Foreign Reserves, Balance Sheet Effect and the Global Financial Crisis

Preliminary version

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Abstract

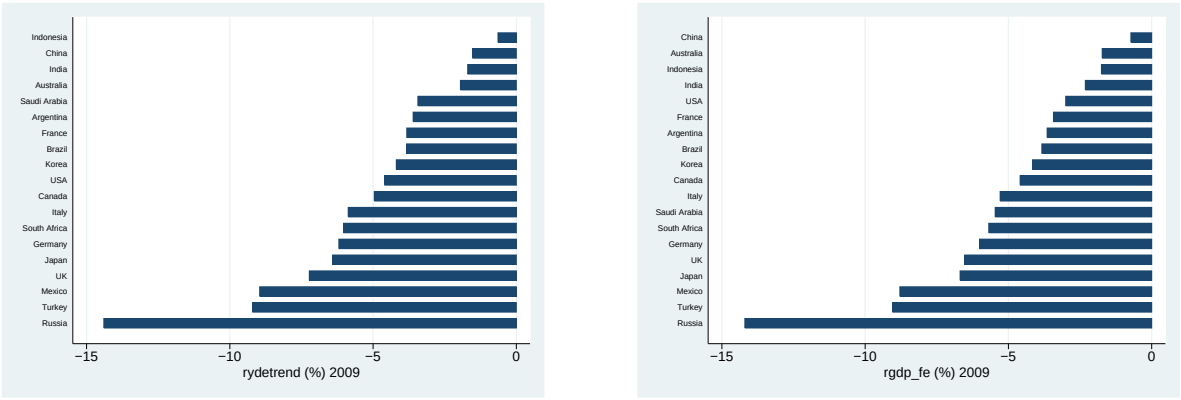
Based on the 'third-generation' crisis models à la Krugman (1999), this paper provides a theoretical framework to study how foreign reserves, accumulated before the onset of the crisis, were useful to enhance countries' resilience to the balance sheet effect during the recent economic turbulence. It is argued that both a targeted lending in foreign currency or a fiscal spending financed by foreign reserves help remove the bad equilibrium represented by a largely depreciated domestic currency and a very low level of domestic investment. Nevertheless, these two policy tools differ in the mechanism through which they stabilize the domestic economy and in terms of the amount of foreign reserves needed. A targeted lending is at work by altering investors' expectation on firms' net worth, thus exerts an influence on domestic investment and exchange rate. As long as foreign reserves are sufficient to cover the economy's external debt, the bad equilibrium is removed even without an actual depletion of reserves. On the contrary, a fiscal spending increases the demand for domestic goods and thus virtually appreciates the domestic exchange rate. An appreciated currency increases firms' net worth and facilitates investment.

JEL Classification: F31, F32, F41, G01, H30
Keywords: Foreign reserves, currency mismatch, balance sheets, real exchange rate

1 Introduction

The global economic turmoil which started with a local crisis in 2007 in the United States has quickly become a widespread global crisis whose magnitude has never been seen since the Great Depression in 1929. One particular phenomenon which can be observed in recent years is that emerging market economies (EME), which seemed most vulnerable during the last waves of financial crises in the 1990s, fared much better than advanced economies during the GFC.

As a matter of fact, figure 1 presents two crisis impact indicators[1] in terms of real GDP losses in the G20 countries (excluding the European Uinon); we can see that many EMEs, such as China, Indonesia, India and Argentina, suffered less output losses than developed industrial economies. Moreover, figure 2 shows that the EMEs which had experienced a large currency depreciation in previous crisis periods (e.g. Thailand) demonstrates a remarkable exchange rate stability during the GFC.



(a) Detrended real GDP growth (b) Forecast errors

Figure 1: Crisis impact indicators

Since 2009, an increasing number of papers started to look at the strengthened resilience of EMEs during the crisis and the underlying reasons[2]. Two noticeable changes in EMEs have been particularly highlighted. First, they have accumulated massive foreign reserve assets between the early 2000s and the onset of the GFC. By examining the conventional metrics[3] of foreign reserve adequacy ratios (see table 1), one can easily see

[1]Both indicators are calculated by Bussière et al. (2012). The detrended real GDP growth measures the difference between the actual annual real GDP growth rate in 2009 and a six-year historical mean before the crisis. The forecast errors capture the difference between the actual real GDP growth in 2009 and the IMF World Economic Outlook (WEO) forecast in the first quarter of 2008 (before the Lehman collapse in September of the same year).

[2]For a detailed review, please refer to Eichengreen (2010), Didier et al. (2012), Gourinchas and Obstfeld (2012), Ceballos et al. (2013), Bussière et al. (2012), Catao and Milesi-Ferretti (2013) and Obstfeld (2013).

[3]There are four commonly used reserve adequacy metrics: reserves to GDP ratio, reserves to imports ratio, reserves to M2 ratio (see Obstfeld et al. (2010)) and reserves to short-term debt ratio (Greenspan-Guidotti's rule).

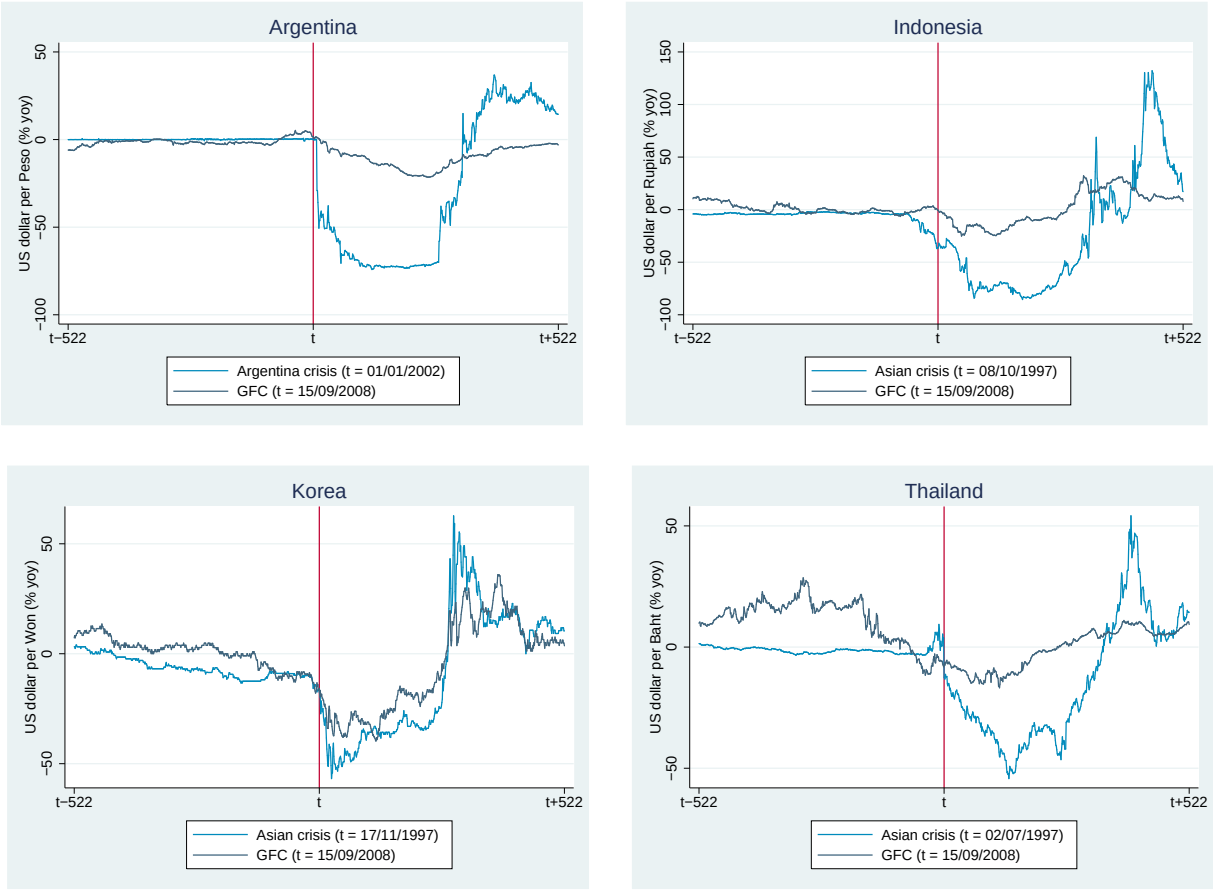


Figure 2: Nominal exchange rate depreciation in times of crises: The series are expressed in year-on-year growth rate (percentage point). A negative value indicates a depreciation. Time t indicates the date of crisis occurrence which is chosen according to Obstfeld (2013) and other relevant literature on emerging market crises. Data source: DataStream, GTIS - FTID/TR

Table 1: Reserve adequacy ratios

Country	$\frac{Reserves}{GDP}$, %		$\frac{Reserves}{imports}$, months		$\frac{Reserves}{m2}$, %		$\frac{Reserves}{st.debt}$, %	
	2000	2007	2000	2007	2000	2007	2000	2007
Argentina	8.84	17.02	9.11	10.04	27.77	55.92	64.97	406.38
Brazil	5.03	13.13	5.37	13.65	11.38	19.25	96.66	343.58
China	14.04	45.24	8.06	17.75	10.24	27.74	872.04	1270.63
India	8.21	24.25	6.22	11.47	15.14	29.73	423.01	344.19
Indonesia	17.22	12.72	6.11	6.02	36.51	31.38	141.84	192.61
Korea	18.02	24.98	5.98	7.19	29.43	41.31	293.39	206.73
Mexico	5.65	8.49	2.22	3.42	22.66	31.66	159.17	344.36
Russia	9.34	36.07	4.77	19.89	43.52	80.68	229.17	507.16
Saudi Arabia	10.38	79.3	4.44	25.23	23.32	144.08	191.36	1072.94
South Africa	4.57	10.35	2.21	3.62	9.23	12.07	54.81	195.82
Thailand	26.09	34.49	5.36	6.28	24.56	31.68	310.90	1012.25
Turkey	8.44	11.31	4.42	4.95	26.33	23.22	85.34	132.91

that many EMEs have doubled or even tripled (e.g. Argentina and Thailand's reserves to short-term debt ratio) their reserve adequacy ratios from 2000 to 2007. At the same time, EMEs seemed to have slowly "[graduated] from fiscal procyclicality" (Frankel et al. (2013)) and have proactively used fiscal policy to rescue their domestic economy during the crisis period. According to Obstfeld (2013) it seems like these fast-growing economies used the tranquil time after the emerging market crises at the end of the 1990s to reform their policy framework so that they have become more resilient to external shocks of the 21st century.

Based on these recent empirical observations, my work provides a simple theoretical framework to understand the reasons explaining this gain in resilience against the crisis in EMEs. The starting point of the story I tell resides on the canonical Krugman (1999) model which reveals the balance sheet effect through investors' expectation on a country's exchange rate as a main source of fragility in EMEs, albeit their relatively sound macroeconomic fundamentals. In particular, in the context of the GFC, a gloomy world economic outlook may trigger investors to downward bet a country's exchange rate especially when the country has a large export sector. A negative perspective on a country's currency would then increase entrepreneurs' financial burden of foreign debt repayment and make them temporary insolvent. I argue in this paper that the government can use several precautionary or in-crisis management measures to restore lenders' confidence on the country's currency. One the one hand, the government can use its previously accumulated foreign reserves as a targeted lending to the private sector; namely the government writes off the private sector's foreign-currency liabilities or provides extra foreign-currency liquidities when any other external funding is cut off. This is equivalent to give lenders' a government guarantee on the loans they grant private entrepreneurs. On the other hand, the country's authorities may choose to stabilize domestic absorption via an increase in government spending. This expansionary fiscal policy can be financed by foreign reserves (expenditure switching policy) for example.

Comparing the targeted lending with fiscal spending, it is shown in this paper that although both policies eliminate the bad equilibrium (i.e. a very depreciated exchange rate and a zero domestic investment) they stabilize the economy through two different

mechanisms. A targeted lending mainly affects lenders' expectation on domestic entrepreneurs' wealth which is used as a collateral for borrowing. The bad equilibrium can be removed even without an actual depletion of reserves as long as the stock of reserves in the economy is sufficient with respect to entrepreneurs' foreign debt. However, a fiscal spending virtually changes the value of the domestic exchange rate by an increase in demand for domestic goods on the good market. Therefore, it is not surprising to see that the targeted lending policy requires less foreign reserves than in case of fiscal spending. In both cases, the stock of reserves matters. In case of targeted lending, it confirms lenders' expectation on the possibility to be fully insured against their loans to entrepreneurs; in case of fiscal spending, it guarantees there are sufficient resources for the government to conduct appropriate fiscal policies.

This paper is closely related to three strands of literature: foreign reserve accumulation, 'third-generation' crisis models and currency mismatch, as well as the countercyclical fiscal policies in EMEs during the GFC.

As for the motives of foreign reserve accumulation, my work fits well in the works on the precautionary motive of reserve holding[4]. In the literature, studies on the precautionary role of reserves have been mainly focusing on how holding reserves can smooth domestic output or/and consumption when the economy is hit by 'sudden stops' (Jeanne and Rancière (2011))[5] or when the government faces increasing costs of external financing or default risks (Bianchi et al. (2012)). In contrast, I rather study how reserves are useful in the context of currency mismatch and the resultant balance sheet effect. In fact, reserves cab bot only be used to provide foreign-currency liquidity in case of 'sudden stops' (Calvo et al. (2008)), they can also alter investors' expectations on the net worth of a country's private sector and on the country's domestic currency exchange rate, thus insulating the domestic economy from the balance sheet effect of the private sector. This is the focal point of my current work. After all, the last wave of emerging market crises, especially in Asia, is largely explained by this balance sheet effect and curiously, this aspect of the insurance role of reserves has not been thoroughly analyzed. My current work can also be regarded as a theoretical underpinning to a few recent empirical papers[6] which point out that reserves to external short-term debt ratio[7] is the most relevant metric to predict countries' economic performance during the GFC. Moreover, I argue

[4]For a detailed review, see Aizenman and Lee (2007), Alfaro and Kanczuk (2009), Aizenman and Hutchison (2010), Obstfeld et al. (2010), Jeanne and Rancière (2011), Bianchi et al. (2012), Benigno and Fornaro (2012), Bussière et al. (2012) and Calvo et al. (2013).

[5]Based on a calibration using a sample of sudden stops in 34 middle-income countries over 1975-2003, Jeanne and Rancière (2011) show that the negative impact of the financial account reversal on domestic absorption can be offset by a depletion of reserves; a 10% fall in capital inflows leads to less than 3% of GDP collapse if there is a buffer stock of reserves.

[6]See Llaudes et al. (2010), Bussière et al. (2012) and Catao and Milesi-Ferretti (2013)

[7]In the case of emerging market economies, their short-term debts are mostly denominated in foreign currency due to the 'Original sin' (Eichengreen et al. (2007))

that depending on the policy tool used, foreign reserves need to be or not to be virtually depleted. This is related to the empirical finding of Bussière et al. (2012) who document that reserves are rather 'nuclear power' than real 'gunpowder'. Finally, my work does not only focus on the motives of reserve accumulation, it also analyzes and compares different ways of 'using' reserves. This is a new angle of studying foreign reserves.

My current work is also closely related to the literature on the 'third-generation' crisis. In the aftermath of the Asian financial crisis, Krugman (1999) demonstrates that multiple equilibria exist when the private sector in a country faces credit constraint (where the net worth serves as a collateral) and is exposed to large foreign-currency debt. While Krugman (1999) aims at proving the existence of multiple equilibria, I propose concrete policy choices to eliminate the bad one. Moreover, I add a government sector into Krugman (1999)'s framework. By doing so, lenders' expectation concerns not only entrepreneurs' wealth but also the strength and the willingness of the government to stabilize domestic economy whenever it is necessary. My paper is also inspired by Aghion et al. (2000) and Aghion et al. (2004) who provide a micro-founded version of Krugman's model. While these two papers focus on how a monetary policy affects the multiple equilibria, I study on fiscal policies and targeted lending in foreign currency.

The currency mismatch is a key assumption for the balance sheet effect to work. In the scope of this paper, as I aim at illustrating how different public policies may be used to stabilize the domestic economy rather than at explaining why entrepreneurs want to hold foreign-currency liabilities *ex ante*, I take currency mismatch as given. There are nevertheless various well-founded motivations in the literature explaining the demand for foreign-currency liabilities. Burnside et al. (1999) and Schneider and Tornell (2004) argue that foreign-currency borrowing results from a risk-overtaking behavior of domestic firms when they know that the government will bail out domestic banks in case of default. Jeanne (2000) and Jeanne (2003) point to the signaling and commitment effect of borrowing in foreign currency. Namely, by allowing the private sector to hold foreign debt which is subject to exchange rate fluctuations, the government sends the market a signal about its commitment not to inflate the economy or depreciate the currency. The need for foreign funding can also be explained by the fact that the domestic financial market is underdeveloped; there is no sufficient domestic savings to be channeled to firms. This is the assumption pointed out by Aghion et al. (2000) that I follow in my analysis.

Regarding how to reduce the impact of the currency mismatch, Jeanne and Zettelmeyer (2002) compare the pros and cons of the monetary policy or the choice of exchange rate. They conclude that the monetary policy is contradictory in dealing with the balance sheet effect. With perfect capital mobility, the country where the private sector is hit by negative expectations on the exchange rate should increase the interest rate to prevent an actual depreciation. However, a rise in interest

rates is detrimental to domestic investment. I explore in this paper a policy choice that has been mentioned but not analyzed in Jeanne and Zettelmeyer (2002): how fiscal policies can play a role when the monetary policy is not efficient in dealing with the multiple equilibria. Different fiscal policy tools are analyzed in the subsequent sections. Jeanne and Wyplosz (2003) takes a different angle to analyze how an international lender-of-last-resort can be useful in dealing with the issue of currency mismatch. The GFC has unfortunately demonstrated that an international coordination in the matter of crisis management is far from developed nowadays. Many countries might prefer to constitute a buffer stock for self-insurance instead of resort to the assistance of international financial institutions.

Finally, my paper is related to some recent empirical works on how EMEs used countercyclical fiscal policies to tackle the GFC. As Crowe et al. (2009), Eichengreen (2010) and Didier et al. (2012) point out, in the past, fiscal policy in emerging market countries used to be procyclical because EME business cycles tend to be driven by capital flows (see Kaminsky et al. (2005)). This strand of literature has emphasized the role of countercyclical fiscal policies to smooth domestic production. I rather study to what extend these policies can help alleviate the balance sheet effect in the private sector. Prasad (2011), Didier et al. (2012) and Obstfeld (2013) argue that many EMEs have reduced the external debt denominated in foreign currency and the external financing is oriented towards equity (which have advantages of being denominated in local currency and state-contingent) and foreign direct investment. However, as Llaudes et al. (2010) points out 'large increases in reserves played a more important role than any change in the currency denomination of external debt' in reducing a country's exposure to external liabilities. The private sector might still shave net foreign liabilities in their balance sheet and is thus vulnerable to valuation losses in case of domestic currency depreciation. Indeed, as Eichengreen (2010) states, '[w]hile on-balance sheet foreign currency mismatches had been reduced, corporations [...] had increased their off-balance sheet foreign currency exposure through derivative positions.'

This paper is organized as follows. Section 2 describes the model setting. Section 3 analyzes and derives conditions for the existence of multiple equilibria in absence of government intervention. Section 4 studies and compare two possible fiscal policies aiming at stabilizing the domestic economy. Section 5 concludes.

2 The model

The analysis in this paper is based on a simple theoretical framework of multiple equilibria which can be regarded as an extension of Krugman (1999). The model

presents a small open real economy composed of three agents: 'hand-to-mouth' workers, entrepreneurs and a government.

2.1 Workers

As in Krugman (1999), the role played by workers is completely passive. They provide the labor force to entrepreneurs and get paid at the marginal product of labor. They do not have access to financial market so that they consume all the labor income every period (so called 'hand-to-mouth' labor). The choice of passive labor force is motivated by the fact that the main mechanism of the balance sheet effect goes through entrepreneurs' investment decision to which the focus is placed in this paper. It is further assumed that the labor supply is inelastic and the total mass of labor is equal to one.

The workers consume both domestic goods, C_t^H, and foreign goods, C_t^F. The domestic goods are regarded as the numéraire with an unitary price. Therefore, the price of foreign goods in terms of domestic goods, p_t, also denotes the real exchange rate of domestic goods. For simplicity, I assume that the elasticity of substitution between domestic goods and foreign goods is one. The workers maximize their utility subject to the budget constraint as described below:

$$\begin{aligned} \underset{C_t^H, C_t^F}{\text{Maximize}} \quad & U(C_t^H, C_t^F) = (C_t^H)^{1-\mu}(C_t^F)^{\mu} \\ \text{subject to} \quad & C_t^H + p_t C_t^F = C_t \end{aligned}$$

C_t refers to the total consumption by domestic workers, expressed in terms of domestic goods. The workers' maximization program yields the following results:

$$\begin{aligned} C_t^H &= (1-\mu)C_t \\ C_t^F &= \frac{\mu C_t}{p_t} \end{aligned}$$

The consumption of domestic goods is thus a constant share μ of the total consumption C.

2.2 Entrepreneurs

Entrepreneurs own and invest in capital; they also produce domestic goods using two inputs: domestic capital and labor. The production function is a standard neoclassical production function. Namely, the production is increasing in both inputs with decreasing marginal returns and is homogeneous of degree one.

$$Y_t = F(K_t, N_t) = K_t^{\alpha} N_t^{1-\alpha}$$

Notice that capital K_t and labor N_t are both chosen in $t-1$. Therefore, at the beginning of period t, the output Y_t is predetermined. Moreover, an immediate result that can be derived from the Cobb-Douglas production function is that a constant share $(1-\alpha)$ of output accrues to workers (labor income) and another share α of output goes to entrepreneurs (capital income).

The capital is indeed chosen a period earlier through investment and fully depreciates every period, namely $K_t = I_{t-1}$. The investment, just like the total consumption, is made of both domestic goods and foreign goods. Again I assume, for simplicity, that the elasticity of substitution between domestic goods I_t^H and foreign goods I_t^F in the investment is one. As a result, the share of investment in domestic goods is also μ, namely:

$$
\begin{aligned}
I_t^H &= (1-\mu) I_t \\
I_t^F &= \frac{\mu I_t}{p_t} \\
K_{t+1} &= I_t
\end{aligned}
$$

Each period, the only important decision that entrepreneurs need to make is how much to invest in capital which is financed by borrowing from both domestic lenders and foreign lenders[8].

There are two important assumptions which characterize entrepreneurs' investment behavior: entrepreneurs face credit constraint on the one hand and they have foreign-good denominated liabilities on the other.

First, the credit constraint assumption stipulates that the maximum amount of credit that entrepreneurs may obtain in period t depends on their net worth. Namely, when making lending decisions, lenders form an *expectation* on entrepreneurs' wealth which serves as a collateral for borrowing: $L_t^e \leq \psi W_t^e$. L_t^e denotes *expected* credit that lenders are willing to grant entrepreneurs. W_t^e refers to entrepreneurs' *expected* wealth. ψ is a parameter of the tightness of the credit market. The higher ψ[9], the higher leverage

[8] Another decision is how much labor to hire. As in this paper, I assume the labor is 'hand-to-month' and the labor supply is inelastic, $N_t = 1$ every period.

[9] The value of ψ clearly depends on the stage of development in a country. $\psi = 0$ when no borrowing (especially external borrowing) is possible. This can be the case in less developed countries where the financial market is far from developed. In this extreme case, the balance sheet effect is not at work as there is no foreign borrowing at all. In an advanced economy, ψ is expected to be high, the private sector mainly replies on borrowing to finance the investment. As Aghion et al. (2000) argue, the financial market is mature in advanced economies, there is sufficient domestic credit available such that the balance sheet effect may or may not apply. The emerging market economies (middle-income countries) that I focus on in this paper should have a ψ in between the two former cases with a sufficient need of foreign credit.

entrepreneurs have. Entrepreneurs' investment at time t can be written as:

$$I_t^e = W_t^e + L_t^e \leq (1+\psi)W_t^e \tag{1}$$

The functional form of the credit constraint is well-founded in the literature on financial accelerator (see Bernanke et al. (1999)), based on the idea of contract enforcement. The investment constraint (1) can be binding or unbinding depending on the value of the collateral. When this constraint is binding, $I_t^e = (1+\psi)W_t^e$. When the constraint is unbinding, the amount of investment is determined by the equalization between marginal product of capital and marginal cost. Namely, $F_k(K_{t+1}, N_{t+1}) = R_t^*$, where $F_k(\cdot)$ denotes the marginal product of capital (see Appendix A). This gives $I_t = \bar{I} = \left(\frac{\alpha}{R^*}\right)^{\frac{1}{1-\alpha}}$ when the credit constraint is not binding.

The second assumption that entrepreneurs have foreign-good denominated liabilities is crucial to trigger the balance sheet effect that this paper wants to study. As entrepreneurs have foreign-good denominated liabilities, their wealth W_t is subject to the valuation effect of the exchange rate. As in Krugman (1999), I take the currency mismatch as given in order to concentrate on the link between lenders' expectation on the domestic exchange rate, and entrepreneurs' wealth and investment. There are several ways to endogenize the portfolio choice of entrepreneurs as I summarized in the literature review. A nature extension of my current work is to endogenously determine entrepreneurs' portfolio choice.

Entrepreneurs' wealth function can thus be written as follows:

$$W_t^e = \alpha Y_t - D_t - p_t^e D_t^* \tag{2}$$

Notice that Y_t is predetermined in period t as both inputs of production are chosen a period earlier. αY_t is the output accruing to entrepreneurs (equivalent to entrepreneurs' earnings after paying the labor force). D_t and D_t^* respectively denote the domestic-good denominated and foreign-good denominated net debts. They are both exogenously given. Therefore, the expectation on entrepreneurs' wealth in period t only depends on the expectation on the exchange rate p_t^e. Clearly, if lenders *thought* the price of the domestic good would depreciate, they would *expect* an increase in entrepreneurs' burden of foreign debt repayment, thus a decrease in entrepreneurs' net worth. As a result, lenders would cut down their investment, driving down the next-period production (period $t+1$) through equation (1).

Combining equations (1) and (2), the demand for investment of entrepreneurs can be derived below; it is a truncated function of the expected exchange rate.

$$I_t = \begin{cases} 0 & p_t > \bar{p}_t \\ (1+\psi)(\alpha Y_t - D_t - p_t^e D_t^*) & \underline{p}_t < p_t^e < \bar{p}_t \\ \bar{I} = \left(\frac{\alpha}{R_t^*}\right)^{\frac{1}{1-\alpha}} & p_t < \underline{p}_t \end{cases} \tag{3}$$

$\bar{p}_t = \frac{\alpha Y_t - D_t}{D_t^*}$ denotes the threshold value of *expected* exchange rate beyond which entrepreneurs' wealth is reduced to zero or beneath. On the contrary, $\underline{p}_t = \frac{\alpha Y_t - D_t - \frac{\bar{I}_t}{1+\psi}}{D_t^*}$ denotes the threshold value of *expected* exchange rate below which entrepreneurs' wealth is high enough and the credit constraint (1) does not bind. In between these two threshold values, the investment is a negative function of the expected exchange rate.

In sum, as the red cycle in figure 3 illustrates, the mechanism of the model goes through lenders' expectation on the domestic exchange rate which affects entrepreneurs' expected wealth via foreign debt repayment. The expected investment in the economy will ultimately determine the actual level of the domestic exchange rate on the good market as I will detail in the next subsection. Therefore, the only endogenous variables in this model that are important in period t are domestic investment I_t, domestic exchange rate p_t and entrepreneurs' wealth W_t. As a matter of timing, all the decisions are made within the period t. The impact of the period t decisions on the future economy only goes through domestic investment which will be entirely used for the next-period production. From Section 3 and on, I will drop the time subscripts as we only need to focus on period t variables.

2.3 Government and the good market clearing

I introduce a government in the model economy. Entering period t, the government has some resources in hands in the form of foreign reserve assets B^* that have been accumulated beforehand. The following sections of the paper will focus on how the government should use its resources to stabilize the domestic economy whenever it is necessary. For purposes of analysis, the costs of accumulating reserves or collecting taxes *ex ante* are not incorporated into analysis.

To close the model, it is also assumed that the domestic economy exports part of domestic output abroad. I denote X_t^* units of domestic goods exported which are expressed in terms of foreign goods. I assume that the foreign elasticity of substitution is also one. In Appendix D, I present an alternative model in which the foreign elasticity of substitution is bigger than one.

The aggregate demand for the domestic goods can be written below;

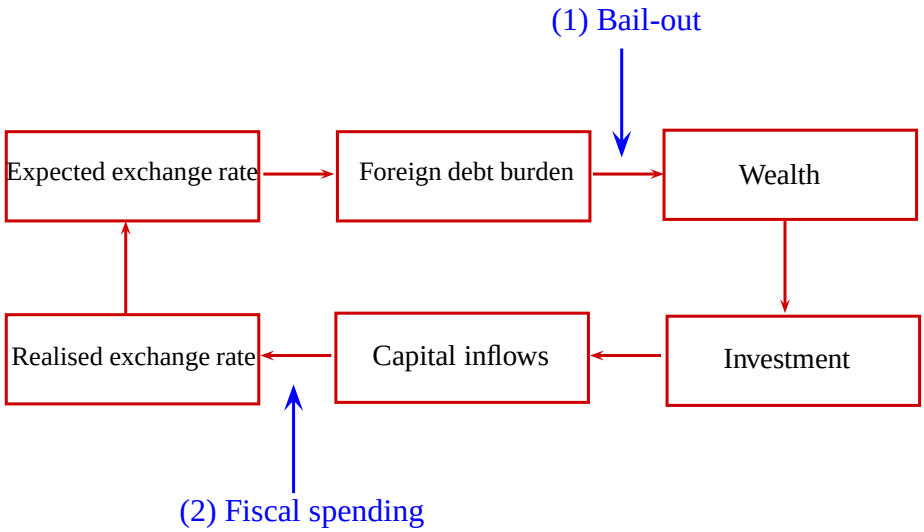


Figure 3: Model scheme

$$\begin{aligned} Y_t &= (1-\mu)C_t + (1-\mu)I_t + p_t X_t^* \\ &= (1-\mu)(1-\alpha)Y_t + (1-\mu)I_t + p_t X_t^* \end{aligned} \tag{4}$$

This is actually the equation which determines the real exchange rate given a level of investment. Bear in mind that the production is predetermined and the foreign demand is exogenously given. Therefore, equation (4) gives an unambiguous negative relationship between exchange rate and investment, as described below:

$$p_t = \frac{Y_t[\mu + (1-\mu)\alpha] - (1-\mu)I_t}{X_t^*} \tag{5}$$

An increase in domestic total investment appreciates the value of domestic good (an appreciation of the domestic currency in a nominal model). This is because an increase in domestic investment raises the demand for domestic goods. As the supply of domestic goods is predetermined, an increase in the demand leads to a rise in the price of domestic goods.

The model economy is summarized in figure 3. I will show that there are multiple equilibria in a decentralized economy in Section 3 and how two government policies (targeted lending or fiscal spending) can help eliminate the bad equilibrium in Section 4.

3 Multiple equilibria in a decentralized economy

3.1 Market equilibrium

This stylized model can be solved using a system of two equations (3) and (5) in an orthogonal plan of $p(p^e)$ and $I(I^e)$.

Equation (3) links the *expected* exchange rate[10] and *expected* investment from lenders' viewpoint. This gives a truncated curve of the demand for investment (henceforth called II curve), as figure 4 shows:

- When lenders expect a large depreciation, meaning that $p^e > \bar{p}$, the burden of foreign-good denominated debt repayment is so heavy that entrepreneurs' wealth is driven to beneath zero. In this case, no pledgeable income is available for lenders. Therefore, rational investors would never lender to the economy. Thus, $I = 0$. This scenario is represented as a vertical segment on the y-axis
- When foreign investors expect a large appreciation which increases entrepreneurs' wealth so largely that the credit constraint (1) never binds. Domestic investment reaches the unbinding level: $\bar{I} = \left(\frac{\alpha}{R^*}\right)^{\frac{1}{1-\alpha}}$. This situation is represented by the vertical segment with $I = \bar{I}$ for all values of $p^e < \underline{p}$
- When $\underline{p} < p < \bar{p}$, the investment is determined by the binding credit constraint (1)

Recall that $\bar{p} = \frac{\alpha Y - D}{D^*}$ and $\underline{p} = \frac{\alpha Y - D - \frac{\bar{I}}{1+\psi}}{D^*}$.

Equation (5) gives an unambiguous negative relationship between p and I; it determines the level of the domestic exchange rate given a level of investment. A downward sloping line (henceforth called the DD curve) which represents equation (5), along with x- and y-axes form the feasible set of the economy (see figure 5).

3.2 Conditions for the existence of multiple equilibria

Combining the II and DD curves gives the equilibrium points in the model economy as figure 6 illustrates. There can be multiple equilibria: a good equilibrium and a bad equilibrium (the middle intersection point is unstable, proof in Appendix B), should the following conditions be fulfilled:

1. $\frac{[\mu+(1-\mu)\alpha]Y}{X^*} \geq \bar{p} = \frac{\alpha Y - D}{D^*}$

[10] Here I can talk about the *expected* exchange rate, as the credit constraint is forward-looking, lenders make lending decisions before the actual realization of the exchange rate which is determined by equation (4).

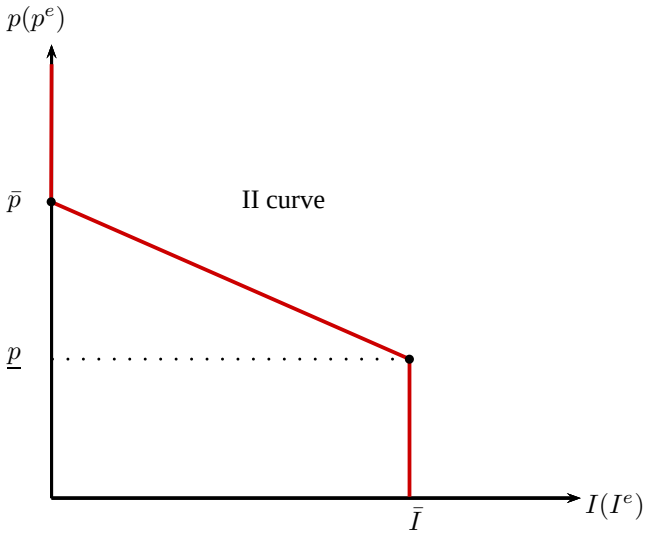


Figure 4: Demand for investment

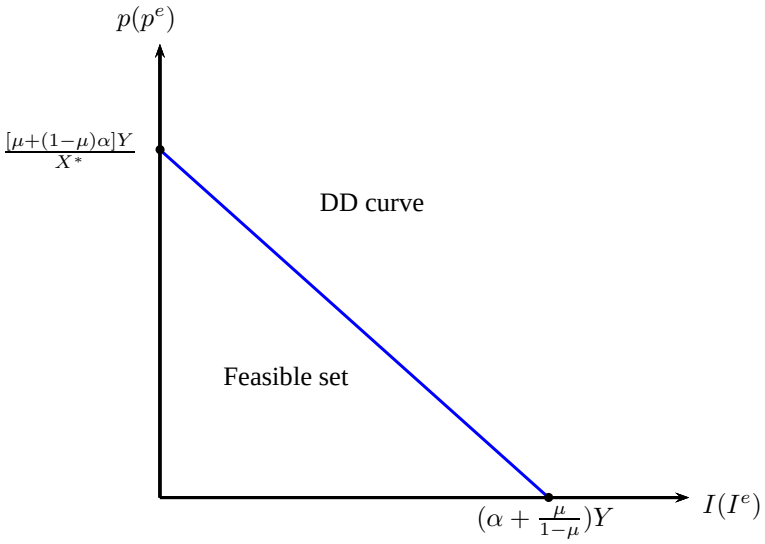


Figure 5: Aggregate resources

2. $|-\frac{1-\mu}{X^*}| \geq |-\frac{1}{(1+\psi)D^*}|$

The condition 1 is to insure that a bad equilibrium exists. This yields $\frac{D^*}{X^*} \geq \frac{\alpha-d}{\mu+(1-\mu)\alpha}$. $d = \frac{D}{Y}$ denotes the per GDP ratio of domestic-good denominated liabilities, which is exogenously given.

The condition 2 is to insure that there is a good equilibrium. It requires the DD curve to have a steeper slope than the II curve when the credit constraint is binding[11]. This leads to $\frac{D^*}{X^*} \geq \frac{1}{(1-\mu)(1+\psi)}$.

As a result, to remove the bad equilibrium, it is sufficient to violate the condition 1.

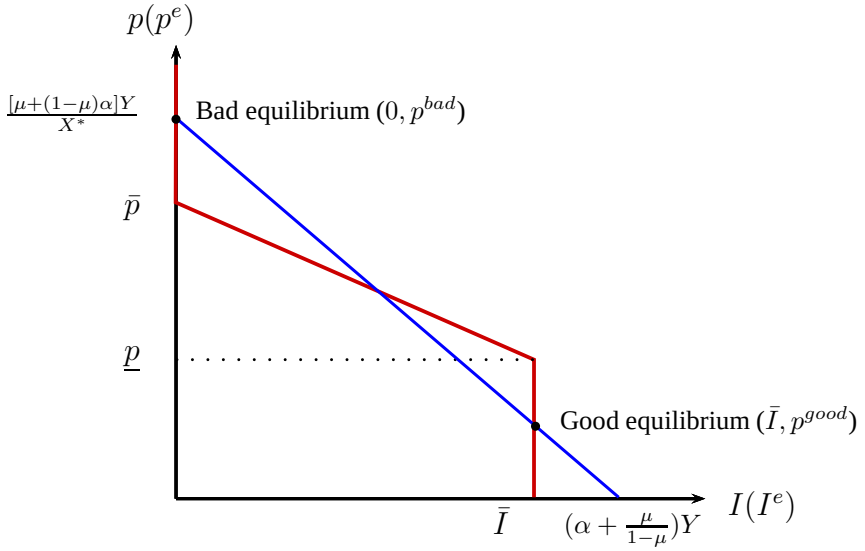


Figure 6: Multiple equilibria

Therefore, as long as $\frac{D^*}{X^*} \geq max\left(\frac{1}{(1-\mu)(1+\psi)}, \frac{\alpha-d}{\mu+(1-\mu)\alpha}\right)$, there are multiple equilibria in the economy. This is equivalent to say that the model economy needs to be sufficiently exposed to foreign-good denominated liabilities (relative to foreign income from exports) such that multiple equilibria exist. For small values of ψ (tightness of the credit constraint), it can be proved that $\frac{1}{(1-\mu)(1+\psi)} > \frac{\alpha-d}{\mu+(1-\mu)\alpha}$. It is sufficient to have $\frac{D^*}{X^*} \geq \frac{1}{(1-\mu)(1+\psi)}$ so as to validate the existence of multiple equilibria.

In sum, the existence of multiple equilibria mainly depends on four key parameters: the leverage ratio (ψ), the propensity to imports (μ), the level of foreign-good denominated debt (D^*) and the level of exports (X^*). The story on the expectation is simple, similar to the one told by Krugman (1999). If investors expect a depreciation of the price of domestic goods, they anticipate a decrease in entrepreneurs' wealth due to a higher repayment burden of foreign-good denominated debt, the resultant lower collateral value

[11]Strictly speaking, there might be another possible equilibrium: when the DD curve is very steep, it might intersect the x-axis before reaching the vertical segment $I = \bar{I}$ (namely $p < 0$). This gives a corner solution which is the intersection point between the DD curve and the x-axis. This is however not an interesting solution. For purposes of this paper, I concentrate on the interior solutions of the model.

decreases lenders' incentives to invest in the economy. A reduction in capital inflows is thus expected, driving down the price of domestic goods and further confirms investors' expectation. This unambiguously leads to the bad equilibrium $(0, p^{bad})$. On the contrary, an optimistic expectation on the price of domestic goods will lead to the good equilibrium.

I will show in the next section to what extent appropriate public policies can eliminate the bad equilibrium and stabilize the domestic economy, especially in the context of unfavorable international economic environment.

4 Government policies

To understand the differences between the different ways of using reserves, suppose we are in the context of the GFC and lenders expect a negative shock on foreign demand X due to the so called 'Global trade collapse (Baldwin (2009))'. Without any government intervention, a domestic good price depreciation is expected through the resource constraint (4).

The objective of the government is to eliminate the bad equilibrium which co-exists with the good one in the decentralized economy. There are two ways to achieve this objective: a targeted lending to entrepreneurs in foreign goods or an increase in public spending. It will be shown below how these two policy tools work in the current framework.

4.1 Targeted lending to the private sector

As the government has previously accumulated foreign reserves, one policy choice is to lend directly foreign goods to the private sector so as to insulate entrepreneurs' net worth from a potential exchange rate depreciation. As a consequence, the impact of the exchange rate on entrepreneurs' balance sheets would be largely reduced. A depreciation increases the foreign debt repayment but also increases the government's targeted lending, all expressed in terms of domestic goods. This policy is similar to the idea of setting an 'international banking fund' which provides liquid foreign-good assets to 'truly solvent banks' (Jeanne and Wyplosz (2003)). The difference here is that the targeted lending is provided by the national government[12].

The promise of the government to strength entrepreneurs' wealth by targeted lending changes the wealth function (2). It in fact alters the lenders' perspectives on entrepreneurs' wealth, thus on the value of collateral for their lending. The new wealth

[12]Clearly, the 'international banking fund' has never be founded since Jeanne and Wyplosz's paper in 2003. One argument in this model in favor of holding international reserves at the national level is that the stock of reserves gives a positive signal to the market on the economy's financial capacity to conduct appropriate policies in the times of crises. Moreover, national authorities should know better their domestic private institutions and can be more easily to select 'truly solvent' banks or firms to which the lending in foreign good should be granted

function is written:

$$W^e = \alpha Y - D - p^e D^* + p^e B^{*e} \tag{6}$$

The aggregate resource function (4) which determines the actual level of exchange rate does not change, as nothing changes the demand of domestic goods. As a result, the DD curve remains the same while the II curve shifts upward (with the unbinding level of demand for investment $\bar{I}$ unchanged which only depends on international interest rate). Figure 7 shows the new equilibrium and compares it with the multiple equilibria in a decentralized economy.

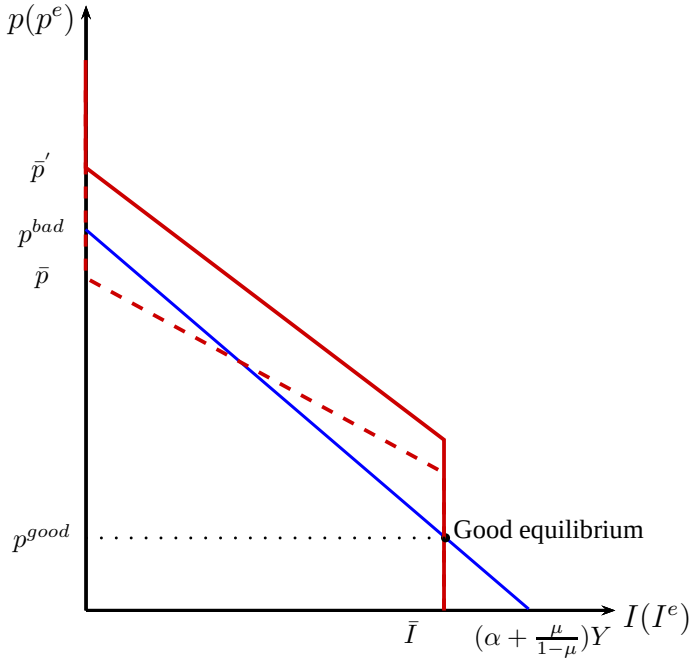


Figure 7: Equilibrium with targeted lending

Figure 7 clearly shows that when the government lends foreign goods to the private sector, it eliminates the bad equilibrium $(0, p^{bad})$, where $p^{bad} = \frac{Y[\mu+(1-\mu)\alpha]}{X^*}$, as it is derived in Section 3. The good equilibrium is the same as in the decentralized market equilibrium. Put it in another way, the government's commitment to lend foreign good to entrepreneurs whenever it is necessary is equivalent to give lenders a government guarantee on their loans. This immediately eliminate the bad equilibrium. In theory, if the government has enough foreign reserves to cover foreign-good denominated liabilities, it does even not need to actually use its stock of reserves. As long as the government's commitment is credible (backed by the stock of foreign reserves), the expectation of lenders will be altered towards the good equilibrium through equation (6).

In fact, with the government's targeted lending pB^*, the slope of the II curve becomes steeper. The bad equilibrium is removed as long as $0 < p^{bad} \leq \bar{p}' = \frac{\alpha Y - D}{D^* - B^*}$. This gives:

$$D^* - \frac{\alpha - d}{\mu + (1-\mu)\alpha} X^* \leq B^* < D^* \tag{7}$$

The minimum level of reserves needed for targeted lending is equal to $B^{*bail}_{min} = D^* - \frac{\alpha-d}{\mu+(1-\mu)\alpha} X^*$. From the first condition for the existence of multiple equilibria, one can see that B^{*bail}_{min} is larger than zero as long as there are multiple equilibria. Namely, when the foreign-good income cannot cover foreign liabilities, reserves are needed to make sure that entrepreneurs' wealth is above zero.

The amount of reserves needed [13] depends on the private sector's exposure to foreign-good debt (D^*). The higher foreign debt, the higher reserves needed for targeted lending policy. It is negatively correlated with foreign-good income earned through exports. If at time t, the flow of exports exceeds that of foreign liabilities, B^* might become negative, namely there is an accumulation of reserves instead of depletion. The amount of reserves for targeted lending policy also depends on the marginal propensity to imports and the share of domestic lending per GDP. The higher μ, the more foreign goods are needed, thus higher reserves are needed to pay out foreign goods

In reality, during the GFC, some emerging economies which were seriously hit by the balance sheet effect during the last wave of emerging economy crisis experienced rather an exchange rate stability. This is the case in Thailand for example (see Figure 2). Obstfeld (2013) attributes this exchange rate stability to the ample level of reserves in Thailand compared to its external debt. In the case of Korea, albeit a large absolute level (sixth largest reserve holder), the reserves to short-term debt ratio is less impressive in Korea in comparison to other EMEs (see table 1). If reserves are scaled by total external debt of different maturities, they can only cover 70% of the entire exposure of the Korean private sector to foreign-currency debt. According to Cho, the Korean government depleted its foreign reserves to supply foreign currency liquidity required to reduce the accumulated leverage in the private banking sector; '[i]t was not a sheer coincidence that the amount of decrease in foreign reserves during the crisis period from September to December 2008, approximately US$40 billion, was almost the same as that of short-term foreign debts (Cho (2012)).'

4.2 Expansionary fiscal policy

The second policy choice of the government is to increase public spending. Bearing in mind that in the framework of Krugman (1999), a fiscal spending cannot be understood in the Keynesian sense, as the price is fully flexible in his stylized model and the supply

[13] This is a flow variable which refers to the amount of reserves required to conduct a certain public policy. This is different from the stock of reserves which is a stock variable.

of domestic goods is predetermined at the beginning of each period. Therefore, an expansionary fiscal policy would raise domestic demand which appreciates the price of domestic goods given a fixed level of good supply; this would then increase entrepreneurs' wealth and investment. Albeit unconventional, this framework allows me to illustrate two ways of stabilizing domestic economy.

The fiscal spending can in fact be financed by previously accumulated foreign reserves. The public policy affects directly the aggregate resource constraint and gives:

$$Y = (1-\mu)(1-\alpha)Y + (1-\mu)I + G + pX^* \tag{8}$$

$$G = pB^* \tag{9}$$

It instantaneously affects the exchange rate as a fiscal spending raises the demand for domestic goods, thus raising the price of domestic goods. Through equation (8), the exchange rate is determined: $p = \frac{Y[\mu+(1-\mu)\alpha]-(1-\mu)I}{X^*+B^*}$.

The DD curves is rotated downwards around the point $\left((\alpha+\frac{\mu}{1-\mu})Y, 0\right)$. The II curve remains unchanged as in the decentralized economy.

Figure 8 shows the new equilibrium and compares it with the multiple equilibria in the decentralized economy. It can be seen that a fiscal spending financed by previously accumulated reserves can also eliminate the bad equilibrium $(0, p^{bad})$, where $p^{bad} = \frac{Y[\mu+(1-\mu)\alpha]}{X^*}$ as before. However, the good equilibrium in this case is not the same as in the decentralized economy or in case of targeted lending. In fact, although the realized investment is the same unbinding level of investment $\bar{I}$, the exchange rate is appreciated to $p^{good'}$. $(p^{good'} < p^{good})$. This is because a fiscal spending changes immediately the demand for domestic goods and determines consequently a new level of exchange rate through the aggregate resource constraint (4). Foreign reserves are depleted in this case.

As for the conditions eliminating the bad equilibrium, it can be observed in figure 8 that $p^{'}$ needs to be smaller than $\bar{p}$. Namely, $0 < p^{'} < \frac{Y[\mu+(1-\mu)\alpha]}{X^*+B^*} \leq \bar{p} = \frac{\alpha Y - D}{D^*}$. This gives:

$$D^* \frac{[\mu+(1-\mu)\alpha]}{\alpha - d} - X^* \leq B^{*fisc} \tag{10}$$

The minimum level of reserves needed to conduct the expansionary fiscal policy is: $B^{*fisc}_{min} = D^* \frac{[\mu+(1-\mu)\alpha]}{\alpha-d} - X^*$. The condition 1 for the existence of multiple equilibria also guarantees that $B^{*fisc} > 0$.

One may argue that government spending is usually financed by domestic taxes instead of foreign reserves. Suppose now that the fiscal spending is financed by previously collected taxes. In this case, the government resources are denominated in domestic-good

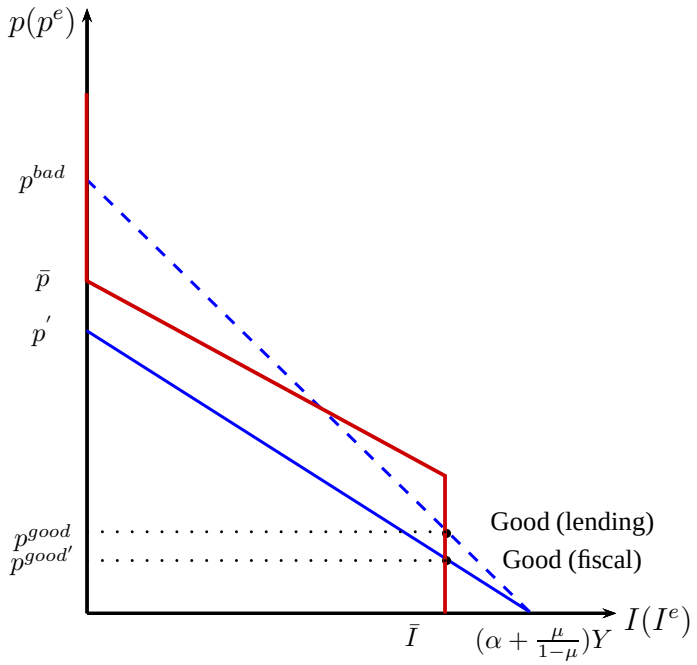


Figure 8: Equilibrium with fiscal spending financed by reserves

only. The new aggregate resource constraint becomes:

$$Y = (1-\mu)(1-\alpha)Y + (1-\mu)I + G + pX^* \tag{11}$$

$$G = T \tag{12}$$

The exchange rate is determined: $p^{''} = \frac{y[\mu+(1-\mu)\alpha]-T}{X^*}$. This time, the DD curve is shifting downwards in parallel to the former DD curve in the decentralized economy. The II curve remains unchanged. As one can see from figure 9, the bad equilibrium can also be eliminated, but the exchange rate needs to be more importantly appreciated in good equilibrium than in the case where fiscal spending is financed by foreign reserves.

The condition for removing the bad equilibrium requires: $p^{''} < \bar{p}$, namely

$$\frac{Y[\mu + (1-\mu)\alpha] - T}{X^*} \leq \frac{\alpha Y - D}{D^*}$$

This gives a criterion for the minimum taxes that the governments needs to stabilize the domestic economy in case of bad shocks. Namely, $T \geq Y[\mu + (1-\mu)\alpha] - \frac{(\alpha Y - D)X^*}{D^*}$. Namely, the minimum amount of taxes needed to eliminate the bad equilibrium is $T_{min} = y[\mu + (1-\mu)\alpha] - \frac{(\alpha Y - D)X^*}{D^*}$.

One counterfactual question which can be naturally asked is: if the public spending financed by taxes achieves the same equilibrium as in the case where fiscal spending is financed by foreign reserves, can the bad equlibrium also be removed? This situation

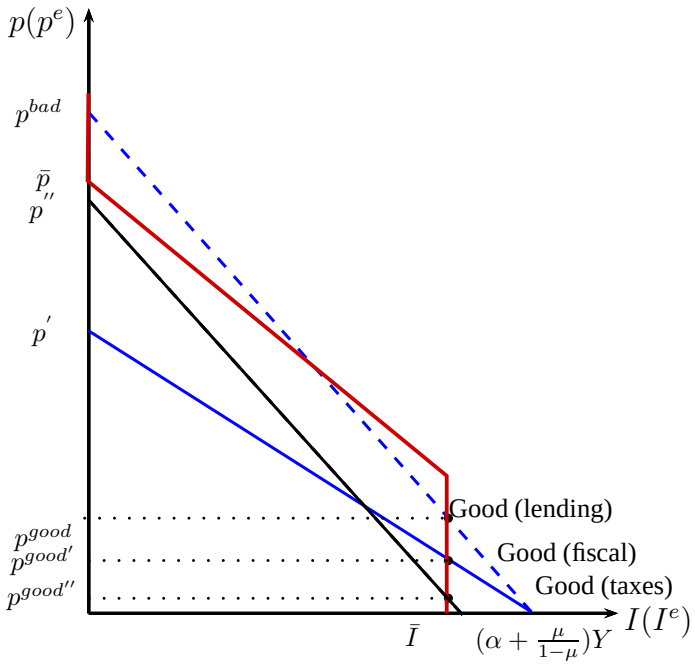


Figure 9: Equilibrium with fiscal spending financed by taxes

is represented by the black line in figure 10. It can be proved (see Appendix C) that a fiscal spending finaced by taxes cannot unambiguously remove the bad equilibrium as the minimum taxes which helps the economy to achieve the same good equilibrium as in the case of a fiscal spending financed by foreign reserves is smaller than the minimum taxes needed to remove the bad equilibrium.

The difference in the efficiency of the fiscal spendings which only differ in terms of financing method resides in the fact that using reserves not only raises the demand for domestic goods but also converts foreign goods into domestic goods - this also exerts an appreciation effect on the domestic exchange rate. Therefore, it is easier to remove the bad equilibrium by using foreign reserves. The underlying reason is that a fiscal spending financed by foreign reserves not only strengthens the domestic exchange rate through an increase in the demand for domestic goods, it also works through a conversion of foreign goods into domestic goods in the first place.

4.3 Differences between a targeted lending policy and a fiscal spending

A targeted lending policy and a public spending policy, although both can remove the bad equilibrium, work through two different mechanisms. They also differ in terms of the amount of reserves needed. I discuss these differences in this section.

First, a targeted lending policy works through lenders' expectation while a fiscal spending virtually shifts the demand for domestic goods and raises the real exchange rate. In fact, the targeted lending policy affects entrepreneurs' wealth function. As we

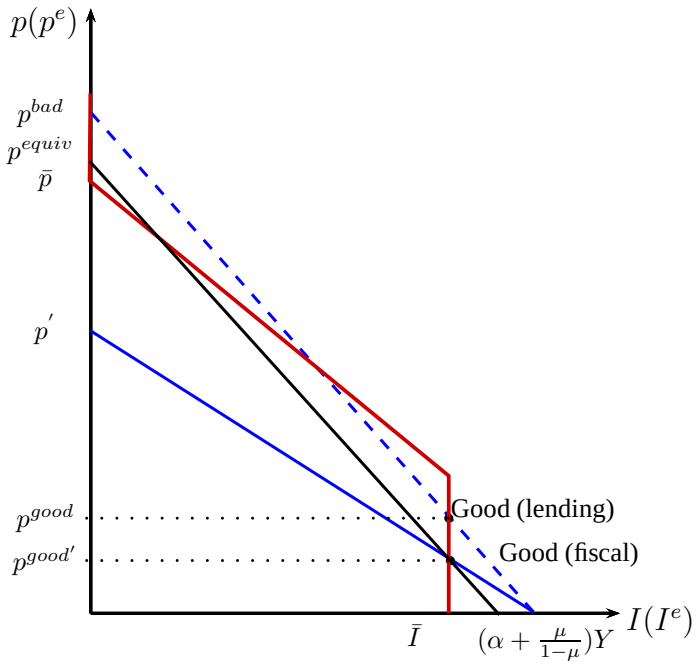


Figure 10: Fiscal spending: equivalence

can see in figure 7, what changes with the announced targeted lending is to increase the threshold exchange rate for which entrepreneurs' wealth falls beneath zero ($\bar{p}^{'} > \bar{p}$). Similarly, this policy makes it easier for the credit constraint not to bind ($\underline{p}^{'} > \underline{p}$). As a results, lenders will believe that entrepreneurs' wealth is positive and kept as high as possible; so is the collateral for borrowing, therefore, lenders will be willing to provide funding to this economy. With the targeted lending, the government only needs to hold sufficient foreign reserves to cover the private sector's foreign liabilities so as to eliminate the bad equilibrium. Foreign reserves will need to be deployed only if a shock on foreign demand X^* materializes.

This theoretical funding is in line with the empirical literature on the role of foreign reserves in the GFC. Bussière et al. (2012) finds that the pre-crisis reserves to short term debt ratio is the most significant reserve adequacy ratio when assessing the role of reserves on the real GDP growth across different emerging and developing economies during the GFC. Moreover, this papers finds that it is rather the level of foreign reserves which matters than the active use.

As for the fiscal spending, the mechanism is different. An increase in government spending will unambiguously change the exchange rate through the aggregate demand for domestic goods. To insure the same amount of investment (when the credit constraint is unbinding), the government needs to appreciate the price of domestic goods by increasing government consumption so as to reduce the balance sheet effect. If the insurance provided by a targeted lending policy works through entrepreneurs' wealth, the fiscal spending affects the level of domestic exchange rate. I have also shown that the

funding of fiscal spending matters. For the same amount of resources (denominated in domestic goods), a fiscal spending financed by foreign reserves pB^* can eliminate the bad equilibrium while a fiscal spending financed by taxes $T = pB^*$ cannot unambiguously remove it. More resources need to be deployed in the latter case.

We can also compare the minimum level of reserves needed to implement the targeted lending or fiscal spending financed by reserves. In fact, accumulating foreign reserves is not costless, the less reserves needed to achieve the same policy objective the better.

Let us denote $\Gamma = B^{*bail}_{min} - B^{*fisc}_{min}$.

$$\begin{aligned}\Gamma &= D^* - \frac{(\alpha - d)X^*}{\mu + (1-\mu)\alpha} - [D^* \frac{[\mu + (1-\mu)\alpha]}{\alpha - d} - X^*] \\ &= \Big[d + (1-\alpha)\mu\Big]\Big[\frac{X^*}{\mu + (1-\mu)\alpha} - \frac{D^*}{\alpha - d}\Big] \\ &= -\Big[d + (1-\alpha)\mu\Big]X^* \frac{1}{\alpha - d}\Big[\frac{D^*}{X^*} - \frac{\alpha - d}{\mu + (1-\mu)\alpha}\Big]\end{aligned}$$

$\Gamma < 0$ as the conditions for multiple equilibria state that $\frac{D^*}{X^*} \geq max\left(\frac{1}{(1-\mu)(1+\psi)}, \frac{\alpha - d}{\mu + (1-\mu)\alpha}\right)$.

As a result, $B^{*fisc}_{min} > B^{*bail}_{min}$. To increase government spending requires a higher level of reserves than a direct lending in foreign goods. The reason behind is that a lending policy is a direct write-off of the private sector's foreign-good debt. The need for this is fixed in terms of foreign goods. However, for an expansionary fiscal policy to stabilize the domestic exchange rate, the amount of foreign reserves that the government needs to sell and with which it can buy domestic goods depends on the magnitude of the depreciation. The more severe the depreciation, the more reserves are needed. Therefore, in terms of the level of reserves needed, a targeted lending seems to be a more efficient policy than an expansionary fiscal policy.

In sum, a lending policy or an increase in government spending can both stabilize an economy where the private sector faces the balance sheet effect due to the level of foreign-good denominated debt in the economy. In terms of foreign reserves needed, a lending policy uses less resources than the expansionary fiscal policy. This result remain robust even if I relax some assumptions. Appendix D shows a modified version of the model where the elasticity of substitution for exports is not unitary. The main results presented above remain valid.

5 Conclusion

This work provides a simple theoretical framework to study different mechanisms through which foreign reserves can be useful in an economy facing the issue of currency mismatch. It is shown that foreign reserves can be considered as a contingent asset when the exchange rate valation effect is taken into account. In fact, when there is a negative shock or a negative expectation on a country's currency, the domestic value of foreign reserves increases such that they can be used to stabilize the domestic economy, either through a targeted lending to the private sector or through an expansionary fiscal policy. The former channel through a targeted lending requires less foreign reserves than in the second case. The underlying reason is that a targeted lending is equivalent to give investors' a governmental guarantee on the private sector's liabilities (especially foreign liabilities). Having sufficient foreign reserves alters investors' expectation and pushes the economy towards the good equilibrium as it is defined in Krugman (1999).

The current framework is a little bit too simple. One may think about testing the results of this paper in a more complex model. I especially need to endogenize entrepreneurs' portfolio choice and the costs of purchasing foreign reserves *ex ante*.

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A Demand for investment when the credit constraint is unbinding

B Unstable middle intersection point

Based on figure 11, I show here that the middle intersection point (point A) between the DD and II curves is unstable. There are only two stable multiple equilibria: good equilibrium (G) and bad equilibrium (B).

Proof. Suppose the lenders form an expectation at time t which locates at the point A^{-} on the II curve. The expected investment at the point A^{-1} will then determine the exchange rate through the aggregate resource constraint, namely the DD curve. The economy goes from point A^{-1} to $A^{-'}$. Given the new exchange rate at point $A^{-'}$, lenders will adjust their investment. The economy goes from $A^{-'}$ to $A^{-''}$. Again, the adjusted investment determines the exchange rate using the DD curve. This pushes the stable equilibrium to the B point (bad equilibrium). The same logic chain applies when the economy starts at the point A^{+} ■

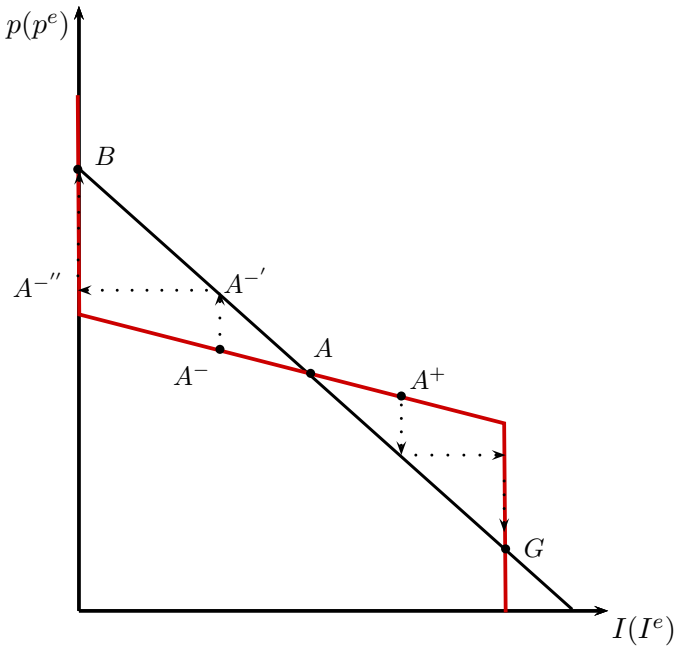

Figure 11: Unstable middle point

C Equivalence in fiscal spending

D Robustness

I relax in this section the assumption about the unitary elasticity of substitution of foreign demand.

Aggregate resources The aggregate resource constraint (4) becomes:

$$Y = (1-\mu)C + (1-\mu)I + \Phi p^{\sigma} \tag{13}$$

$$p = \left[\frac{Y[\mu + (1-\mu)\alpha] - (1-\mu)I}{\Phi}\right]^{\frac{1}{\sigma}} \tag{14}$$

Φ is an index of Foreign country's characteristics.Using a standard trade model with monopolistic competition, it can be proved that Φ is determined by the total expenditure that Foreign country spends on all imported goods (including exports from Home country which is considered in the main text).

We derive the first and second order derivatives of Equation (14) with respect to I:

$$\frac{\partial p}{\partial I} = \frac{1}{\sigma}\left[\frac{(\mu + (1-\mu)\alpha)Y - (1-\mu)I}{\Phi}\right]^{\frac{1-\sigma}{\sigma}}\left[\frac{-(1-\mu)}{\Phi}\right] < 0$$

$$\frac{\partial^2 p}{\partial I^2} < 0$$

The DD curve is concave and remains decreasing.

Demand for investment

$$I = \begin{cases} 0 & p^e > \bar{p} \\ (1+\psi)(\alpha Y - D - p^e D^*) & \underline{p} < p^e < \bar{p} \\ \bar{I} = \left(\frac{\alpha}{R^*}\right)^{\frac{1}{1-\alpha}} & p^e < \underline{p} \end{cases} \tag{15}$$

The II curve remains the same as before. The DD curve is determined by Equation (14) and is non-linear.

The possible multiple equilibria are shown in figure 12. The multiple equilibria exist if As the DD curve is concave, we only need the condition below to have multiple equilibria:

$$p^A \geq \bar{p} = \frac{(\alpha - d)Y}{D^*}$$

$$\text{with } p^A = \left[\frac{(\mu + (1-\mu)\alpha)Y}{\Phi}\right]^{\frac{1}{\sigma}}$$

This gives

$$\frac{D^*}{\Phi^{\frac{1}{\sigma}}} \geq \frac{\alpha - d}{[\mu + (1-\mu)\alpha]^{\frac{1}{\sigma}}} Y^{1-\frac{1}{\sigma}}$$

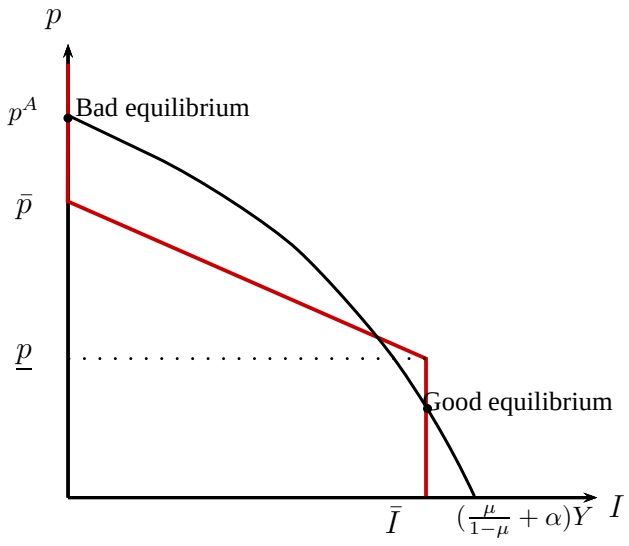

Figure 12: Multiple equilibria

In case of a targeted lending, using the demand for investment function, the condition to eliminate the bad equilibrium becomes:

$$0 < p^A \leq \bar{p}' = \frac{\alpha - d}{D^* - B^*} Y$$

This gives:

$$D^* - \frac{\alpha - d}{[\mu + (1-\mu)\alpha]^{\frac{1}{\sigma}}} Y^{\frac{\sigma-1}{\sigma}} \Phi^{\frac{1}{\sigma}} \leq B^* < D^*$$

Recall that when $\sigma = 1$, the criterion (7) in Section 4

$$D^* - \frac{\alpha - d}{[\mu + (1-\mu)\alpha]} \Phi \leq B^* < D^*$$

Condition to eliminate the bad equilibrium is

$$0 < p^{A'} \leq \bar{p} = \frac{\alpha - d}{D^*} Y$$

$p^{A'}$ is determined by the following function:

$$\Xi(p) = [\mu + (1 - \mu)\alpha]Y + p^{A'} B^* + (p^{A'})^{\sigma} \Phi$$

It can be easily proved that $\Xi(p)$ is monotonic and increasing in p. Therefore there is a unique solution for $\Xi(p) = 0$. Increasing B^* lowers the value of p.