

Currency Crises and Monetary Policy in an Economy with Credit Constraints¹

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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.

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 large 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.² 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, Gertler, and Gilchrist (1999) have called a financial accelerator mechanism. In some of these models (Aghion, Bacchetta, and Banerjee, 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;³ moreover this effect on output may in turn affect the exchange rate, further amplifying the shock and causing it to persist.

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

²See Aghion, Bacchetta, and Banerjee (1999a, b), Krugman (1999a), Chang and Velasco (1999).

³In 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.

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.⁴ 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 repayment obligations of the firms, and consequently a fall in profits.⁵ 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, Figure 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.⁶ It is striking that all the countries that had a ratio higher than 1.5 have experienced some type of crisis in the 1990s (except for South Africa). The second fact is that there are substantial and persistent deviations from purchasing power parity following an exchange rate shock.⁷ By contrast Banerjee (1999) argues that

⁴Aghion, Bacchetta, and Banerjee (2000a) contains a precursor of the model in this paper. Krugman (1999b) presents an elegant simplification of the model in Aghion, Bacchetta, and Banerjee (2000a).

⁵The 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. Obstfeld, 1994), the impact of private foreign currency debt has not been analyzed.

⁶Debt to banks from BIS countries is often used as a measure of foreign currency debt, as no good measure is available. Corsetti, Pesenti, and Roubini (1998) present the same ratio as in Figure 1 for Asian countries.

⁷After 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).

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.⁸

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.⁹ 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.

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 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.¹⁰ 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 therefore advocate monetary tightening,¹¹ and those who blame shifts in expectations

⁸In Chang and Velasco (1999) it is important that most of the borrowing is in the tradeable sector but the lending capacity of bank depends on the valuation of non-tradeable assets. Moreover non-tradeables are not used in the production of tradeables. By contrast, in Aghion, Bacchetta, and Banerjee (1999a, b) the fact that non-tradeables are used in the production of tradeables is absolutely key.

⁹It is indeed striking that countries that experienced a large depreciation in the ERM crisis in 92-93 had a relatively good output performance, while countries that suffered from the Mexican and Asian crises faced serious recessions.

¹⁰Surveys of the currency crises literature, include Garber and Svensson (1995), Obstfeld and Rogoff (1996), and Flood and Marion (1998).

¹¹This view has been consistently advocated by the IMF. In particular, Stanley Fischer

and bad luck (the multiple equilibrium view) and consequently support a more lenient approach to monetary policy.¹² 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 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. 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 analysing 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.¹³ There is a single tradeable 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

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".

¹²See for example Radelet and Sachs (1998) and Furman and Stiglitz (1998).

¹³The assumption that prices are preset for one period is commonly made in monetary models of an open economy, following Obstfeld and Rogoff (1995).

— as is well-known, in a world of multiple equilibria, such shifts can have real effects.¹⁴ 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.¹⁵ These deviations will play a crucial role in the analysis.

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.

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. 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

¹⁴For 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). In Appendix 3, however, we consider the case where the distribution of expectational shocks is taken into account ex ante and then derive sufficient conditions for the existence of a non-deterministic sunspot equilibrium.

¹⁵Producers set prices in domestic currency by taking the foreign price (adjusted by the expected exchange rate) as given. In contrast to some recent models in the so-called "New Open Economy Macroeconomics", we implicitly assume perfect competition on the product market.

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.¹⁶ Arbitrage by investors between domestic and foreign currency bonds in a world with perfect capital mobility yields the following interest parity (IP) condition:

$$1 + i_t = (1 + i^*) \frac{E_{t+1}}{E_t} \quad (1)$$

where i^* is the foreign interest rate which we assume to be constant over time.

In addition, consumers have a standard real money demand function $m_t^d = m^d(y_t, i_t)$. The function m^d has the usual properties of being increasing in y_t and decreasing in i_t ,¹⁷ furthermore, we assume: $m^d(0, i_t) > 0$.¹⁸ Thus, at any date t , money market equilibrium can be expressed by the (LM) _{t} equation:

$$M_t^S = P_t \cdot m^d(y_t, i_t) \quad (2)$$

where M_t^S 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: $M_t^S = (1 + z_t)M_{t-1}^S$. Computing the growth rate of equation (2), we can determine the evolution of the inflation rate π_t :

$$1 + \pi_t = (1 + z_t) \frac{m_{t-1}^d}{m_t^d} \quad (3)$$

¹⁶For example, see Krugman and Obstfeld (2000) and Blanchard (1996) for pedagogical presentations of the LM and IP relationships.

¹⁷This follows from consumers' arbitrage between holding money for transaction purposes and holding (domestic) bonds that yield interest rate i_t .

¹⁸This 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, for example when we introduce a competitiveness effect (see Section 3 below).

Equation (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, equation (2) yields:

$$i_1 = \phi(M_1^S, y_1) \tag{4}$$

where ϕ is the inverse of the m^d function with respect to i . The relationship between i_1 and M_1^S 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 subsection 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 take the credit multiplier to be constant constant, i.e., $\mu_t = \mu$.¹⁹ 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 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. Analyzing the factors underlying this choice raises important but difficult questions, and no consensus has yet been achieved as to the main determinants of the currency composition of debt. Yet, there is broad consensus on the fact that individual decisions concerning the amount and currency composition of private debts,

¹⁹See for example Aghion, Banerjee, and Picketty (1999) for a specification of credit monitoring costs which produces a constant multiplier.

do not internalize pecuniary externalities and in particular the impact that such individual decisions may have on aggregate variables such as prices and exchange rates. For the sake of simplicity we shall take the currency composition of private debt as given, with a constant amount of domestic currency debt, d^c , with the residual amount d_t in each period t , being contracted in foreign currency.²⁰

Having fixed 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:

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

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:

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

²⁰See the Appendix in Aghion-Banerjee-Bacchetta (2000b) for a simple model of currency composition of debt based on transaction costs. The basic idea there is that entrepreneurs prefer to borrow in foreign currency because the cost of transacting in the foreign exchange market is slightly lower for domestic entrepreneurs than for their lenders, e.g because domestic firms exchange more systematically their domestic currency against foreign currency than lenders, who are either foreign investors or small consumers. However, entrepreneurs still need to borrow some fixed amount in domestic currency in order to pay some local suppliers for whom it would be particularly costly to exchange foreign currency back into domestic currency in order to purchase consumption goods from domestic stores. We show that this model generates an equilibrium amount of domestic currency debt, which is the smaller of a constant, d^c , and the total amount of borrowing d_t . Finally, 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)).

where: $0 < y_2 < \tilde{y}$. Equation (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:

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

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 affect 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:

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

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 equations (1), (2), (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. Appendix 2 analyzes the model's dynamics as well as its stability conditions. 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. Finally, we examine how the results in this section are modified once we introduce a competitiveness effect.

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. In other words, we implicitly assume that the government follows an *interest rate targeting* or *inflation rate targeting* (π_3 is fixed) policy.²¹ In Aghion, Bacchetta, Banerjee (2000b), we show that this assumption can be relaxed without significantly altering the results.²² Taking 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., LM₂) in which the period-2 nominal interest rate i_2 is taken as given. Using the PPP assumption $P_2 = E_2^e = E_2$ (the latter equality follows from the absence of shock in period 2) we get:

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

which provides a negative relationship between E_1 and y_2 . This relationship

²¹Indeed, as shown above, we have: $1 + i_2 = (1 + i^*)(1 + \pi_3)$.

²²For example, suppose that the government targets the rate 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:

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

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 which 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 (see Aghion-Bacchetta-Banerjee (2000b)).

is shown in Figure 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 an 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 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 equation (5):

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

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

²³Note 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.

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 equation (9) (along with the constraint $0 < y_2$) graphically in the (E_1, y_2) space gives us our W- curve as depicted in Figure 3. The W curve includes an upward segment of the vertical axis when E_1 is such that equation (9) yields $y_2 \leq 0$. In the following subsection, we show that under certain conditions the economy summarized by this graphical representation, has two “locally stable” equilibria and argues that the process of switching from the “good” equilibrium to the “bad” equilibrium can be naturally interpreted as a currency crisis.

To conclude this section let us briefly compare our model with a standard open macro model. Such a model would include the same kind of IPLM relationship between expected output and the current nominal exchange rate, but on the other hand: (i) our downward-sloping W curve would be replaced by an upward-sloping IS curve (with entrepreneurs’ output decisions being constrained by aggregate demand instead of being constrained by current wealth); (ii) our price rigidity assumption would be replaced by some kind of a Phillips curve that would determine the rate of price adjustment as a function of the other variables of the model. As we shall argue below, making the W curve become (partly) upward sloping, for example by introducing competitiveness effects into the model or by making the credit multiplier μ depend negatively on the *real* interest rate, will not by itself affect the conclusion that monetary tightening is the optimal response to the risk of a currency crisis; furthermore, replacing the Phillips curve by precise price stickiness assumptions turns out to considerably clarify our understanding of how the relative speeds of price adjustment and production/lending affects the occurrence or possibility of a currency crisis and the optimal response to it; in particular, currency crises cannot occur in this framework when prices are fully flexible and therefore PPP holds in all periods; when price stickiness lasts for one period, we will argue below that monetary tightening is the unambiguous optimal response to the risk of a currency crisis whenever the credit multiplier does not react (too much) to changes in the nominal interest rate; but when price stickiness lasts for more than one period, then

²⁴The 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.

the optimality of monetary tightening may become qualified, especially when the credit multiplier depends too negatively on the real interest rate.

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 Figure 4, there are three possible outcomes. Figure 4a shows a 'good' case with high output and a low exchange rate value as the unique equilibrium. Figure 4b shows a 'bad' case, where the unexpected currency depreciation is so large that it drives profits and therefore period-2 output to zero.²⁵ Finally, Figure 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: $(\frac{E_1}{P_1})_{y_2=0,W} < (\frac{E_1}{P_1})_{y_2=0,IPLM}$, or equivalently:*

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

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

²⁵A zero level of output is obviously an extreme simplification. In a more general framework, firms would gain competitiveness through a currency depreciation as shown in subsection 3.3. Moreover, output would remain positive for firms without foreign currency debt.

on by pure expectational shift. If everyone believes that there will be crisis, then a crisis occurs. The Appendix shows that these multiple outcomes can also occur when these expectational shifts are taken into account when setting prices (formally, we show the existence of non-degenerate sunspots equilibria).

On the other hand, in the case where the initial configuration is as in Figure 4a, only a negative real shock 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 Figure 4a, to the one depicted figure 4c. This, in turn, can start off a crisis if people expect the “bad” equilibrium. Such a process is illustrated in Figure 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

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

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

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

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

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.

3.3 A Competitiveness Effect

Since the output of credit-constrained firms is entirely determined by the supply of credit, our model does not permit a competitiveness effect operating through the usual Keynesian channel.²⁷ Here, we sketch an extension of our basic model that allows for competitiveness effect(s) to operate, and examine how our basic analysis would be modified by introducing such effects.

Suppose that an unanticipated shock results in a (short-run) currency depreciation, making domestic goods cheaper than (the same) foreign goods. This *competitiveness effect* could increase the volume of domestic exports for a same level of investment, provided we allow our entrepreneurs to somehow "work harder". Specifically, assume that entrepreneurs are committed to meet demand at the pre-set price. Therefore when there is an unanticipated shock and domestic goods become cheaper, entrepreneurs have to meet the higher demand. They do so by working harder—which they can always do, but usually prefer not to. Finally assume that when the entrepreneurs have to increase production, some non-contractable aspects of output *quality* suffer from such an increase in output *quantity*, and as a result the demand for domestic products, even at the lower price, remains finite.²⁸

In this extended model, because the deviation from PPP occurs in period 1, the output in that period, y_1 , will be an increasing function of E_1 . This implies that an increase in the current nominal exchange rate E_1 can now have a *positive* impact on real output y_2 . This, in turn, means that the W curve is less likely to be downward sloping and may even have slopes of varying sign.²⁹ It also implies that output is less likely go to zero as in the benchmark model.³⁰

²⁷See Bernanke, Gertler, and Gilchrist (1999) for a model with both credit constrained and demand constrained firms.

²⁸This allows us to maintain ex ante PPP without having domestic demand become infinite when the domestic price falls below the world price.

²⁹Krugman (1999b) and Bacchetta (2000) presents an example which incorporates a competitiveness effect.

³⁰A complete analysis of the extended model with competitiveness effects, would require a careful dynamic specification, since the foreign currency debt effect is likely to be more short-lived than the competitiveness effect.

In particular, when foreign currency debt is low or the credit constraint is not binding, the competitiveness effect will dominate and the W curve becomes upward sloping. In that case, a currency depreciation is good for firms. Note however that to make a case for a lax monetary stance, we are focusing on economies like the UK in the early 1990s where a currency depreciation increases future output (because the W curve is upward sloping or because credit constraints do not bind). However, this rules out multiple equilibria and currency crises of the kind analysed above.

4 The Public Sector

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 what the government can and will do. Our analysis so far shows that currency crises may also occur in a (credit-constrained) economy with flexible exchange rates and where government policy is taken as given.

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.³¹ 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:

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

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

$$M_2^S = DC_2 + IR_2 \quad (11)$$

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 \bar{IR} , in line with the first generation literature (e.g., Krugman (1979)); and that DC_2 is fixed at some level \bar{DC} . This situation can be depicted in Figure 7.

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 \bar{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: $M_2^S = \bar{DC} + \bar{IR}$. 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 .

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

³¹With 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.

C defined by the intersection between W_1 and \overline{IPLM} in Figure 7.³² 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. This does not mean that government behavior and public deficits cannot also have an effect on the occurrence of currency crises, as we will argue argued in the next subsection. Thus, the potential sources of currency crises highlighted in first-generation models, can also be shown to be relevant when analyzed in the context of the "third-generation" model in this paper.

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.³³ 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 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.

What does our model tell us about the optimal exchange rate regime? In the case of large shocks, we have just argued that the outcome is likely to be quite similar under a fixed or a floating exchange rate regime. However, this conclusion would change if a government could credibly commit to *never*

³²Note 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).

³³Bensaid and Jeanne (1997) present a reduced-form second-generation model with an explicit cost of high nominal interest rates leading to multiple equilibria.

abandon a given exchange rate parity, for example by instituting a currency board or some kind of dollarization policy. Nevertheless, these strategies are not without risks. One potential drawback of maintaining a fixed exchange rate regime over a long period, e.g., through establishing a currency board, is the fact that combined with persistent price rigidity it can lead to currency overvaluation (i.e., to real appreciation, as argued by Calvo and Vegh (1999)); this, in turn, may further squeeze firms' profits and thereby add to the difficulty of maintaining a fully credible fixed exchange rate policy.³⁴ Second, full dollarization (i.e., giving up the domestic currency and using the foreign currency for all transactions) would obviously avoid a currency crisis. However, the elimination of crises should be weighted against the potential costs of abandoning the domestic currency.³⁵ A full analysis of the costs and benefits of dollarization is left for future research.

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 subsection, 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

³⁴The impact of the exchange rate regime on the currency composition of debt is still not well understood (see Eichengreen and Hausman, 1999, for a discussion).

³⁵For example, suppose that the domestic country is subject to idiosyncratic shocks, or more generally to shocks that are asymmetrically -or at least imperfectly- correlated with shocks in the foreign currency area, and that domestic prices are sticky (e.g., fixed for two periods or more). Then, not giving up the domestic currency would allow the domestic country to implement countercyclical policies, e.g. to increase E in a fixed exchange rate regime or to reduce i in a flexible exchange rate regime, in order to reduce the real interest rate and/or to increase the real exchange rate and thereby to prevent a big recession following a large negative shock. This is particularly relevant if competitiveness effects of the kind analyzed above, are significant.

period t we have:

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

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. With a fixed exchange rate, we should also add the change in the central bank's international reserves, but for simplicity we only consider a floating exchange rate 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:

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

The first important point that emerges from equation (13) is that public sector's debt is affected negatively by unanticipated currency depreciations in exactly the same way as private sector's debt.³⁶ 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 foreign currency debt can 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 indicate that public *foreign* debt can indeed have a destabilizing role on the domestic currency.

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, $g_1 - t_1$.³⁷ The impact on the private sector depends on which

³⁶Notice that throughout the paper we consider only short-term (one period) debt. To the extent that the government can have longer maturities than the private sector, it may be less sensitive to exchange rate depreciations.

³⁷This increase could be an exogenous change in fiscal policy or an endogenous decline in tax revenue due to some negative shock affecting domestic output.

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 ³⁸). 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 crisis is caused by a budget deficit financed by future inflation. The mechanism of 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.³⁹ 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 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

The appropriate monetary policy response to the recent crises has been a hotly debated issue. In this Section we show that our model is particularly well suited to analyzing the impact of monetary policy.⁴⁰ In 5.1 we show that the optimality of monetary tightening to avoid a currency crisis is robust to having the credit multiplier depend negatively upon the real interest rate; however, in 5.2 we determine circumstances under which monetary tightening

³⁸See footnote x above.

³⁹Aghion, Bacchetta, and Banerjee (2000b) analyze this case, by introducing commercial banks and their reserve and capital requirements explicitly into the framework.

⁴⁰This section summarizes some of the findings of Aghion, Bacchetta, Banerjee (2000b).

may cease to be the optimal response to a crisis.

5.1 A credit multiplier μ which depends upon the *real* interest rate

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 a because of a real shock. In other words, we are now in a situation such as the one depicted in Figure 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 Figure 4a. Figure 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. Figure 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 Appendix 1, 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 realize that the real interest rate is related to 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 $\mu' > 0$.⁴¹ Equation (5) then gets re-expressed in the form:

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

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,

⁴¹The 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.

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. Figure 3, with μ constant, represents the case where the foreign currency debt effect dominates. In Figure 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 equation (9)) is:

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

where $s = (1 - \alpha)(1 + \mu)$. It is clear from this expression that when there is no foreign currency debt, i.e., when $d^c = d_1$, 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 $d^c = 0$. When credit markets are completely absent, i.e., when $\mu = 0$, we must have $d^c = d_1$ 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 still binds, the W curve can be downward-sloping and relatively flat.⁴² 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.⁴³

Let us now examine monetary policy where the W curve slopes up as in Figure 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

⁴²What happens between $\mu = 0$ and the non-binding credit constraint is rather complex since each of the terms $f'(\cdot)$, $\frac{\mu'}{1+\mu}$ 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 play an important role and for this reason we have chosen not to discuss these aspects in detail.

⁴³The connection between financial development and the μ function is more tightly drawn in Appendix 1.

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. Finally, there may still be more complex situations where the W curve can have different slopes as in Figure 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, as in the extended model with competitiveness effects, 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 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.⁴⁴

5.2 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. But one can think of different reasons why it might also depend on the *nominal* interest rate i_1 . For example, it might take 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

⁴⁴Aghion, Bacchetta, and Banerjee (2000b) analyze the output impact of tight monetary policy in the medium term, i.e., in period 3.

undermining creditors' confidence in the credit market).

In a model otherwise similar to the model developed above, but with the one difference that the credit multiplier *only* depends upon the nominal interest rate, Aghion-Bacchetta-Banerjee (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,⁴⁵ 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.

5.3 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 that monetary tightening in period 2 will move the IPLM curve in the (E_1, y_2) space downward, thereby avoidind a currency crisis in period 2. But what about period 3? Consider indeed what happens in the two-dimensional space (E_1, y_3) , As we have seen in section 2 above, y_3 is an

⁴⁵For example, in Aghion-Bacchetta-Banerjee (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:

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

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.

increasing function of E_1 , namely:

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

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 (in footnote x above we have shown that in this case i_2 is a decreasing function of y_3 - an increase in y_3 reduces the inflation rate π_3 and therefore also $i_2 = (1 + i^*)(1 + \pi_3)$); and furthermore the IPLM equation:

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

in turn implies that E_1 is an increasing function of i_2 , since an increase in i_2 will reduce the demand for the domestic currency tomorrow and therefore also today). 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 Appendix 1. 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 subsection, 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; but the presence of large competitiveness effects will instead decrease the likelihood of a crisis. 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.

Finally, in the appendix to this paper, we extend our analysis by imposing the consistency assumption that the first-period price satisfies ex ante PPP and we then reinterpret the possibility of multiple equilibria and of the occurrence of a currency crisis, as corresponding to the existence of non-degenerate sunspot equilibria.

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 prior 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.

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A Appendix 1: The Credit Multiplier

The credit multiplier μ_t is derived, as in Aghion-Bacchetta-Banerjee (1999b), from ex post 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: $cP_t k_t$. 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.

B Appendix 2: Dynamics

This Appendix examines the dynamic stability conditions of the basic model. As it turns out, the model can be solved recursively: given that P_1 and y_1 are predetermined and that the PPP condition holds from period 2 onward, the variables that need to be actually solved for are E_1 , π_t for $t \geq 2$, and y_t for $t \geq 2$. The equilibrium values of these variables are respectively determined by equations (1) for $t = 1$, (3) for $t \geq 2$, (5) for y_2 , and (7) for $t \geq 3$. Thus, only output and inflation dynamics are needed to solve the system. Since μ is constant, output does not depend on inflation. Then output is given by equation (7), which is a simple difference equation as d_t can be expressed as a function of y_t : $d_t = \mu f^{-1}(y_t)/(1 + \mu)$. As long as output is initially positive, it will converge to some positive value in the steady state. There are two

cases. Either equation (7) has a root larger than one and output will grow until it reaches the level \tilde{y} where the credit constraint is not binding and (7) is no longer valid; or equation (7) has a root lower than one and converges to some output level $\bar{y} \leq \tilde{y}$. The convergence path is always stable since we have:

$$\frac{\partial y_{t+1}}{\partial y_t} = (1 - \alpha)[(1 + \mu)f'(k_t) - (1 + i^*)\mu] > 0$$

The term in square brackets is always positive since $f'(k_t) > (1 + i^*)$ when entrepreneurs are credit constrained.

Inflation dynamics are given by equation (3). If the interest elasticity of money demand is not too large, inflation will converge to a steady state level $\bar{\pi}$. Differentiating equation (3) with respect to inflation gives:

$$(m_t^d + (1 + z_t)\frac{\partial m_{t-1}^d}{\partial \pi_t})d\pi_t = -(1 + \pi_t)\frac{\partial m_t^d}{\partial \pi_{t+1}}d\pi_{t+1}$$

Define the semi-elasticity of money demand as $\xi_t \equiv (\partial m_t^d / \partial i_t) / m_t^d = (\partial m_t^d / \partial \pi_{t+1}) / m_t^d$ and evaluate the above expression at the steady state. This gives:

$$\frac{\partial \pi_{t+1}}{\partial \pi_t} = -\frac{1 + (1 + z)\xi}{1 + \pi}$$

It can be easily seen that the system will converge to a finite rate of inflation $\bar{\pi} = z$ if $\xi \in [-(2 + \pi)/(1 + z), \pi/(1 + z)]$. For π and z small, this condition means that the semi-elasticity of money demand should be between -2 and 0 , which is empirically plausible. Moreover, convergence will be stable if $\xi < -1/(1 + z)$.

C Appendix 3: Sunspot Equilibria

In this section, we relax the assumption that the period 1 shock is fully unanticipated. Instead, we shall assume that the distribution of shocks is known ex ante when setting the period 1 price P_1 , and we shall be interested in *all* the equilibria in which this initial price is set to satisfy ex ante PPP. In particular, we shall not restrict attention to the dynamic equilibria in which, ex ante, everyone has the same point expectation about the exchange rate. Multiple equilibria here will correspond to there existing a *non-degenerate* sunspot equilibrium, and an ex ante point expectation about exchange rates

will simply be a possible limit point of the set of sunspot equilibria. The existence of non-degenerate sunspot equilibria provides more rigorous foundations for the idea that our model can generate multiple equilibria. This, together with the existence of a degenerate equilibrium corresponding to the case of a unique “relevant” equilibrium, confirms that the intuitions derived from our simpler formulation are in fact robust. In particular one can immediately notice the similarity between the condition stated in this proposition and the one stated in Proposition 1.

We will prove the following result:

Proposition 2 *Suppose that $f(0) = 0$, that the W curve is downward-sloping, and that: $\frac{m^d(0, i_2)}{m^d(\widehat{y}_2, i_2)} < \frac{(1+i^*)(d_1-d^c)}{y_1-(1+r_0)d^c} < 1$ for some positive value \widehat{y}_2 . Then, there exist at least two sunspot equilibria, one of which is deterministic and the other equilibrium involves a randomization between $y_2 = 0$ and $y_2 = \bar{y}$, where $\bar{y} > \widehat{y}_2 > 0$.*

Suppose, that government policy fixes future interest rates i_t for $t \geq 2$. The W - and $IPLM$ - relationships between E_1 and y_2 can then be re-expressed respectively by:

$$\begin{aligned} W & : y_2 = \chi\left(\frac{E_1}{P_1}\right) \\ IPLM & : E_1 = \frac{K}{L(y_2, i_2)} \end{aligned}$$

where $\chi\left(\frac{E_1}{P_1}\right) = f[(1+\mu)(1-\alpha)\{y_1 - (1+r_0)d^c - (1+i^*)\frac{E_1}{P_1}(d_1-d^c)\}]$ and $K = \frac{1+i^*}{1+i_1}M_2^s$. But unlike in section 2 we also impose the rational expectations restriction:

$$RE : P_1 = E_1^e,$$

where E_1^e is the expected exchange rate as of the beginning of period 1.

We restrict attention to the case where χ is a concave and such that $\chi\left(\frac{K}{L(0, i_2)}\frac{1}{P_1}\right)$ becomes negative for P_1 sufficiently small. Note first that under the above assumptions there exists at least one deterministic sunspot equilibrium $(\widehat{y}_2, \widehat{P}_1)$, namely:

$$\begin{aligned} \widehat{y}_2 & = f[(1+\mu)(1-\alpha)\{y_1 - (1+i^*)d_1\}] \\ \widehat{P}_1 & = \frac{K}{L(\widehat{y}_2, i_2)} \end{aligned}$$

This is indeed a sunspot equilibrium since it also satisfies: $P_1^0 = E_1^e$. But one can also show the existence of other - non-deterministic- sunspot equilibria under suitable additional assumptions. The remaining part of this appendix will be devoted to the formal proof of Proposition 2. Namely, suppose that $f(0) = 0$ and that: $\frac{m^d(0, i_2)}{m^d(\bar{y}_2, i_2)} < \frac{(1+i^*)(d_1-d^c)}{y_1-(1+r_0)d^c} < 1$. Then, there exist at least two sunspot equilibria, one of which is deterministic and the other equilibrium involves a randomization between $y_2 = 0$ and $y_2 = \bar{y}$, where $\bar{y} > \widehat{y}_2 > 0$.

To see this, let \overline{P}_1 be defined by: $\chi(\frac{K}{L(0, i_2)} \frac{1}{\overline{P}_1}) = 0$. (Such a \overline{P}_1 exists since by assumption $\chi(\frac{K}{L(0, i_2)} \frac{1}{P_1})$ becomes negative for P_1 sufficiently small). This, together with the assumption $f(0) = 0$, implies that \overline{P}_1 must satisfy the equation:

$$y_1 - (1 + r_0)d^c - (1 + i^*) \frac{E_1^0}{\overline{P}_1} (d_1 - d^c) = 0.$$

where $E_1^0 = \frac{K}{L(0, i_2)}$. Let: $a = (1 + i^*)(d_1 - d^c)$ and $b = y_1 - (1 + r_0)d^c$. Then, we can rewrite the above equation as:

$$\overline{P}_1 = \frac{a}{b} E_1^0 = \frac{a}{b} \frac{K}{L(0, i_2)}.$$

By construction, $(y_2 = 0, E_1 = E_1^0)$ belongs to the support of a sunspot equilibrium since $y_2 = 0$ is an equilibrium given the ex post exchange rate E_1^0 and the ex ante price \overline{P}_1 . Now, the other point $(y_2 = \bar{y}, E_1 = \overline{E}_1)$ on that support, if there is to be only one such point, must be such that:

$$\begin{aligned} W &: \bar{y} = \chi\left(\frac{\overline{E}_1}{\overline{P}_1}\right) \\ IPLM &: \overline{E}_1 = \frac{K}{L(\bar{y}, i_2)} \\ RE &: \overline{P}_1 = E_1^e = (1 - q)E_1^0 + q\overline{E}_1 \end{aligned}$$

where $0 < q < 1$. Substituting for $\overline{P}_1 = \frac{a}{b} E_1^0$ into the latter equation, we get:

$$q = \frac{1 - \frac{a}{b}}{1 - \frac{\overline{E}_1}{E_1^0}}.$$

Using the fact that $\overline{E}_1 > \widehat{P}_1 = \widehat{E}_1$, a sufficient condition for the inequality $0 < q < 1$ to hold, is: $\frac{\overline{E}_1}{E_1^0} < \frac{a}{b} < 1$, which in turn is equivalent to the condition stated in Proposition 2. This completes our proof.

One short remark to conclude our analysis of sunspot equilibria: whilst the *nominal* interest rate i_0 is obviously affected by having the period one shock being anticipated at the time where the price P_1 is being fixed, on the other hand the *real* interest rate r_0 remains the same as before, with:

$$1 + r_0 = (1 + i^*) \frac{P_0}{P_1} \frac{E_1^e}{E_0} = (1 + i^*) \frac{P_0}{E_0}.$$

Ratio of liabilities to claims with respect to foreign banks in 1997

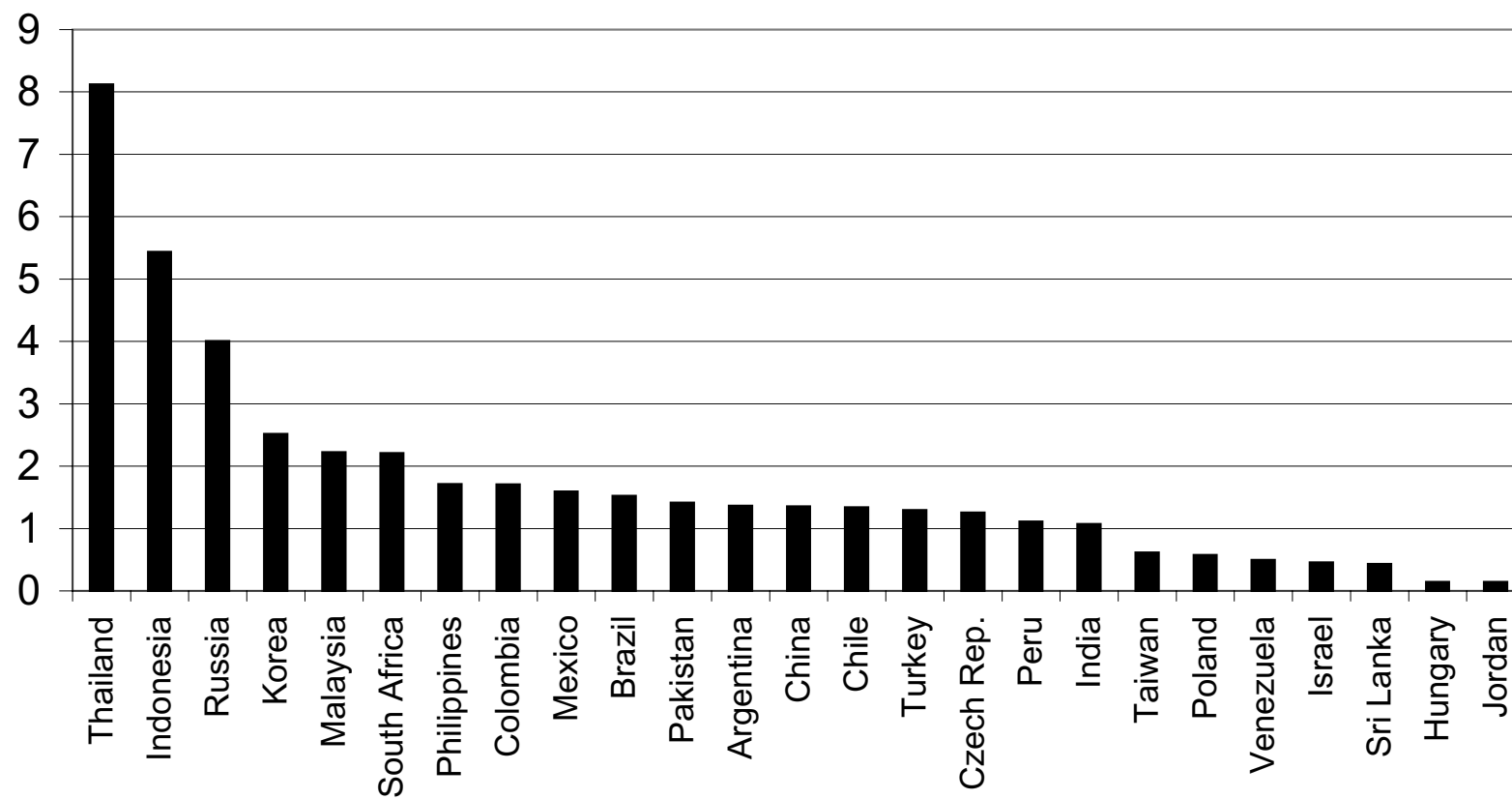


Figure 1

Source: Joint BIS-IMF-OECD-World Bank statistics on external debt.
The ratio is computed as line J divided by line M.

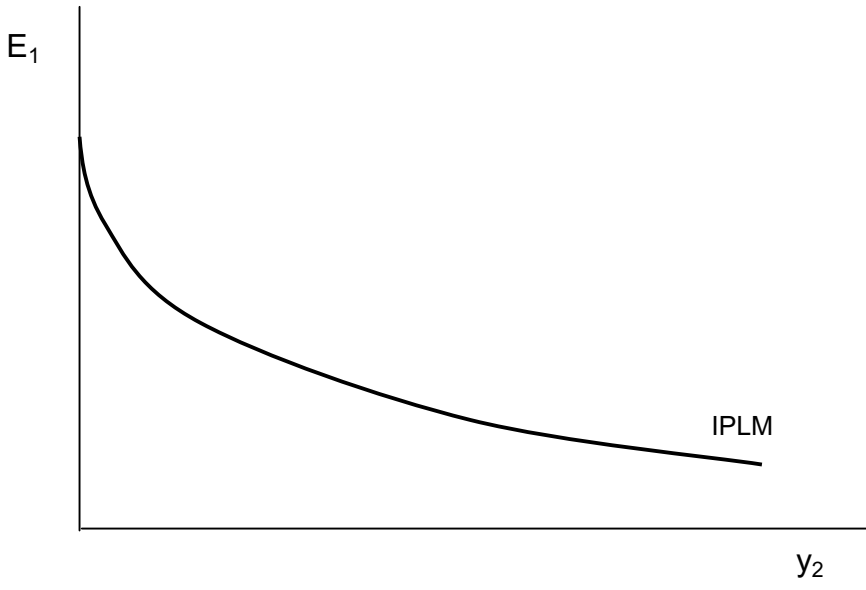


Figure 2

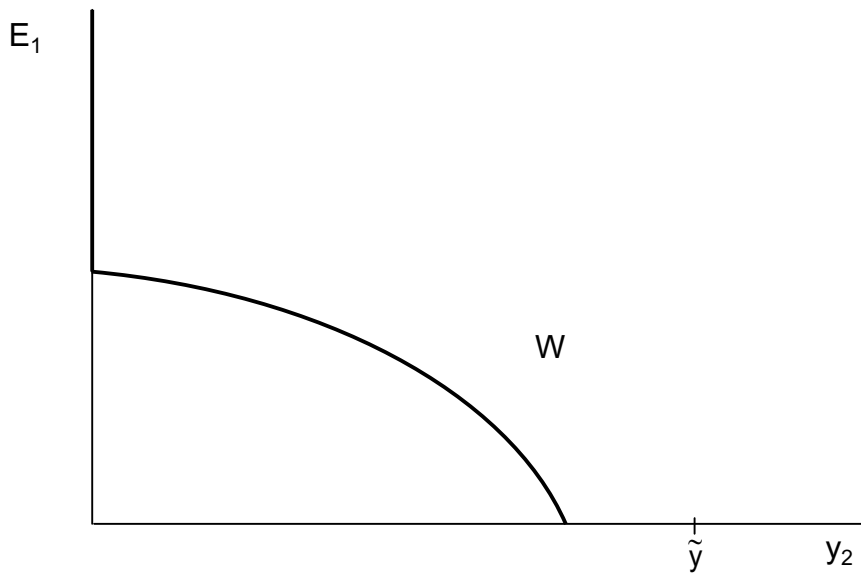


Figure 3

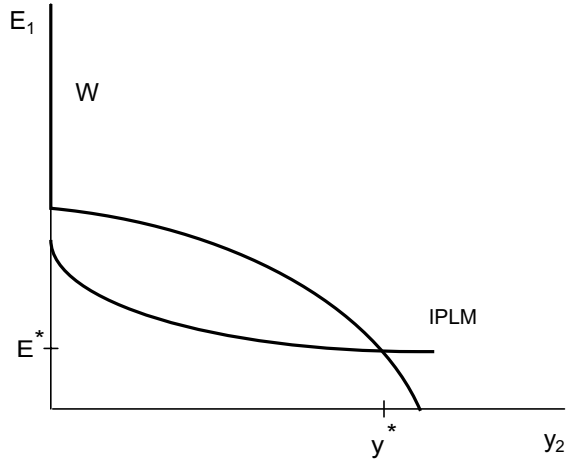


Figure 4a

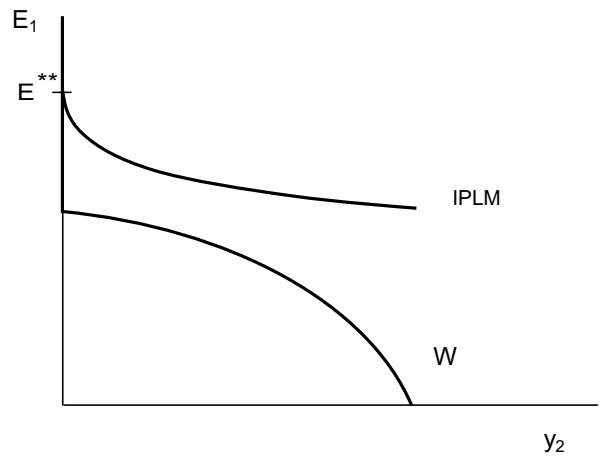


Figure 4b

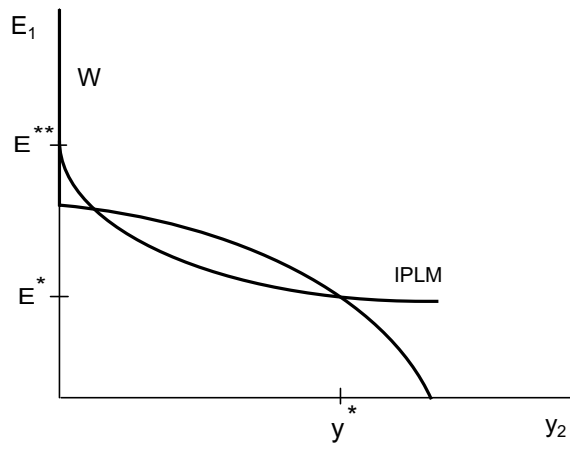


Figure 4c

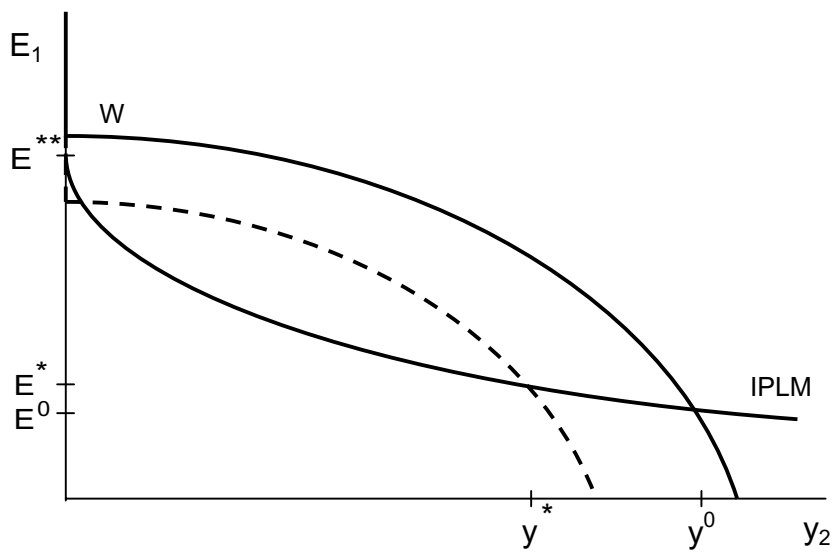


Figure 5

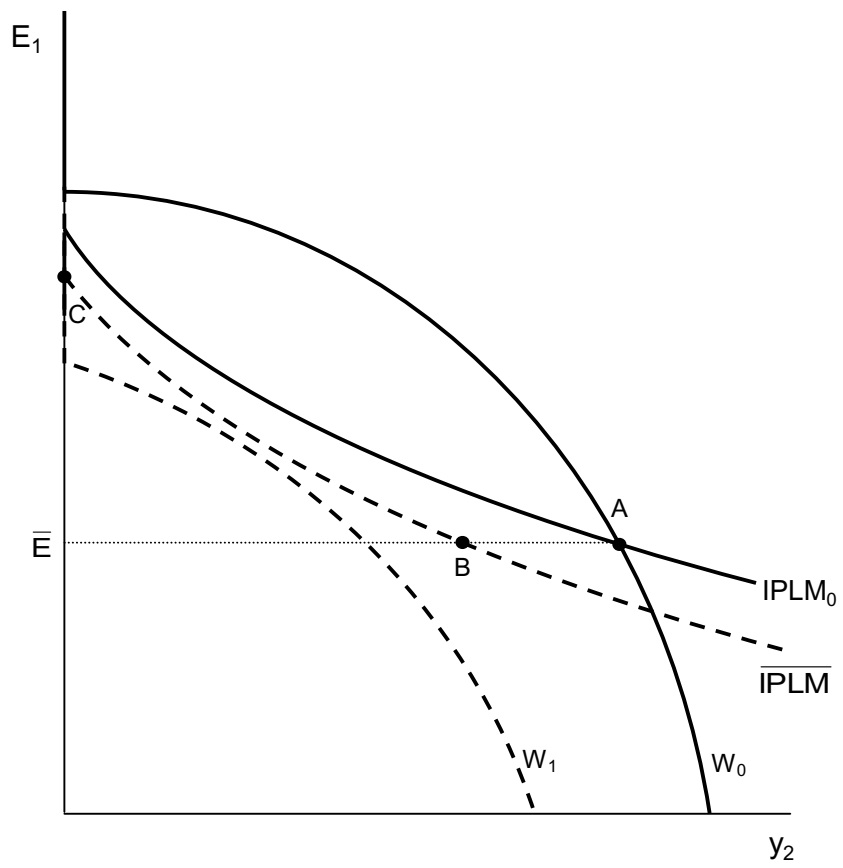


Figure 6

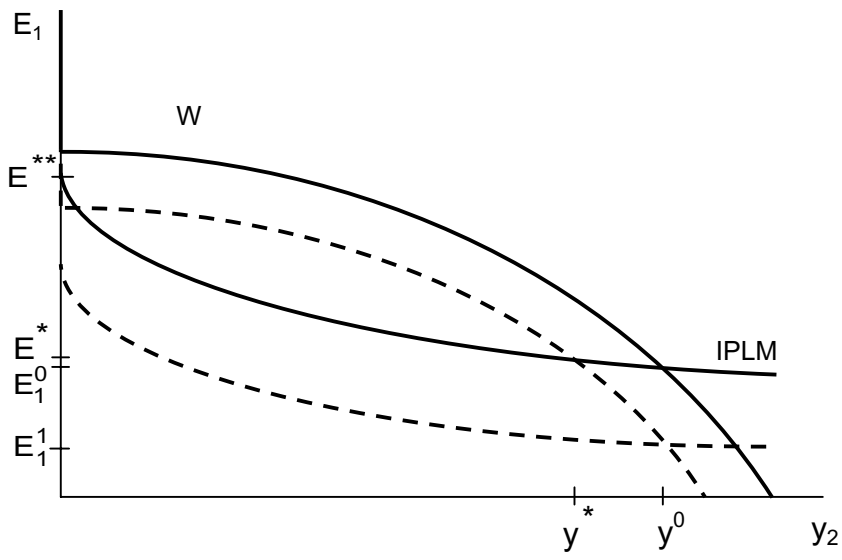


Figure 7

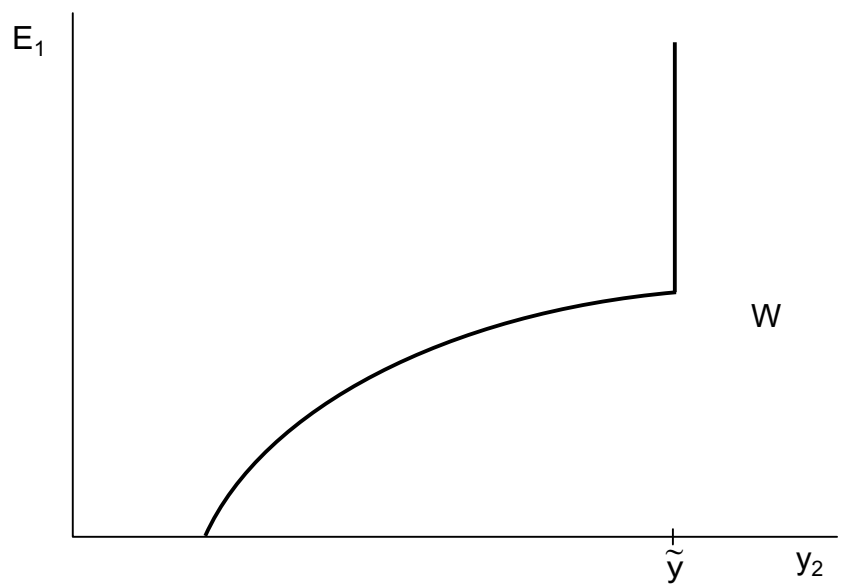


Figure 8

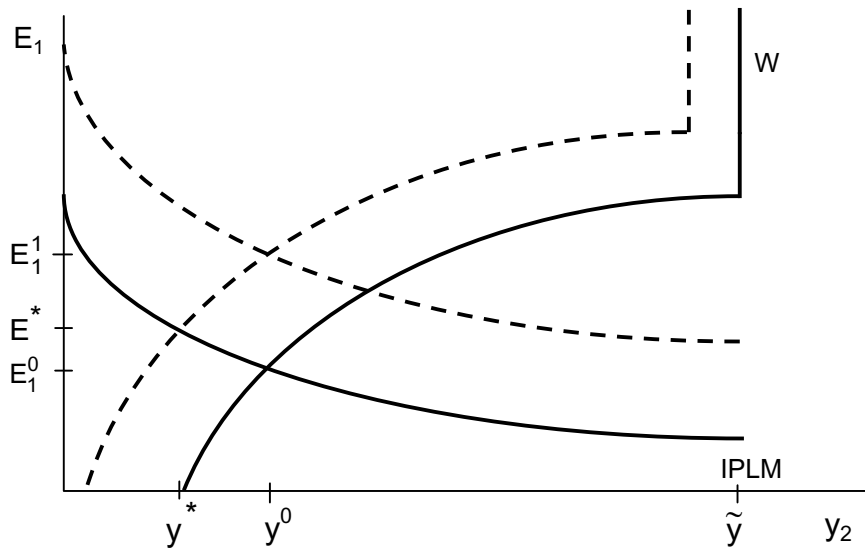


Figure 9a

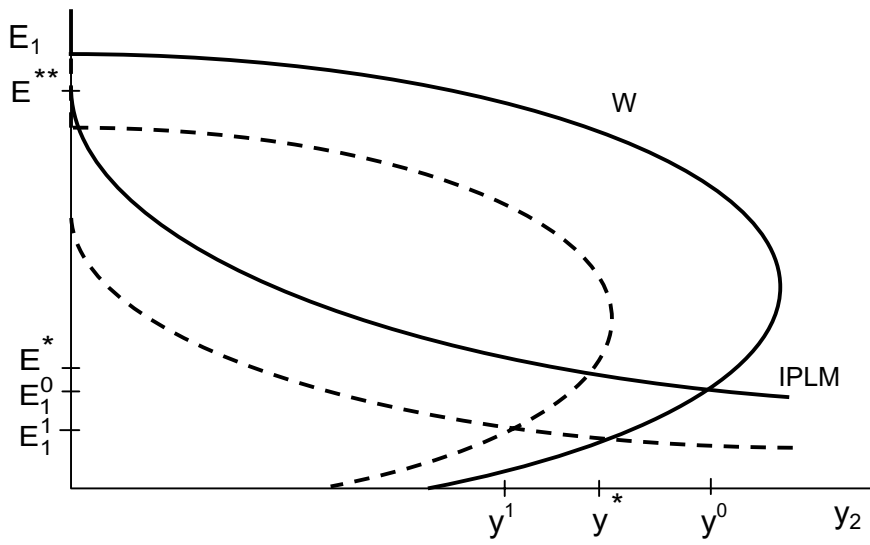


Figure 9b