Balance sheet effects, foreign reserves and public policies

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Abstract

Based on a theoretical model, this paper shows that foreign reserves are useful for a country to enhance the resilience of its domestic economy against balance sheet effects in the context of external financing strains. Using foreign reserves, the government can either lend in foreign currency to the private sector or conduct expenditure-switching policy to increase fiscal spending on domestic goods. Both policies cam remove the bad equilibrium represented by a large depreciation of the domestic currency and a very low level of investment. Nevertheless, these two policy tools differ in the ways they stabilize the domestic economy and in terms of the minimum required amount of foreign reserves. A targeted lending works by altering investors' expectation on domestic exchange rate and firms' net worth. As long as foreign reserves are sufficient to cover the private sector's external debt, the bad equilibrium is removed even without an actual depletion of reserves. On the contrary, fiscal spending increases the demand for domestic goods and affects the relative price, leading to domestic exchange rate appreciation that increases firms' net worth and facilitates investment.

JEL Classification: F31, F32, F41, G01, H30
Keywords: Foreign reserves, currency mismatch, balance sheet effects

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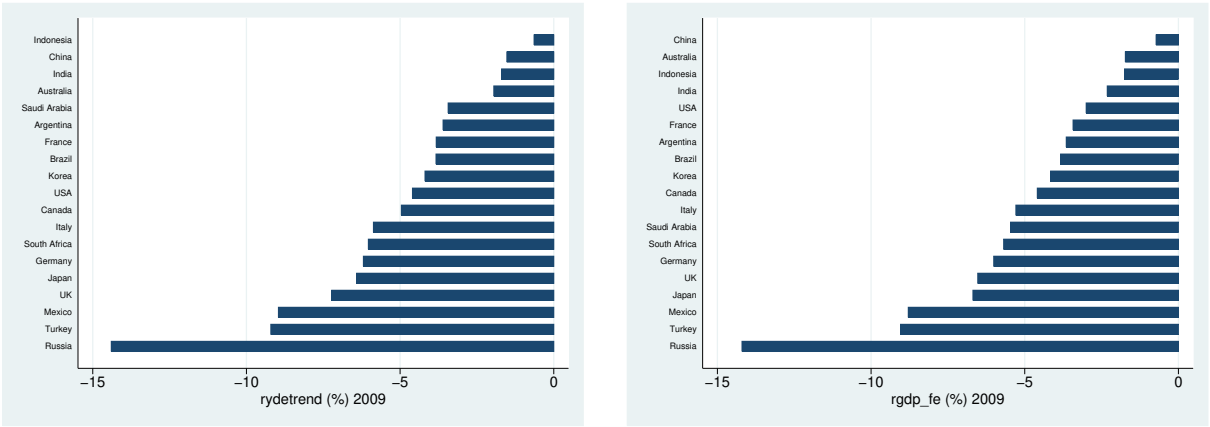
1 Introduction

The global economic turmoil, which had started with a local crisis in 2007 in the United States, quickly became a widespread global financial crisis (GFC) of a magnitude never seen since the Great Depression in 1929. One striking phenomenon in this crisis is that emerging market economies (EMEs) that seemed most vulnerable during the last waves of financial crises in the 1990s fared much better than advanced economies.

First, emerging market economies fared better in terms of output losses. Figure 1 presents two crisis impact indicators[1] in terms of real GDP losses in the G20 countries (excluding the European Uinon). One 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 some EMEs, such as Argentina, Indonesia and Thailand, which had experienced large currency depreciation in previous crisis periods, demonstrated a remarkable exchange rate stability during the GFC[2].



(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 GFC and the underlying explanations[3]. 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

[1]Both indicators are calculated by Bussière et al. (2014). 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]In the case of Korea, although very volatile, the exchange rate depreciated less in the GFC than in the Asian financial crisis.

[3]For a detailed review, please refer to Eichengreen (2010), Didier et al. (2012), Gourinchas and Obstfeld (2012), Ceballos et al. (2013), Catao and Milesi-Ferretti (2014), Obstfeld (2013) and Bussière et al. (2014).

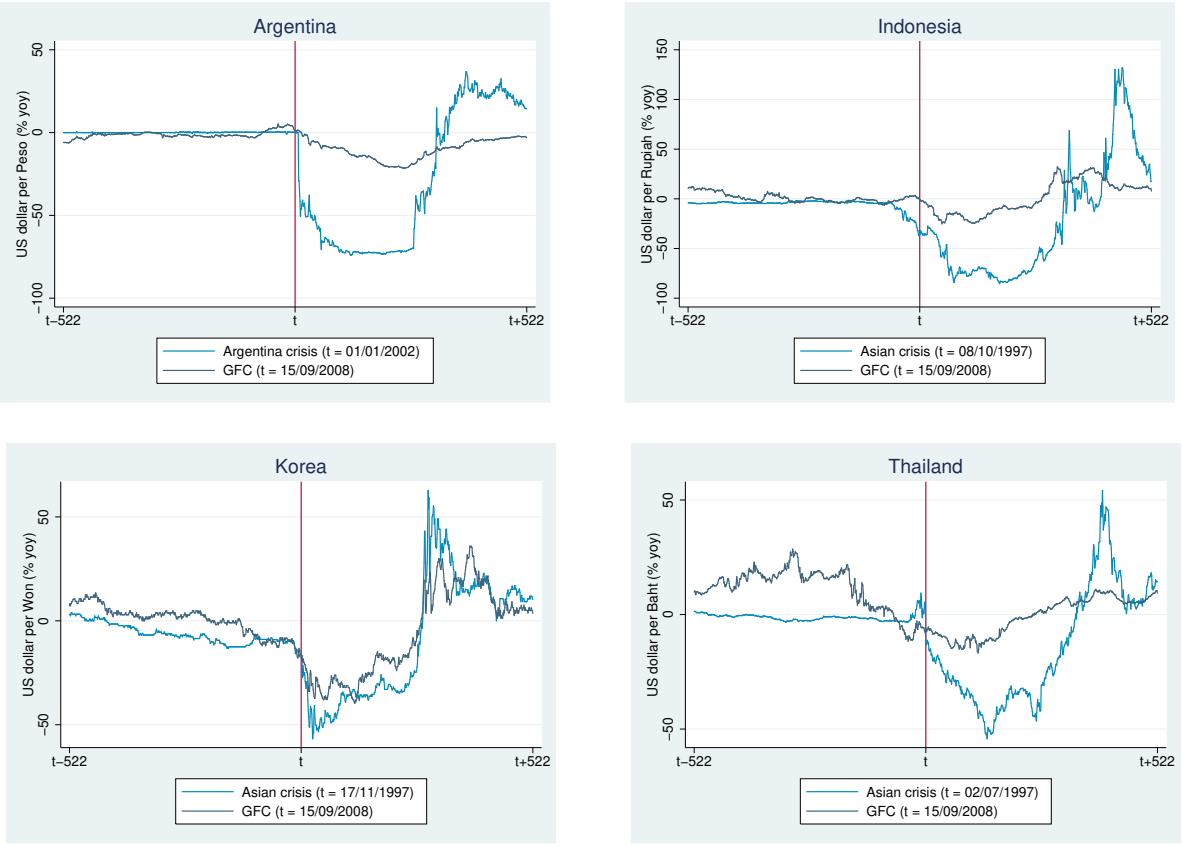


Figure 2: Nominal exchange rate depreciation in times of crises: Using daily data, the series are expressed in year-on-year growth rate (percentage point). A negative value indicates depreciation. Time t indicates the date of crisis occurrence which is chosen according to Obstfeld (2013) and other relevant 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

the conventional metrics[4] of foreign reserve adequacy (see Table 1), one can easily see 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 seem to have slowly '[graduated] from fiscal procyclicality' [Frankel et al. (2013)] and have proactively used fiscal policy to stabilize 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 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 channels through which EMEs better protected themselves against the GFC. The starting point of the story that I tell is the canonical Krugman (1999) model, which attributes the main source of fragility in EMEs to balance sheet effects implied by investors' expectation on a country's exchange rate. I am in fact interested to show how holding international reserves can eliminate the bad equilibrium associated with a negative perception on a country's exchange rate. This is a relevant question in the context of the GFC, as a gloomy world economic outlook may trigger investors to downward adjust their expectations on a country's exchange rate, especially when this country has a large export sector and is more likely to be affected by the 'global trade collapse' [Baldwin (2009)]. A negative perspective on a country's currency would then increase entrepreneurs' financial burden of foreign debt repayment, lower their net worth and even make them temporary insolvent. I argue in this paper that the government can use foreign reserves to restore lenders' confidence on the country's currency. There are, however, several ways regarding how reserves work to eliminate the unfavorable equilibrium. One the one hand, the government can use its previously accumulated foreign reserves as a targeted lending to the private sector; namely the government provides foreign-currency lending when external funding is cut off. This is equivalent to give lenders' a government guarantee on the loans they grant to private entrepreneurs or

[4]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).

to let the government borrow abroad for the sake of the private sector. On the other hand, the country's authorities can also 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 they work through two different mechanisms. In the case of targeted lending, foreign reserves can be regarded as a state-contingent insurance. Its value expressed in domestic terms increases with domestic depreciation. The government's commitment to lend strengthens lenders' confidence on domestic entrepreneurs' wealth and thus sustains capital inflows in the domestic economy. The bad equilibrium can thus 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 actually appreciates domestic real exchange rate and raises entrepreneurs' wealth as a result. This is achieved by an increase in demand for domestic goods on the good market. The need for reserves depends on the magnitude of domestic exchange rate depreciation.

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[5]. In the literature, Jeanne and Rancière (2011)[6] studies how holding reserves can smooth domestic output or/and consumption when the economy is hit by 'sudden stops'. Bianchi et al. (2012) focus on how reserves are needed when the government faces increasing costs of external financing or default risks. In contrast, I rather study how reserves are useful in the context of currency mismatches and the resultant balance sheet effects. In fact, reserves can not only be used to provide foreign-currency liquidity in case of 'sudden stops' [Calvo (1998)], they can also alter investors' expectations on the net worth of a country's private sector through the exchange rate channel, thus insulating the domestic economy from balance sheet effects. 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 balance sheet effects and curiously, this

[5]For a detailed review of the precautionary motive for foreign reserve accumulation, see Aizenman and Lee (2007), Alfaro and Kanczuk (2009), Aizenman and Hutchison (2012), Obstfeld et al. (2010), Jeanne and Rancière (2011), Bianchi et al. (2012), Benigno and Fornaro (2012), Calvo et al. (2013) and Bussière et al. (2014). There are additional approaches to study foreign reserve accumulation: mercantilist approach [see Dooley et al. (2003), Korinek and Serven (2010) and Jeanne (2012)] and structural approach [Dominguez (2010), Bacchetta et al. (2013) and Cheng (2014)].

[6]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.

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[7] that relate foreign reserve accumulation to (short-term) external debt ratio[8]. Moreover, 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. I argue that depending on the policy tool used, foreign reserves need to be or not to be actually depleted. This is related to the empirical finding of Bussière et al. (2014) who document that reserves are rather 'nuclear power' than real 'gunpowder'.

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 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. 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 the government's targeted lending in foreign currency and fiscal policies.

The currency mismatches are key for the balance sheet effect to work. In the scope of this paper, I take currency mismatch as given. This is because my objective is to illustrate how different public policies may be used to stabilize the domestic economy rather than to explain why entrepreneurs want to hold foreign-currency liabilities *ex ante*. 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 that is subject to exchange rate fluctuations, the government sends to 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.

[7] See Llaudes et al. (2010), Catao and Milesi-Ferretti (2014) and Bussière et al. (2014)

[8] 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)]

Regarding how to reduce the impact of currency mismatches, Jeanne and Zettelmeyer (2002) compare the pros and cons of using the monetary policy and different exchange rate regimes. They conclude that monetary policy is contradictory in dealing with balance sheet effects. 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 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 effective in dealing with the multiple equilibria. Two different fiscal policy tools - targeted lending or fiscal spending - are analyzed in the subsequent sections. Jeanne and Wyplosz (2003) take 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 international coordination for crisis management is far from established nowadays. Many EMEs might prefer holding 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, fiscal policies in emerging market countries were used to be procyclical in the past 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. Following this literature, my model illustrates how countercyclical policies can help alleviate balance sheet effects in the private sector. Prasad (2011), Didier et al. (2012) and Obstfeld (2013) argue that many EMEs have reduced their external debt denominated in foreign currency and external financing there 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) point 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 have net foreign liabilities in its 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 derives and analyzes conditions for the existence of multiple equilibria in absence of government intervention. Section 4 introduces a government and studies its public policies to stabilize the domestic private economy facing negative balance-sheet effects. Section 5 concludes.

2 The model

The aim of this paper is to provide a theoretical framework showing the ways in which foreign reserves are useful to stabilize the domestic economy exposed to external financing strains. In the paper, I especially focus on the risks associated with currency mismatches and the resultant balance sheet effects in the private sector. For this purpose, the analysis in this paper is based on a stylized model with multiple equilibria similar to Krugman (1999). Although very simple, it is enough to demonstrate the different ways the government can stabilize the domestic economy using foreign reserves. The model is based in a small-open real economy populated by a representative 'hand-to-mouth' worker and a representative firm[9]. A government will be introduced in Section 4 when I analyze public policies.

2.1 Firm

The main actor in the decentralized economy is a representative firm. It uses labor N_t and capital K_t to produce output Y_t. The labor supply is ample and thus perfectly inelastic, i.e. $N_t = 1$. Capital is chosen a period earlier through investment (I_{t-1}) and fully depreciates every period, namely $K_t = I_{t-1}$. Capital is also supposed to be perfectly mobile across borders. The production function is a standard neoclassical production function. It is increasing in both inputs with decreasing marginal returns and homogeneous of degree one, namely $Y_t = F(K_t, N_t) = K_t^{\alpha} N_t^{1-\alpha}$. α is the share of capital in the production function.

Two important assumptions characterize the firm's investment behavior. It faces credit constraints on the one hand, and on the other hand it has foreign-good denominated liabilities and thus is exposed to currency mismatches.

Regarding the credit constraint, the firm cannot borrow as much as they want; the maximum borrowing capacity is limited by its net worth (W_t)[10]. This is often the case for firms, especially private firms, in emerging market economies. The credit constraint assumption states that

$$L_t \leq \psi W_t \tag{1}$$

[9] In this paper I talk about balance sheet effects for a firm. But the analysis can also be applied to banks exposed to foreign liabilities, such as in Jeanne and Zettelmeyer (2002). There are no fundamental differences between firms and banks regarding balance sheet effects.

[10] The credit constraint assumption derives directly from the literature on contract enforceability, such as in Bernanke et al. (1999)

where, L_t denotes borrowing made by the firm from the market. W_t denotes the firm's net worth. ψ is a parameter of the tightness of the credit market. The higher ψ[11], the higher leverage the firm has.

From here, we can derive the aggregate demand for investment of the representative firm, which is composed of the firm's net worth W_t and borrowed fund L_t:

$$I_t = W_t + L_t \leq (1 + \psi)W_t \tag{2}$$

The above demand function for investment (2) can be binding or unbinding depending on the value of the collateral W_t and the tightness of credit constraints ψ. When this constraint is binding, $I_t = (1 + \psi)W_t$. When the constraint is unbinding, I_t is strictly lower than $(1+\psi)W_t$. In this case, I_t is pinned down by equalizing the marginal product of capital and the marginal cost that is equal to the world interest rate as capital is perfectly mobile. Namely, $F_k(K_{t+1}, N_{t+1}) = R_t = R^*$, where $F_k(\cdot)$ denotes the marginal product of capital, R_t and R^* are domestic and world interest rates respectively. Combining with the functional form of the production function, one can derive $I_t = \bar{I} = \left(\frac{\alpha}{R^*}\right)^{\frac{1}{1-\alpha}}$ when the credit constraint is not binding.

Regarding the second assumption on foreign-good denominated liabilities, it is assumed that the firm needs both foreign and domestic goods for investment[12]. In presence of currency mismatches, the wealth function of the firm can be rewritten as follows:

$$W_t = \alpha Y_t - D_t - p_t D_t^* \tag{3}$$

The net worth of the firm W_t is equal to its capital income αY_t minus the repayment of domestic debt D_t and minus the repayment of foreign debt valuated at the current exchange rate $p_t D_t^*$. Notice that D_t^* is denominated in terms of foreign goods and p_t is the relative price of foreign goods in terms of domestic goods, thus the real exchange rate. D_t and D_t^* being predetermined at the beginning of period t, there is a linear relationship between the firm's net worth and the real exchange rate. This is the source of balance

[11]The value of ψ depends on the stage of financial development in a given country. $\psi = 0$ means that no borrowing is possible. This can be the case in the least developed countries. In this extreme case, the balance sheet effect is not at work as there is no foreign borrowing at all. In another extreme case, when $\psi = 1$, there are no credit frictions. The firm's wealth, thus balance sheet effects, will not play a crucial role in determining overall investment in the economy. This is not an interesting case for the purpose of this paper. Advanced economies, for instance, are supposed to have a very high ψ. The emerging market economies (middle-income countries) that I will focus on in this paper should have a ψ in between the two former cases and have a strong demand for foreign credit.

[12]This mixed nature of financing source can be explained by the underdevelopment of financial markets in emerging market economies. Domestic funding is insufficient to sustain the demand for investment, as Aghion et al. (2000) argue.

sheet effects in the model.

Combining equations (2) and (3), the demand for investment of the firm is derived below; it is a truncated function of the current real exchange rate p_t.

$$I_t = \begin{cases} 0 & p_t > \bar{p}_t \\ (1+\psi)(\alpha Y_t - D_t - p_t^e D_t^*) & \underline{p_t} < p_t < \bar{p}_t \\ \bar{I} = \left(\frac{\alpha}{R^*}\right)^{\frac{1}{1-\alpha}} & p_t < \underline{p_t} \end{cases} \tag{4}$$

$\bar{p}_t = \frac{\alpha Y_t - D_t}{D_t^*}$ denotes the threshold value of the exchange rate beyond which the firm's wealth is reduced to zero or negative values. $\underline{p_t} = \frac{\alpha Y_t - D_t - \frac{\bar{I}}{1+\psi}}{D_t^*}$ denotes the threshold value of the exchange rate below which the firm's wealth is high enough that the credit constraint (1) no longer binds. Between $\underline{p_t}$ and $\bar{p}_t$, the investment is a negative function of the current exchange rate.

Table 2 provides comparative statics showing how the threshold values of the real exchange rate change with the underlying macroeconomic variables.

2.2 Worker and domestic good market equilibrium

The role of the representative worker is minimized in the model as the focus of the paper is on the link between exchange rate pressure and the balance sheet of the firm. The worker provides the labor force to the firm and gets paid at the marginal product of labor. The worker does not have access to financial markets so that he consumes all his income every period (so called 'hand-to-mouth' labor). The worker consumes both domestic goods, C_t^H, and foreign goods, C_t^F. As mentioned above, domestic goods serve as the numéraire with a unitary price and therefore the price of foreign goods in terms of domestic goods, p_t, denotes the real exchange rate. An increase in p_t means a depreciation of the price of the domestic goods (hereafter loosely speaking depreciation of the local currency).

As in Krugman (1999), I assume that the elasticity of substitution between domestic goods and foreign goods is one for both consumption and investment[13]. μ denotes the

Table 2: Comparative Statics

	Y	D	D^*	ψ
$\bar{p}$	↑	↓	↓	/
$\underline{p}$	↑	↓	↓	↑

[13]This assumption keeps the model tractable and allows a direct visual representation of the key

share of the foreign-good component in total consumption C_t or total investment I_t. Therefore, we have:

$$C_t^H = (1-\mu)C_t \qquad I_t^H = (1-\mu)I_t$$
$$C_t^F = \frac{\mu C_t}{p_t} \qquad I_t^F = \frac{\mu I_t}{p_t}$$

In the absence of a government, the aggregate demand for domestic goods, that matches the total output produced by the domestic firm, is composed of the consumption by the worker, the total investment denominated in domestic goods by the firm and exports as stated in equation (5).

$$\begin{aligned} Y_t &= (1-\mu)C_t + (1-\mu)I_t + p_t X_t^* \\ &= (1-\mu)(1-\alpha)Y_t + (1-\mu)I_t + p_t X_t^* \end{aligned} \tag{5}$$

where, X_t^* stands for exports denominated in foreign goods[14].

The good market equilibrium (5) pins down a linear relationship between the real exchange rate and the level of total investment, as illustrated in equation (6). An increase in total investment appreciates the domestic real exchange rate. This is because an increase in total 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.

$$p_t = \frac{Y_t[\mu + (1-\mu)\alpha] - (1-\mu)I_t}{X_t^*} \tag{6}$$

The basic features of the model being presented, let us look at how the model works and generates balance sheet effects. The main trigger in the model is the expectation that foreign creditors form about the real exchange rate in the domestic economy. Hereafter, I add an superscript e when talking about expectations. As one can see in equations (4) and (6), the expectation of the real exchange rate p_t^e will affect the firm's wealth W_t that in turn will affect total investment I_t that ultimately determines the realization of the real exchange rate p_t.

Figure 3 summarizes the mechanism of the model. In fact, at the beginning of period

results. Loosening this assumption will not affect the qualitative results that this paper aims to provide.

[14]The value of domestic exports in terms of foreign goods, X_t^*, is considered exogenous and fixed. This is equivalent to assume that the foreign elasticity of substitution is unitary. Allowing the elasticity of substitution to be bigger than one does not change the qualitative results presented in this paper. It is easy to extend the current model to include a CES trade framework with monopolistic competition.

t, foreign creditors form an expectation of the real exchange rate before making lending decisions. An expected depreciation of the real exchange rate would lower the firm's expected wealth via higher repayment burden of foreign debt that has been granted to the domestic firm a period earlier. Therefore, the borrowing capacity of the firm would be lower as the collateral value for foreign creditors, which is a share of the expected wealth of the firm, would be lower. Equation (4) thus pins down the total investment needed in the economy based which foreign creditors would make their final lending decisions. Capital inflows will ultimately pin down the real exchange rate on the good market by equation (6) at the end of period t. In rational expectation equilibrium, the actual realization of the exchange rate and investment coincide with the initial guesses. As everything is in reality determined simultaneously within a period, from here and on the time subscript is dropped.

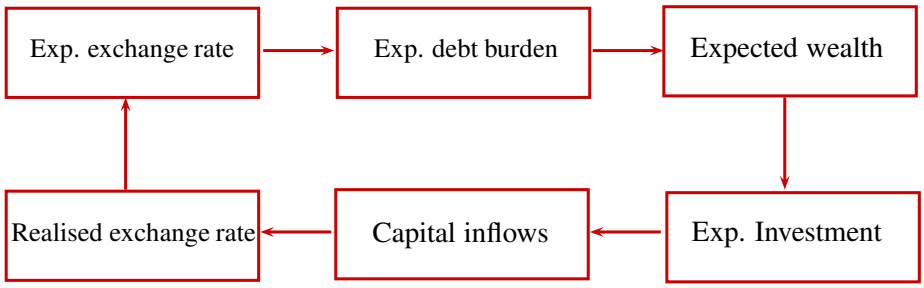


Figure 3: Model scheme

3 Multiple equilibria in a decentralized economy

This stylized model can be solved in an orthogonal plan of $p(p^e)$ and $I(I^e)$ using two equations (4) and (6).

First, equation (4) relates the *expected* exchange rate p_t^e to the *expected* investment I_t^e. This gives a truncated curve of the demand for investment (henceforth called II curve), as Figure 4 shows.

When foreign creditors expect large depreciation, meaning that $p^e > \bar{p}$, the burden of repaying foreign-good denominated debt becomes so heavy that the firm's wealth is driven to zero or beneath. In this case, no pledgeable income is available as collateral for

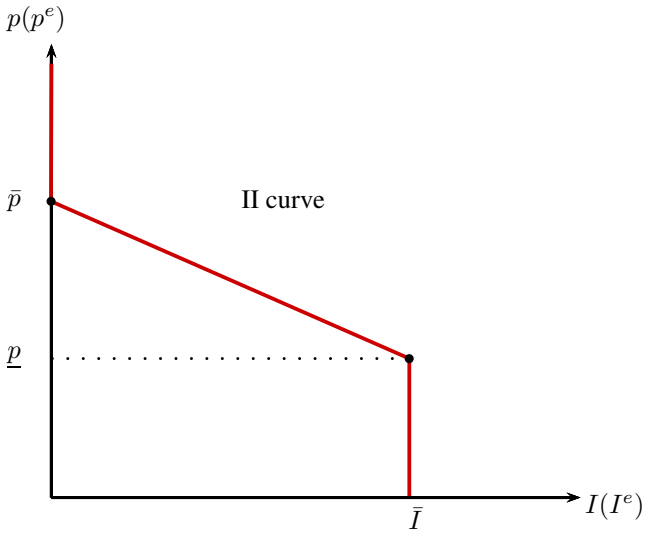


Figure 4: Demand for investment

foreign creditors. Therefore, rational creditors would never lend to the domestic economy. Thus, $I = I^e = 0$. This scenario is represented by the red vertical segment on the y-axis.

When foreign creditors expect large appreciation, namely $p^e < \underline{p}$, the firm's wealth expressed in domestic good increases such that the credit constraint (2) 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 red vertical segment at $I = \bar{I}$ for all values of $p^e < \underline{p}$.

When $\underline{p} \leq p^e \leq \bar{p}$, the demand curve of the investment is represented by a downward sloping line.

Second, equation (6) gives an unambiguously negative relationship between I and p. The realization of the domestic exchange rate is uniquely pinned down by the total investment in the economy I, after foreign creditors have decided how much to lend. The downward sloping line in Figure 5 (henceforth called the DD curve) represents this relationship.

Under which conditions multiple equilibria exist? To understand that, let us combine the II and DD curves in the $(p(p^e), I(I^e))$ plan as shown in Figure 6.

Multiple equilibria are understood as the coexistence of a good equilibrium - appreciated real exchange rate and high investment - and a bad equilibrium - depreciated real exchange rate and low investment. There are two necessary conditions to guarantee the existence of multiple equilibria. A bad equilibrium exists if $\bar{p} \leq \frac{[\mu+(1-\mu)\alpha]Y}{X^*}$. Additionally, a slop condition is needed to insure a good equilibrium exists: the DD curve needs to have a steeper slope than the II curve when the credit constraint is binding[15], namely

[15]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 that is the intersection point between the DD curve and the x-axis. This is, however, not

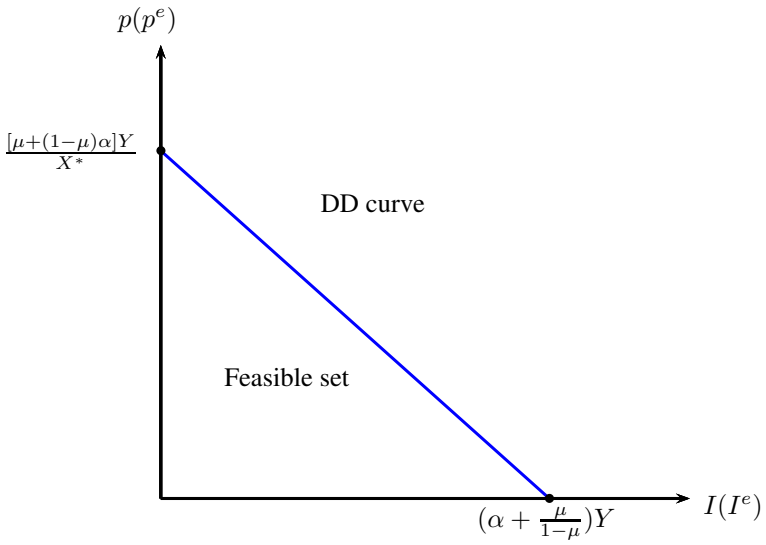


Figure 5: Aggregate resources

$|-\frac{1-\mu}{X^*}| \geq |-\frac{1}{(1+\psi)D^*}|$. Notice that the middle intersection point is unstable (see proof in Appendix A).

Simplifying these two inequalities, one can deduce that 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. It can be further proved that for small values of μ, $\frac{1}{(1-\mu)(1+\psi)}$ is always bigger than $\frac{\alpha-d}{\mu+(1-\mu)\alpha}$, namely the slope condition dominates.

Using equations (4) and (6), one can calculate the bad and good equilibria:

$$I^{bad} = 0 \qquad I^{good} = \bar{I} = \left(\frac{\alpha}{R^*}\right)^{\frac{1}{1-\alpha}}$$

$$p^{bad} = \frac{Y[\mu+(1-\mu)\alpha]}{X^*} \qquad p^{good} = \frac{Y[\mu+(1-\mu)\alpha]-(1-\mu)\bar{I}}{X^*}$$

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 Public policies

From this section, I introduce a benevolent government/central bank[16] in the model economy. Entering period t, the government has some previously accumulated resources,

an interesting solution (as the equilibrium exchange rate is equal to zero). For purposes of this paper, I rule out this extreme case.

[16]The model economy is a real economy; one may think of the government in the model as the consortium of a conventional government and a central bank. One may think that many central banks in emerging market economies are not fully independent.

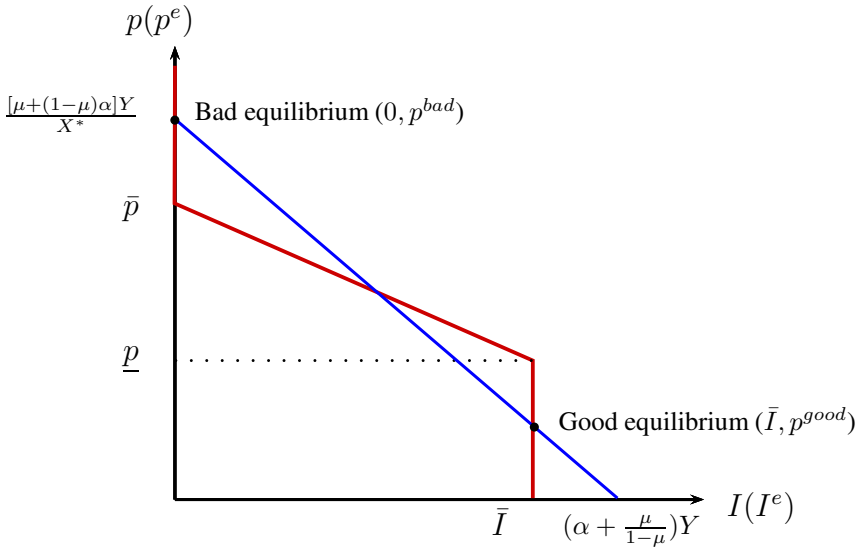


Figure 6: Multiple equilibria

either in the form of foreign reserve assets B^* or in the form of taxes T. The following sections of the paper will focus on the government's strategies of using its resources to stabilize the domestic economy whenever it is necessary. For purposes of analysis, resources are considered given and the *ex ante* costs of resource accumulation are thus not taken into account.

To understand how the government can use foreign reserves to stabilize its domestic economy, suppose we are in the context of the GFC. Lenders form a negative expectation on exporting countries' exchange rate due to a gloomy perspective on foreign demand [e.g. a decrease in foreign demand X^* due to the 'global trade collapse Baldwin (2009)']. Without any government intervention, a domestic depreciation is foreseeable through the resource constraint (6).

The objective of the government is to eliminate the bad equilibrium associated with a large currency depreciation and a very low level of investment. This requires altering foreign creditors' expectation on the domestic real exchange rate or intervening directly on the exchange rate market, such that the firm's wealth and borrowing capacity are not tainted. Several ways of public intervention are analyzed and compared subsequently: targeted lending in foreign goods by the government to the firm or an increase in public spending (financed by taxes or foreign reserves).

4.1 Targeted lending to the private sector

In case where the government has previously accumulated foreign reserves, B^*, one policy choice is to commit to lending directly foreign goods to the private sector whenever the exchange rate is under pressure so as to insulate the firm's net worth from potential exchange rate depreciation. As a consequence, the potentially higher repayment of foreign

debt, due to potentially depreciated exchange rate, is offset by government lending in the same currency. Under this view, foreign reserves can be regarded as a state-contingent insurance, as its value increases with potential depreciation of the domestic exchange rate. The policy can thus alter foreign creditors' expectations on the firm's net worth, and sustain external financing even under unfavorable macroeconomic conditions. The new wealth function of the firm is written in equation (7).

$$W^e = \alpha Y - D - p^e D^* + p^e B^* \tag{7}$$

This public lending 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 a national government[17]. As long as foreign reserves cover the foreign liabilities in the domestic economy, there will be a full insurance.

The aggregate resource function (5) that determines the actual level of exchange rate does not change, as nothing changes the demand for 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. The latter only depends on the international interest rate). Figure 7 shows the new equilibrium and compares it with the multiple equilibria in a decentralized economy.

Figure 7 clearly shows that when the government lends foreign goods to the private sector, it eliminates the bad equilibrium $(0, p^{bad})$. With the firm's new wealth equation (7), the slope of the II curve becomes steeper. The new threshold value of the real exchange rate beyond which the firm's wealth is driven to zero or beneath, $\bar{p}'$, is raised, making it less likely to happen. The bad equilibrium is removed as long as $0 < p^{bad} \leq \bar{p}' = \frac{\alpha Y - D}{D^* - B^*}$ with $B^* < D^*$. This gives:

$$D^* - \frac{\alpha - d}{\mu + (1-\mu)\alpha} X^* \leq B^* < D^* \tag{8}$$

Notice that the good equilibrium remains the same as in the decentralized market equilibrium. This is because the government's commitment to lend in foreign goods only aims at altering foreign creditors' expectation on the domestic real exchange rate. As long as the commitment is credible (i.e. backed by sufficient foreign reserves), the

[17] Clearly, the 'international banking fund' has never be founded since Jeanne and Wyplosz's paper in 2003. One argument in my 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 goods should be granted.

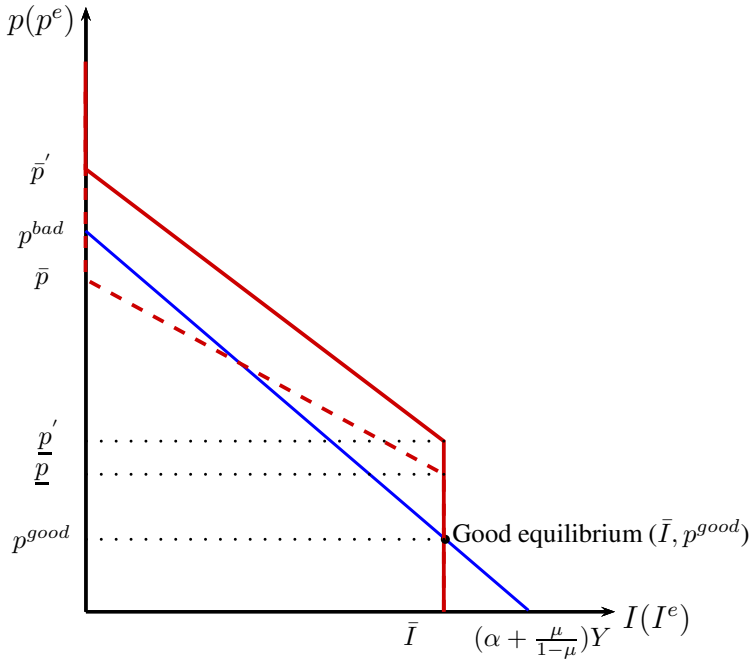


Figure 7: Equilibrium with targeted lending

government does not even need to actually deplete its foreign reserves to stabilize the domestic economy.

From equation (8), the minimum level of reserves needed for targeted lending is equal to $B^{*lend}_{min} = D^* - \frac{\alpha - d}{\mu + (1-\mu)\alpha} X^*$. As long as the first condition for the existence of multiple equilibria holds, one can prove that B^{*lend}_{min} is larger than zero. Namely, when the foreign-good income from exports cannot cover foreign liabilities, reserves are needed to make sure that the expected wealth of the firm is above zero.

The amount of reserves needed [18] depends on the private sector's exposure to foreign-good debt (D^*). The higher foreign debt, the more reserves are needed for targeted lending policy. It is negatively correlated with foreign-good income earned through exports X^*. If at time t, the flow of exports (augmented by a coefficient) exceeds that of foreign liabilities, B^* might become negative, namely there is an accumulation of reserves. The amount of reserves for targeted lending policy also depends on the marginal propensity to imports μ and the per GDP domestic lending ratio d. The higher μ, the more foreign goods are demanded, thus higher reserves are needed to pay out imported goods.

Notice that the targeted lending policy is equivalent to the situation where the government uses its own net worth W^G as a collateral to secure external funding for the sake of the domestic firm. In the model, the government's net worth comes from its foreign reserve holding valued at the current real exchange rate, namely, $W^G = p^e B^*$. The

[18] 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.

government's net worth moves in the opposite direction compared to that of the firm. An expected depreciation of the real exchange rate would increase the government's net worth and reduce that of the firm. Therefore, while the firm has difficulties to sustain external financing facing an adverse shock on the real exchange rate, the government can serve as a financial intermediary. In this case, the investment function (2) becomes:

$$\begin{aligned} I^e &\leq (1+\psi)(W^e + W^G) \\ &= (1+\psi)(\alpha Y - D - p^e D^* + p^e B^*) \end{aligned}$$

where the second parenthesis is exactly the same as in equation (7), in the case of a targeted lending policy.

In reality, during the GFC, some emerging economies that were seriously hit by balance sheet effects during the last wave of emerging market crises 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 of reserves (sixth largest reserve holder), its reserves to short-term debt ratio is less impressive in comparison with 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 [Cho (2012)]. 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)].' Based on the implications of the current model, the market may think Korea did not hold enough foreign reserves to rule out the bad equilibrium. As a result one observes in Figure 2 that the exchange rate of Korean won was still very volatile during the GFC compared to other EMEs' currencies.

4.2 Expansionary fiscal policy

The second policy choice of the government is to conduct an expenditure-switching policy to increase public spending on domestic goods. Bearing in mind that in the framework of Krugman (1999), a fiscal spending should not be understood in the Keynesian sense, as prices are fully flexible in this stylized model and the supply of domestic goods is predetermined at the beginning of each period. Therefore, an expansionary fiscal policy in period t raises domestic demand and appreciates the domestic exchange rate.

Different from the targeted lending policy, a fiscal spending actually affects the ex-

change rate through the aggregate resource constraint. Suppose the fiscal spending is financed by previously accumulated foreign reserves, the aggregate resource constraint (5) becomes:

$$\begin{aligned} Y &= (1-\mu)(1-\alpha)Y + (1-\mu)I + G + pX^* \\ G &= pB^* \end{aligned} \tag{9}$$

And the real exchange rate is pinned down: $p = \frac{Y[\mu+(1-\mu)\alpha]-(1-\mu)I}{X^*+B^*}$.

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 $(0, p^{bad})$. However, the good equilibrium in this case also changes. In fact, although the realized investment achieves the same unbinding level $\bar{I}$, the exchange rate is appreciated to $p^{good'}$, with $p^{good'} < p^{good}$. This is because a fiscal spending changes immediately the demand for domestic goods and determines consequently a new level of exchange rate through the new aggregate resource constraint (9). Foreign reserves are depleted in this case.

The bad equilibrium is eliminated in this policy setting as long as $p^{'}$ is smaller than $\bar{p}$ (see Figure 8). Namely, $0 < p^{'} = \frac{Y[\mu+(1-\mu)\alpha]}{X^*+B^*} \leq \bar{p} = \frac{\alpha Y - D}{D^*}$. This gives:

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

The minimum level of reserves needed to conduct an 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 fiscal spending is financed by previously collected taxes. In this case, government resources are denominated in domestic goods only. The new aggregate resource constraint becomes:

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

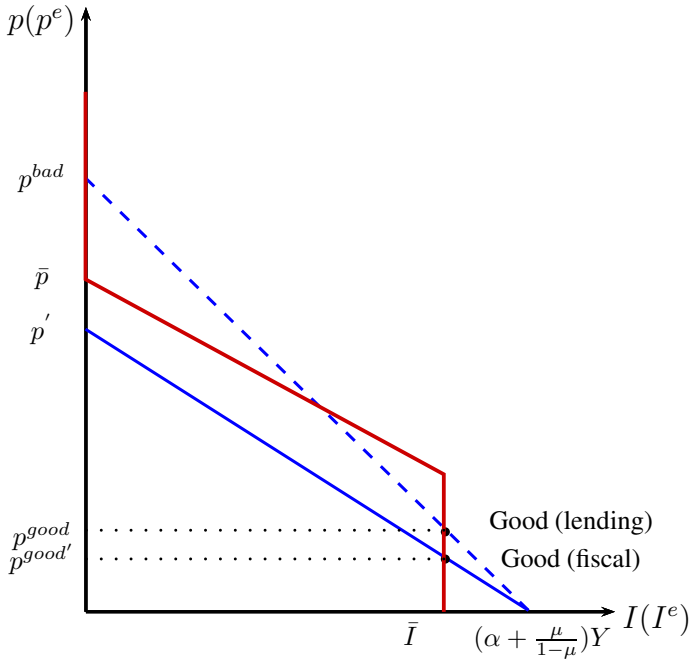


Figure 8: Equilibrium with fiscal spending financed by reserves

Equation (11) determines the exchange rate: $p = \frac{Y[\mu+(1-\mu)\alpha]-T-(1-\mu)I}{X^*}$. This time, the DD curve (black line in Figure 9) is shifting downwards, parallel to the DD curve in the decentralized economy (dashed blue line). 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 largely appreciated in the good equilibrium than in the case where fiscal spending is financed by foreign reserves.

The condition for removing the bad equilibrium requires: $p^{''} = \frac{Y[\mu+(1-\mu)\alpha]-T}{X^*} \leq \bar{p} = \frac{\alpha Y-D}{D^*}$. This gives a criterion for the minimum taxes that the governments needs to stabilize the domestic economy:

$$Y[\mu + (1-\mu)\alpha] - \frac{(\alpha Y - D)X^*}{D^*} \leq T \tag{12}$$

.

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 that can be naturally asked is: if the public spending financed by taxes achieved the same equilibrium as in the case where fiscal spending is financed by foreign reserves, could the bad equilibrium still be removed? This situation is represented by the black line in Figure 10. It can be proved that a fiscal spending financed by taxes cannot unambiguously remove the bad equilibrium. The minimum taxes that help the economy achieve the same good equilibrium as in the case of a fiscal spending financed by foreign reserves are smaller than T_{min}[19].

[19]It can be shown that the minimum taxes requested to achieve the same good equilibrium as in the

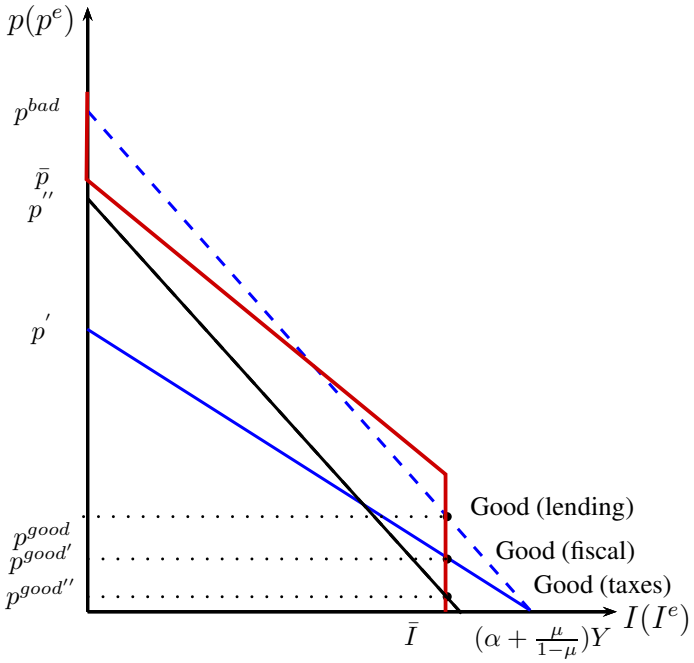


Figure 9: Equilibrium with fiscal spending financed by taxes

The difference between these two ways to finance fiscal expansion is grounded in the fact that using reserves not only raises the demand for domestic goods but also implies an exchange rate intervention by converting foreign goods to domestic goods. Therefore, it is easier to remove the bad equilibrium by using foreign reserves. There are concrete examples where countries use foreign reserves for fiscal expansion. China, for instance, used US$67.5 billion from its foreign reserve holding to recapitalize four state-owned banks in 2003. Similarly, in 2007, US$200 billion were deplete to fund China Investment Corporation.

4.3 Differences between targeted lending and 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 minimum amount of resources required. I discuss these differences in this section.

First, a targeted lending policy can be at work through lenders' expectation while a fiscal spending truly changes the demand for domestic goods and appreciates the real exchange rate. In fact, the targeted lending policy affects the firm's wealth function through expectations. As one can see in Figure 7, the government's commitment to lend in foreign goods increases the threshold exchange rate for which the firm's wealth falls beneath zero ($\bar{p}^{'} > \bar{p}$). Similarly, this policy makes it easier for the credit constraint not to

case of a fiscal spending financed by foreign reserves are equal to $p^{good'} B^{*fisc}_{min}$ (see Figure 10). $p^{good'}$ is determined by plugging the unbinding level of investment $\bar{I}$ into equation (9). One can then easily demonstrate that $p^{good'} B^{*fisc}_{min} < T_{min}$.

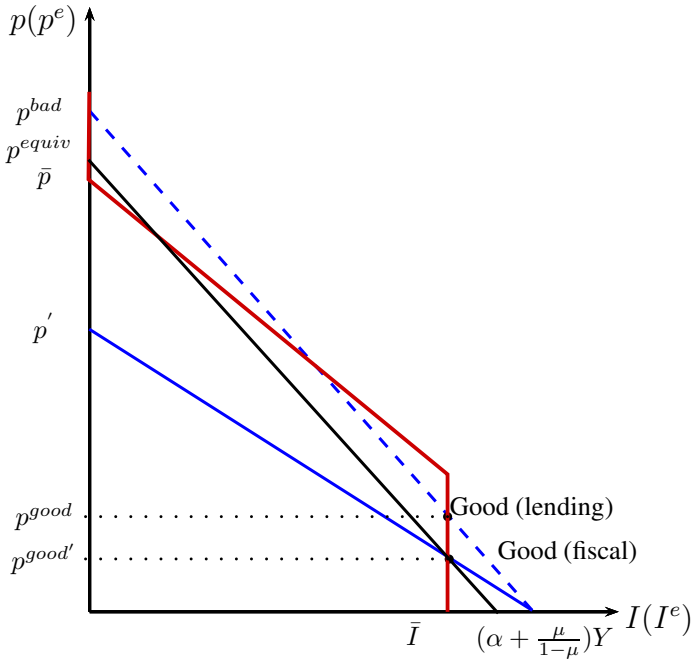


Figure 10: Fiscal spending: equivalence

bind ($\underline{p}^{'} > \underline{p}$). As a result, foreign creditors will believe that the firm's wealth will remain positive for a wider range of values of the expected exchange rate. 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 only be deployed if the expected depreciation materializes (e.g. a realized shock on foreign demand X^*).

This theoretical result is in line with the empirical literature on the role of foreign reserves in the GFC. Bussière et al. (2014) find that the pre-crisis reserves to short-term debt ratio is the most significant reserve adequacy ratio when assessing the impact of holding reserves on the real GDP growth across different emerging and developing economies during the GFC. Moreover, their paper finds that it is rather the existence of foreign reserves that matters than the active use.

As for 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, the government needs to appreciate the price of domestic goods by increasing government consumption so as to maintain the firm's wealth. If the insurance provided by a targeted lending policy works through the firm's wealth directly, fiscal spending affects the level of domestic exchange rate and affects the firm's wealth only indirectly. I have also shown that the financing sources of fiscal spending matter. For the same amount of resources, a fiscal spending financed by foreign reserves can eliminate the bad equilibrium more easily than a fiscal spending financed by taxes. More resources are need in the latter case.

I compare now the minimum levels 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 $\Gamma = B^{*lend}_{min} - B^{*fisc}_{min}$.

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

$\Gamma < 0$ unambiguously as long as there are multiple equilibria, namely $\frac{D^*}{X^*} \geq max\left(\frac{1}{(1-\mu)(1+\psi)}, \frac{\alpha - d}{\mu + (1-\mu)\alpha}\right)$.

As a result, $B^{*fisc}_{min} > B^{*lend}_{min}$. This means that an increase in government spending requires a higher level of reserves than the direct lending policy in foreign goods. The reason behind is that the lending policy can be regarded as a direct write-off of the private sector's foreign-good debt or an official government guarantee on the private sector's debt. The need in terms of foreign goods is capped by the total amount of external debt facing the economy. 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 buys 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, targeted lending uses less resources than expansionary fiscal policy.

5 Conclusion

This work provides a simple theoretical framework to study different mechanisms through which foreign reserves can be useful in an economy where the private sector faces credit constraints and currency mismatches. It is shown that foreign reserves can be considered as a state-contingent insurance when the exchange rate valuation effect is taken into account. This is an aspect that has not yet been emphasized in the literature on foreign reserves. 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 works through investors' expectation and requires less foreign reserves than in the second case. The

underlying reason is that a targeted lending is equivalent to giving investors a governmental guarantee on the private sector's liabilities (especially foreign liabilities). Having sufficient foreign reserves alters investors' expectation and removes the bad equilibrium.

The current framework remains simple. A more comprehensive theoretical framework is needed to endogenize the firm's portfolio choice and different costs related to *ex ante* foreign reserve purchases.

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A 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^- will then determine the exchange rate through the aggregate resource constraint, namely the DD curve. The economy goes from point A^- 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^+ ■

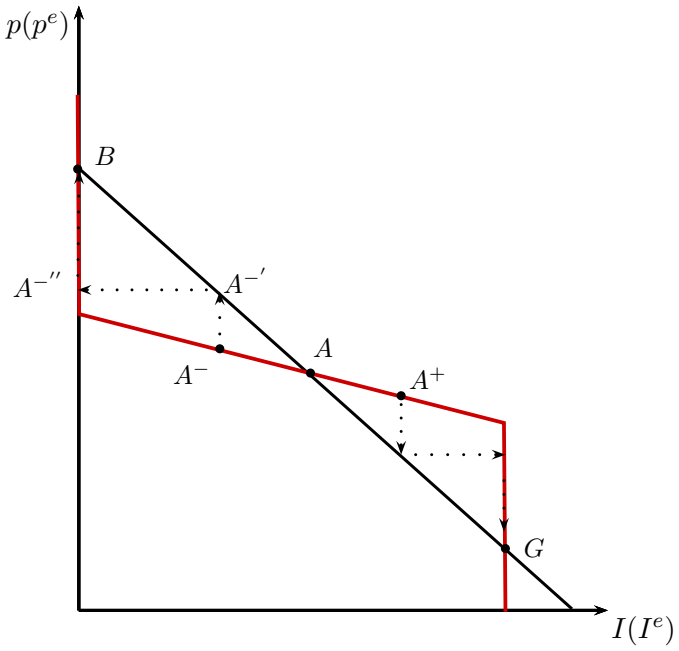

Figure 11: Unstable middle point