) at 1. As in most of the literature, the discount factor β is set at 0.99. The elasticity of substitution between varieties locally produced ζ is equal to 6, following Bouakez and Eyquem (2015) or Kitano and Takaku (2015). Alternative values of ζ are considered in Section 6.

Regarding the elasticity of substitution between home and foreign goods, μ, it is fixed at 1.5 as in Bouakez and Eyquem (2015), and the home bias (ω) is set at 0.72, which corresponds to a trade openness degree at 0.28, as for example in Kitano and Takaku (2015), Elekdağ and Tchakarov (2007) or Cook (2004).

Furthermore, the consumption to GDP ratio (C/Y) at the steady state is set at 60% in line with most of the literature.

Finally, the country premium elasticity ϕ_d is set at 0.0007 in line with Schmitt-Grohé and Uribe (2003) or Sangaré (2016). Alternative calibrations for this parameter are tested in Section 6.

[16]Considering a case study, in reference to the Figure 1 and to the empirical analysis can constitute an interesting extension.

4.2 Firms

Following Kitano and Takaku (2015), the capital intensity (α) is set at 0.35, which means a labor intensity ($1-\alpha$) at 0.65. The depreciation rate of capital δ is fixed at 0.025, which is in line with, among others, Christensen and Dib (2008). The adjustment cost function parameter Φ is equal to 6 following Chang and Fernández (2013). A sensitivity analysis is led in Section 6.

Wholesale firms support an external finance premium which depends on the capital to net worth ratio with an elasticity of 0.042 (Christensen and Dib, 2008); a smaller value of this parameter is tested in Section 6 following Badarau and Levieuge (2011).

Wholesalers exit at the end of a period with probability $1-\xi_e$, with ξ_e equal to 0.985, in line with Levieuge (2009), and at the steady state, the consumption of existing firms (C^e/Y) is assumed to be 2% of GDP.

Regarding the price setting, the price rigidity parameter ϱ_H is fixed at 0.75, a widely used value in the literature (e.g. Bouakez and Eyquem (2015)). This corresponds to a probability of 0.25 to set the price optimally.

The steady state leverage ratio (K/N) is set at 3 following Devereux et al. (2006), and investment at the steady state (I/Y) is assumed to represent 18% of GDP that is consistent with most of the literature.[17]

4.3 Monetary and fiscal policies

Regarding the monetary policy, the temporal autocorrelation of nominal interest rate, ρ is commonly fixed at 0.85. Regarding the home economy, a not-too-aggressive monetary policy is considered: the weight for expected inflation, γ_π, is fixed at 1.1. In the foreign economy, the monetary authority is supposed to be more aggressive: $\gamma_\pi^* = 1.8$.

As in Bouakez and Eyquem (2015), this configuration allows to obtain a decrease in the interest rate differential between H and F, that should lead to the depreciation of the real exchange rate, as found in empirical studies (e.g. Kim, 2015).

For the fiscal policy, the autocorrelation of public spending shocks ρ_g is set at 0.8 in line with most of the literature, and alternative values are tested in Section 6.

5 The effects of public spending

In the closed-economy model à la Bernanke et al. (1999), an increase in public spending acts as an increase in aggregate demand. Provided that the central bank does not increase

[17]For the foreign economy, I^*/Y^* is set at 20% since C^e/Y is zero.

its policy rate too aggressively in response to such an inflationary shock (or provided that the Phillips curve is rather flat), the initial boost of the economic activity leads to an increase in firms' net worth. As agency problems are thus reduced, the external financial premium (hereafter EFP) of non-financial corporations decreases. Finally, this stimulates private investment and economic activity even further. The initial shock is amplified through balance sheet effects.

In an open-economy, the balance sheet effects depend on the currency composition of firms' indebtedness and on the evolution of the real exchange rate in the wave of the fiscal shock. In particular, its has extensively been found in the recent literature that the domestic currency tends to depreciate following a positive public spending stimulus, notably because of induced changes in real interest rate differentials. Bouakez and Eyquem (2015) for example give in-depth demonstration of this, both at partial and general equilibrium level[18]. To clearly understand the impact of foreign currency denominated debt on the effect of public spending, let's consider two polar cases.

On the one hand, if firms are highly indebted in foreign currency, the depreciation of the domestic currency following the fiscal shock leads to an increase in the real debt burden of firms, relative to their net wealth which is denominated in domestic currency. This drives up the EFP of domestic firms. Consequently, investment drops so much that this may offset the expected positive macroeconomic effects of fiscal stimulus.

Conversely, if firms are mainly indebted in local currency, the global effect of public spending is close to the one that prevails for closed economy. The rise in aggregate demand leads to an increase in firms' earnings and net wealth. The EFP decreases. This stimulates investment. Even more, by stimulating exports (while imports are discouraged), the depreciation of the domestic currency strengthens the global demand. Hence, the expected positive effect of fiscal expansion may be enhanced.

Figure 3 shows the responses of output, consumption, investment, real exchange rate (RER), net worth, external finance premium (EFP) to an increase by 1% in public spending. The dotted line corresponds to the case firms are mainly indebted in foreign currency ($\kappa = 0.1$), while the solid line refers to a situation in which indebtedness is mainly denominated in local currency ($\kappa = 0.9$).[19]

Consistently with the recent literature, an increase in public spending leads to an increase in the real exchange rate, which corresponds to a depreciation of the home currency, relative to the foreign currency. Actually, when financial markets are imperfect and incomplete,

[18] See also Kim (2015) and Kollmann (2010), as well as the explanations related to Figure 3 below.

[19] Note that changing the value of κ does not change the steady state. Indeed, at the steady state, only N depends on κ. As a state variable, N only appears in the K/N ratio, which remains unchanged irrespective of κ. Hence, the value of κ only modifies the path to the steady state.

exchange rate fluctuations are led by real interest rate differentials. Intuitively, when public spending at home increases, the global demand rises both at home and abroad, since the government consumes home goods in proportion ω and foreign goods in proportion $1-\omega$. Nonetheless, because of home bias, the aggregate demand increases more in the home than in the foreign economy. As a result, home inflation increases more than the foreign inflation. Furthermore, the home monetary policy authorities are supposed to be less aggressive than the foreign central bank. Hence, the real interest rate increases less in the home economy than in the foreign country. This explains the depreciation of the local currency in real terms (see Equations 18 and 91). In turn, this depreciation has different effects depending on the currency denomination of external debt.

When firms are mainly indebted in local currency, here at the 90% level (i.e. $\kappa = 0.9$), the cost of capital and future earnings are mostly determined by local conditions. While net worth reduces in impact because of the rise in interest rates, net worth accumulation increases due to the rise in global demand strengthened by the real depreciation of local currency. Actually, the ensuing increase in exports and decrease in imports lead to a rise in firms' revenues. It follows a reduction in the EFP and thus a (relatively large) increase in private investment, which boosts output.

When firms are indebted in foreign currency, here at the 90% level (i.e. $\kappa = 0.1$),the domestic currency depreciation means an increase in the real value of firms leverage. Net worth declines[20] that makes the EFP raises. As a consequence, investment decreases and remains below its steady state value as long as the cost of acquiring new capital is high.[21] Certainly, the depreciation of the local currency encourages exports and reduces imports. However, this potentially stimulating effect is largely offset by the decrease in private investment. A positive impact of public spending on output remains, but it is weak, and smaller than in the opposite local currency indebtedness case.

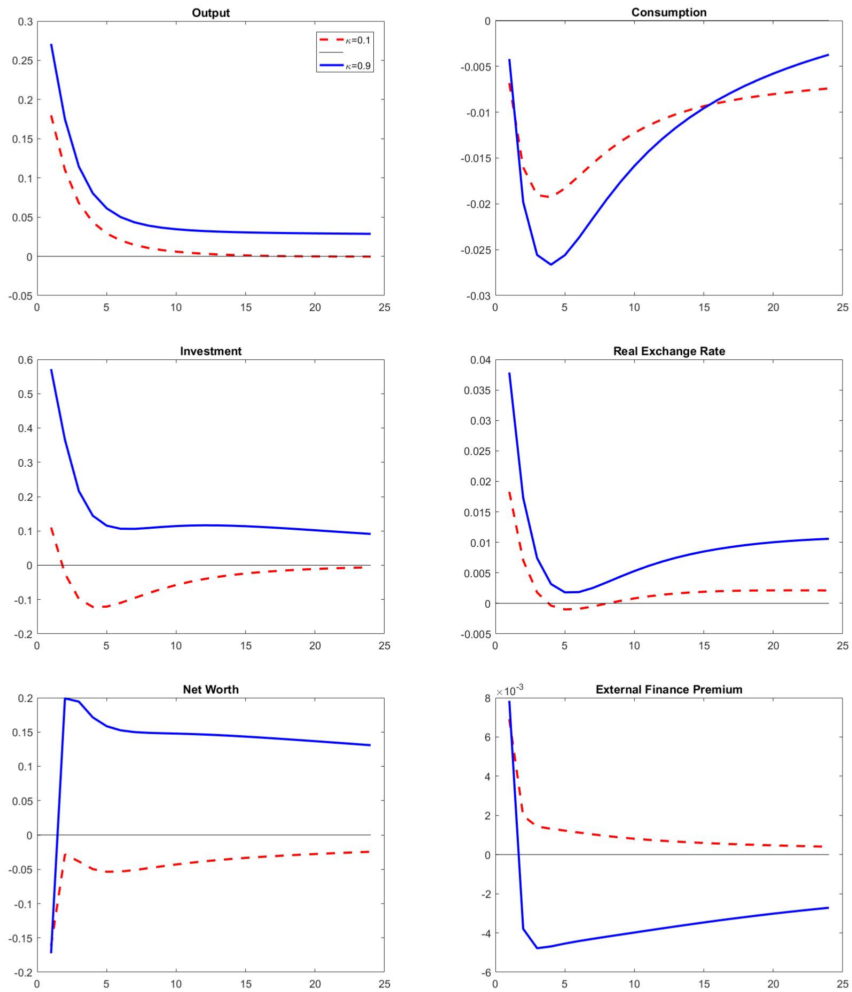
To be more precise regarding the impact of public spending on output, we compute the fiscal multiplier, defined as the ratio of the change in output (ΔY) to the change in public spending (ΔG). More precisely, four kinds of fiscal multipliers are computed (Spilimbergo et al., 2009):[22]

[20]Note that following the log-linearized version of Equation 32, the elasticity of net worth to the variation of the RER $\left(-\Theta(1-\kappa)\frac{R_n^*}{\pi}\left(\frac{K}{N}-1\right)\right)$ is negative for capital-to-net worth ratio larger than 1. Actually, it is always the case here since $\frac{K}{N} \leq 1$ would mean that firms do not borrow.

[21]The investment increases at the impact, but decreases from the second period, and the cumulative effect of public spending on investment is highly negative, around -1 since the 10th period. The positive response at the impact is justified by the initial increase of net export following the depreciation of the real exchange rate.

[22]In practice, and following Zubairy (2014) among others, the fiscal multiplier is computed by using the

Figure 3: Impulse response functions to a 1% increase in public spending



- the impact multiplier, which measures the change in output at time t due to a change in public spending at the same time

$$\Lambda_t = \frac{\Delta Y_t}{\Delta G_t}$$

- the peak multiplier, defined as the largest impact of public spending on output over a period $[t; t+T]$

$$\Lambda_T^{max} = max_T \frac{\Delta Y_{t+T}}{\Delta G_t}$$

- the multiplier at some horizon T, measuring the change in output at time $t+T$ due to

coefficients read on the response function (Figure 3) adjusted for the steady state ratio G/Y. For instance, the impact multiplier is: $irf_t \frac{Y}{G}$ where irf_t is the coefficient read on the response function at time t.

a change in public spending at time t

$$\Lambda_T = \frac{\Delta Y_{t+T}}{\Delta G_t}$$

- the cumulative multiplier, which gives the cumulative change in output over a period $[t; t+T]$ due to the cumulative change in public spending over the same period;

$$\Lambda_{t+T} = \frac{\Sigma_{s=0}^{T} \Delta Y_{t+s}}{\Sigma_{s=0}^{T} \Delta G_{t+s}}$$

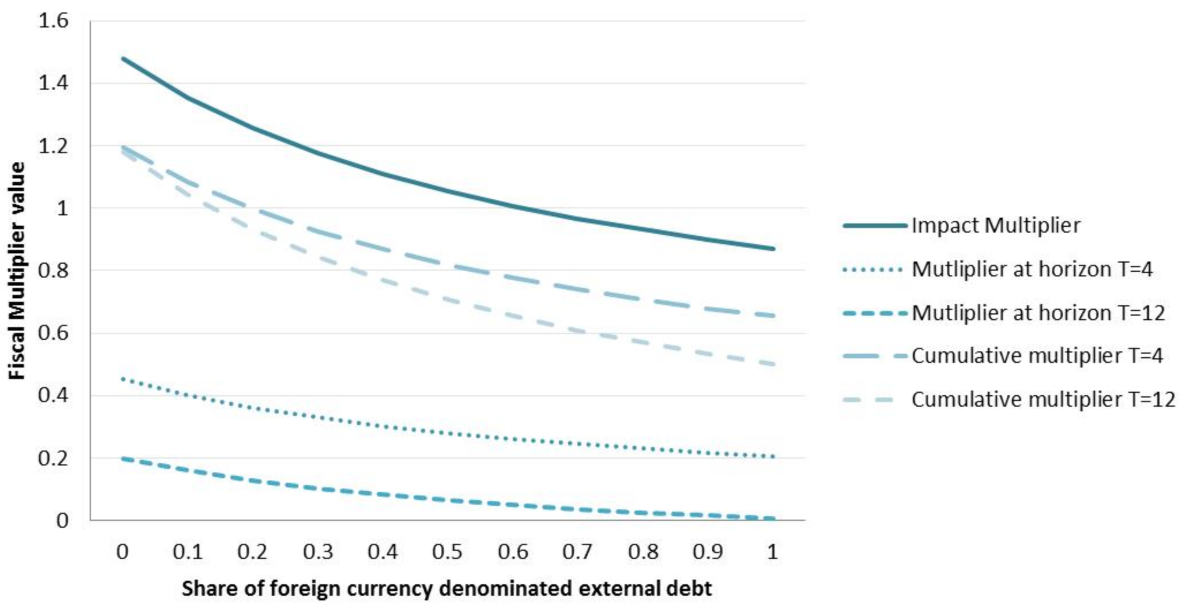
Note that, in our case, the impact multiplier coincides with the peak multiplier since the most important effect of public spending on GDP is observed at the impact.

Figure 4 shows the value of these multipliers as a function of the share of debt denominated in foreign currency (i.e. $(1-\kappa)$). The higher this share is, the smaller the multiplier is. This is true whatever the used definition of the multiplier.

When 90% of firms' indebtedness is denominated in local currency, the multiplier is around 1.4, rather than it is less than 0.9 when firms are indebted at the 90% level in foreign currency.

These results are consistent with the estimates presented in Section 2: countries with external debt mostly denominated in foreign currency have smaller multipliers than countries indebted in local currency.

Figure 4: Value of the fiscal multiplier according to the share of foreign currency denominated external debt



6 Sensitivity Analysis

6.1 Changing the parameters

In this section, the sensitivity of the results to alternative calibrations of some parameters is tested. Especially, the fiscal multiplier is computed for different values of the autocorrelation of spending shocks parameter, the country risk premium elasticity, the capital adjustment cost parameter, the elasticity of external finance premium, and the elasticity of substitution between home goods.

Table 1 shows the value of the fiscal multiplier with alternative parameters and for different values of κ. Overall, the negative effect of foreign currency denomination of indebtedness on the fiscal multiplier remains whatever the calibration of the parameters, even if the magnitude of this effect changes.

Regarding the autocorrelation of spending shocks, the higher the coefficient, the larger the multiplier. The spread between the multiplier for $\kappa = 0.1$ and that for $\kappa = 0.9$ also slightly increases with the value of ρ_g. A higher autocorrelation in spending shocks means larger persistence of an increase in public spending. The consequences of an expansive fiscal policy are larger when the persistence degree is higher. Furthermore, for a given level of public spending shock autocorrelation, a high share of debt denominated in foreign currency reduces the fiscal multiplier; and for a given level of foreign currency denominated debt, the multiplier increases with the degree of public spending shock autocorrelation.

Considering the elasticity of the country risk premium, the spread between the multiplier for $\kappa = 0.1$ and that for $\kappa = 0.9$ does not significantly change according to the value of ϕ_d. The same observation can be made about the impact of a different elasticity of substitution between home goods. The calibration of these parameters does not really affects our results.

In contrast, changing the capital adjustment cost parameter implies relatively large changes in the multiplier values. A smaller adjustment cost implies both larger multipliers whatever the value of κ and a larger spread between the extreme cases $\kappa = 0.1$ and $\kappa = 0.9$. This result is consistent with the mechanism explained in the previous section: the negative effect of foreign currency denomination of debt occurs through the RER, the net worth and, by the way, through the investment level. The higher adjustment costs are, the less firms adjust their decisions, hence the observed change in investment is smaller. The responses of investment and output to fiscal policy are therefore reduced.

Regarding the elasticity of the external finance premium, a smaller elasticity leads to a smaller spread between the value of the multiplier when $\kappa = 0.1$ and $\kappa = 0.9$. Once again, this result seems consistent with results in Section 5 since a smaller elasticity of the EFP means that financing costs do not increase so much following a decrease in the net worth. Investment therefore declines less in the case θ is small than in the case θ is relatively higher.

Table 1: Sensitivity: value of the impact multiplier with alternative calibrations

	κ=0.1	κ=0.5	κ=0.9	Spread
$\rho_g = 0.6$	0.83	0.92	1.09	0.26
$\boldsymbol{\rho_g = 0.8}$	**0.90**	**1.06**	**1.35**	**0.46**
$\rho_g = 0.9$	0.97	1.21	1.68	0.70
$\phi_d = 0.0001$	0.88	1.02	1.26	0.38
$\boldsymbol{\phi_d = 0.0007}$	**0.90**	**1.06**	**1.35**	**0.46**
$\phi_d = 0.001$	0.91	1.07	1.39	0.48
$\Phi = 3$	0.98	1.22	1.75	0.77
$\boldsymbol{\Phi = 6}$	**0.90**	**1.06**	**1.35**	**0.46**
$\Phi = 12$	0.86	0.97	1.14	0.28
$\theta = 0.025$	0.91	1.03	1.23	0.32
$\boldsymbol{\theta = 0.042}$	**0.90**	**1.06**	**1.35**	**0.46**
$\zeta = 1.1$	0.80	0.93	1.16	0.36
$\boldsymbol{\zeta = 6}$	**0.90**	**1.06**	**1.35**	**0.46**

6.2 What about the financial accelerator mechanism?

The model has been reformulated to eliminate the financial accelerator in order to test whether this mechanism actually affects the value of the multiplier. The model is exactly the same, but firms do not accumulate net worth anymore, and they do not have to support an external finance premium. The only "price to pay" to invest is the real interest rate.

Using the same calibration than the benchmark case, the values of the multiplier obtained are really different when the financial accelerator is eliminated from the model, and the impact of foreign currency denominated debt is significantly reduced. In fact, for a share of foreign currency denominated debt at the 90% level (i.e. $\kappa = 0.1$), the multiplier is around 0.9, and for a share of foreign currency denominated debt at the 10% level (i.e. $\kappa = 0.9$) the multiplier is 0.95. In both cases, the multiplier is below one, showing that the financial accelerator mechanism magnifies the effect of public spending, or at least, modifies the impact of public spending on economic growth. Without the financial accelerator, the fiscal multiplier remains below one whatever the value of κ.

The financial accelerator mechanism seems therefore important in the analysis of fiscal policy efficiency.

7 Concluding Remarks

The empirical literature shows that fiscal multipliers in emerging market economies are smaller than those in advanced economies. While the existing literature often considers the level of development as a determinant of the fiscal multiplier, we argue that this gap can be due to specificities in EMEs. Especially, this paper considers the role of the currency denomination of private indebtedness, a feature that, to the best of our knowledge, has not been analyzed in the literature yet.

First, using a PCH-VAR, the negative impact of foreign currency denominated debt on the fiscal multiplier is underlined. Countries with a high share of external debt denominated in foreign currency have smaller multipliers than countries mainly indebted in local currency.

Second, this result is rationalized in a DSGE model with sticky prices, imperfect and incomplete international financial markets, a not-too-aggressive monetary policy and a financial accelerator à la Bernanke et al. (1999). In this framework, firms can borrow both in local and foreign currency, and their financial structure generates economic fluctuations, affecting the efficiency of fiscal policy.

We show that when firms are indebted in foreign currency, the increase in public spending generates a depreciation of the exchange rate, leading to a decrease in firms' net worth. The financing cost of investment therefore increases and this generates a decline in the investment level. The effect of public spending on growth remains positive but the decrease in investment weakens this impact, and the fiscal multiplier falls below one. At the contrary, when firms are indebted in local currency, the increase in public spending generates a depreciation of the exchange rate that stimulates the demand, therefore reducing the financing costs. Hence, investment increases, and the positive effect of an expansive fiscal policy is magnified. The fiscal multiplier is larger than one in that case.

These results show that the currency denomination of indebtedness is an important determinant of the fiscal multiplier. The high share of debt denominated in foreign currency in EMEs could be part of the features that makes fiscal multipliers so small in these countries. This statement outlines the need for reforms regarding the financial sector in emerging countries. While an increasing number of reforms have been implemented there,[23] foster-

[23] According to the database of Cerutti et al. (2017), in 2000, only 6 EMEs and LICs countries had implemented some reforms to constrain foreign currency loans. In 2013, the same number of countries was

ing the use of local currency to finance economic activity seems still an important task for governments.

three times higher.

Appendix

Table 2: Stationarity tests (p-values)

	No time trend				Time trend			
Variables in levels	IPS		Fisher		IPS		Fisher	
GDP	2.22	(0.98)	-1.28	(0.89)	-0.34	(0.37)	0.12	(0.45)
Public consumption	3.71	(0.99)	-0.6	(0.73)	2.07	(0.98)	-0.31	(0.62)
Variables in first difference	IPS		Fisher		IPS		Fisher	
GDP	-13.94	(0.00)	42.77	(0.00)	-13.65	(0.00)	41.24	(0.00)
Public consumption	-14.68	(0.00)	68.95	(0.00)	-13.01	(0.00)	66.63	(0.00)

Table 3: Optimal lag length selection

lag	MMSC-AIC
1	**7.20E-32**
2	1.12E-31
3	1.86E-31
4	3.87E-31
5	4.41E-31
6	9.00E-30

The Steady State

Variable without time index denotes its steady state value.

Home Economy

$$C = \left[w^{1/\mu} C_H^{\mu-1/\mu} + (1-w)^{1/\mu} C_F^{\mu-1/\mu} \right]^{\mu/\mu-1} \tag{47}$$

$$C_H = w \left(\frac{P_H}{P} \right)^{-\mu} C \; ; \quad C_F = (1-w) \left(\frac{P_F}{P} \right)^{-\mu} C \tag{48}$$

$$P = \left[w P_H^{(1-\mu)} + (1-w) P_F^{1-\mu} \right]^{1/(1-\mu)} \tag{49}$$

$$RER = \frac{SP^*}{P} \tag{50}$$

$$\tau = \frac{P_F}{P_H} \tag{51}$$

$$I = \left[w^{1/\mu} I_H^{\frac{\mu-1}{\mu}} + (1-w)^{1/\mu} I_F^{\frac{\mu-1}{\mu}} \right]^{\frac{\mu}{1-\mu}} \tag{52}$$

$$I_H = w \left(\frac{P_H}{P} \right)^{-\mu} I \ ; \quad I_F = (1-w) \left(\frac{P_F}{P} \right)^{-\mu} I \tag{53}$$

$$I = \delta K \Leftrightarrow \frac{I}{K} = \delta \tag{54}$$

$$mc = \frac{P_H^W}{P_H} \tag{55}$$

$$\frac{WL}{Y} = mc \frac{P_H}{P} (1-\alpha) \tag{56}$$

$$q = 1 \tag{57}$$

$$\frac{Y}{K} = \frac{P}{\alpha mc P_H} \left[R^K - (1-\delta) \right] \tag{58}$$

$$\frac{I}{Y} = \frac{\alpha mc \delta}{R^K - (1-\delta)} \tag{59}$$

$$R_n = \frac{1}{\beta} \tag{60}$$

$$\Theta = \Theta \left(\frac{K}{N} \right) \tag{61}$$

$$R^k = \Theta \left(\kappa \frac{R_n}{\pi} + (1-\kappa) \frac{R_n^*}{\pi^*} \right) \tag{62}$$

$$C^e = \frac{(1-\xi_e)}{\xi_e} N \tag{63}$$

$$P_H = \widehat{P}_H = \frac{\zeta}{\zeta - 1} mc P_H \tag{64}$$

$$mc = \frac{P_H^W}{P_H} = 1 - \frac{1}{\zeta} \tag{65}$$

$$PG = T \tag{66}$$

Foreign Economy

$$C^* = \left[(1-w)^{1/\mu} {C_H^*}^{\mu-1/\mu} + w^{1/\mu} {C_F^*}^{\mu-1/\mu}\right]^{\mu/\mu-1} \tag{67}$$

$$P^* = \left[(1-w){P_H^*}^{(1-\mu)} + w{P_F^*}^{1-\mu}\right]^{1/(1-\mu)} \tag{68}$$

$$I^* = \left[(1-w)^{1/\mu} {I_H^*}^{\frac{\mu-1}{\mu}} + w^{1/\mu} {I_F^*}^{\frac{\mu-1}{\mu}}\right]^{\frac{\mu}{1-\mu}} \tag{69}$$

$$I_H^* = (1-w)\left(\frac{P_H^*}{P^*}\right)^{-\mu} I^* \ ; \quad I_F^* = w\left(\frac{P_F^*}{P^*}\right)^{-\mu} I^* \tag{70}$$

$$I^* = \delta^* K^* \Leftrightarrow \frac{I^*}{K^*} = \delta^* \tag{71}$$

$$mc^* = \frac{{P_F^*}^W}{P_F^*} \tag{72}$$

$$\frac{W^* L^*}{Y^*} = mc^* \frac{P_F^*}{P^*}(1-\alpha^*)$$

$$q^* = 1 \tag{73}$$

$$\frac{Y^*}{K^*} = \frac{P^*}{\alpha^* {P_H^*}^W}\left({R^*}^K - (1-\delta^*)\right) \tag{74}$$

$$\frac{I^*}{Y^*} = \frac{\alpha mc^* \delta}{R^{K^*} - (1-\delta)} \tag{75}$$

$$R_n^* = \frac{1}{\beta} \tag{76}$$

$$R^{K^*} = \left(\frac{R_n^*}{\pi^*}\right) \tag{77}$$

$$P_F^* = \widehat{P}_F^* = \frac{\zeta^*}{\zeta^*-1} mc^* P_F^*$$

$$mc^* = \frac{P_F^{W^*}}{P_F^*} = 1 - \frac{1}{\zeta^*} \tag{78}$$

Log-linearized model

Home Economy

DEMAND

Total demand: (following Equation 44)

$$\begin{aligned}\widehat{Y}_t =& \mu(1-w)\left(\widehat{\tau}_t + \widehat{rer}_t\right) \\ &+ w\left(\frac{I}{Y}\widehat{I}_t + \frac{C^e}{Y}\widehat{C}^e_t + \frac{G}{Y}\widehat{G}_t + \frac{C}{Y}\widehat{C}_t\right) \\ &+ (1-w)\left(\frac{I^*}{Y^*}\widehat{I}^*_t + \frac{C^*}{Y^*}\widehat{C}^*_t + \frac{G^*}{Y^*}\widehat{G}^*_t\right)\end{aligned} \tag{79}$$

Households consumption: (following Equation 8)

$$\widehat{C}_t = E_t\widehat{C}_{t+1} + \frac{1}{\sigma_c}\left(\widehat{\pi}_{t+1} - \widehat{R}_{n,t}\right) \tag{80}$$

Capital demand: (following Equation 29)

$$\widehat{R}^K_t = \left(1 - \frac{1-\delta}{R^K}\right)\widehat{mpc}_t - \frac{\Phi\delta^2}{R^K}\widehat{K}_t + \frac{1-\delta}{R^K}\widehat{q}_t - \hat{q}_{t-1}$$

Expected cost of capital: (following Equation 31)

$$\begin{aligned}\widehat{R}^k_{t+1} =& \theta\left(\widehat{q}_t + \widehat{K}_{t+1} - \widehat{N}_{t+1}\right) + \Theta\left(\kappa\frac{R_n}{\pi R^k}\right)\left(\widehat{R}_{n,t} - \widehat{\pi}_{t+1}\right) \\ &+ \Theta(1-\kappa)\left(\frac{R^*_n}{R^k\pi^*}\right)\left(\widehat{R}^*_{n,t} - \widehat{\pi}^*_{t+1} + \widehat{rer}_{t+1} - \widehat{rer}_t\right) - \Theta\left(\phi_d(1-\kappa)\frac{R^*_n}{R^k\pi^*}\right)\widehat{d}_t\end{aligned} \tag{81}$$

Real price of capital: (following Equation 28)

$$\widehat{q}_t = \frac{\Phi\delta(\widehat{I}_t - \widehat{K}_t)}{q} \tag{82}$$

Consumption of exiting firms: (following Equation 33)

$$\widehat{C}^e_t = \widehat{N}_t \tag{83}$$

SUPPLY

Marginal productivity of capital: (following Equation 29)

$$\widehat{mpc}_t = \widehat{mc}_t + \widehat{Y}_t - \widehat{K}_t - \frac{(1-w)}{(2w-1)}\widehat{rer}_t \tag{84}$$

Inflation:

$$\widehat{\pi}_t = \widehat{\pi}_{H,t} + (1-w)\Delta\widehat{\tau}_t \tag{85}$$

Domestic inflation: (following Equation 40)

$$\widehat{\pi}_{H,t} = \beta E_t \widehat{\pi}_{H,t+1} + \frac{(1-\varrho_H)(1-\beta\varrho_H)}{\varrho_H}\widehat{mc}_t \tag{86}$$

Terms of trade and RER: (following Equation 17)

$$\widehat{rer}_t = (2w-1)\widehat{\tau}_t \tag{87}$$

Production function: (following Equation 19)

$$\widehat{Y}_t = \widehat{a}_t + \alpha\widehat{K}_t + (1-\alpha)\widehat{L}_t \tag{88}$$

Labor supply: (following Equation 7)

$$\widehat{L}_t = \frac{1}{\sigma_l}\left(\widehat{W}_t - \sigma_c\widehat{C}_t\right) \tag{89}$$

Wholesale marginal costs: (following Equation 27)

$$\widehat{W}_t = \widehat{mc}_t + \widehat{Y}_t - \widehat{L}_t - \frac{(1-w)}{(2w-1)}\widehat{rer}_t \tag{90}$$

Real Exchange Rate: (following Equation 18) :

$$\widehat{rer}_t = E_t\widehat{rer}_{t+1} + \widehat{R}^*_{n,t} - E_t\widehat{\pi}^*_{t+1} - \widehat{R}_{n,t} + E_t\widehat{\pi}_{t+1} - \phi_d\widehat{d}_t \tag{91}$$

State variables

Net foreign assets accumulation: (following Equation 46) [24]

$$\widehat{d}_t = \frac{1}{\beta}\widehat{d}_{t-1} - (1-w)\widehat{\tau}_t + \widehat{Y}_t - \frac{C}{Y}\widehat{C}_t - \frac{C^e}{Y}\widehat{C}^e_t - \frac{I}{Y}\widehat{I}_t - \frac{G}{Y}\widehat{G}_t \tag{92}$$

[24]Since d=0, $\widehat{d}_t$ denotes d_t/Y (e.g. Bouakez and Eyquem (2015))

Net worth accumulation: (following Equation 32)

$$\begin{aligned}\frac{\widehat{N}_t}{\xi_e} =& R^K \frac{K}{N}\widehat{R}^K_{t-1} + R^K\theta\left(1-\frac{K}{N}\right)\left(\widehat{q}_{t-1}+\widehat{K}_t\right) + R^K\left(\theta\left(\frac{K}{N}-1\right)+1\right)\widehat{N}_{t-1} \\ &+ \Theta\left(1-\kappa\right)\frac{R^*_n}{\pi^*}\left(\frac{K}{N}-1\right)\left(\widehat{\pi}^*_t - \widehat{R}^*_{n,t-1} + \widehat{rer}_{t-1} - \widehat{rer}_t - \phi_d\widehat{d}_t\right) \\ &+ \Theta\kappa\frac{R_n}{\pi}\left(\frac{K}{N}-1\right)\left(\widehat{\pi}_t - \widehat{R}_{n,t-1}\right)\end{aligned} \tag{93}$$

Capital accumulation: (following Equation 24)

$$\widehat{K}_{t+1} = \delta\widehat{I}_t + (1-\delta)\widehat{K}_t \tag{94}$$

Monetary policy, fiscal policy and productivity shocks

Monetary policy:

$$\widehat{R}_{n,t} = \rho\widehat{R}_{n,t-1} + (1-\rho)\left(\gamma_\pi E_t\widehat{\pi}_{t+1} + \gamma_y\widehat{Y}_t\right) \tag{95}$$

Fiscal policy:

$$\widehat{G}_t = \rho_g\widehat{G}_{t-1} + \varepsilon_{g_t} \tag{96}$$

Productivity:

$$\hat{a}_t = \rho_a\hat{a}_{t-1} + \varepsilon_{a_t} \tag{97}$$

7.0.1 Foreign Economy

Total demand:

$$\begin{aligned}\widehat{Y}^*_t =& \mu(1-w)\left(\widehat{\tau}^*_t - \widehat{rer}_t\right) + w\left(\frac{C^*}{Y^*}\widehat{C}^*_t + \frac{I^*}{Y^*}\widehat{I}^*_t + \frac{G^*}{Y^*}\widehat{G}^*_t\right) \\ &+ (1-w)\left(\frac{C}{Y}\widehat{C}_t + \frac{C^e}{Y}\widehat{C}^e_t + \frac{I}{Y}\widehat{I}_t + \frac{G}{Y}\widehat{G}_t\right)\end{aligned} \tag{98}$$

Households consumption:

$$\widehat{C}^*_t = E_t\widehat{C}^*_{t+1} + \frac{1}{\sigma_c}\left(E_t\widehat{\pi}^*_{t+1} - \widehat{R}^*_{n,t}\right) \tag{99}$$

Capital demand:

$$\widehat{R}^{K^*}_t = \left(1-\frac{(1-\delta^*)}{R^{K^*}}\right)\widehat{mpc}^* - \frac{\Phi{\delta^*}^2}{R^{K^*}}\widehat{K}^*_t + \frac{(1-\delta^*)}{R^{K^*}}\widehat{q}^*_t - \widehat{q}^*_{t-1} \tag{100}$$

Expected cost of capital:

$$\widehat{R}^{K^*}_{t+1} = \widehat{R}^*_{n,t} - E_t \widehat{\pi}^*_{t+1} \tag{101}$$

Real price of capital:

$$\widehat{q}^*_t = \frac{\Phi\delta^* \left(\widehat{I}^*_t - \widehat{K}^*_t\right)}{q^*} \tag{102}$$

Marginal productivity of capital:

$$\widehat{mpc}^*_t = \widehat{mc}^*_t - (1-w)\widehat{\tau}^*_t + \widehat{Y}^*_t - \widehat{K}^*_t \tag{103}$$

Inflation:

$$\widehat{\pi}^*_t = \widehat{\pi}^*_{F,t} + (1-w)\Delta\widehat{\tau}^*_t \tag{104}$$

Domestic inflation

$$\widehat{\pi}^*_F = \beta^* E_t \widehat{\pi}^*_{F,t+1} + \frac{(1-\varrho^*_F)(1-\beta^*\varrho^*_F)}{\varrho^*_F}\widehat{mc}^*_t \tag{105}$$

RER:

$$\widehat{rer}^*_t = -\widehat{rer}_t \tag{106}$$

Terms of trade:

$$\widehat{\tau}^*_t = -\widehat{\tau}_t \tag{107}$$

Wholesale production:

$$\widehat{Y}^*_t = \hat{a}^*_t + \alpha\widehat{K}^*_t + (1-\alpha)\widehat{L}^*_t \tag{108}$$

Labor supply:

$$\widehat{L}^*_t = \frac{1}{\sigma^*_l}\left(\widehat{W}^*_t - \sigma^*_c\widehat{C}^*_t\right) \tag{109}$$

Wholesale marginal cost:

$$\widehat{W}^* = \widehat{mc}^*_t + \widehat{Y}^*_t - \widehat{L}^*_t - (1-w)\widehat{\tau}^*_t \tag{110}$$

Capital accumulation:

$$\widehat{K}^*_{t+1} = \delta^*\widehat{I}^*_t + (1-\delta^*)\widehat{K}^*_t \tag{111}$$

Monetary Policy:

$$\widehat{R}^*_{n,t} = \rho^*\widehat{R}^*_{n,t-1} + (1-\rho^*)\left(\gamma^*_\pi E_t\widehat{\pi^*}_{t+1} + \gamma^*_y\widehat{Y}^*_t\right) \tag{112}$$

Fiscal policy:

$$\widehat{G}^*_t = \rho^*_g\widehat{G^*}_{t-1} + \varepsilon^*_{g_t} \tag{113}$$

Productivity:

$$\hat{a}_t^* = \rho_a^* \hat{a}_{t-1}^* + \varepsilon_{a_t}^* \tag{114}$$

Table 4: Parameters – Baseline calibration

Parameter	Definition	Value	Source
σ_c	Inverse of inter-temporal elasticity of substitution of consumption	2	Bonam and Lukkezen (2014)
σ_l	Inverse of Frisch elasticity of labor supply	1	Bonam and Lukkezen (2014)
β	Discount factor	0.99	*Usual*
ϕ_d	Country premium elasticity	0.0007	Schmitt-Grohé and Uribe (2003)
ζ	Elasticity of substitution between varieties	6	Bouakez and Eyquem (2015) and Kitano and Takaku (2015)
α	Capital intensity	0.30	Kitano and Takaku (2015)
δ	Depreciation rate of capital	0.025	*Usual*
μ	Elasticity of substitution across domestic and foreign goods	1.5	Bouakez and Eyquem (2015), Kitano and Takaku (2015)
ϱ_H	Prices rigidity parameter	0.75	
w	Home bias	0.72	Kitano and Takaku (2015)
Φ	Adjustment cost function parameter	6	Chang and Fernández (2013)
θ	Elasticity of extern financing premium to the capital-to-net wealth ratio	0.042	Christensen and Dib (2008)
ξ_e	Probability of firms to exit	0.985	Levieuge (2009)
γ_π	Weight of inflation for home monetary policy	1.1	(Varying)
γ_π^*	Weight of inflation for foreign monetary policy	1.8	(Varying)
ρ	Temporal autocorrelation of nominal interest rates	0.85	*Usual*
ρ_g	Autocorrelation of public spending shocks	0.8	*Usual*
ρ_a	Autocorrelation of productivity shocks	0.8	*Usual*

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