ELSEVIER European Economic Review 45 (2001) 1121–1150

EUROPEAN ECONOMIC REVIEW

www.elsevier.com/locate/econbase

Currency crises and monetary policy in an economy with credit constraints

Philippe Aghion[a,b,c], Philippe Bacchetta[c,d,e,*], Abhijit Banerjee[f]

[a] Harvard University, Cambridge, MA 02183, USA
[b] University College, London WC1E 6BT, UK
[c] Center for Economic Policy Research, London, UK
[d] Study Center Gerzensee, P.O. Box 21, CH-3115 Gerzensee, Switzerland
[e] DEEP, Université de Lausanne, CH-1015 Lausanne, Switzerland
[f] Massachusetts Institute of Technology, Cambridge, MA 02142, USA

Abstract

This paper presents a simple model of currency crises which is driven by the interplay between the credit constraints of private domestic firms and the existence of nominal price rigidities. The possibility of multiple equilibria, including a 'currency crisis' equilibrium with low output and a depreciated domestic currency, results from the following mechanism: If nominal prices are 'sticky', a currency depreciation leads to an increase in the foreign currency debt repayment obligations of firms, and thus to a fall in their profits; this reduces firms' borrowing capacity and therefore investment and output in a credit-constrained economy, which in turn reduces the demand for the domestic currency and leads to a depreciation. We examine the impact of various shocks, including productivity, fiscal, or expectational shocks. We then analyze the optimal monetary policy to prevent or solve currency crises. We also argue that currency crises can occur both under fixed and flexible exchange rate regimes as the primary source of crises is the deteriorating balance sheet of private firms.

JEL classification: E4; E5; F3

Keywords: Monetary policy; Foreign currency debt; Currency crisis

* Corresponding author. Tel.: +41-31-780-31-01; fax: +41-31-780-31-00.
E-mail address: phbacchetta@szgerzensee.ch (P. Bacchetta).

0014-2921/01/$ - see front matter
PII: S0014-2921(00)00100-8

1. Introduction

Currency crises have been traditionally viewed as retribution for governments that have mismanaged the economy and/or lack credibility: Both the so-called first-generation models and the more recent second-generation models broadly answer to this description. However, the recent crises in East and Southeast Asia have led to a wide-spread questioning of this view. [1] It is observed that most of the crisis economies enjoyed government surpluses and increasing foreign exchange reserves (unlike what the first-generation models would suggest) as well as low unemployment and booming exports (unlike in most of the second-generation models). Of course there are other forms of government failure. In the case of the East and Southeast Asian countries there is some evidence that the financial sector in these countries was not very well regulated. Without denying that this was an important element of the crisis, there is reason to doubt that it is the whole story: First because the lack of transparency in the financial sector of these countries was already well-known among market participants and second because these economies have now recovered and face interest rates not significantly higher than before the crisis, without any major overhaul of the financial sector.

It is therefore not surprising that over the last two or three years, a third generation of models of financial crises has begun to emerge. These models have in common the idea that the crisis should be seen as a result of a shock that was amplified by what Bernanke et al. (1999) have called a financial accelerator mechanism. In some of these models (Aghion et al., 1999a, b) there is a real shock that gets amplified while in others (Krugman, 1999a; Chang and Velasco, 1999) there are multiple equilibria with the crisis brought on by a pure shift in expectations. The basic story is similar: A real currency depreciation can have a large effect on output if it affects the credit access of some subset of agents; [2] moreover this effect on output may in turn affect the exchange rate, further amplifying the shock and causing it to persist.

The present paper is a contribution to this line of research. It differs from the previous papers in that it is an explicitly dynamic monetary model with nominal rigidities playing an important role. [3] This approach allows us to tell a very simple story of currency crises: If nominal prices are rigid in the short run, a currency depreciation leads to an increase in the foreign currency debt

[1] For example, see Krugman (1999a), Furman and Stiglitz (1998), Radelet and Sachs (1998).

[2] In Chang and Velasco (1999) the effect on the borrowing capacity of the firm sector is indirect – it comes from a fall in the lending capacity of the banking sector. Therefore their model is not strictly a financial accelerator model.

[3] Aghion et al. (2000a) contains a precursor of the model in this paper. Krugman (1999b) presents an elegant simplification of the model in Aghion et al. (2000a).

repayment obligations of the firms, and consequently a fall in profits.[4] Since lower profits reduce net worth, it may result in less investment and lower output in the next period. This, in turn, brings a fall in the demand for money, and thus a currency depreciation. But arbitrage in the foreign exchange market then implies that the currency must depreciate in the current period as well. In other words, if people believe that the currency will depreciate, it may indeed depreciate. Multiple short-run equilibria in the market for foreign exchange are thus possible. A currency crisis occurs either when expectations change or when a real shock shifts the economy to the ‘bad’ equilibrium.

This story of currency crises has the significant advantage that it is based on two well-known facts: First, the countries most likely to go into a crisis were those in which firms held a lot of foreign currency denominated debt. For example, Fig. 1 shows the ratio of claims to liabilities with respect to BIS banks; since these transactions are basically in foreign currency, this ratio is a measure of aggregate foreign currency exposure.[5] It is striking that all the countries that had a ratio higher than 1.5 have experienced a serious crisis in the 1990s. The second fact is that there are substantial and persistent deviations from purchasing power parity following an exchange rate shock.[6] By contrast Banerjee (1999) argues that the models such as Krugman (1999a), Chang and Velasco (1999) and our own previous work, require large changes in the relative price of tradeables and non-tradeables, as well as specific assumptions about the role of tradeable and non-tradeable goods in the economy.

This credit-based approach to currency crises is consistent with numerous features observed in recent crises and left unexplained by the previous literature. For example, countries with less developed financial systems are more likely to experience an output decline during a crisis.[7] Second, a currency crisis can also happen under a flexible exchange rate or without any significant decline in foreign exchange reserves. Third, crises may occur even in countries where governments face low unemployment and/or conduct sound fiscal policies and do not resort much on seigniorage.

---

[4] The damaging impact of foreign currency debt is often mentioned in the context of currency crises. See, for example, Cooper (1971), Calvo (1998) and Mishkin (1996, 1999). While the role of foreign currency *public* debt has received some attention in the theoretical literature on crises (e.g. Bohn, 1990; Obstfeld, 1994; Falcetti and Missale, 1999), the impact of private foreign currency debt has hardly been analyzed (see, however, Jeanne, 2000a).

[5] Debt to banks from BIS countries is often used as a measure of foreign currency debt, as no good measure is available. Corsetti et al. (1998) present the same ratio as in Fig. 1 for Asian countries.

[6] After a currency crisis, deviations from PPP, or from the law of one price, are also large for tradeable goods. This evidence speaks even more in favor of price stickiness than the systematic studies of PPP deviations for major currencies, such as Engel (1993).

[7] It is indeed striking that several countries that experienced a large depreciation in the ERM crisis in 1992–1993 had a relatively good output performance; while others, like Finland, and countries that suffered from the Mexican and Asian crises faced serious recessions.

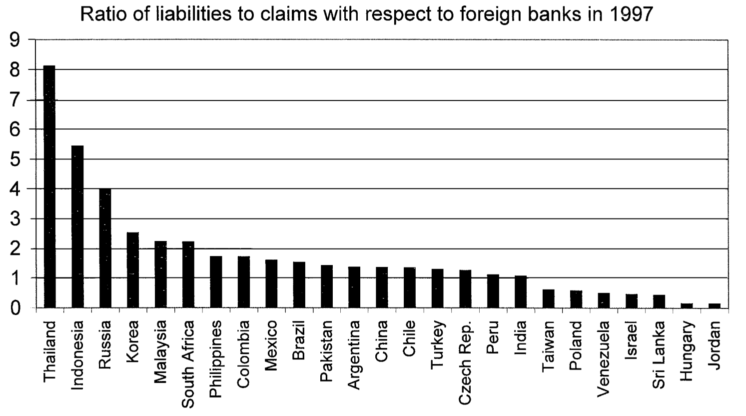

Fig. 1.

Obviously public policy variables such as fiscal deficits can play an important role in facilitating the occurrence of a currency crisis, as stressed by the existing literature on the subject. However, in contrast to first- and second-generation models, in the world described in this paper a deterioration of fiscal balances will lead to a crisis mainly through its impact on private firms' balance sheets rather than through simple money demand adjustments as in the previous models.[8] Moreover, the presence of public sector debt may exacerbate the problems of private sector debt, especially if a large fraction of public sector debt is in foreign currency. This result is in sharp contrast with the previous literature that finds that foreign currency (public) debt has a stabilizing role.

Another advantage of our monetary model is that it lends itself very naturally to the analysis of monetary policy. There has been an important debate on the stance of monetary policy in the context of currency crises; in particular, the previous literature does not provide much guidance in the debate between those who emphasize past government failure and advocate monetary tightening,[9] and those who blame shifts in expectations and bad luck (the multiple equilibrium view) and consequently support a more lenient approach to monetary policy.[10] In our basic model in which the credit multiplier is either constant or dependant upon the *real* interest rate and price stickiness remains limited, a restrictive monetary policy is the optimal response to the risk of a currency crisis. However, this conclusion may cease to hold when

[8] Surveys of the currency crises literature, include Garber and Svensson (1995), Obstfeld and Rogoff (1996), and Flood and Marion (1999).

[9] This view has been consistently advocated by the IMF. In particular, Stanley Fischer argues that 'those who criticize temporary high interest rates fail to see that further depreciation caused by lower rates would have raised the burden of dollar-denominated debts'.

[10] See for example Radelet and Sachs (1998) and Furman and Stiglitz (1998).

credit supply is affected by the *nominal* interest rate and/or price stickiness is sufficiently persistent compared to the duration of debt contracts.

The rest of the paper is organized as follows. Section 2 lays out the basic model. Some features of the model are taken as given, such as price stickiness, money demand, or the level of foreign currency debt. Microfoundations for these features are presented in Aghion et al. (2000b), where we also introduce commercial banks. Section 3 shows that this model naturally gives itself to graphical analysis. Using this graphical apparatus we examine the occurrence of currency crises and demonstrate the possibility of multiple equilibria. Section 4 introduces the public sector into the model, first by analyzing explicitly a fixed exchange rate system and second by introducing fiscal variables. In Section 5 we analyze the impact of monetary policy and we conclude in Section 6.

2. The basic model

2.1. General framework

We consider an infinite-horizon small open economy monetary model where goods prices are determined at the beginning of each period and remain fixed for the entire period. [11] There is a single good and purchasing power parity (PPP) holds ex ante, i.e., $P_t = E_t^e$ for each t, where P_t is the domestic price, E_t^e is the expected nominal exchange rate (the price of foreign currency in terms of domestic currency) at the beginning of period t, and the foreign price is constant and equal to one.

A key ingredient of our model will be a shock in period one that occurs *after* the price in that period has been set. This shock may be real – such as a change in productivity or competitiveness or the risk perceptions of bondholders at home or abroad. Or it may be a pure shift in expectations – as is well known, in a world of multiple equilibria, such shifts can have real effects. [12] The shock causes a deviation from purchasing power parity: Since prices cannot move during period one, the nominal exchange rate has to move to absorb the shock. [13] These deviations will play a crucial role in the analysis.

[11] The assumption that prices are preset for one period is commonly made in monetary models of an open economy, following Obstfeld and Rogoff (1995).

[12] For most of the paper we assume that the shock is wholly unanticipated and is not taken into account by the domestic market when setting the date-1 price. This assumption is commonly made by the existing models of open monetary macroeconomics (see again Obstfeld and Rogoff, 1995). It can be shown, however, that our results hold when the distribution of expectational shocks is taken into account ex ante.

[13] We are basically assuming that the good is not tradeable once the price is set. In this paper, the existence of price stickiness is taken as given. In Aghion et al. (2000b), we present a model based on monopolistic competition with pricing to market that justifies this feature.

Finally we assume that credit markets are imperfect. Specifically, we assume that the economy is populated by identical entrepreneurs who face a credit limit which is a fixed multiple of their current real wealth w_t, in the spirit of Bernanke and Gertler (1989). Entrepreneurs' wealth is thus the fundamental variable that determines investment and output.[14]

In all other respects the model is quite standard: Output is produced using capital and the production function $y_t = f(k_t)$ has the standard concave shape. In our context, k_t is best thought of as working capital. There is full capital mobility and uncovered interest parity holds. The exchange rate can be either floating or fixed, even though the fixed exchange rate case is only explicitly analyzed in Section 4. Consumers need money for their transactions and there is a central bank that can alter interest rates or the exchange rate by affecting money supply.

The timing of events can be summarized as follows. In the first period, the price P_1 is preset and firms invest. Then, an unanticipated shock occurs followed by a monetary adjustment which determines both the nominal interest rate i_1 to be paid at the end of the *second* period (interest rates are always set one period ahead) and the nominal exchange rate E_1 (when the latter is not maintained fixed). Subsequently, period 1's output and profits are generated and firms' debts are repaid. Finally, a fraction $(1-\alpha)$ of net retained earnings after debt repayment, namely w_2, is saved for investment in period 2. Periods after period 1 are identical in all respects except in that after period 2, no further shock occurs and the economy converges to its steady state.

The remaining part of this section, first, describes in detail the monetary side of the economy and, second, analyzes the entrepreneurs' borrowing and production decisions.

2.2. The monetary sector

The interaction between consumers, foreign investors, and the central bank gives us both a money market equilibrium condition (i.e., an LM curve) and an interest parity condition (i.e., an IP curve). Since both types of conditions are standard in open economy macroeconomics, we shall not expand on their microfoundations.[15] Arbitrage by investors between domestic and foreign currency bonds in a world with perfect capital mobility yields the

[14] Empirical evidence on credit-constrained firms in the context of financial crises is given by Honkapohja and Koskela (1999) in the Finnish case. They also document the increase in foreign currency debt before the crisis in 1991–1992.

[15] For example, see Krugman and Obstfeld (2000) and Blanchard (1996) for pedagogical presentations of the LM and IP relationships.

following interest parity (IP) condition:

$$1 + i_t = (1 + i^*)\,\frac{E^{\mathrm{e}}_{t+1}}{E_t}, \tag{1}$$

where i_t is the domestic short-term nominal interest rate and i^* is the foreign rate which we assume to be constant over time.

In addition, consumers have a standard real money demand function $m^{\mathrm{d}}_t = m^{\mathrm{d}}(y_t, i_t)$. The function m^{d} has the usual properties of being increasing in y_t and decreasing in i_t;[16] furthermore, we assume: $m^{\mathrm{d}}(0, i_t) > 0$.[17] Thus, at any date t, money market equilibrium can be expressed by the $(\mathrm{LM})_t$ equation:

$$M^{\mathrm{S}}_t = P_t \cdot m^d(y_t, i_t), \tag{2}$$

where M^{S}_t is the nominal money supply at date t. Let z_t denote the rate of nominal money supply growth between periods $t-1$ and t, so that: $M^{\mathrm{S}}_t = (1 + z_t)M^{\mathrm{S}}_{t-1}$. Computing the growth rate of Eq. (2), we can determine the evolution of the inflation rate π_t:

$$1 + \pi_t = (1 + z_t)\,\frac{m^{\mathrm{d}}_{t-1}}{m^{\mathrm{d}}_t}. \tag{3}$$

Eq. (3) holds for all periods without shocks, in our analysis for $t \geq 2$. In period one, since price P_1 is preset, it is the interest rate i_1 that adjusts to equilibrate the money market. Thus, Eq. (2) yields

$$i_1 = \phi(M^{\mathrm{S}}_1, y_1), \tag{4}$$

where ϕ is the inverse of the m^{d} function with respect to i. The relationship between i_1 and M^{S}_1 is unambiguously negative due to the standard liquidity effect. Thus, either of the two variables can be used to discuss the effects of monetary policy in period one.

2.3. Output and entrepreneurs' debt

Our analysis in this section rests on two basic assumptions on the real side of the economy. First, due to the existence of credit constraints, at date t entrepreneurs can at most borrow an amount d_t proportional to their cash flow w_t: $d_t \leq \mu_t w_t$. They can borrow either in domestic currency at interest rate i_{t-1} or in foreign currency at i^*. Throughout most of the paper, we shall

[16] This follows from consumers' arbitrage between holding money for transaction purposes and holding (domestic) bonds that yield interest rate i_t.

[17] This last assumption is needed in our context since output only depends on past profits and therefore can be equal to zero. It can be dropped in a more general context.

take the credit multiplier to be constant, i.e., $\mu_t = \mu$.[18] This assumption will be relaxed in Section 5 where we allow the credit multiplier to depend upon the real and/or nominal interest rates.

Since working capital is the only production input and fully depreciates within one period, entrepreneurs' capital stock at the beginning of each period t is: $k_t = w_t + d_t$. Thus, current output becomes a function of current entrepreneurs' wealth whenever the credit constraint is binding, namely:

$$y_t = f((1+\mu)w_t).$$

When the constraint is not binding ($d_t < \mu w_t$), the levels of borrowing and output are simply given by the standard first-order condition: $f'(k_t) = 1 + i^*$.

The second assumption relates to the choice that domestic investors face between domestic and foreign currency debt. We assume that in period t, the quantity of domestic currency debt is d_t^c.[19] This assumption is easy to justify in the case considered in this paper, where the crisis results from an unanticipated shock. In this case, the borrowers do not take account of the potential for a crisis when they are making their decision about the currency composition of debt and as a result, even very small advantages with respect to transaction costs or currency risk can lead to a lot of foreign currency borrowing.

In the presence of uncertainty, we show in Aghion et al. (2000b) that foreign currency debt can be justified in our context by the firms' limited liability.[20] Independently of the rationale for holding foreign currency debt, the key issue when crises are anticipated is whether the endogeneity of currency exposure would eliminate the possibility of a crisis. Note that when the borrower chooses the currency composition of his own debt, he takes as given the composition of debt in the rest of the economy – he will not deviate from his privately optimal choice of currency composition to prevent a crisis. He may have private reasons for preferring domestic currency debt if there is some chance of a crisis, especially if default is costly for him. However, given that he cannot prevent the crisis by making this choice, moving to domestic debt simply shifts the risk on to the lender, who will accept it only if the price the borrower pays for the insurance (in terms of foregone benefits from holding foreign currency debt as well as the cost of

[18] See for example Aghion et al. (1999) for a specification of credit monitoring costs which produces a constant multiplier.

[19] The main conclusions and results in this paper remain unchanged if the *fraction* of domestic versus foreign currency debt, instead of the *amount* of domestic currency debt, is taken as a basic parameter of the model (see Bacchetta, 2000).

[20] For other justifications, see Jeanne (2000a), who shows that foreign currency debt may serve as a commitment device and may lower the cost of debt. Burnside et al. (2000) show that foreign currency debt is also preferred when government subsidies to banks are contingent on a devaluation.

compensating the lender for the extra risk he bears) is worthwhile; this would only be the case if a crisis were sufficiently likely. It follows that if all the other borrowers were to choose levels of d_t^c that are such that no crisis is possible, an individual borrower would simply choose the level of d_t^c that is optimal for him absent the possibility of a crisis. If this preferred level of foreign currency debt happens to be higher than the minimum needed to make a crisis possible, the only equilibrium value of d_t^c is one where there will sometime be a crisis.

Given the currency composition of domestic entrepreneurs' debt, we can now express their aggregate nominal profits net of debt repayments at the end of any period t, namely:

$$\Pi_t = P_t y_t - (1 + i_{t-1})P_{t-1}d_t^c - (1 + i^*)\,\frac{E_t}{E_{t-1}}P_{t-1}(d_t - d_t^c).$$

Whenever profits are positive, entrepreneurs retain a proportion $(1 - \alpha)$ of profits and use them to finance their future investment (a proportion α of profits is distributed and/or consumed). Total net wealth available for the next production period $t + 1$ is thus equal either to zero, when net profits at date t are negative, or to

$$w_{t+1} = (1 - \alpha)\,\frac{\Pi_t}{P_t}.$$

It follows that second period output y_2, which is a function of the wealth w_2 available at the beginning of period 2, is given by

$$y_2 = f\left((1 + \mu)(1 - \alpha)\left\{y_1 - (1 + r_0)d_1^c - (1 + i^*)\,\frac{E_1}{P_1}(d_1 - d_1^c)\right\}\right), \tag{5}$$

where r_0 is the real interest rate defined as $1 + r_t = (1 + i_t)P_t/P_{t+1}$ and $0 < y_2 < \tilde{y}$. Eq. (5) clearly shows that output would react negatively to an increase in the debt burden induced by a currency depreciation, that is by an increase in E_1. Note that changes in the nominal interest rate i_1 do not affect the debt burden in period 1 and output in period 2. The reason is simply that i_1 is the interest rate applying to the second period.

However, i_1 will affect the cost of domestic currency debt and therefore the debt burden in period 2 positively, and therefore the output in period 3 negatively. More formally, we have

$$y_3 = f\left((1+\mu)(1-\alpha)\left\{y_2 - (1+i_1)\,\frac{P_1}{P_2}d_2^c - (1+i^*)\,\frac{E_2}{E_1}\,\frac{P_1}{P_2}(d_2 - d_2^c)\right\}\right). \tag{6}$$

In any period $t \geq 3$, the PPP condition continues to hold but in addition the discrepancy between E_1 and P_1 no longer affects the total debt burden of entrepreneurs, i.e., domestic and foreign currency debt become fully equivalent.

Hence, for $t \geq 3$ output y_{t+1} is simply given by

$$y_{t+1} = f[(1+\mu)(1-\alpha)\{y_t - (1+i^*)d_t\}]. \tag{7}$$

The model is now fully laid out. Equilibrium in this model is defined as a sequence of prices (P_t), exchange rates (E_t) and output levels (y_t), which for a given monetary policy in period 1 satisfy the above Eqs. (1)–(3), (5) and (7) for all t. The dynamics of aggregate output y_t for $t > 2$, are easy to compute and can be simulated numerically. However, a diagrammatic presentation offers more insight into the nature of the equilibrium and is presented in the following section.

3. The occurrence of currency crises

In this section we focus on the first two periods of production and lending $t = 1, 2$, so that we can analyze the mechanics of the model using simple graphical representation. In particular, we describe the mechanism leading to multiple expectational equilibria and the subsequent possibility of a currency crisis.

3.1. A graphical representation of the model

Throughout the remaining part of the paper, we concentrate on the case where the nominal interest rate in period 2, i_2, is maintained constant by monetary policy in subsequent periods.[21] In other words, we implicitly assume that the government follows an *interest rate targeting* or *inflation rate targeting* (π_3 is fixed) policy $(1+i_2=(1+i^*)(1+\pi_3))$. It can be shown that this assumption can be relaxed without significantly altering the results.[22] Taking

[21] Jeanne (2000b) presents first and second generation models using a related two-period approach.

[22] For example, suppose that the government targets the rate of money growth z instead, and for simplicity let us take the inflation rate in period 4, π_4, as given; then using the fact that

$$1 + \pi_3 = (1 + z_3)\,\frac{m_2^{\mathrm{d}}(y_2, i_2)}{m_3^{\mathrm{d}}(y_3, i_3)}$$

and

$$1 + i_3 = (1 + i^*)(1 + \pi_4),$$

we can endogeneize i_2 as a function of y_2 and y_3, increasing in y_2 and decreasing in y_3. In particular, by decreasing y_3, a tight monetary policy, i.e., an increase in the nominal interest rate i_1, in period 1, will induce an increase in i_2. This in turn will tend to counteract, but only partly so, the positive effects of such a policy on the demand for the domestic currency and therefore on its value relative to the foreign currency.

i_2 as given, the mechanics of the model will now be shown to be fully described by two curves in the (E_1, y_2) space: An IPLM- ('Interest-Parity-LM') curve which describes how future (i.e., period-2) expected output y_2 influences the current (i.e., period-1) exchange rate, E_1, and a W- (or 'Wealth'-) curve which describes the period-2 output response of credit-constrained entrepreneurs, y_2, to variations in the (end of) period-1 exchange rate.

The IPLM curve is completely standard: It is simply obtained by combining the interest parity condition (1) with the LM equation (2) at $t=2$ (i.e., LM_2) in which the period-2 nominal interest rate i_2 is taken as given. Using the PPP assumption $P_2 = E_2^{\mathrm{e}} = E_2$ (the latter equality follows from the absence of shock in period 2) we get

$$E_1 = \frac{1+i^*}{1+i_1} \cdot \frac{M_2^{\mathrm{S}}}{m^{\mathrm{d}}(y_2, i_2)} \tag{8}$$

which provides a negative relationship between E_1 and y_2. This relationship is shown in Fig. 2 as the IPLM curve.[23] It is easy to see why the IPLM curve slopes down: An increase in (expected) future output y_2 increases the demand for money (i.e., for domestic currency) in period 2, which in turn will naturally generate a nominal currency appreciation in that period, i.e., a reduction in $E_2 = P_2$. The anticipation of a currency appreciation 'tomorrow' (i.e., in period 2) increases the attractiveness of holding domestic currency today, and therefore induces a currency appreciation today, i.e., a reduction in E_1.

The IPLM curve can be shifted by changes in monetary policy at date $t=1, 2$. For example, a tight monetary policy which reduces M_1^{S} or increases i_1 (from (4)), results in a nominal currency appreciation, i.e., a reduction in E_1 for any given y_2. Therefore, a tight monetary policy shifts the IPLM curve upwards. The same occurs with a reduction in M_2^{S}. These effects are standard: For a given output level, the domestic currency appreciates after a monetary compression in the first period due to a shortage of liquidity and it depreciates after a monetary compression in the second period due to an expected reduction in inflation. Finally, increases in i_2 also shift the IPLM upwards.

The slope of the IPLM curve also depends on how mobile capital is and the extent of substitutability between domestic and foreign currency assets. We have so far assumed perfect mobility and perfect substitutability. Relaxing the first assumption, for example by introducing the possibility of capital controls, will weaken the relationship between i_1 and E_1. In the extreme case of no

[23] Note that our curve differs slightly from the AA curve in Krugman and Obstfeld (2000), which relates E_1 to Y_1 instead of Y_2, and keeps all period 2 variables constant.

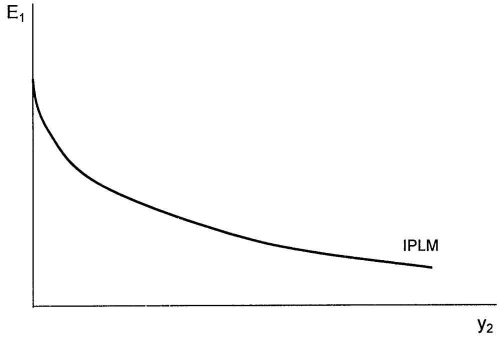

Fig. 2.

capital mobility, the IPLM curve disappears. Relaxing the second assumption introduces a foreign exchange risk premium, a case which is examined in Section 3. In that case what matters is what determines the premium.

While the IPLM curve is directly drawn from standard macroeconomic textbooks and holds even when credit markets are perfect, the W curve captures the effect of imperfect credit markets. It is given by Eq. (5):

$$y_2 = f\left((1+\mu)(1-\alpha)\left\{y_1 - (1+r_0)d_1^c - (1+i^*)\,\frac{E_1}{P_1}(d_1 - d_1^c)\right\}\right). \tag{9}$$

At the beginning of period 1, all variables on the right-hand side of (9) are fixed except for E_1 (P_1 is given since prices are preset and fixed for the entire period 1).[24] Changes in E_1 (with P_1 fixed) have a negative effect on y_2: An increase in E_1 (a depreciation) reduces first period profits Π_1 through an increase in the foreign currency debt burden of domestic entrepreneurs. Representing Eq. (9) (along with the constraint $0 < y_2$) graphically in the (E_1, y_2) space gives us our W-curve as depicted in Fig. 3. The W curve includes an upward segment of the vertical axis when E_1 is such that Eq. (9) yields $y_2 \leq 0$. In the following section, we show that under certain conditions the economy summarized by this graphical representation has two 'locally stable' equilibria; we argue that the process of switching from the 'good' to the 'bad' equilibrium can be naturally interpreted as a currency crisis.

[24] The nominal exchange rate E_1, however, has an impact on y_2 when there are deviations from PPP in period 1, i.e., if there is an unanticipated shock to fundamentals or to expectations such that $E_1 \neq P_1$. The W-curve has in common with the Phillips curve that it is vertical in the absence of unanticipated shocks.

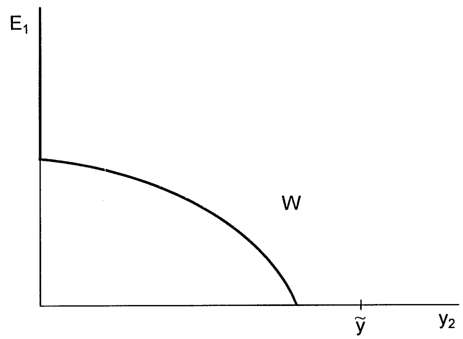

Fig. 3.

3.2. Equilibrium

For a given future path of inflation or nominal interest rates, the equilibrium values of E_1 and y_2, are determined by the two equations, (1) at $t = 1$ and (5), in which i_2 is taken as given. In other words, the short-run equilibrium of the model is simply defined by the intersection of the IPLM and W curves. As shown in Fig. 4, there are three possible outcomes. Fig. 4a shows a 'good' case with high output and a low exchange rate value as the unique equilibrium. Fig. 4b shows a 'bad' case, where the unexpected currency depreciation is so large that it drives profits and therefore period-2 output to zero. Finally, Fig. 4c shows an intermediate case with multiple equilibria, where only the two extreme equilibria are stable. We will refer to the stable equilibrium with low output and a depreciated domestic currency (i.e., a high E_1 at E^{**}) as the 'currency crisis' equilibrium.

The reason for multiple equilibria is simple: If a large currency depreciation is expected, consumers will reduce their money demand because expected output is lower. This in turn leads to a currency depreciation, confirming the consumers' expectations. On the other hand, if no large depreciation is expected, it will not occur in equilibrium because in this case domestic consumers will not reduce their demand for the domestic currency.

Sufficient conditions for having a multiplicity of equilibria require the W curve intersecting the y_2-axis below the IPLM curve. We thus have:

Proposition 1. A sufficient condition for multiple equilibria including a 'currency crisis' equilibrium, is that $(E_1/P_1)_{y_2=0,\mathrm{W}} < (E_1/P_1)_{y_2=0,\,\mathrm{IPLM}}$, *or equivalently,*

$$\frac{y_1 - (1+r_0)d_1^{\mathrm{c}}}{(1+i^*)(d_1 - d_1^{\mathrm{c}})} < \frac{1+i^*}{1+i_1}\,\frac{M_2^{\mathrm{s}}}{P_1}\,\frac{1}{m^{\mathrm{d}}(0,i_2)}.$$

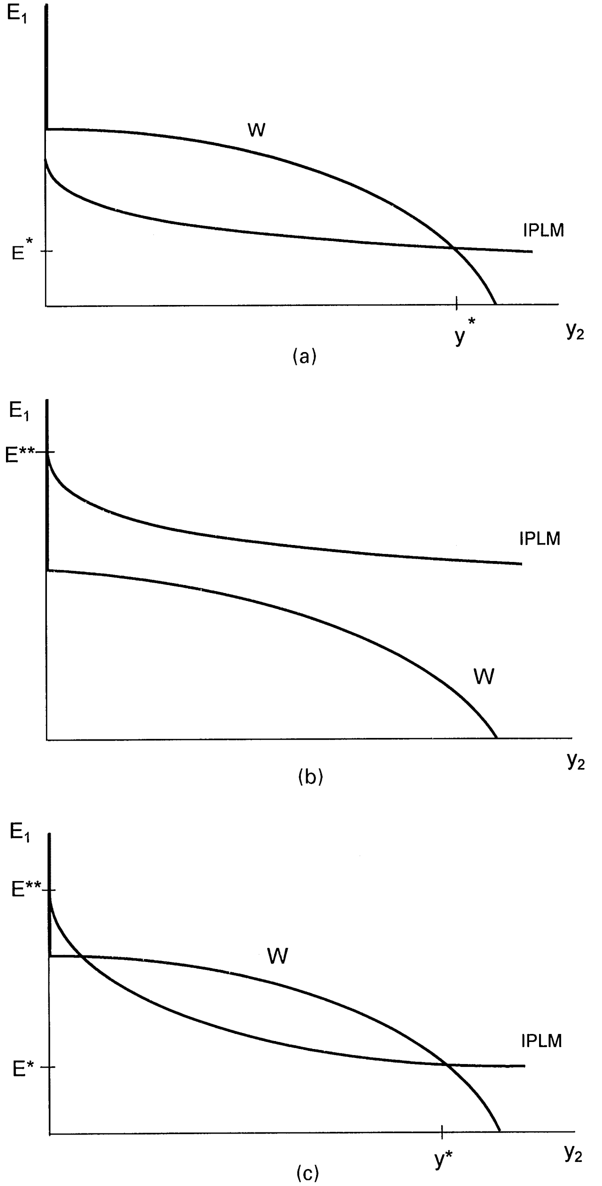

Fig. 4.

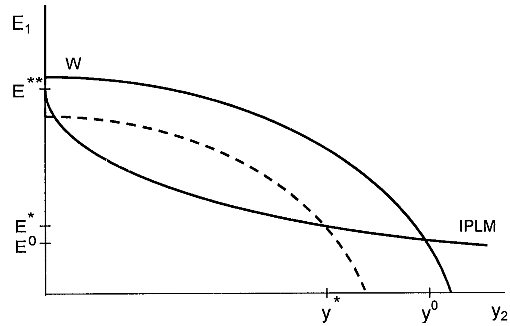

Fig. 5.

A currency crisis of this type can be set off by a variety of factors. In the case where there are actually multiple equilibria, the crisis could be brought on by pure expectational shift. If everyone believes that there will be crisis, then a crisis occurs. [25]

On the other hand, in the case where the initial configuration is as in Fig. 4a, only shocks to fundamentals can bring on a crisis. In this case a small fall in productivity (a shift in the $f(\cdot)$ function) or a slight tightening of the credit market (a shift in μ) can shift the W curve down and shift the economy from a configuration of the kind depicted in Fig. 4a, to the one depicted in Fig. 4c. This, in turn, can start off a crisis if people expect the 'bad' equilibrium. Such a process is illustrated in Fig. 5. The initial equilibrium is at (y^0, E^0). The negative shock leads to a currency depreciation, either to (y^*, E^*) or in the worst case to $(0, E^{**})$. The latter case corresponds to a currency crisis situation.

Similarly, suppose that, due to a substantial increase in the perceived exchange rate risk the country now has to pay a risk premium on bonds denominated in its currency. In this case the interest-parity equation (1) becomes

$$1 + i_t = (1 + i^*)\,\frac{E_2}{E_1} + \eta,$$

where η is the foreign exchange risk premium after the shock. [26]

[25] It is possible to show that these multiple outcomes can also occur when expectational shifts are taken into account when setting prices (formally, we can show the existence of non-degenerate sunspots equilibria).

[26] In general, the magnitude of the foreign exchange risk premium η is likely to increase with transaction costs and market thinness.

This increase in risk shifts the IPLM curve upwards, as the new IPLM equation becomes

$$E_1 = \frac{1+i^*}{1+i_1}\,\frac{M_2^{\mathrm{s}}}{m^{\mathrm{d}}(y_2,i_2)} + \eta.$$

Starting from a 'good case' situation with only one equilibrium with low E_1 and high y_2, this upward shift in IPLM may again lead to a multiple equilibria situation, and therefore to the possibility of a currency crisis. This possibility is actually reinforced by the fact that an increase in the foreign exchange premium raises the interest rate on foreign borrowing which in turn will tend to move the W curve downward.

Similar effects would also follow from an increase in country risk. This leads to an increase in the interest rates faced by domestic entrepreneurs both with regard to domestic and foreign currency debt obligations. An increase in the country risk premium would thus shift the W curve downward without affecting the IPLM curve. In Sections 4 and 5 we examine the effects of shocks induced by fiscal and/or monetary policy.

4. The effect of the policy regime

It is worth pausing at this point and noting that the mechanism generating a currency crisis in this paper departs from most existing models of currency crises, as it relies entirely upon private sector's behavior. By contrast, both the 'first-generation' and the 'second-generation' models generate currency crises in the case of a fixed exchange rate economy, based upon expectations about the policy regime. Our analysis so far shows that currency crises may also occur in a (credit-constrained) economy with flexible exchange rates and moreover, does not require us to refer to distortions in government policy.

This does not imply that our approach of currency crises cannot be linked to previous theories: As we shall try to argue in this section, it complements previous explanations, e.g., by Krugman (1979) or Obstfeld (1994). In subsection 4.1, we analyze an explicitly fixed exchange rate regime, while in subsection 4.2 we briefly consider the government's balance sheet constraint and its interaction with private firms.

4.1. Exchange rates regimes

To illustrate the fact that the specific exchange rate regime is not the most crucial element in the analysis, we now consider the case of an economy with an (initially) *fixed* exchange rate system. Whilst such a system can maintain a stable exchange rate when the economy is hit by *small* shocks, the initial exchange rate regime has little influence in preventing a currency crisis following a *large* shock.

In a fixed exchange rate system, the role of the central bank's international reserves, as well as the rule leading to the abandonment of the fixed rate, need to be specified. Fixing the exchange rate in our model implies a given path of money supply in all periods $t > 1$, possibly through the use of international reserves; furthermore, it implies that at date $t = 1$, the central bank can no longer use the interest rate i_1 as a policy instrument, if the interest parity condition is to hold perfectly.[27] More formally, assume that the exchange rate is initially fixed at $E_t = \bar{E}$. Then, the PPP and interest parity conditions imply that the monetary equilibrium equation (2) in period 2 can be rewritten as

$$M_2^{\mathrm{S}} = \bar{E} \cdot m^{\mathrm{d}}(y_2, i^*), \tag{10}$$

where money supply M_2^{S} is now endogenous. On the other hand, equilibrium of the central bank's balance sheet imposes the condition

$$M_2^{\mathrm{S}} = \mathrm{DC}_2 + \mathrm{IR}_2, \tag{11}$$

where DC_2 is domestic credit, typically claims on the government, and IR_2 represents international reserves expressed in domestic currency in period 2.

To understand why a large real shock may force a government to abandon the fixed exchange rate regime and can precipitate the occurrence of a currency crisis, assume that international reserves cannot fall below some floor level $\overline{\mathrm{IR}}$, in line with the first generation literature (e.g., Krugman, 1979); and that DC_2 is fixed at some level $\overline{\mathrm{DC}}$. This situation can be depicted in Fig. 6.

Suppose that initially, before the shock, the economy is in the good equilibrium described by the intersection between the two curves IPLM_0 and W_0 (point A). Then, let $\overline{\mathrm{IPLM}}$ denote the lowest IPLM curve consistent with a fixed exchange rate at $E \leq \bar{E}$; this corresponds to a money supply equal to $M_2^{\mathrm{S}} = \overline{\mathrm{DC}} + \overline{\mathrm{IR}}$. Finally, let B denote the point on that curve which corresponds exactly to the nominal exchange rate $\bar{E}$. In other words, the parity $E = \bar{E}$ can be maintained only if output y_2 is at least equal to its value at point B.[28]

Now, suppose that a large negative productivity or trade shock shifts the W-curve downward (from W_0 to W_1). Clearly, after the shock it becomes impossible to sustain the parity $\bar{E}$ since the W_1 curve intersects the horizontal line $E = \bar{E}$ to the left of B. This implies that the fixed exchange rate $\bar{E}$ has to be abandoned, which in turn may lead the economy to the 'bad' equilibrium C

[27] With imperfect substitutability between domestic and foreign assets, the central bank has more flexibility in defending the currency and changing i_1. For large shocks, however, this does not make the analysis significantly different from the full substitutability case.

[28] Notice that the analysis can also be conducted in terms of the 'shadow' exchange rate as often done in the literature. The intervention of the $\overline{\mathrm{IPLM}}$ curve with the W curve gives the shadows exchange rate $\hat{E}$. As long as $\hat{E} < \bar{E}$, the fixed exchange rate can be maintained.

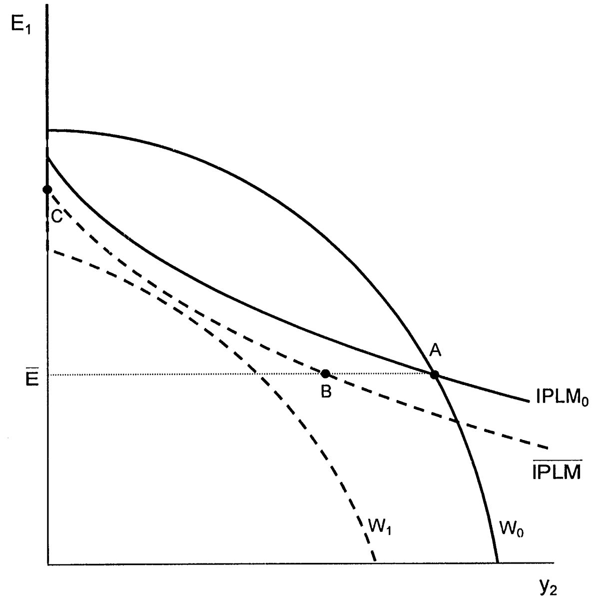

Fig. 6.

defined by the intersection between W_1 and $\overline{IPLM}$ in Fig. 6.[29] It is important to note that the decline in reserves that triggers the currency crisis is caused here by the underlying weakness in the financial health of private firms and not by a fiscal deficit as in the first-generation models of currency crises.

Similarly, we can use our framework to analyze credibility aspects of the kind emphasized by the second generation of currency crises models. For example, instead of assuming a floor level of international reserves, suppose that the government's objective is to minimize a loss function which increases both with the size of output declines and the extent of a currency devaluation. Then, if output depends negatively on the *nominal* interest rate as will be discussed in Section 5, we can easily re-obtain the multiple equilibrium result of the second generation models.[30] To see this, note first that an increase in the high interest rate i_0 reduces output y_2 and therefore increases the likelihood of a currency depreciation in period 1. Thus, if at date 0 investors increase their expectation of a currency devaluation in period one, the

[29] Note that once the fixed exchange rate is abandoned, the IPLM curve is likely to be shifted by changes in interest rates. A restrictive monetary policy will increase i_1 and shift IPLM down. However, the IPLM may still shift up thereafter due to an increase in i_2, which itself is caused by the expectation of a further depreciation (as in Krugman, 1979).

[30] Bensaid and Jeanne (1997) present a reduced-form second-generation model with an explicit cost of high nominal interest rates leading to multiple equilibria.

interest parity condition in period 0 implies that i_0 must increase, but this in turn will cause an output fall, thereby making the expectation of a currency depreciation self-fulfilling.

Two conclusions can be drawn from these illustrations. First, our model also explains currency crises in economies with an initially fixed exchange rate. Second, first- and second-generation features can interact with the balance sheets of private firms and thereby lead to a currency crisis through the same basic mechanism as above.

4.2. Public versus private debt in currency crises

In the first generation of currency crises models, it is the inconsistency between public sector behavior and a fixed exchange rate that is at the source of a crisis. In this section, we emphasize the interaction between fiscal variables and the private sector. This interaction can take two forms. First, a fiscal shock such as an increase in government expenditure or a decline in tax revenues, may crowd out the private sector and thereby lead to a currency crisis. Second, a negative shock to fundamentals or to expectations may affect both the private and the public sector in such a way that the deterioration of the private sector's financial health is exacerbated by the deterioration of the public budget.

To organize thoughts it is useful to look at a consolidated government's balance sheet. Assume that government activities are such that in each period t we have

$$P_t(g_t - t_t) + \left[x^{\mathrm{G}}(1+i_{t-1}) + (1-x^{\mathrm{G}})(1+i^*)\,\frac{E_t}{E_{t-1}}\right] P_{t-1} d_t^{\mathrm{G}} = P_t d_{t+1}^{\mathrm{G}} + P_t s_t, \tag{12}$$

where g_t and t_t denote real expenditure and revenue; d_t^{G} is the privately held public debt contracted in period $t-1$ and due to be reimbursed in period t; x^{G} denote the fraction of government debt which is in domestic currency; and s_t represents real seigniorage revenue. If the exchange rate were fixed, we would also need to add the change in the central bank's international reserves, but for simplicity we only consider the floating exchange rate case in this subsection. If we divide (12) by P_t and assume that PPP holds at $t-1$, we get the budget constraint in real terms:

$$g_t - t_t + \left[x^{\mathrm{G}}(1+r_{t-1}) + (1-x^{\mathrm{G}})(1+i^*)\,\frac{E_t}{P_t}\right] d_t^{\mathrm{G}} = d_{t+1}^{\mathrm{G}} + s_t. \tag{13}$$

The first important point that emerges from Eq. (13) is that public sector's debt is affected negatively by unanticipated currency depreciations in exactly the same way as private sector's debt.[31] Thus, it is not difficult to imagine a 'second-generation' model (e.g., in the line of Obstfeld, 1994) where multiple equilibria and the possibility of currency crises, stem from a high proportion of public foreign currency debt. This is in sharp contrast with the existing literature (again, see Obstfeld, 1994) where currency crises occur in economies with high proportions of *domestic* currency debt and where having foreign currency debt can help avoid a crisis altogether. Behind this contrast lies the fact that previous models would typically assume *ex post* PPP and no foreign price uncertainty, which implies that foreign currency bonds are a perfect hedge against currency fluctuations. The experience with countries issuing foreign-currency debt, such as Mexico with its dollar-linked *tesobonos*, tends to support the view that public *foreign* currency debt is not always an stabilizing influence.

Let us now turn to the interaction between the private and the public sector. Consider for example an increase in the primary fiscal deficit at time one, $g_1 - t_1$.[32] The impact on the private sector depends on which other variable adjusts in (13). First, assume that an increase in the deficit is financed by an increase in seigniorage s_1. This implies an increase in money growth from period 2 on, which in particular means an increase in M_2^S and in i_2 (due to an increase in π_3). In our graphical analysis, this implies that the IPLM curve will shift upward, which in turn can push the economy from a 'good' into a 'currency crisis' equilibrium. Interestingly, as in 'first-generation' models, the proximate cause of the crisis is a budget deficit financed by future inflation. The mechanism behind the crisis, however, is quite different since it is not the currency attack on the fixed exchange rate, but rather the deteriorating financial health of private firms, which causes the crisis.

Now, suppose that the increased budget deficit leads to a reduction in the amount of lending to firms, through a decline in the credit-multiplier μ. This may be due to some standard crowding out between public and private debt; or because a larger deficit would reduce the amount of government funds available to save insolvent or illiquid banks or firms from bankruptcy. This decline in μ will lead to a downward shift of the W curve, which again may result in the possibility of a crisis. Here again, a negative shock on the public sector leads to a crisis through its impact on private firms.

To summarize our discussion in this section, we have argued that although a currency crisis may be directly triggered by a weakening of private sector firms' balance sheets, it can also be provoked by imbalances in the public

[31] Notice that throughout the paper we consider only short-term (one-period) debt. To the extent that the government can have longer maturities that the private sector, it may be less sensitive to exchange rate depreciations.

[32] This increase could be an exogenous change in fiscal policy or an endogenous decline in tax revenue due to some negative shock affecting domestic output.

sector. This may help explain crises episodes like Brazil in the late 1990s, where the corporate and banking sectors suffered from the increasing fiscal imbalances.

5. Monetary policy

5.1. The case for monetary tightening

The appropriate monetary policy response to the recent crises has been a hotly debated issue. Our model, being an explicitly monetary model, is well suited as a framework for discussing these issues.[33] Consider the model developed in Sections 2 and 3. Suppose it is known that the economy has a significant chance of switching to the currency crisis equilibrium, either because of a shift in expectations or because of a real shock. In other words, we are now in a situation such as the one depicted in Fig. 4c. Can the monetary authorities do anything that would guarantee that the economy avoids a currency crisis?

Obviously what they need to do is to shift the IPLM curve so that the economy moves to a configuration of the type shown in Fig. 4a. Fig. 7 shows this case. The correct policy response in this case is obviously to increase the interest rate i_1 and/or decrease M_2^S so that the IPLM curve shifts downward. Fig. 7 thus shows a situation in which the currency crisis can be avoided and initial output can be restored, through appreciating the currency to E_1^1. This can be seen as the standard case for a tight monetary policy during a currency crisis.

The main argument of those defending a lax monetary policy, however, is that interest rate increases negatively affects output. To take this into consideration, we consider a model of the credit market, developed in the appendix, where credit depends negatively on the real interest rate, i.e., $\mu(r_t)$ with $\mu' < 0$. To see how this additional effect modifies the W curve we have to take account of the relationship between the real interest rate and the exchange rate. Using the interest parity condition and the definition of the real interest rate, we have: $1+r_1=(1+i^*)P_1/E_1$. This allows us to rewrite the credit multiplier as $\mu_t = \mu(E_1/P_1)$, where $\mu' > 0$.[34] Eq. (5) then gets re-expressed in the form

$$y_2=f\left(\left(1+\mu\left(\frac{E_1}{P_1}\right)\right)(1-\alpha)\left\{y_1-(1+r_0)d_1^c-(1+i^*)\frac{E_1}{P_1}(d_1-d_1^c)\right\}\right). \quad (14)$$

[33] We do not examine the interaction between monetary policy and the credibility of the authorities (e.g., see Drazen, 1999, for such an analysis). See Goldfajn and Baig (1998), Goldfajn and Gupta (1999), and Kray (2000) for empirical analyses of this issue and Lahiri and Végh (2000) and Flood and Jeanne (2000) for other theoretical analyses.

[34] The μ function is increasing in E_1/P_1, since a high value of E_1/P_1 predicts that future inflation will be high relative to future depreciation, and therefore depresses the real interest rate.

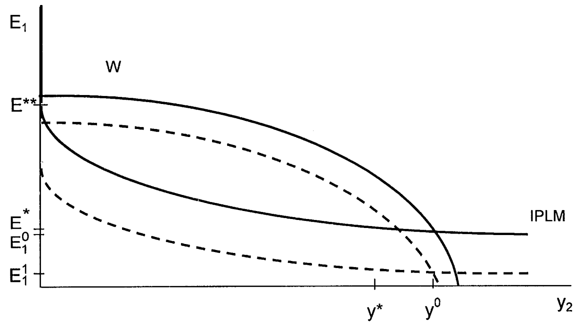

Fig. 7.

Changes in E_1 (with P_1 fixed) have now two effects on y_2. In addition to an increase in the foreign currency debt burden of domestic entrepreneurs, an increase in E_1 reduces the real interest rate r_1, which in turn relaxes the credit constraint and therefore increases the availability of funds d_2 at the beginning of period 2. The slope of the W curve depends on the relative importance of the two effects. Fig. 3, with μ constant, represents the case where the foreign currency debt effect dominates. In Fig. 8 the relationship between y_2 and E_1 is positive. It becomes a vertical line at $\tilde{y}$ when μ is so large (r_1 so small) that the credit constraint is no longer binding. Note that other shapes of the W curve are possible. In particular, it might be positively sloped for low values of E_1 and negatively sloped for high values of E_1.

The exact expression for the slope of the W curve (from Eq. (9)) is

$$\frac{d(E_1/P_1)}{dy_2} = f'(s\Pi_1)s\left[\frac{\mu'}{1+\mu} - (1+i^*)(d_1 - d_1^{\mathrm{c}})\right],$$

where $s = (1-\alpha)(1+\mu)$. It is clear from this expression that when there is no foreign currency debt, i.e., when $d_1^{\mathrm{c}}{=}d_1$, the W curve is always upward-sloping. As the proportion of foreign currency debt increases, the slope of the W curve decreases, turning negative; the limit is achieved at $d_1^{\mathrm{c}} = 0$. When credit markets are completely absent, i.e., when $\mu = 0$, we must have $d_1^{\mathrm{c}} = d_1 = 0$ and therefore the W curve would always be vertical. This is as it should be: When there is no credit, exchange rate variations should not affect investment capacity. The W curve is also vertical when μ is very large and therefore the credit constraint is not binding: In this case output should not be affected by the profitability of the firm sector. In the intermediate case where there is a substantial amount of borrowing but the credit constraint

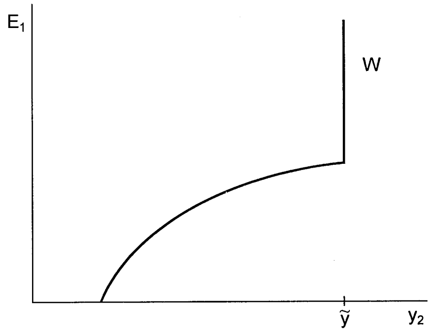

Fig. 8.

still binds, the W curve can be downward-sloping and relatively flat.[35] This turns out to be the case where we can have currency crises. In that sense currency crises will be associated with countries that are at an intermediate level of financial development.[36]

Let us now examine monetary policy where the W curve slopes up as in Fig. 9a. In this case, consider a negative shock that has reduced output from y^0 to y^* and caused a currency depreciation from E_1^0 to E^*. Then, an expansionary monetary policy, i.e., a decrease in i_1 or an increase in M_2^S, can help us maintain the initial level of output, y^0, though such policy will shift the IPLM curve upward and therefore induce a further currency depreciation to E_1^1. Notice, however, that there is no crisis, either potential or actual, in this case. The case where the W curve slopes down is the same as the one analyzed in Fig. 7, so that an interest rate increase can avoid a currency crisis. Finally, there may still be more complex situations where the W curve has both a positive and a negative slope, as in Fig. 9b. In that case a leftward shift in the W curve following a negative shock may again lead to multiple equilibria and a potential crisis. While the optimal monetary policy is now restrictive it can only eliminate the risk of a currency crisis at the cost of reducing aggregate output down to y_1^1.

To summarize, an expansionary policy can be justified *only in situations where the W curve is upward-sloping*, *i.e.*, *only if currency crises are impossible*. The intuition behind this claim is as follows: The effect of lowering nominal interest rates can be beneficial in this model only if lowering nominal interest rates also lowers real interest rates, which in turn raises μ and has an

[35] What happens between $\mu = 0$ and the non-binding credit constraint is rather complex since each of the terms $f'(\cdot)$, $\mu'/(1+\mu)$ and $d_1 - d^c$ depend on the μ function. In particular, the specific way in which we have modeled the credit market and the decision to borrow in foreign currency plays an important role and for this reason we have chosen not to discuss these aspects in detail.

[36] The connection between financial development and the μ function is more tightly drawn in the appendix.

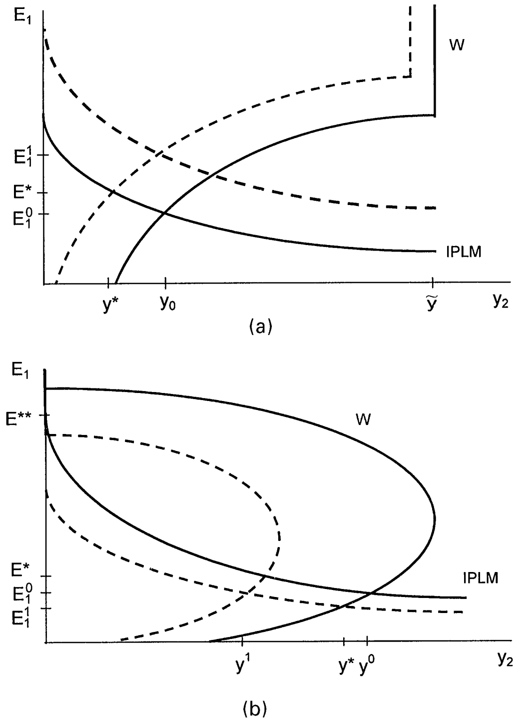

Fig. 9.

expansionary effect on output. Now, the only way to lower real interest rates in our model, is to allow the currency to slide down so that the expected future appreciation of the domestic currency can compensate bond holders for the lower interest rate. But allowing the currency to slide in a crisis-prone economy will cause output to contract (this is precisely what makes the economy crisis prone) and this output contraction in turn will lead to further depreciation of the local currency and push the economy closer to a crisis. Therefore a currency crisis in our model demands a tight monetary policy.

5.2. Extensions and generalizations

5.2.1. A credit multiplier which depends upon nominal interest rates

Our results above rely heavily on the fact that μ depends only on the *real* rate of interest and that prices are preset for one period. But one can think of different reasons why it might also depend on the *nominal* interest rate i_1. For example, in the case where currency crises are accompanied by banking crises, the government can try to bail out some of the banks by printing money. Failing to do so would contribute to bank failures and bank failures will lead to a reduction in μ. In other words a tight monetary policy will directly lead to a fall in μ.[37] It might also be the case that it takes some time before participants in the bond markets are fully able to adjust to the change in the expected inflation rate that results from changes in i_1. A credit contraction following an increase in the nominal interest rate i_1, may also result from the signalling effect of such an increase on a financially fragile economy (e.g. by undermining creditors' confidence in the credit market).

In a model otherwise similar to the one developed above, but with the one difference that the credit multiplier *only* depends upon the nominal interest rate, Aghion et al. (2000a) show that: (i) the W curve is always downward sloping in the space (y_2, E_1); (ii) an increase in the period-1 nominal interest rate i_1 shifts *both* the IPLM curve *and the* W *curve* downward. In particular, if the credit multiplier μ is very sensitive to an increase in the nominal interest rate, the W curve could shift by more than the IPLM curve,[38] and as a result, a tight monetary policy (i.e., an increase in i_1) may no longer be the optimal monetary response to the risk of a currency crisis. This model is of course quite extreme since it is only the nominal rate that affects μ. A more reasonable model would have μ be a function of both the real and the nominal rate. Then, what we just said implies that if the nominal rate effect on μ is strong enough, a tight monetary policy may not be the right response to a crisis.

5.2.2. Prolonged price stickiness

Suppose that price stickiness lasts for more than one period. Does this qualify the above policy conclusion that monetary tightening is the optimal response to the risk of a currency crisis?

Consider first the case where the credit multiplier μ is constant. Then, we know that monetary tightening in period 2 will move the IPLM curve in the (E_1, y_2) space downward, thereby avoiding a currency crisis in period 2. But what about period 3? Consider indeed what happens in the two-dimensional

---

[37] In Aghion et al. (2000b), we examine explicitly the impact of monetary policy on the banking sector.

[38] For example, in Aghion et al. (2000a) where $f(k) = \sigma k$, increasing i_1 shifts the IPLM curve downward by more than the W curve at a given E_1 if and only if

$$-\frac{\mu'(i_1)P_1(y_1 - (1+r_0)d^c - (1+i^*)E_1/P_1(d_1 - d^c)}{(1+\mu(i_1))(1+i^*)(d_1 - d^c)} < \frac{E_1}{1+i_1}.$$

One can easily see that it is when $\mu'(i_1)$ is small in absolute value and/or when the proportion of foreign currency debt $(d_1 - d^c)$ is large, that this condition is most likely to be satisfied. In that case the above policy conclusion that monetary tightening is the way to avoid a currency crisis, will still apply. However, that conclusion might be reversed if $\mu'(i_1)$ turns out to be large in absolute value.

space (E_1, y_3). As we have seen in Section 2 above, y_3 is an increasing function of E_1, namely

$$y_3 = f\left((1+\mu)(1-\alpha)\left\{y_2 - (1+i_1)d_2^c - (1+i^*)\,\frac{P_1}{E_1}(d_2 - d_2^c)\right\}\right),$$

so that the new W curve in the space (E_1, y_3) is upward sloping. On the other hand, the new IPLM curve in the space (E_1, y_3) is either horizontal if i_2 is fixed, or downward sloping if i_2 is endogenously determined by money growth targeting (an increase in y_3 reduces the inflation rate π_3 and therefore also i_2; furthermore, the IPLM equation implies that E_1 is an increasing function of i_2). Now, since the W curve is upward sloping and the IPLM curve is either horizontal or downward sloping in the space (E_1, y_3), there cannot be multiple equilibria and therefore currency crises in period 3 when the credit multiplier μ is constant. Thus, in particular, whilst avoiding a currency crisis in period 2, monetary tightening in period 1 will also avoid such a crisis in subsequent periods.

Consider now the case where μ depends negatively upon the real interest rate, as derived in the appendix. Then, if price stickiness extends to period 2 (i.e., $P_1 = P_2$), then the multiplier μ will end up depending directly upon the nominal interest rate i_1, since increases in i_1 translates one for one into increases in the real interest rate r_1 as $1+r_1 = (1+i_1)P_1/P_2 = 1+i_1$. In other words, we must simply substitute $\mu(i_1)$ for $\mu(r_1)$ in Eq. (14). This means that a tight monetary policy will now shift the W curve downward in the space (E_1, y_2) also in the case where the credit multiplier depends only upon the real interest rate. As we have argued in the previous section, this in turn will tend to undermine the effects of tight monetary policies in avoiding a currency crisis.

6. Conclusion

In this paper we have developed a simple framework to study currency crises and assess the effects of monetary policy. This ‘third generation’ model is particularly well suited to analyze the case of economies like in Asia, where the source of currency crises lied primarily in the deteriorating balance sheets of private domestic firms and commercial banks rather than in uncontrolled budget deficit policies by local governments (e.g., see Mishkin, 1999).

Five main conclusions emerged from our analysis. First, an economy with a large proportion of foreign currency debt is more likely to face currency crises associated with large recessions and currency devaluations. Second, a currency crisis may occur both under a fixed or a flexible exchange rate regime as the primary source of such a crisis is the deteriorating balance sheet of private firms. Third, public sector imbalances can have destabilizing effects on the domestic currency through the crowding-out effects of public debt (especially public foreign currency debt) on the balance sheet and credit access of private firms. Fourth, unless credit supply does not strongly react to changes in the *nominal* interest rate, it is always desirable to *increase* the nominal interest rate if the primary objective is to avoid a currency crisis; this in turn vindicates the IMF approach. This result, however, may cease to apply if credit supply reacts too strongly to changes in the nominal interest rate, for example in the presence of signaling effects or as a result of persistent price rigidity. Fifth, a tight monetary policy will always produce a debt-burden effect on medium-term economic activity.

A natural next step if this framework is to be used for policy purposes, is to empirically assess the relative importance of the various effects pointed out in the paper. In particular, besides the determination of *actual foreign currency debt ratios*, we need to get a better sense of how credit supply reacts in practice to changes in the *real* or the *nominal* interest rate; we also need to assess the *elasticities of money demand* with respect to income and to the nominal interest rate. For example, our analysis indicates that monetary tightening should be used to avoid a currency crisis if the credit multiplier does not react too strongly to changes in the nominal interest rate that leave the real interest rate unchanged. We thus need to understand the actual behavior of this multiplier before drawing definite policy conclusions. Our priority at this stage – but again this requires further empirical investigation – is that the credit multiplier should not dramatically respond to changes in the nominal interest rate alone, at least insofar as those changes are not too dramatic and/or interest rate increases are accompanied by complementary policies aimed at maintaining the credit multiplier, in particular adequate government support to banks and bank restructuring. Finally, we need to evaluate the relative speeds of price versus interest rate adjustments as our analysis suggests that the optimal design of monetary policy, is potentially sensitive to the degree of price stickiness, or more precisely to the duration of the deviation from PPP following the initial shock.

Acknowledgements

We would like to thank Beatriz Armendariz, Olivier Blanchard, Guillermo Calvo, Daniel Cohen, Giancarlo Corsetti, Allan Drazen, Linda Goldberg, Roger Guesnerie, Pentti Haaparanta, Ricardo Hausman, Olivier Jeanne, Robert King, Paul Krugman, Philip Lane, Jacques Melitz, Jeffrey Nilsen, Paolo Pesenti, Hélène Rey, two referees, and seminar paticipants at ISOM, ESSIM, Santiago de Compostela, Gerzensee, Basel, Munich, and Vienna for useful discussions and comments.

Appendix A. The credit multiplier

The credit multiplier μ_t is derived from expost moral hazard considerations. Namely, suppose that domestic entrepreneurs can either produce transparently and fully repay their loan or instead can hide their production in order to default on their debt repayment obligations. There is a nominal cost to hiding, which is proportional to the amount of funds invested: cP_tk_t. Yet, whenever the entrepreneur chooses to default, the lender can still collect his due repayment with probability p. Thus, the borrower will decide not to default if and only if

$$P_t y_t - (1 + i_{t-1})P_{t-1}d_t \geq P_t y_t - cP_t k_t - p(1 + i_{t-1})P_{t-1}d_t,$$

where the LHS (resp. RHS) is the borrower's net expected revenue if she repays (resp. if she defaults on) her debt. Then, the above incentive constraint can be rewritten as: $d_t \leq \mu_t w_t$, where

$$\mu_t = \mu(r_{t-1}) = c/[(1 - p)(1 + r_{t-1}) - c].$$

The multiplier μ_t is increasing in the monitoring probability p (which in turn reflects the level of financial development of the economy) and it is decreasing in the real interest rate r_{t-1}. The currency composition of debt does not affect μ_t since lending is determined before any shock occurs, that is at a time where both the PPP and the interest parity conditions hold.

References

Aghion, Ph., Bacchetta, Ph., Banerjee, A., 1999a. Financial liberalization and volatility in emerging market economies. In: Agénor, P.R., Miller, M., Vines, D., Weber, A. (Eds.), The Asian Financial Crises: Causes, Contagion and Consequences, Cambridge University Press, Cambridge, pp. 167–190 (Published under the wrong title "Capital Markets and the Instability of Open Economies").

Aghion, Ph., Bacchetta, Ph., Banerjee, A., 1999b. Capital markets and the instability of open economies. CEPR discussion paper No. 2083.

Aghion, Ph., Bacchetta, Ph., Banerjee, A., 2000a. A simple model of monetary policy and currency crises. European Economic Review 44, 728–738.

Aghion, Ph., Bacchetta, Ph., Banerjee, A., 2000b. A corporate balance-sheet approach to currency crises. In progress.

Aghion, Ph., Banerjee, A., Piketty, T., 1999. Dualism and macroeconomic volatility. Quarterly Journal of Economics 113, 1357–1397.

Bacchetta, Ph., 2000. Monetary policy with foreign currency debt. Study Center Gerzensee working paper No. 00.03.

Banerjee, A., 1999. Comment on Chang and Velasco. In: Bernanke, B.S., Rotemberg, J.J. (Eds.), NBER Macroeconomics Annual, MIT Press, Cambridge, MA, pp. 58–61.

Bensaid, B., Jeanne, O., 1997. The instability of fixed exchange rate systems when raising the nominal interest rate is costly. European Economic Review 41, 1461–1478.

Bernanke, B., Gertler, M., 1989. Agency costs, net worth, and business fluctuations. American Economic Review 79, 14–31.

Bernanke, B., Gertler, M., Gilchrist, S., 1999. The financial accelerator in a quantitative business cycle framework. In: Taylor, J., Woodford, M. (Eds.), Handbook of Macroeconomics, Vol. 1C. Elsevier, Amsterdam, pp. 1341–1393.

Blanchard, O.J., 1996. Macroeconomics. Prentice-Hall, Englewood Cliffs, NJ.

Bohn, H., 1990. A positive theory of foreign currency debt. Journal of International Economics 29, 273–292.

Burnside, C., Eichenbaum, M., Rebelo, S., 2000. Hedging and financial fragility in fixed exchange rate regimes. European Economic Review 45 (7), this issue.

Calvo, G.A., 1998. Balance of payments crises in emerging markets: Large capital inflows and sovereign governments. Paper presented at the NBER Conference on Currency Crises, Cambridge, MA, February.

Chang, R., Velasco, A., 1999. Liquidity crises in emerging markets: Theory and Policy. In: Bernanke, B.S., Rotemberg, J.J. (Eds.), NBER Macroeconomics Annual. MIT Press, Cambridge, MA, pp. 11–58.

Cooper, R., 1971. Currency devaluation in developing countries. Princeton's Essays in International Finance, reproduced. In: Kenen, P.B. (Ed.), The International Monetary System: Highlights from Fifty Years of Princeton's Essays in International Finance. Westview Press, Boulder and Oxford.

Corsetti, G., Pesenti, C., Roubini, N., 1998. What causes the Asian currency and financial crisis? Part I: A macroeconomic overview. NBER working paper 6833, December.

Drazen, A., 1999. Interest rate defense against speculative attacks under asymmetric information. Mimeo.

Engel, C., 1993. Real exchange rates and relative prices: An empirical investigation. Journal of Monetary Economics 32, 35–50.

Falcetti, E., Missale, A., 1999. The currency denomination of public debt and the choice of the monetary regime. Mimeo.

Flood, R., Marion, N., 1999. Perspectives on the recent currency crises literature. International Journal of Finance and Economics 4, 1–26.

Flood, R.P., Jeanne, O., 2000. An interest rate defense of a fixed exchange rate? Mimeo., IMF.

Furman, J., Stiglitz, J.E., 1998. Economic crises: Evidence and insights from East Asia. Brooking Papers on Economic Activity, 2, 1–135.

Garber, P., Svensson, L.E., 1995. The operation and collapse of fixed exchange rate regimes. In: Handbook of International Economics, Vol. 3. Elsevier, Amsterdam.

Goldfajn, I., Baig, T., 1998. Monetary policy in the aftermath of currency crises: The case of Asia. IMF working paper, WP/98/170, December.

Goldfajn, I., Gupta, P., 1999. Does monetary policy stabilize the exchange rate following a currency crisis? IMF working paper, WP/99/42, March.

Honkapohja, S., Koskela, E., 1999. The economic crisis of the 1990's in Finland. Economic Policy 14, 401–436.

Jeanne, O., 2000a. Foreign currency debt and the global financial architecture. European Economic Review 44, 719–727.

Jeanne, O., 2000b. Currency crises: A perspective on recent theoretical developments. Special Papers in International Economics No. 20, International Finance Section, Princeton University.

Kray, A., 2000. Do high interest rates defend currencies during speculative attacks? Mimeo., World Bank.

Krugman, P., 1979. A model of balance of payments crises. Journal of Money Credit and Banking 11, 311–325.

Krugman, P., 1999a. Balance sheets, the transfer problem, and financial crises. In: Isard, P., Razin, A., Rose, A. (Eds.), International Finance and Financial Crises, Essays in Honor of Robert P. Flood. Kluwer, Dordrecht.

Krugman, P., 1999b. Analytical afterthoughts on the Asian crisis. Mimeo., MIT.
Krugman, P.R., Obstfeld, M., 2000. International Economics – Theory and Policy. Addison-Wesley, Reading, MA.
Lahiri, A., Végh, C.A., 2000. Output costs, BOP crises, and optimal interest rate policy. Mimeo., Department of Economics UCLA.
Mishkin, F.S., 1996. Understanding financial crises: A developing country perspective. Annual World Bank Conference on Development Economics, pp. 29–62.
Mishkin, F.S., 1999. Global financial instability: Framework, events, issues. Journal of Economic Perspectives 13, 3–20.
Obstfeld, M., 1994. The logic of currency crises. Cahiers Economiques et Monétaires, Banque de France 43, 189–213.
Obstfeld, M., Rogoff, K., 1995. Exchange rate dynamics redux. Journal of Political Economy 103, 624–660.
Obstfeld, M., Rogoff, K., 1996. Foundations of International Macroeconomics. MIT Press, Cambridge, MA.
Radelet, S., Sachs, J., 1998. The onset of the East Asian financial crisis. NBER working paper No. 6680.