

## **“Original Sin”, Balance Sheet Crises and the Roles of International Lending**

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Paper written for the Conference  
“Currency and Maturity Matchmaking: Redeeming Debt from Original Sin”,  
sponsored by Harvard University and the Inter-American Development Bank  
Washington, November 21-22, 2002

Draft, November 13, 2002

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<sup>1</sup> We thank Ricardo Hausmann, Barry Eichengreen, Roberto Rigobon and participants at a pre-conference held at Harvard University in July 2002 for helpful comments and suggestions. Any remaining errors are ours. The views expressed in this papers are the authors’ only and do not necessarily reflect the views or policies of the International Monetary Fund.

## I. INTRODUCTION

A number of commentators have expressed the view that the crises of the 1990s were of a new kind, in that they reflected fragilities in the balance sheet of countries rather than current account imbalances.<sup>2</sup> They have argued that the international community should take a new approach—a balance sheet approach—to the management of international financial crises.

One source of balance sheet fragility that is often emphasized, and especially in this conference, is foreign currency debt. One sense in which foreign currency debt is the “original sin” is that it is the source of so many other problems. Foreign currency debt constrains traditional domestic policy instruments, such as monetary or fiscal policies, in dealing with economic shocks, both home-made and foreign. Almost by default, this suggests a larger potential role for international official lending, as reflected in the heavy involvement of international financial institutions in Latin America and other areas of the world suffering from “original sin”. But how and why can international lending be a useful complement to domestic economic policies in these countries? More specifically, how can the role of international lending be rationalized in the context of the “balance sheet approach” to financial crises?

This paper will answer these questions in the context of a simple framework that encompasses—in a highly stylized way—several of the “balance sheet approaches” that have been proposed in the literature. As we will show, the general consensus that foreign currency debt is problematic masks a surprising variety of opinions and models of the dangers involved. Rather than presenting one more model of the dangers of foreign currency debt, this paper will present a framework that is general and flexible enough to organize a discussion of the recent literature, in a way that is not overly dependent on inessential modeling details. The first part of the paper can be viewed as a brief tour of the literature for the practitioner. In the second part of the paper, we discuss some of the challenges for domestic policies that arise in this framework, and the potential roles for international crisis lending.

Our framework gives a stylized summary of two classes of models of balance sheet crises. The first class of models combines a currency mismatch with a maturity mismatch: debt is not only in foreign currency but also short-term, typically banking deposits (Chang and Velasco, 2000, Burnside et al, 2001, 2002, Jeanne and Wyplosz, 2001). Crises take the form of runs on short-term foreign currency debt. The second class of models involves a currency mismatch, without maturity mismatch, in corporate balance sheets (Krugman, 1999, Aghion et al, 2000, 2001a,b, Schneider and Tornell, 2001). Crises involve a severe credit crunch and a fall in investment. In *both* cases, crises can be self-fulfilling, the depreciation of the exchange rate being validated by the real disruption it provokes. Both classes of models are supported by some evidence, making it interesting to explore their policy implications.

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<sup>2</sup> One of the first was Dornbusch (1998). For a recent statement, see Calvo (2002).

We argue that the policy implications of the two classes of models are similar in some areas, but quite different in others. One policy implication that all balance sheet approaches seem to have in common is the relative powerlessness of domestic policies—and especially monetary policy—in protecting the economy against capital account crises. Moreover, there could be an important role for international crisis lending in both classes of models, but the nature of this role is quite different. In the first class of models (models with runs), the optimal policies should be thought of by reference to banking safety nets: lending-in-last-resort, deposit insurance, or suspension of payments. We argue that such policies do not necessarily place unrealistic demands on international crisis lending, although they raise knotty moral hazard issues, just like domestic banking safety nets. In the context of credit crunch models, international crisis lending may also have a useful role, but it has little to do with lending-in-last resort, and more with loosening fiscal constraints. A large international lender can help overcome self-fulfilling crises by lending to the government conditioning on its “true” net worth, i.e. its net worth in normal times, allowing it to pursue activities that mitigate the effects of the credit crunch.

There are several caveats to make. The most important one is that we look at the question from a purely ex post perspective. The “original sin” is taken as given. Obviously, however, the different policies we consider have an impact ex ante on the decisions to borrow in domestic or foreign currency (an endogeneity that several contributions in this volume look at). We briefly discuss this issue at the end of the paper.

## II. ELEMENTS OF A CANONICAL FRAMEWORK

We consider a two-period model of an open emerging economy ( $t = 1, 2$ ). For the sake of brevity and couleur locale we call the domestic and foreign currencies “peso” and “dollar” respectively. The exchange rate  $S_t$  is defined as the time  $t$  domestic currency price of one dollar, so an increase in  $S$  means that the peso depreciates.

The objective of the model is to clarify a range of possible links between expectations about future exchange rates,  $S_2^e$ , and balance sheets—or more precisely, domestic private agent’s net worth in terms of dollars,  $W^*$ . In principle, links can exist in both directions. The link from expected exchange rates to net worth follows more or less directly from the presence of unhedged foreign currency liabilities. However, the balance sheet problems caused by the expected depreciation could also be part of the fundamentals that market participants look at in deciding what to exchange rate to expect. If that is the case, there could be multiple equilibria, one of which one could be pareto-dominated. Expectations of depreciated future exchange rates could lead to low net worth, triggering an economic crisis and depreciated exchange rates which in turn validate the initial expectations.

To develop a framework that generates self-fulfilling crises of this kind we must thus construct a “loop” from  $S_2^e$  to  $W^*$  and back to  $S_2^e$ . We do so in three steps. First, we

describe the link from  $S_2^e$  to new worth  $W^*$ . This step is straightforward and somewhat mechanical; it follows from balance sheet definitions and uncovered interest parity. Second, we describe two alternative links from  $W^*$  to an economic crisis state  $X$ , which is given a particular interpretation in each case. This step is not mechanical, and involves most of the economic substance of this paper. Finally, we discuss a variety of possible ways, suggested in the literature on balance sheet crises, in which  $X$  could affect future exchange rates,  $S_2^e$ . In contrast with the previous step, we do not formalize these alternative links because the (monetary and international) policy implications on which we focus on in this paper turn out to depend only on the presence of *some* link from  $X$  to a depreciated exchange rate, not on how the particular channel is modeled. Thus it is sufficient for the purposes of this paper to assume that a link from  $X$  to  $S_2^e$  exists in reduced form. As we briefly discuss in section III below, this would not be enough if our objective was to analyze fiscal policy in a balance sheet crisis; in that case, the conclusions could depend quite critically on *how* economic crises translate to depreciated exchange rates.

#### A. The Link from Expected Exchange Rates to Net Worth

Assume that the peso/dollar exchange rate satisfies uncovered interest rate parity (UIP):

$$S_1 = \frac{1+i^*}{1+i} S_2^e$$

where  $S_2^e$  is the expected exchange rate, and  $i$  and  $i^*$  are respectively the peso and dollar riskless interest rates in period 1.

Next, consider domestic private agents (firms, or banks) who have debts and income streams denominated in dollars and pesos. The currency composition of income streams and debts is inherited from an earlier time and it is exogenous to the analysis. Let  $D_t$  denote the agents' time  $t$  debt repayment in pesos,  $D_t^*$  their time  $t$  debt repayments in dollars,  $R_t$  their peso income and  $R_t^*$  their dollar income. Note that we assume that the peso value of the agent's cash flows is not affected by the exchange rate. However, this is not a restrictive assumption since having a peso-denominated income stream that exhibits some exchange rate pass-through could be represented as a combination of fixed peso income and dollar income (for which pass-through is unity).

We are now ready to define the agents' net worth. This is the central variable in the balance sheet approach: all the bad things, bank runs or credit crunches, happen because of insufficient or negative net worth. Using UIP and denoting by  $D^* \equiv D_1^* + D_2^*/(1+i^*)$  and  $R^* \equiv R_1^* + R_2^*/(1+i^*)$  the present value dollar debt and dollar income of the agent,

respectively, its net worth can be expressed in terms of the expected exchange rate and the interest rate

$$(1) \quad W^* = \frac{R_2 - D_2 + (R_1 - D_1)(1+i)}{(1+i^*)S_2^e} + R^* - D^*$$

If the agent has enough pesos to repay its peso debt in each period ( $R_1 \geq D_1$  and  $R_2 \geq D_2$ ) then its net worth is decreasing with the expected exchange rate, and could become negative for high levels of  $S_2^e$  if the agent also has dollar debt ( $D^*$ ). The same would be true if we looked at the peso value of the agent's net worth.

### B. The Link from Net Worth to Crises

Why is low net worth a problem? Two answers (not necessarily mutually exclusive) are given in the literature. One view emphasizes the net worth constraint on investment that is standard in corporate finance. Firms cannot borrow more than a given fraction of their net worth; thus, net worth constrains investment. This channel is invoked in Krugman (1999), Aghion, Bacchetta and Banerjee (2000, 2001a, 2001b), and Schneider and Tornell (2001). The alternative view emphasizes the link between net worth and banking crises (Burnside, Eichenbaum and Rebelo, 2001, Jeanne and Wyplosz, 2001). Low net worth leads to the collapse of the banking system. Beginning with the latter we now briefly develop both views.

#### Banking Crises

We now assume that the agent is a bank. Following Jeanne and Wyplosz (2001), we assume that the bank suffers from a combination of currency and maturity mismatches, as follows: (1) its dollar debt exceeds its dollar income both in the first period and in present value terms, i.e.  $D_1^* > R_1^*$  and  $D^* > R^*$ ; (2) while the firm has second period income denominated in pesos, peso debt and first period peso income equals zero ( $R_1 = D_1 = D_2 = 0$ ). As we shall see below, assumption (1) is essential while (2) is made mainly for convenience.

Deposits are repayable on demand, and demand is served sequentially, like in Diamond and Dybvig's (1983) model of bank runs. The withdrawing depositors are randomly allocated in a queue which determines the order in which they are served. The bank repays depositors by selling its claims on future pesos for dollars in the market. If the bank does not have enough dollars to repay all the withdrawing depositors in period 1, the depositors at the end of the queue, and those who have not joined the queue, receive nothing. In the opposite case, the assets that remain in the possession of the bank at the end of period 1 are sold in period 2 to repay the remaining depositors—those who have not withdrawn in period 1. Deposits are interest-bearing, and yield the riskless interest rate  $i^*$ .

Under these assumptions, a fall in the bank's net worth can provoke a run. There is no run if and only if  $W^*$  is positive, i.e. if and only if

$$(2) \quad D^* \leq R^* + \frac{R_2}{(1+i^*)S_2^e}$$

If this solvency condition is satisfied the bank can repay all its depositors irrespective of the date at which they withdraw, and depositors have no (strict) incentives to withdraw early. If this condition is not satisfied, then all depositors run on the bank at period 1. Some depositors will have to take a loss, and each depositor minimizes the likelihood of being one of them by withdrawing his deposits early. Note that by contrast with the Diamond-Dybvig model the equilibrium is unique at the level of an individual bank. For a given balance sheet structure, the occurrence of a run is determined by the expected exchange rate, which is exogenous to the actions of the bank's depositors (the bank being very small).

Finally, assume that banks are heterogeneous in terms of their balance sheet characteristics. Because we have assumed that  $D^* > R^*$ , there is a specific cut-off exchange rate  $\bar{S}_2^e(j)$  for all banks  $j$  at which  $j$ 's net worth is zero. Assume that banks are infinitesimally small with total mass one, and that  $\bar{S}_2^e(j)$  is continuously distributed. Then, there is a cumulative distribution function,  $F(S_2^e)$  that describes the fraction of banks  $n$  for which  $\bar{S}_2^e(j) < S_2^e$ , i.e. whose net worth is smaller than zero. Consequently, the fraction of banks on which there are runs in period 1,  $n$ , is a continuous and increasing function of the expected exchange rate

$$(3) \quad n = F(S_2^e) \quad F' > 0, \quad F(\hat{S}_2^e) = 1$$

where  $\hat{S}_2^e$  denotes the supremum of  $\bar{S}_2^e(j)$ , i.e. the exchange rate at which the highest net worth bank becomes insolvent. An expected depreciation of the peso reduces the net worth of banks, drawing a larger number into insolvency. For  $S_2^e \geq \hat{S}_2^e$ , all banks are insolvent.

### A Credit Crunch

Next, consider the case in which there is a currency mismatch but no maturity mismatch. Specifically, we assume that all dollar debt is long term ( $D_1^* = 0$ ), but maintain the assumption that there is a currency mismatch with respect to the present value of dollar assets and liabilities ( $D_2^*/(1+i^*) > R^*$ ). This case can be interpreted as a firm that relies on some income in the non-tradables sector to maintain positive net worth. For simplicity, we keep the assumption that  $R_1 = D_1 = D_2 = 0$ ; this will be relaxed later. The firm's net worth is then:

$$(4) \quad W^* = R^* + \frac{R_2}{(1+i^*)S_2^e} - \frac{D_2^*}{(1+i^*)}$$

An increase in  $S_2^e$  reduces the firm's net worth in period 1. This does not provoke a default in period 1 since the firm does not have to repay or roll over debt in this period. However, it could constrain the quantity of new debt the firm can issue in period 1. In many corporate finance models net worth is a determinant of the firm's borrowing capacity and consequently its ability to invest.

Following Aghion, Bacchetta and Banerjee (2001), we assume that there is a first-best level of real (i.e. dollar) investment,  $\tilde{I}$ , at which the firm would like to invest if it is not credit constrained. Whether or not it can actually invest  $\tilde{I}$  depends on its borrowing capacity, which in turn is constrained by its dollar net worth. Assuming a simple linear constraint and no internal funds, the firm's actual investment, in dollar terms, can be written as

$$(5) \quad I = \begin{cases} \tilde{I} & \text{if } \tilde{I} \leq \mu W^*(S_2^e) \\ \mu W^*(S_2^e) & \text{if } \tilde{I} > \mu W^*(S_2^e) > 0 \\ 0 & \text{if } \mu W^*(S_2^e) \leq 0 \end{cases}$$

From (4) it is clear that there is a sufficiently small (i.e. appreciated) level of the second period exchange rate so that  $I = \tilde{I}$ . Denote this level  $\underline{S}_2^e$ . Similarly, since we have assumed that  $D_2^*/(1+i^*) > R^*$ , there is a sufficiently high (depreciated) level of the exchange rate such that net worth is zero, and thus  $I = 0$ . Denote this  $\bar{S}_2^e$ . We can now define an “investment gap”  $u$  which is analogous to the bank run function (3), in the sense that it expresses the real cost of low net worth as a function of the second period exchange rate:

$$(6) \quad u \equiv \tilde{I} - I = \begin{cases} \tilde{I} & \text{if } S_2^e \geq \bar{S}_2^e \\ \tilde{I} - \mu W^*(S_2^e) & \text{if } \bar{S}_2^e > S_2^e > \underline{S}_2^e \\ 0 & \text{if } \underline{S}_2^e \geq S_2^e \end{cases}$$

For  $\bar{S}_2^e > S_2^e > \underline{S}_2^e$ , the real costs of a credit crunch are a continuous and strictly increasing function of  $S_2^e$ , since  $W^*(S_2^e)$  is continuous and strictly decreasing in  $S_2^e$ . This is true for each individual firm, and it is true in the aggregate regardless of whether or not firms are heterogeneous. Any increase in  $S_2^e$  beyond  $\bar{S}_2^e$  will cause investment to fall to zero.

### C. The Link from Crises to Depreciated Exchange Rates

The final step is to construct a link from these bad consequences of net worth—a credit crunch, low investment, a banking crisis—to future exchange rates. Broadly classified, the literature has focused on three arguments:

- Low investment demand in the home/nontradable goods sector forces a real depreciation, given a market clearing condition for this sector. This is the channel assumed by Krugman (1999) and Schneider and Tornell (2001) in the context of purely “real” models, i.e. models without money and nominal exchange rates.
- Low future output in conjunction with an assumption about future monetary policy, which implies that low future output feeds through to prices and (with PPP) a depreciated exchange rate (Aghion, Bacchetta and Banerjee (2000, 2001a), Bacchetta (2000), Jeanne and Wyplosz (2001)).
- The collapse of the banking system leads to a debt-financed bail-out (Burnside, Eichenbaum and Rebelo (2001)). The increase in public debt, in turn, is financed by a monetization that causes the exchange rate to depreciate.

Of these three stories, the one that is easiest to incorporate in our framework is the argument that low future output leads to depreciated exchange rates. For the purposes of our framework, this is convenient because it does not matter whether the output disruption comes from a credit crunch or from a banking crisis in the first period. To complete the argument, one must show (or assume) that the monetary authorities partly accommodate the output collapse by allowing the exchange rate to depreciate. One story (Jeanne and Wyplosz, 2001) is that this might be optimal in order to minimize real disruptions if the authorities face a Phillips curve-type tradeoff.<sup>3</sup>

The Burnside, Eichenbaum and Rebelo debt monetization argument could also be adapted to close our stylized model for the case of banking crises. In this context, their story provides an alternative argument of why one might expect a jump in the second period money supply and thus the second period exchange rate. It is a less natural argument in the context of a Bernanke-Gertler type credit crunch story, but could work even here, if one assumed that the collapse in private investment is offset by higher public investment that is financed in part through future monetization (or if low investment and low output increase the fiscal deficit).

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<sup>3</sup> Assume that second period aggregate output is given by a Phillips curve augmented by a term reflecting the real disruptions in the first period,  $x$  (where  $x$  stands either for bank runs  $n$  or the investment gap  $u$ ). If the law of one price applies, this can be written in terms of the exchange rate:

$$Y_2 = \bar{Y} + \alpha(S_2 - S_2^e) - f(x), \quad f(0) = 0, \quad f' > 0,$$

Now assume that domestic monetary authorities set  $S_2$  so as to minimize the quadratic loss  $L_2 = (Y_2 - \bar{Y})^2 + \beta(S_2 - \bar{S})^2$ , taking the expected exchange rate as given. It is easily shown that this yields an expression of the type of equation (7), i.e.  $S_2$  is set as increasing function of  $x$ .

Krugman's (1999) and Schneider and Tornell's (2001) real exchange rate depreciation driven by market clearing in the home goods sector cannot be easily interpreted in our framework, since it requires a rather different type of model. However, it gives rise to essentially the same loop as in the credit crunch version of our framework: depreciated exchange rates lower net worth, implying low investment which in turn depreciates the exchange rate. Moreover, their argument could be extended to banking crises, if one assumes that banks are critical to the financing of demand for the investment good.

In short, underinvestment or banking crises can be linked back to exchange rate depreciation in multiple ways. In the next section, we will focus on policy implications of our balance sheet framework for which the precise nature of this link is not critical. Consequently, we confine ourselves to assuming such a link in reduced form:

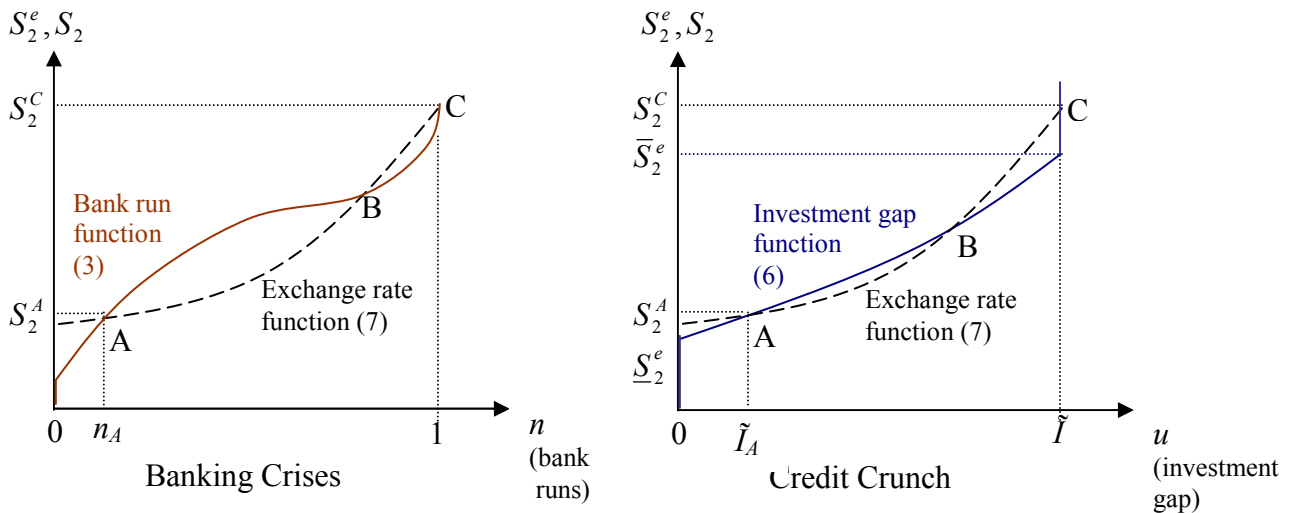
$$(7) \quad S_2 = G(x) \quad G' > 0$$

where  $x$  stands for either the number of runs,  $n$  (in the banking crisis model) or the investment gap  $u$  (in the credit crunch model).

#### D. Equilibria

Putting together the pieces derived in the last three sections, equation (7) defines the link from real economic disruptions to the second period exchange rate, while equations (3) and (6), define the links from the expected second period exchange rate to bank runs or underinvestment, respectively. In a rational expectations equilibrium, expected and actual exchange rates must be the same. Since (7), (3) and (6) all describe increasing functions, the models generically give rise to multiple equilibria, as drawn below (Figure 1).

Figure 1. Equilibria in Banking Crises and Credit Crunch Models



Except for the suggested shapes of the bank run and credit crunch functions (which are derived from a cumulative distribution function in the first case but not in the second) the left and right figures are very similar. In each case, there are two stable equilibria: a “good” equilibrium with low disruptions and an appreciated exchange rate (A), and a “bad” one with complete disruption and a depreciated exchange rate (C). The middle equilibrium B is not stable.

### **III. POLICY IMPLICATIONS**

What are the complications arising from the presence of balance sheet effects? It is useful to distinguish between two classes of problems.

First, even without feedback effects, the link from the expected exchange rate to net worth complicates optimal policy responses to exogenous shocks. Specifically, the currency mismatch in balance sheets can magnify the impact of shocks that have little to do with balance sheets originally. An exogenous deterioration in the fundamentals that makes a depreciation more likely (say an adverse terms of trade shock) disrupts the real economy by decreasing the net worth of firms and banks with a currency mismatch in their balance sheets. As argued above, this can lead to bank runs and/or a collapse in investment and thus a further deterioration in the fundamentals. Whether or not standard policy prescription on how to deal with exogenous balance of payments shocks still apply in this context is not obvious. As shown by Cespedes, Chang and Velasco (2001a, 2001b), for example, standard prescriptions for monetary policy, may or may not continue to apply, depending on the precise nature of the problem.

The presence of a feedback effect from balance sheets to exchange rates creates a further complication because of the possibility of self-fulfilling crises. In the framework outlined above, we have two stable equilibria, one of which dominates the other in output terms. Expectations of depreciated future exchange rates can lead to low net worth, low future output and depreciated exchange rates which validate the initial expectations. The potential task for policy is then somewhat different: rather than looking at the optimal reaction of policy to exogenous shock in the presence of a new channel through which shocks are transmitted, the question is how policy can be used to rule out the crisis equilibrium. This is the policy question on which we concentrate in the remainder of this paper.

#### **A. Exchange Rate Regimes and Dollarization**

In principle, the problems described in the previous section can arise both under pegs and in floating regimes. What is important is the possibility of an adverse shift in expectations about future exchange rates,  $S_2^e$ . This could be either an expected devaluation (in a pegged regime) or just a depreciation (in a floating regime).

The vulnerability of the economy to self-fulfilling balance sheet crises does not depend on the nature of the exchange rate regime per se, but on the likelihood that the monetary authorities will resist a depreciation of the domestic currency. In particular, an exchange rate

regime which credibly fixes  $S_2$  removes self-fulfilling crises. Thus, a credible fixed peg solves the problem at a very general level, for all the specifications of our framework. Clearly, if a country permanently adopts the dollar as its currency the currency mismatch in balance sheets is no longer an issue. Conditional on having a currency mismatch, this is an argument in favor of full dollarization.

However, there are two caveats. First, the argument only works if dollarization is viewed as irreversible.  $S_2^e$  must be equal to the official parity (i.e. unity) in all circumstances. A devaluation through re-pegification in the second period, which would amount to  $S_2^e > 1$ , must be viewed as impossible. Some would argue that even full dollarization can never achieve this.

A second caveat is that the currency mismatch itself could be endogenous to the currency regime. It is often argued that regimes with fixed but adjustable exchanges are conducive to currency mismatches because domestic borrowers tend to underestimate the risk of a devaluation. If this is true, a flexible regime might be preferable because it reduces the underlying balance sheet problem, but this point is clearly outside the scope of our analysis, which takes mismatches as a given.

In the remainder of this paper, we assume that the simple solution to currency mismatches—irrevocable dollarization—is either unfeasible or undesirable for reasons outside our model. This forces us to consider the scope of economic policies in an environment that in principle allows for the possibility of adverse exchange rate expectations, taking mismatches as a given. We begin with a discussion of domestic policy and then turn to the potential roles for international lending.

## B. Monetary policy

Can domestic monetary policy in a floating exchange rate regime deal with the basic inefficiency introduced by the presence of foreign currency debt, i.e. eliminate the equilibrium at point C? In the two examples considered so far, the answer is clearly “no”. This can be seen from the fact that the peso interest rate,  $i$ , does not appear in the balance sheet expressions (2) and (4). In the examples we have focused on so far, monetary policy is thus irrelevant: net worth is *entirely independent* of how domestic interest rates are set. This extreme result is a consequence of the assumption that  $R_1 = D_1 = D_2 = 0$ , which implies that net peso income in the first period ( $R_1 - D_1$ ) is zero. As a result, net worth in equations (2) and (4)—given international interest rates and dollar assets and liabilities—depends only on today’s dollar value of *future* pesos, i.e. on

$$\frac{R_2}{(1+i^*)S_2^e} \equiv \frac{(1+i)}{(1+i^*)S_2^e} \cdot \frac{R_2}{(1+i)} = \frac{1}{S_1} \cdot \frac{R_2}{(1+i)}$$

Raising the interest rate appreciates the exchange rate today and thus the dollar value of peso income today, but at the same time it reduces the peso value of future peso income. If the period 1 net peso cash flow is zero, the two effects cancel out, and domestic monetary policy is impotent. For an increase in interest rates to be the right policy response, the agent must have a positive net cash flow in period 1, whose dollar value is increased by the appreciation (or which can be invested at the high interest rate, to put it in another way). This can be seen by going back to the net worth definition (1):

$$(8) \quad W^* = \frac{R_2 - D_2}{(1 + i^*)S_2^e} + \frac{(R_1 - D_1)(1 + i)}{(1 + i^*)S_2^e} + R^* - D^*$$

Both the first and the last two terms on the right hand side are independent of domestic monetary policy, and the impact of domestic interest rates works entirely through first period net income.

Does the more general balance sheet structure underlying equation (8) still give rise to multiple equilibria, and could domestic monetary policy be used to eliminate the “bad” equilibrium? It depends. Consider first the bank run model, which assumed that banks are heterogeneous in terms of their balance sheet characteristics. There is obviously a trivial case where  $R_1 - D_1$  is greater than zero for all banks. In this case, defending the first period exchange rate—i.e. tightening monetary policy in the face of an adverse shift in expectations—will always work: no matter how depreciated  $S_2^e$  is, there is always a sufficiently high interest rate so that positive net worth can be restored. But this is not the case when banks are heterogeneous in the sense that  $R_1 - D_1$  is greater than zero for some but smaller than zero for others. Assume that in this case the central bank sets  $i$  to minimize the number of bank runs, i.e. the share of banks with positive net worth, taking  $S_2^e$  as given. Denote the central bank’s reaction function by  $i(S_2^e)$ , and by  $N(S_2^e)$  the corresponding number of insolvent banks. Then, assuming that  $R^* - D^* < 0$ , it is easy to see that  $N(S_2^e)$  is monotonically increasing in  $S_2^e$ .<sup>4</sup> The only difference relative to the previous section is that  $N(S_2^e)$  is bounded from above by the fraction of banks for which  $R_1 - D_1 < 0$ , since it is always possible to maintain the solvency of the other banks through a sufficiently tough interest rate defense. Thus, if the exchange rate function (7) is steep enough (see Figure 1) multiple equilibria will continue to exist. While monetary policy can minimize the impact of adverse exchange rate expectations on the banking system in the first period, it cannot prevent bank runs from occurring. Since the share of banks that suffer from runs remains a positive function of exchange rate expectations, monetary policy will not, in general be able to rule out self-fulfilling crises.

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<sup>4</sup> Because the net worth of *all* banks is decreasing with  $S_2^e$ , it cannot be the case that the monetary authorities manage to reduce the number of bank runs when  $S_2^e$  increases (if they could, this would mean that interest rate policy was not optimal to begin with).

The same logic can be applied to the credit crunch model. Again, there is a trivial case where an interest rate defense always works: this is the case when  $R_1 - D_1 > 0$  holds for all firms. If  $R_1 - D_1$  is greater than zero for some firms but smaller than zero for others then there will again be an optimal first period monetary policy that seeks to minimize the damage from adverse exchange rate expectations. In this case, the policy would set the interest rate so as to maximize the volume of investment at any given  $S_2^e$ . Denote this maximum volume  $I(S_2^e)$ . Using an argument exactly analogous to the one in footnote 4, it can be shown that  $I(S_2^e)$  is decreasing in  $S_2^e$ , i.e. that the investment gap is increasing in  $S_2^e$  (again, the critical property is that for any given interest rate, net worth is falling in  $S_2^e$ ). The only difference with the credit crunch case sketched in the previous section is that the investment gap function is not bounded by  $\tilde{I}$  (aggregate unconstrained investment) but rather by  $\tilde{I}$  minus the unconstrained investment of the firms for which  $R_1 - D_1 > 0$ , since their net worth can always be raised as high as needed by setting  $i$  sufficiently high. With this qualification, Figure 1 still applies and multiple equilibria will still exist in general.

The main conclusion is thus that monetary policy will be rendered ineffective, in the sense that it cannot protect the economy from adverse shifts in expectations with real costs, for a very wide range of balance sheet problems. However, this conclusion is subject to a caveat, which merits some discussion before moving on. It refers to the assumption, maintained throughout the paper, that monetary policy can affect net worth only through its impact on the exchange rate at which first period peso flows are valued or equivalently (given UIP and  $S_2^e$ ) on the interest rate with which second period flows are discounted. This has the effect of narrowing the potential role of monetary policy along two dimensions:

First, it eliminates the possibility for sterilized exchange market intervention. Given UIP and  $S_2^e$ , interest rate policy and exchange rate policy are one and the same thing. This excludes a strategy in which the central bank seeks to prop up net worth by *both* maintaining the interest rate low (thus raising the present value of second period net peso income) and the exchange rate appreciated (thus raising the dollar value of first period net peso income). If such a strategy were attempted through sterilized intervention—i.e. stabilizing  $S_1$  by selling dollars in the open market, while at the same time injecting liquidity into the market so that interest rates remain low—there would be an infinite demand for dollars, and the central bank reserves would soon be depleted. But it is clear that if UIP is violated—either because foreign and domestic bonds are not perfect substitutes, or because capital controls in some forms are introduced—sterilized intervention might work to some extent and this might help the central bank sustain net worth in the face of some shifts in exchange rate expectations. Whether or not this would be enough to eliminate the “bad” equilibrium in Figure 1 is of course an open issue; it depends on the degree to which sterilized intervention could mitigate the impact of shifts in  $S_2^e$  on net worth.

A second channel we have implicitly ruled out is the possibility that monetary policy could directly affect the net flows—and in particular, through an effect on peso income—that make up the bank and firm balance sheets in our model. Again, dropping this assumption would weaken our conclusions but may not overturn them. Assume, for example, that some units in the economy are never constrained in their investment or spending, and that the first period income  $R_1$  of the banks or firms we have considered so far depends on spending by these units. Then, by lowering interest rates the monetary authorities might be able to stimulate  $R_1$  directly, in addition to changing the net present value of  $R_2$  and  $D_2$ . In itself, this need not invalidate the conclusions; it just adds one additional channel which the monetary authorities have to consider when optimally setting first period interest rates in an environment of heterogeneous agents. However, it is of course possible to conceive of a situation where this “direct revenue effect” of monetary policy is so strong that it maintains high net worth for a wide range of second period exchange rate expectations, and eliminates the “bad” equilibrium.<sup>5</sup> This is just saying that the analysis presented in this paper should be viewed as relevant to situations where balance sheet effects are important relative to more traditional channels for monetary policy.

### C. Fiscal Policy

To discuss fiscal policy, it is necessary to introduce the government into our framework. In the following, we limit ourselves to a simple extension in which we assume that government spending can in principle make up for the bad effects of bank runs and/or private underinvestment subject to an intertemporal budget constraint. The problem is that in a balance sheet crisis this constraint may become binding, limiting the government’s capacity to deal with the consequences of adverse exchange rate expectations just when it is needed most. Thus, economy-wide balance sheet mismatches could place limitations on the use of fiscal policy which are similar in flavor as the ones discussed for monetary policy in the preceding section.

The simplest way to introduce the government in our framework is as an additional agent alongside firms or banks, subject to its own net worth constraint. In principle, there are two channels through which this government could break the vicious circle that leads to self-fulfilling runs: in the first period, through measures to limit the banking crisis (through bank recapitalization) or the investment gap; in the second period, by altering the feedback from these disruptions to future exchange rates. Since we have not modeled the latter except

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<sup>5</sup> This would be the case if the effect of loose monetary policy on  $R_1$  is so strong that it generates a positive first period net cash flow  $R_1 - D_1$  which is sufficiently large to outweigh the negative impact of the discounted second period cash flow. In Figure 1, this amounts to shifting the bank run or investment gap functions up until they no longer intersect with the exchange rate function (except on the y axis).

through the reduced form relationship assumed at the end in section II.C, we focus on the former.

To maximize the potential beneficial impact from fiscal policy, we abstract from the possibility that the government itself could be subject to runs. This means assuming that government net worth,  $W_G^*$ , is described by equation (4) (the net worth constrained for firms, which lacked short term dollar debt) rather than (2) (the net worth constraint for banks). In the government context, local currency receipts  $R$  could be interpreted as taxes, while local currency liabilities  $D$  could be interpreted either as domestic debt or as committed expenditures (say, entitlements). For the time being, we take these variables as given, i.e. we look at the effects of government policy for a given path of taxes, debt and committed expenditures. However, we will return to the implications of a fiscal adjustment at the end of the section.

We focus on the credit crunch story (an analogous argument could be made for the bank run story). In this version of the model, there are three avenues through which the government could limit the economy-wide investment gap arising from an adverse shift in exchange rate expectations: first, by transferring subsidizing private investment (i.e. paying for private investment projects), second, through public investment, and third as an additional source of lending for credit-constrained private firms. If private and public investment are perfect substitutes, than the first and two channels are essentially equivalent. In contrast, the third channel is somewhat different. Here, the government does not actually spend funds but rather serves as an intermediary between private credit markets and firms, borrowing against its own net worth and onlending to firms. In what follows, we focus on the subsidy/public investment story because it is closer to traditional fiscal policy and also is somewhat simpler to discuss.

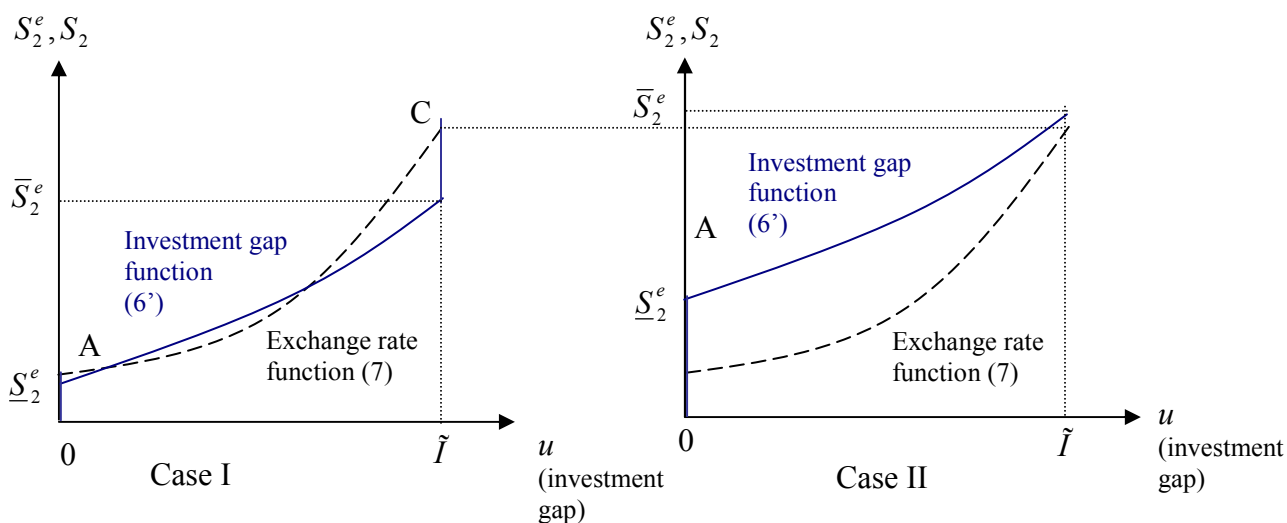
Assume that the government can borrow dollar funds from private capital markets up to its full net worth (this is like saying that it can borrow subject to its intertemporal dollar budget constraint) and transfers them to firms who invest them. The government's objective is to close the economy-wide investment gap as far as possible. In that case, the investment gap will be defined like in equation (6), except that investment is now constrained by *total* private and public sector borrowing capacity,  $\max\{0, \mu W^*(S_2^e)\} + \max\{0, W_G^*(S_2^e)\}$ , and the thresholds  $\underline{S}_2^e$  and  $\bar{S}_2^e$  are redefined as the exchange rates at which total rather than private borrowing capacity becomes equal to  $\tilde{I}$  and equal to zero, respectively.

$$(6') \quad u \equiv \tilde{I} - I = \begin{cases} \tilde{I} & \text{if } S_2^e \geq \bar{S}_2^e \\ \tilde{I} - \max\{0, \mu W^*(S_2^e)\} + \max\{0, W_G^*(S_2^e)\} & \text{if } \bar{S}_2^e > S_2^e > \underline{S}_2^e \\ 0 & \text{if } \underline{S}_2^e \geq S_2^e \end{cases}$$

Comparing (6') and (6), it is clear that the effect of the investment subsidies is to shift the investment gap function up. The thresholds  $\underline{S}_2^e$  and  $\bar{S}_2^e$  must be at least as high as before, and

for each exchange rate level at which the private sector is credit constrained, the investment gap must be smaller than before (strictly smaller if the government has strictly positive net worth at that exchange rate level). But is it enough to eliminate the bad equilibrium? The answer depends on the solvency of the government, as illustrated in Figure (2).

Figure 2. Equilibria in Credit Crunch Model with Government



If the upward shift in the investment function gap function relative to Figure 1 is small (Case I), then the presence of an investment subsidy policy will lower the investment gap conditioning on the the good equilibrium (point A) and may remove it altogether, but it does not rule out the inferior equilibrium (point C). This is the case in which adding pooling the government borrowing capacity with that of the private sector did not add all that much. Case II illustrates a situation where the extra borrowing capacity makes a big difference. At the equilibrium exchange rate level corresponding to point C in Case I, the Case II investment gap is just a little too small to validate the depreciated exchange rate level. Thus, there is a unique equilibrium at A.

Could a similar effect be achieved by government *lending* rather than government transfers to private firms? In principle, the answer is Yes. Since the underlying market failure is one of coordination among private creditors, the government can reduce this failure by acting as a large financial intermediary, i.e. by lending to firms in the amount of the difference between their borrowing capacity conditioning on the “good” equilibrium outcome, and their actual borrowing under actual expected exchange rates. However, this lending policy can never be more effective in removing the “bad” equilibrium than the investment subsidy policy described above, since in making its loans the government relies on borrowed funds which are constrained by its net worth conditioning on *actual* exchange rate expectations. In other words, the same economy-wide borrowing constraint applies as in equation (6’). While in principle government lending can overcome the private creditor coordination failure with respect to firms, it remains constrained by a private creditor coordination failure with respect to its *own* borrowing.

The lesson is that the government can improve matters—be it through transfers, public investment, lending, or bank recapitalization—only if it is “solvent enough” even in the adverse circumstances of a balance sheet crisis. This solvency standard is much more stringent than the conventional definition of fiscal solvency, which is typically about positive government net worth conditioning on current exchange rates. In contrast, being solvent enough to rule out a self-fulfilling balance sheet crisis means having sufficient net worth to close the investment gap (or recapitalize banks), *even conditioning on the depreciated (crisis) exchange rate*.

We have so far assumed that government net worth is given for any second period exchange rate level. However, fiscal policy may have some control over government net worth through measures to increase tax revenue or cut expenditures. To the extent that applying these measures pushes government solvency over the critical threshold where the country is no longer vulnerable to adverse shifts in expectations, this creates a rationale for fiscal adjustment. Of course, if policy measures of this kind are applied at the onset of a crisis, they will only work if their direct contractionary effects on output do not fully offset the expansionary benefits of the activities that they are meant to finance, namely public investment and/or bank recapitalization.

#### **D. International crisis lending**

International crisis lending is the one area in which the distinction between the credit crunch channel and the bank run channel of balance sheet crises really matters. We begin by restating the Jeanne-Wyplosz (2001) argument about international lending as support of last resort lending targeted to specific banks, and then turn to the question of how, if at all, international lending might play a role in the context of the credit crunch model.

Throughout the section, we interpret “international crisis lending” as international *official* crisis lending. However, this is merely a consequence of the fact that in the past, large-scale lending to emerging market governments during a crisis has come mainly from official sources, namely IFIs and in some cases, bilateral creditors. What is essential in our framework is merely that the lender be *large*, in the sense that exchange rates are endogenous to its lending. In principle, a syndicate of banks could be a large lender in this sense. In practice, however, contingent credit lines from banks or bank syndicates have been rare, so there seem to be difficulties in placing large-scale crisis lending in the hands of the private sector (for reasons outside our framework).

#### **Bank Runs**

One feature of the “bad” equilibrium C in Figure 1, is that both “truly insolvent” banks suffer from runs—those that have negative net worth even at the appreciated second period exchange rate  $S_2^A$  associated with the “good” equilibrium—and “conditionally solvent” banks which would have positive net worth in “normal” circumstances, i.e. for  $S_2 = S_2^A$ . Now suppose the domestic monetary authorities announce a policy of either lending dollars

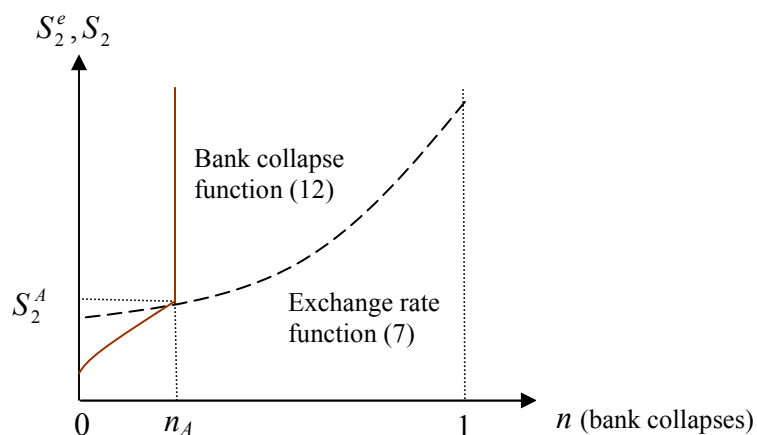
to conditionally solvent institutions that require them in the event of a run, or guarantees on the dollar deposits of these institutions.<sup>6</sup> If the monetary authorities have sufficient dollars to back these policies, both of these policies would eliminate the “bad” equilibrium by guaranteeing the continuing operation of conditionally solvent banks. There would still be runs on insolvent institutions that are not protected by the central bank, but the collapse of these institution, by definition, is consistent only with the relatively appreciated exchange rate  $S_2^A$ . The bad equilibrium disappears because the banking collapses that are allowed by the authorities are too minor to validate depreciated exchange rate expectations.

More formally, let us redefine  $n$  as the number of banking *collapses* rather than bank runs in the framework of section II.<sup>7</sup> Let  $n_A$  denote the number of banks that collapse even in the “good” equilibrium A, i.e. the “truly insolvent” banks. Then, the authorities’ intervention policy effectively alters equation (3) as follows:

$$(3') \quad n = \min\{n_A, F(S_2^e)\}$$

where  $F(S_2^e)$  is defined as before, i.e. as the mass of banks that become insolvent at a given expected exchange rate. Equation (3’) guarantees that the number of banking collapses will never exceed those that occur in the “good equilibrium”, which is unique, as can be seen from Figure 3.

Figure 3. Equilibrium in Banking Crisis Model with Last Resort Lending



<sup>6</sup> As argued by Jeanne and Wyplosz (2001), lending or selling dollars in the open market will not work since this amounts to a sterilized intervention, which is ineffective because of UIP (see Section III.A above).

<sup>7</sup> In a situation when official intervention takes the form of targeted (discount window) lending there could still be runs on conditionally solvent institutions, but these will be inconsequential: private depositors would merely be replaced by official creditors.

To the extent that the domestic monetary authorities have insufficient reserves to cover the foreign currency liquidity gap (i.e.  $R_1^* - D_1^*$ ) for each of the conditionally solvent banks, this way ruling out the “bad” equilibrium provides a natural justification for an international lender of last resort. Thus, the role of international lending in the bank run model is to lend dollars to the domestic monetary authorities in sufficient amounts that enable it to implement the domestic financial safety net described above.

### **Credit Crunch**

Does the relatively straightforward role for international crisis lending that arises in the bank run model carry over to the credit crunch model? The answer is clearly no. In the credit crunch model there are no runs, and consequently there is not role for a domestic financial safety net that might require foreign backing. Bad things happen not because conditionally solvent institutions go belly up. In the credit crunch model, these institutions make it to the second period anyway, since they have no short run dollar liabilities. Instead, real costs arise from the fact that net worth constrains investment.

In this context, the potential role for international lending is quite different from the bank run case. Two possible channels seem worth considering.

Logically, the most straightforward mechanism would be one where access to international official financing substitutes for the lack of access to private credit markets when firms are net-worth constrained. As Krugman (1999, p. 42) observes, official “credit lines would have to do more than provide balance-of-payments financing, or even provide lender-of-last-resort facilities to banks: they would have to make up the credit being lost by firms, so as to allow investment to continue.” One way to implement the “good” equilibrium in our framework would be to lend to each credit constrained firm the difference between what it could borrow in the “good” equilibrium and what it can actually borrow, i.e.

$\mu W^*(S_2^e) - \mu W^*(S_2^A)$ . In this case, the “investment gap” would be capped at  $u_A$ , the level associated with the good equilibrium (see Figure 1), and investment gap function (7) from Figure 1 would be replaced by a new function that looks exactly like the bank collapse function (3') depicted in Figure 3.

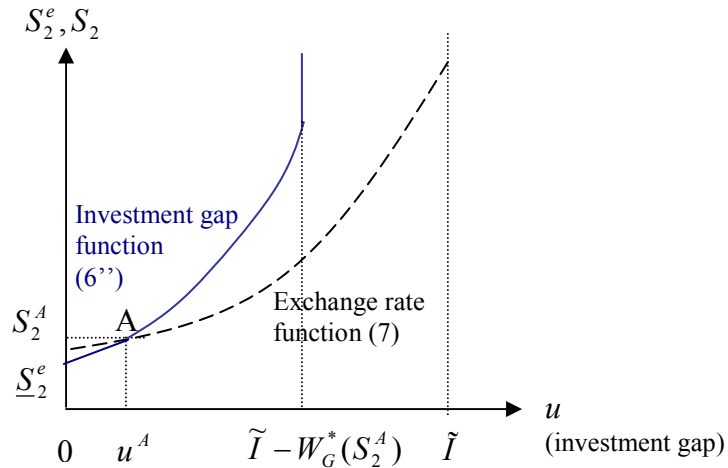
One difficulty with this approach is that the official lender needs to know not just whether a firms is “conditionally solvent” or not, but its net worth both in current circumstances and in a hypothetical “normal” state. Perhaps for this reason, we see comparatively little direct lending from official lenders to private sector firms in emerging markets, with the IFC and some of the regional development banks constituting notable exceptions. Even where such lending takes place, it seems to be motivated by credit constraints associated with the underdevelopment of domestic financial markets and political risk (which may be lower for official lenders), rather than the temporary exclusion from private capital markets owing to adverse currency expectations or capital account reversals.

An alternative mechanism, which is easier to interpret, is to use international lending to loosen the *government* borrowing constraints discussed in the previous section. The government, in turn, could onlend these funds to firms, partly substituting for their reduced access to private credit, or it could use them for public investment or transfers that finance private investment, as developed in the previous section. In the transfers example, this would work as follows. The international lender would announce that for any exchange rate in excess of the “good” equilibrium level, it is prepared to extend credit to the government in the amount which it could borrow from private markets in the “good” (appreciated) equilibrium. The effect of this policy is to cap the overall investment gap at  $\tilde{I}$  minus the government net worth arising in the “good” equilibrium,  $W_G^*(S_2^A)$ . Assuming that  $W_G^*(S_2^A)$  and  $W^*(S_2^A)$  are strictly positive, equation (6') becomes

$$(6'') \quad u \equiv \tilde{I} - I = \begin{cases} \tilde{I} - \max\{0, \mu W^*(S_2^e)\} - W_G^*(S_2^A) & \text{if } S_2^e \geq S_2^A \\ \tilde{I} - \mu W^*(S_2^e) - W_G^*(S_2^e) & \text{if } S_2^A > S_2^e > \underline{S}_2^e \\ 0 & \text{if } \underline{S}_2^e \geq S_2^e \end{cases}$$

where  $\underline{S}_2^e$  is defined as before, i.e. as the exchange rate level where the economy can borrow in the full amount  $\tilde{I}$ . borrowing constraint is no longer binding. Comparing (6') and (6''), it is evident that below  $S_2^e = S_2^A$  the investment gap is unchanged, i.e. the same economy-wide borrowing constraint applies. In this appreciated region, no crisis lending takes place. Above  $S_2^e = S_2^A$ , however, international crisis lending allows a higher level of investment. Thus, the presence of the official lender has the effect of “kinking up” the investment gap schedule at  $u = u^A$ . This could remove the bad equilibrium, as shown in Figure 4.

Figure 4



In equilibrium, net worth  $W_G^*(S_2^A)$  materializes, enabling the large lender to be fully repaid.

#### IV. CONCLUSION

This paper has focused on a particular risk generated by currency and maturity mismatches in corporate and financial sector balance sheets: the risk of self-fulfilling financial and currency crises. Even within the confines of this focus, we find a surprising variety of models with sometimes quite different policy implications. To the practitioner, the balance sheet approach might seem to involve a mind-boggling range of policies (from fiscal policy to lending-in-last resort). On this basis, one could conclude that the “balance sheet approach” is very difficult to specify and implement in practice.

However, as we have tried to show in a stylized framework that encompasses the main ideas from a number of models, this variety masks some common themes. We have focused on two. First, balance sheet vulnerabilities place tight constraints on the capacity of domestic (monetary and fiscal policies) to deal with capital account crises. Second, the fact that balance sheet crises cannot take place without a coordination failure among private creditors implies a potentially important role for large-scale crisis lending, moral hazard concerns notwithstanding.

The main results of this paper are elaborations of these two themes. They can be summarized in five points.

1. Conditional on the presence of private sector balance sheet vulnerabilities—in particular, currency mismatches—balance sheet crises can occur under any exchange rate regime, except for irreversible dollarization (if there is such a thing).
2. Private sector balance sheet mismatches put monetary policy in a bind. If it defends the exchange rate by raising interest rates, it will lower the present value of future domestic currency income. If it lets the exchange rate go, it will lower the *dollar* value of both current and discounted future income. If firms or banks have dollar liabilities, there is a problem either way. In general, there will be a trade-off, so that for a given balance sheet structure of the private sector, there is a monetary policy that minimizes the damage from an adverse shift in exchange rate expectations. But this minimal damage may still be big enough to trigger a crisis in which the currency collapses.
3. Even assuming that there are fiscal policy measures that directly limit the crisis—for example, public investment, transfers of lending to private firms to main investment in a credit crunch, or recapitalization of insolvent banks—the government may not be able to take these measures because it cannot finance them (other than through monetization of debt). The reason is that its *own* net worth, and thus its ability to borrow, are likely to be constrained in a crisis because of high interest rates and/or depreciated exchange rate expectations.
4. The preceding argument can explain the benefits of a fiscal adjustment prior to the crisis, provided this puts the government over the threshold were it can take measures that limit crisis damage to an extent that invalidates any adverse shift in expectations. Note that the

implicit solvency standard is quite high, since the government must be able to finance these measures *in crisis circumstances*, i.e. conditioning on depreciated exchange rates.

5. International crisis lending can help in two ways that are quite different, depending on the nature of the balance sheet crisis. In the context of bank runs, it can lend to domestic monetary authorities in the amount needed to operate a dollar discount window, or guarantee the dollar deposits of “conditionally solvent” banks (i.e. banks that have positive net worth in “normal” times). This limits bank runs to the “truly insolvent” banks, and prevents the bad state in which even conditionally solvent banks collapse. In the context of a credit crunch, the international lender can loosen fiscal constraints, allowing the fiscal authorities to implement policies that mitigate the decline in aggregate investment. It does so by lending to the government in the amount that the government could borrow from private markets conditional on the realization of the good equilibrium, rather than conditional on actual (depreciated) exchange rate expectations. This can remove the possibility of a bad equilibrium, allowing the authorities to repay in full.

Our analysis was limited in several important ways. First, we have looked at a special aspect of the question—the case where the crisis is self-fulfilling. Second, we took a purely *ex post* perspective. One must also think of how *ex post* policies change the financial structure *ex ante*. Then one has to compare the merits of stabilization policies *ex post* with those of regulation *ex ante*. Clearly a lot more research is needed before we can think of the balance sheet approach to crises as a set of prescriptions—as opposed to a new way of thinking about crises.

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