BORROWING AND BALANCE-OF-PAYMENTS CRISES

Tuomas Komulainen[1]

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Abstract

The study extends the first generation theory on currency crisis. We study bond financing of fiscal deficits both in domestic and in foreign currency, and compare the timing and magnitude of the attack with the basic case where the deficits are monetized. In addition, we study how uncertain capital flows and risk premium affect the timing of crisis. We find that borrowing may not necessarily postpone the crisis. But if the public debt level is low, the timing of currency crisis can be postponed with borrowing. Furthermore, with bonds denominated in foreign currency the crisis occurs later than with bonds denominated in domestic currency. The magnitude of the attack is largest when the bonds are denominated in foreign currency. With uncertain risk premium the timing of crisis is not anymore unique and a larger magnitude of capital flows widens the range in which crisis may occur.

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[1] Bank of Finland and BOFIT, e-mail: tuomas.komulainen@bof.fi. The author is grateful to Lauri Kajanoja, Jukka Pirttilä and Pedro Rodriguez for their valuable comments. All views expressed are those of the author and do not necessarily reflect the views of the Bank of Finland.

I. Introduction

Excessive budget deficits and government indebtedness have been mentioned as reasons for some of the recent currency crises, for example in Russia in 1998 and in Argentina in 2001 (e.g. Sutela 2000, Mussa 2002). Similarly, government budget deficits and foreign borrowing caused the debt crises in many developing countries in 1980's. Although the currency crisis literature is quite extensive nowadays, surprisingly few studies have analyzed the influence of government borrowing on currency crises.[2]

In the currency crisis model by Krugman (1979) the collapse of a fixed exchange rate regime is caused by excessive money creation to finance fiscal deficits.[3] Buiter (1987) extended the model to include once-off government borrowing with foreign currency denominated bonds. The study does not, however, analyze the case where domestic credit is held constant with the borrowing. Calvo (1998) discussed the case where the deficits are financed with domestic currency denominated bonds, but it does not study the timing of crisis explicitly. In Flood and Marion (2000) the budget deficits are partly financed with bonds denominated in domestic currency, but again the study does not analyze role of the borrowing to the timing of crisis or to the magnitude of the attack.

Indeed, the role of debt denomination is not yet explicitly studied in the earlier currency crisis models. Even though crisis prevention is an important question for debt management authorities in emerging market countries. Furthermore, none of the studies we are aware of has included a risk premium that depends on the government's indebtedness.[4] Thus, we include into a basic currency crisis model by Flood and Garber (1984) bond financing of deficits, and a risk premium, which depends on the government indebtedness. We will analyze the consequence of bond financing both in domestic and in foreign currency.

Financial liberalization in the 1980s was followed by large capital inflows, i.e. borrowing either by the government or private banks and firms. In the crisis times capital flows reversed and the volatility of capital flows has been mentioned as one possible reason for the recent crises (Calvo and Vegh 1999, Calvo 1996, 2002). Calvo et al (1996) and Calvo and Reinhart (1999) show, that the magnitude of capital flows and their reversals has been substantial in the recent crises. Several studies have introduced uncertainty in the first generation theory on currency crisis, but no study, which we are aware of, has yet analyzed the influence of uncertain capital flows on currency crises.[5]

[2] Daniel (2001) is an exception. She creates a model related to literature on fiscal theory of price level and studies the consequence of stochastic shock to government transfers on currency crisis.

[3] See also the simplified version of the model in Flood and Garber (1984). See also Flood et al. (1996) which includes a bond market into the currency crisis model and studies the role of sterilization.

[4] See e.g. Willman (1988), Flood et al. (1996) and Flood and Marion (2000) for different versions of risk premiums used in currency crisis models.

[5] See Agenor et al. (1992) and Willman (1992) for surveys on studies on first generation theory. The first generation theories usually assume that uncovered interest parity holds, and so take into account capital

For instance, in Flood and Garber (1984) domestic credit growth depends on a random component and in Willman (1989) the threshold level of reserves is uncertain. In our extension the demand for bonds and the risk premium is stochastic, which reflects the volatility of capital movements.

With these extensions the currency crisis model in this study tells a following story: the government of an emerging market country finances its budget deficit by issuing bonds. Foreign investors' demand for bonds and the risk premium depend from the EM country's indebtedness. Furthermore, the demand for bonds and the risk premium is volatile. When investors expect a speculative attack to be successful, capital inflows cease and an attack materializes. We have an extended Krugman (1979) type of crisis model, and we will study and compare the dynamics of reserves, timing of crisis and magnitude of the attack.

II Model

The basic currency crisis model presented here follows Flood and Garber (1984), Flood et al. (1996) and Kajanoja (2001). The equations of the model are as follows:

(1) $$\frac{M_t}{P_t} = \alpha_0 - \alpha_1 i_t \qquad \alpha_0 > 0,\ \alpha_1 > 0$$

(2) $$P_t = P_t^* S_t$$

(3) $$i_t = i^* + \frac{\dot{S}}{S} + \rho B_t \qquad \rho > 0$$

(4) $$M_t = D_t + R_t$$

, where M_t denotes the monetary base, P_t the price of domestic good and P_t^* the price of foreign good. The domestic and foreign one period interest rates are marked with i_t and i_t^*. S_t denotes the exchange rate, quoted as the price of a unit of foreign currency, and $\dot{S}$ is the time rate of change of S_t. The stock of foreign reserves is denoted by R_t and domestic credit by D_t.

Equation (1) gives the demand for real balances, equation (2) is the purchasing power parity and equation (4) displays a decomposition of the monetary base. Equation (3) is the covered interest rate parity with a risk premium, which depends on the

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movements, but not their volatility. See e.g. Carr and Darby (1981) and Kanniainen and Tarkka (1984) on the role of monetary shocks in the money demand.

government's indebtedness B_t.[6] Except for the risk premium the basic set-up (equation 1 - 4) is similar to earlier currency crisis models, like Flood and Garber (1984) or Flood et al. (1996).[7]

A. Domestic currency debt

We now proceed by assuming that the primary budget deficit δ of the government and the debt payments from earlier period are financed with domestic currency bonds B_t:[8]

(5) $$B_t = \delta + (1 + i_t)B_{t-1}$$

The increase in government borrowing is defined:

(6) $$\dot{B}_t = \delta + i_t B_{t-1}$$

Domestic credit is constant during the fixed exchange rate period, and equation (1) can be written into the following format:

(7) $$D + R = P * \overline{S}[\alpha_0 - \alpha_1(i * + \rho B_t)]$$

We obtain the dynamics of international reserves during the fixed rate period by taking the time derivative of each side of equation (7):

(8) $$\dot{R} = -\alpha_1 \rho \dot{B}_t$$

The reserves are diminishing over time, since the risk premium is increasing due to government borrowing and money demand will be lower. The shadow exchange rate $\tilde{S}$, which would prevail if investors would suddenly buy the entire reserves, can be calculated from the equation:

(9) $$D_T = P * \tilde{S}[\alpha_0 - \alpha_1(i * + \frac{\dot{S}}{S} + \rho B_t)]$$

, where D_T marks the domestic credit just after the attack and is determined as:

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[6] Although we do not include defaults into the model, investors ask a higher return if the bonds outstanding of a country are increasing.

[7] Appendix A calculates the magnitude of the attack and the time of the crisis without the risk premium and with the assumption that the budget deficit is financed with the growth of domestic credit.

[8] We assume that a currency crisis occurs earlier than the time when investors are not anymore ready to finance the deficit and the debt payments. In addition, we assume that the bonds are entirely held by foreigners.

(10) $$D_T = D_{T-1} + \mu_T$$

, where μ_T marks the growth of domestic credit needed to finance the deficit and interest payments after the attack:

(11) $$\mu_T = \delta + iB_T$$

, where debt stock at the time T_D of the crisis is denoted: [9]

(12) $$B_T = \frac{\delta}{i}\left(e^{i_a T_D} - 1\right)$$

Naturally the debt stock increases if the time of the crisis is postponed with borrowing. Denoting P* = 1 and $a = \alpha_0 - \alpha_1 i^* > 0$ we can write the shadow exchange rate as:

(13) $$\tilde{S} = k_0 + k_1 D$$

, where

(14) $$k_0 = \frac{\alpha_1 \mu_T}{(a - \alpha_1 \rho B_T)^2}$$

(15) $$k_1 = \frac{1}{a - \alpha_1 \rho B_T}$$

At the instant of the crisis $\dot{\tilde{S}}$ jumps from zero to $\mu_T k_1$ and the size of the attack is defined:

(16) $$\Delta R_D = \alpha_1 \mu_T k_1$$

Using equations (8) and (16) the condition of the attack can be written:

(17) $$R_0 - \alpha_1 \rho \dot{B}_T T_D = \alpha_1 \mu_T k_1$$

The time T_D of the crisis is determined:

(18) $$T_D = \left(R_0 - \frac{\alpha_1 \mu_T}{a - \alpha_1 \rho B_T} \right) \frac{1}{\alpha_1 \rho \dot{B}_T}$$

[9] In equation (12) i_a denotes the average interest rate between time zero and T_D.

In addition to initial level of reserves, the timing of crisis now depends on the risk premium (i.e. indebtedness) and on the growth of domestic credit after the crisis.

B. Foreign currency debt

If the borrowing is carried out with bonds denominated in foreign currency, the debt dynamics are determined by the following equations:

(19) $$S_t B_t^* = \delta + (1+i^*)\overline{S}B_{t-1}^* + \rho\left(1+\frac{\dot{S}}{S}\right)\overline{S}B_{t-1}^*$$

(20) $$S_t \dot{B}_t^* = \delta + \left(i_t^* + \rho\frac{\dot{S}}{S}\right)\overline{S}B_{t-1}^*$$

The domestic interest rate is now denoted as:

(21) $$i_t = i* + \frac{\dot{S}}{S} + \rho\left(1+\frac{\dot{S}}{S}\right)\overline{S}B_t^*$$

When the borrowing is carried out in foreign currency bonds, the dynamics of reserves during the fixed exchange rate period follow:

(22) $$\dot{R} = -\alpha_1\rho\overline{S}\,\dot{B}_t^* - (i*+\rho\overline{S}B_t^*)\overline{S}B_{t-1}^* + \overline{S}\,\dot{B}_t^*$$

Using equations (19) and (20) it can be written in the following form

(23) $$\dot{R} = -\alpha_1\rho\overline{S}\,\dot{B}_t + \delta$$

Indeed, the reserves increase until the decrease in money demand due to higher risk premium is equal to the budget deficit.[10] Afterwards reserves decline.

The shadow exchange rate that equilibrates the money market is now determined by:

(24) $$\widetilde{S} = k_0 + k_1 D$$

, where

(25) $$k_0 = \frac{\alpha_1\mu_{\$T}(1+\rho\overline{S}B_T^*)}{(a-\alpha_1\rho\overline{S}B_T^*)^2}$$

[10] The result that reserves may increase with bond issues in foreign currency is quite obvious and resembles also Buiter (1987).

and

$$k_1 = \frac{1}{a - \alpha_1 \rho \bar{S} B_T^*} \tag{26}$$

The growth of domestic credit needed to finance the deficit and interest payments after the attack:

$$\mu_{\$T} = \delta + i^* \left(1 + \frac{\dot{S}}{S} \right) \bar{S} B_T^* \tag{27}$$

where the debt stock at time of crisis is determined

$$\bar{S} B_T^* = \frac{\delta}{i} \left(e^{i_a T_\$} - 1 \right) \tag{28}$$

And the magnitude of the attack becomes:

$$\Delta R_\$ = \alpha_1 \mu_{\$T} k_1 (1 + \rho \bar{S} B_T^*) \tag{29}$$

The time of the crisis is now determined:

$$T_\$ = \left(R_0 - \frac{\alpha_1 \mu_{\$T} (1 + \rho \bar{S} B_T^*)}{a - \alpha_1 \rho \bar{S} B_T^*} \right) \frac{1}{\alpha_1 \rho \bar{S} \dot{B}_T - \delta} \tag{30}$$

When the government deficits are financed with bonds denominated in foreign currency, the timing of crisis depends negatively on risk premium and on domestic credit growth after the attack, and positively on the amount of borrowing (i.e. government deficit δ).

C. Comparison

We compare the magnitude of the attack and the timing of balance of payments crisis in those three cases we have studied: the budget deficits are financed either with domestic credit expansion (appendix A), with bonds denominated in domestic currency (section II. A), or with bonds denominated in foreign currency (section II. B). Appendix B summarizes the timing and the magnitude of the attack in those three cases. Let's analyze first the timing of crisis with domestic credit expansion (T) and with bond financing in domestic currency (T_D). We find that if $\mu \leq \alpha_1 \rho \dot{B}_T$, then the crisis occurs earlier with bond financing than with domestic credit expansion ($T_D < T$). That is to say, if the growth in domestic credit is modest, but the indebtedness and risk premium are high, borrowing in domestic currency does not postpone the crisis. However, usually

$\mu > \alpha_1 \rho \dot{B}_T$ holds.[11] Indeed, if the needed domestic credit growth is relatively high, currency crisis occurs earlier with domestic credit expansion than with bond financing ($T < T_D$).

When analyzing timing of crisis with bond issues in domestic currency (T_D) and in foreign currency ($T_\$$), we find the amount of foreign currency borrowing (the budget deficit δ) critical for the comparison. If the lower money demand ($\alpha_1 \rho \bar{S} \dot{B}_T$) due to higher risk premium is relatively low, but the borrowing needs are large, the crisis is postponed with foreign currency borrowing ($T_\$ > T_D$). The policy conclusion of the result is that when the indebtedness of a country is still low, but the borrowing needs are high, borrowing in foreign currency postpones the crisis.[12]

Let's turn to the magnitude of the crisis, which also reflects the amount of exchange rate depreciation during the crisis. The magnitude is largest with foreign currency borrowing ($\Delta R_\$$) and smallest with domestic credit expansion (ΔR). The intuition behind the result is that if the bonds are denominated in foreign currency, a larger growth of domestic credit is needed to finance the debt payments after the currency depreciation. Indeed, due to large decline in reserves and large magnitude of currency depreciation bond financing in foreign currency might have the largest welfare costs.

These results have some policy implications for countries with fiscal deficits and borrowing needs. In those countries, where the public debt levels are low, the authorities can postpone the currency crisis if they borrow in foreign currency. Especially, if it can be truly expected that fiscal adjustment will eventually take place and the crisis - with large devaluation - will not materialize. If the debt level is high and crisis expectations already exist, borrowing neither in domestic nor in foreign currency will not help; it may even make the situation worse.

III. Uncertain capital flows and risk premium

We introduce uncertain capital flows into the model where government deficits are financed with bonds denominated in domestic currency. We study two regimes with two different risk premiums: during the turbulent times in global capital markets (e.g. especially in emerging markets) capital inflow is low and the risk premium is high $\rho_H B_t$. During the stable period it is easier for the emerging market country to sell its bonds globally and the risk premium is low $\rho_H B_t$.[13] For example, during turbulent times and with borrowing the reserves diminish with higher pace:

[11] During normal times lower money demand due to higher risk premium should be less than due to domestic credit growth. Nevertheless, recent crisis episodes have shown that interest rates may increase very high in the crisis times.

[12] A caveat is needed; if the indebtedness is high, the timing of crisis occurs earlier with borrowing in foreign currency.

[13] We further assume that $f < R_0$, so that crisis can not occur immediately.

(31) $$\dot{R} = -\alpha_1 \rho_H \dot{B}_t$$

With uncertain capital movements and risk premium the timing of crisis is not anymore unique. The timing is now determined with a range [T_{min}, T_{max}], where the limit T_{min} denotes the periods before the crisis can not happen and T_{max} the periods after which the crisis occur with certainty. The limits are determined by:

(32) $$T_{\max} = \left(R_0 - \frac{\alpha_1 \mu_T}{a - \alpha_1 \rho_L B_T} \right) \frac{1}{\alpha_1 \rho_L \dot{B}_T}$$

and

(33) $$T_{\min} = \left(R_0 - \frac{\alpha_1 \mu_T}{a - \alpha_1 \rho_H B_T} \right) \frac{1}{\alpha_1 \rho_H \dot{B}_T}$$

We observe that with uncertain capital flows crisis may occur earlier, but it may also postpone the crisis. Furthermore, if the magnitude of uncertain capital flows is increased - ρ_H is higher and ρ_L is lower -, the range in which crisis may occur widens. Indeed, with uncertain capital movements and risk premium crises may occur earlier or later than the other fundamentals might predict.

IV. Conclusions

This short note extended the first generation theory on currency crisis with various issues. We studied bond financing of fiscal deficits both in domestic and in foreign currency, and compared the timing and magnitude of the attack with the basic case where the deficits are monetized. In addition, we studied how uncertain risk premium due to capital movements affect the timing of crisis. A number of results emerged. Bond financing may not necessarily postpone currency crisis since the lower money demand due to higher risk premium brings the crisis forward. Indeed, with bond financing the timing of crisis depends also on the indebtedness of the country and on the government's borrowing needs. If the indebtedness of a country is low but the borrowing needs are high, currency crisis is postponed with bond financing. Especially if the borrowing is carried out with bonds denominated in foreign currency. The magnitude of the attack is however larger. With uncertain capital flows and risk premium the timing of crisis is not anymore unique, and a larger magnitude of capital flows widens the range in which currency crisis may occur.

Obviously the model has its shortcomings and the results should be read carefully. We assumed that the time and the debt level after which investors are not anymore ready

to finance the government arises later than time of the balance-of-payments crisis.[14] We also assumed that all the bond issues are held by foreigners. In addition, we introduced uncertain capital movements through the risk premium. A different and richer approach could make the model closer to reality.

Anyhow, we believe that our extensions are necessary and bring the first generation theory of currency crisis closer to reality. Although widely employed by governments, debt financing of fiscal deficits has not yet been adequately studied in the currency crisis literature. For example, the model presented explains why currency crisis may occur, although the domestic credit growth before the crisis is modest or the banking sector healthy. Moreover, the extension of a risk premium and uncertain capital movements is able to illustrate the high interest rates and the suddenness of recent crises. These are familiar circumstances from the recent crisis episodes in Russia, Turkey and Argentina, where fiscal deficits were financed with bond issues. Suddenly, capital inflows ceased, interest rates jumped and the currency crisis materialized.

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[14] The caveat might not be that serious since in our model the risk premium depends on the debt level.

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Appendix A: Basic currency crisis model

We calculate the magnitude of the attack and the timing of crisis in the basic case where the fiscal deficits δ are financed with the growth of domestic credit μ. Equations (1), (2) and (4) are still the same, but equation (3) is now without the risk premium:

(A1) $$i_t = i^* + \frac{\dot{S}}{S}$$

The dynamics of the reserves during the fixed rate period follow:

(A2) $$\dot{R} = -\mu$$

The shadow exchange rate $\tilde{S}$ is now determined:

(A3) $$\tilde{S} = \frac{\alpha_1 \mu}{\left(\alpha_0 - \alpha_1 i^*\right)^2} + \frac{D}{\alpha_0 - \alpha_1 i^*}$$

The magnitude of the attack can be written into format:

(A4) $$\Delta R = \frac{\alpha_1 \mu}{\alpha_0 - \alpha_1 i^*}$$

Denoting $a = \alpha_0 - \alpha_1 i^* > 0$ the timing of the crisis T is determined by:

(A5) $$T = \left(R_0 - \frac{\alpha_1 \mu}{a} \right) \frac{1}{\mu}$$

The timing of crisis depends now only on the initial level of reserves R_0 and on the growth of domestic credit μ.

Appendix B: Timing and magnitude of crisis

Method of deficit financing	**Timing**
Domestic credit expansion	$T = \left(R_0 - \frac{\alpha_1 \mu}{a} \right) \frac{1}{\mu}$
Bonds in domestic currency	$T_D = \left(R_0 - \frac{\alpha_1 \mu_T}{a - \alpha_1 \rho B_T} \right) \frac{1}{\alpha_1 \rho \dot{B}_T}$
Bonds in foreign currency	$T_\$ = \left(R_0 - \frac{\alpha_1 \mu_{\$T} (1 + \rho \bar{S} B_T^*)}{a - \alpha_1 \rho \bar{S} B_T^*} \right) \frac{1}{\alpha_1 \rho \bar{S} \dot{B}_T - \delta}$

Method of deficit financing	**Magnitude**
Domestic credit expansion	$\Delta R = \frac{\alpha_1 \mu}{a}$
Bonds in domestic currency	$\Delta R_D = \frac{\alpha_1 \mu_T}{a - \alpha_1 \rho B_T}$
Bonds in foreign currency	$\Delta R_\$ = \frac{\alpha_1 \mu_{\$T} (1 + \rho \bar{S} B_T^*)}{a - \alpha_1 \rho \bar{S} B_T^*}$