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Interactions Between
Banking Crises and Currency Crises:
A Theoretical Model

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Abstract

A second-generation model of currency crises is combined with a standard model of banks as providers of insurance against liquidity risk. In a pegged exchange rate regime, after funds have been committed to the banks, news arrives about the quality of the banks' assets and about the exchange rate fundamentals. A run on the banks may cause a currency crisis, or *vice versa*. There are also multiple equilibria (with either twin crises or no crisis), depending on depositors' expectations of other depositors' actions. Suspension of deposit convertibility can prevent a speculative attack from forcing the abandonment of the peg.

Keywords: banks, currency crisis, suspension of convertibility

JEL Nos: F41, G21

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1. Introduction

Recently there has been a great deal of interest in the interaction between banking crises and currency crises. Empirical evidence of a correlation between the two, particularly for emerging markets, is reported by Burkart and Coudert (2002), Kaminsky and Reinhart (1999) and Komulainen and Lukkarila (2003), amongst others. Theoretical work on the subject may be divided into two strands. In one strand, there is assumed to be a currency mismatch associated with foreign loans to (or deposits in) the domestic banking system, whose assets consist of loans to domestic agents (Chang and Velasco, 2000; Takeda, 2001). In the other strand, associated with a series of papers by Miller (1996a, 1998, 2000), the banking system is not assumed to be subject to such a currency mismatch. Our paper belongs to the second strand.

We contribute to the literature in three significant ways. First, we demonstrate that, even in an environment where the fundamentals of the banking and the foreign sector exhibit no correlation, fragility in either sector can cause a panic in the other. Put differently, contagion can spread in both directions. Second, we focus on the role of the domestic depositor in twin crises, and on bank deposits as a source of funds for currency speculation. Finally, we consider the impact of a policy of 'suspension of convertibility' of bank deposits on the outcome in the currency market. Compared with the papers by Miller, our contribution differs in its approach to currency crises (the model is of a second-generation rather than a first-generation type) and in the explicit modeling of the banking contract.

The seminal model of Diamond and Dybvig (1983) shows how banks may be subject to sunspot panics because of the maturity mismatch between their assets and their liabilities. With rational expectations, such sunspot panics can be eliminated by a commitment to suspend convertibility of deposits in the event of a run. In practice, however, bank runs occur, and are usually associated with bad news about the banks' solvency, with less solvent banks experiencing larger runs (e.g. Schumacher, 2000). To allow for this possibility we develop the model of Jacklin and Bhattacharya (1988). Whilst theoretically banks might offer depositors run-proof contracts, such contracts are often dominated by alternatives in which there is some probability of a run induced by bad news (Alonso, 1996).

We combine a second-generation model of currency crises[1] with a standard model of the banking contract. There are three assets available to consumers: bank deposits, domestic currency or foreign currency. The exchange rate between domestic currency and foreign currency is initially pegged, but might be significantly devalued at some future date. *Ex ante*, returns on bank deposits exceed those on domestic or foreign currency. Subsequent bad news in the currency market (such as an adverse terms of trade shock) may cause depositors to seek to withdraw their funds from the bank in order to convert them into foreign currency, even when expected returns to bank deposits exceed those on domestic currency. Alternatively, bad news about banks' solvency may cause an information-based bank run. The likelihood of devaluation is assumed to be decreasing in the quantity of foreign exchange reserves. If banks' assets are liquidated and the funds distributed to depositors, this increases the funds available for currency speculation and may induce a currency crisis that would not otherwise have occurred. For certain values of the parameters there are multiple equilibria, with either twin crises or no crisis.

If the banks are fundamentally sound but the attractions of currency speculation are stimulating deposit withdrawals, then a government may be tempted to sacrifice depositors' rights by the suspension of convertibility. This is the unpleasant trade-off that the government of Argentina faced during the crisis of 2001.[2] On December 2 of that year the government, fearing the reaction of depositors, reluctantly announced measures that restricted deposit withdrawals in a final attempt to protect the peg. In what follows we discuss the circumstances in which a banking authority that is not concerned about the exchange rate may choose to suspend convertibility of deposits.

[1] Our modelling approach to currency crises follows Morris and Shin (1998) and Obstfeld (1996).
[2] For an excellent overview of Argentina's financial crisis see De la Torre, Levy-Yeyati and Schmukler (2002).

2. The Model

The foundation of the model is the modern view of banks as offering consumers insurance against liquidity risk, so that they can exploit the higher returns available on longer-term investments. There are three periods (t=0,1,2) and a continuum of agents whose measure is normalised to one. Each agent is endowed with one unit of the single divisible good that can be stored, invested or consumed. All agents are *ex ante* identical, but each agent faces a privately observed uninsurable risk of being either of type 1 or of type 2. At the beginning of period 1 agents learn their type, which remains private information. Type-1 agents care only about consumption in period 1 and type-2 agents care only about consumption in period 2. Let π and 1-π denote the probabilities of each agent being type 1 and type 2 respectively. These probabilities are public knowledge. Each type's *ex post* preferences are described by a continuous, twice differentiable, concave utility function, $u(c)$.

Endowments can be stored at no cost. Thus in each period the safe asset offers a gross return of one. In addition, there is a risky technology available at t=0 that yields a random gross return $\widetilde{R}$ at t=2 for each unit invested at t=0. Agents have the following prior beliefs about the distribution of $\widetilde{R}$: with probability 1-θ the return is equal to the low value R_L (<1), and with probability θ the return is equal to the high value R_H (>1). The true value of $\widetilde{R}$ only becomes known in period 2. The risky technology is irreversible, in the sense that liquidation in period 1 yields only τ ($0<\tau<1$) units of the good. There are two types of risk involved here: the uncertain return to the risky project at t=2, and the risk to agents of discovering, after committing funds to the risky project in period 0, that they need to consume in period 1 rather than period 2 (which we term the liquidity risk).

2.1. Banks

In the above environment banks play an important role by designing demand deposit contracts that insure depositors against the liquidity risk. The optimal contract {c_1^*, c_{2H}^*, c_{2L}^*) specifies consumption allocations contingent on the time of withdrawal and (for t=2) contingent on the return of the risky technology. Let ρ ($0<\rho<1$) denote the discount factor and I the fraction of resources that the bank invests in the risky technology. The following program solves for the optimal contract:

(1) Maximise $\pi u(c_1) + \rho(1-\pi)(\theta u(c_{2H}) + (1-\theta)u(c_{2L}))$

subject to:

(2) $\pi c_1 = 1 - I$,

(3) $(1-\pi)c_{2H} = R_H I$,

(4) $(1-\pi)c_{2L} = R_L I$, and

(5) $u(c_1) \leq \theta u(c_{2H}) + (1-\theta)u(c_{2L}) \equiv Eu(c_2(\theta))$.

Equations (2), (3) and (4) are the resource constraints. Equation (2) states that the total resources available to satisfy the period-1 demands of type-1 agents can be no more than the amount that the bank has invested in storage (it is possible to liquidate some of the investment in the risky technology early, but it is not optimal to plan to do so). Equations (3) and (4) state that the resources available in period 2 are equal to the return of the risky technology. Inequality (5) is the no-run constraint (i.e. type-2 agents prefer their prospective return from the banking contract in period 2 to that offered to those withdrawing their deposits in period 1). In addition θ has to be sufficiently high that the banking contract is preferable to storage.

2.2. Foreign Exchange Market

The exchange rate (foreign currency units per unit of domestic currency) depends in the absence of government intervention on the state of fundamentals, z, and is denoted $f(z)$. We assume that this function is strictly increasing so that a high state of fundamentals corresponds to a "strong currency". The state of fundamentals is uniformly distributed over the unit interval [0,1]. Instead of allowing the currency to float in this way, the government may peg the exchange rate.

2.3. Government

At the beginning of period 0 the government pegs the exchange rate at e^* ($e^* \geq f(z)$ for all z, so the peg never represents an undervaluation), and maintains the peg through period 1. At the beginning of period 2, however, it re-evaluates its commitment to the peg. Let V (> 0) denote the value that the government derives from pegging the exchange rate. The government also faces costs in defending the exchange rate that depend on both the state of fundamentals and the total demand for foreign currency, X. Let $C(X, z)$ denote this cost function which we assume to be continuous, increasing in X and decreasing in z. Thus the costs of defence depend negatively on the fundamentals and positively on the amount of speculative pressure, as in Morris and Shin (1998). The government only maintains the peg in period 2 if V exceeds $C(X, z)$. If $V < C(X, z)$, the currency is floated.

2.4. Interim Information

When agents learn their types at the beginning of period 1, they also receive a signal, s, about the state of the banking system that leads them to update their posterior beliefs about the return distribution of the risky technology. Let $\theta_s^{'}$ denote their posterior belief about the probability that the above return will be equal to R_H conditional on s. The consistency of posterior beliefs with the priors requires that $\sum prob(s)\theta_s^{'} = \theta$. Following Alonso (1996), although at t=0 the bank could condition the deposit contract on the state of the banking system, such a conditional contract does not necessarily maximise depositors' *ex ante* utility. Consequently we assume that no such conditional contract is offered.

At t=1 all agents also learn the state of fundamentals, which remain unchanged thereafter. The order of events is as follows. Still during period 1, type-2 agents decide whether to try to withdraw their funds from the banking system (imitating type-1 agents), and, if so, whether to convert these funds into foreign currency. Then, at the beginning of period 2, conditional on agents' reactions to the new information about the state of both the banking system and fundamentals, the government decides whether to keep defending the peg.[3]

[3] This ordering of events entails that private agents react to the information before the government. Alternatively we could assume that the fundamentals become known only at the beginning of period 2, after type-2 agents have made their period-1 decisions on the basis of their expectations of the period-2 fundamentals. Then the government chooses (at the beginning of period 2) whether to abandon the peg having observed the true value of the fundamentals. This is the normal way in which multiple equilibria arise in currency crisis models. We adopt our chosen formulation to demonstrate that multiple equilibria can also arise through a different mechanism – uncertainty about the actions of other type-2 depositors. The basic results would still emerge under the alternative assumptions.

3. Bank Panics and Foreign Exchange Market Crisis

We begin the analysis of the model by examining the reaction of depositors to news about the state of the banking system. This first step will determine the potential demand for foreign currency, X, by type-2 agents.

3.1. Information Runs in the Banking System

For the purposes of this section we assume that agents know that the currency peg will be maintained. We relax this assumption in the next section.

When type-2 agents learn the state of the banking system ($\theta_s^{'}$), they update their prior beliefs about the returns of the risky technology. Then their posterior expected utility from the second-period deposit contract allocation is equal to $\theta_s^{'}u(c_{2H}^{*}) + (1-\theta_s^{'})u(c_{2L}^{*}) \equiv Eu(c_2^{*}(\theta_s^{'}))$. For sufficiently low values of $\theta_s^{'}$ the deposit contact will cease to be incentive compatible (i.e. type-2 agents will run to the bank to extract funds in period 1, like type-1 depositors; we term this situation an information-based run). Let θ^{*} be such that $u(c_1) = Eu(c_2^{*}(\theta^{*}))$; then if $\theta_s^{'}=\theta^{*}$ the posterior beliefs are such that type-2 depositors will be indifferent between withdrawing their deposits from the bank in period 1 and leaving them there until period 2. Then it follows that

<u>*Proposition* 1</u>: If $\theta_s^{'}<\theta^{*}$, then an information run will take place and the bank will liquidate the two technologies. The total amount distributed to depositors will be equal to $D \equiv \pi c_1^{*} + \tau(1-\pi c_1^{*})$ units of consumption.

<u>Proof</u>: At t=0, the bank's total investment in the risky technology, I, was equal to 1-πc_1^{*}. Multiplying this amount by τ yields the liquidation value of the risky technology. Adding to this product the amount that the bank has kept in storage in order to satisfy its contractual obligation to type 1 agents, $\pi_1 c_1^{*}$, yields the total amount of funds that at t=1 the bank has available for distribution when an information run takes place. If the inequality in the statement of the proposition holds,

then type-2 agents prefer to attempt to withdraw c_1^* in period 1 and to store the liquidation allocation for one period (all depositors receive the type-1 allocation since types are private information) rather than wait for the period-2 allocation specified in their contract. Notice that not all depositors can be successful in this. Because $\tau < 1$, there are insufficient resources to satisfy the demands of all depositors in period 1, even if the risky technology is liquidated. The proportion of depositors receiving c_1^* is equal to D/c_1^*.

In essence, θ^* represents the minimum value of θ for which the banking system is stable in the absence of currency speculation. Although some depositors do not receive anything in the event of an information run, and would therefore have been better off *ex post* had *no* type-2 depositors tried to withdraw their funds in period 1, it is a dominant strategy for each individual type-2 depositor to attempt to withdraw in period 1 when $\theta_s^{'}$ is sufficiently low, whatever the other type-2 depositors decide to do.

Next, we turn our attention to the foreign exchange market.

3.2. Speculation and Crisis in the Foreign Exchange Market

When the state of fundamentals is revealed, type-2 agents have three options whose payoffs depend on the state of the banking system, their expectations about the actions of other depositors and their calculations of the future exchange rate. The first option is not to withdraw their deposits, in which case their expected consumption allocation at t=2 will be equal to $Eu(c_2^*(\theta_s^{'}))$. Their second option is to withdraw their deposits in period 1 but simply to store the resulting funds until period 2. (Remember that only a proportion D/c_1^* of type 2 depositors will receive c_1^* when there is a run). The third option is to withdraw their deposits in period 1 and immediately to convert any funds available into foreign currency at the pegged rate e^*, planning to convert them back into domestic currency in period 2 at the rate $e^*/f(z)$.

Next, we derive the total demand for foreign currency, X. Obviously X=0 if type-2 agents choose the first or second option, i.e. they decide not to attack the currency. If they choose the third option and attack the currency then $X=(1-\pi)D$ (total deposits withdrawn in period 1 multiplied by the proportion of type-2 individuals, since type-1 individuals simply consume their allocation in period 1).

The equilibrium of the model depends on (a) the state of the banking system ($\theta_s^{'}$), (b) the state of fundamentals (z), and (c) the beliefs that type-2 agents have about the actions of other depositors and the government's utility function. For simplicity we assume that the government's utility function is known to all agents. This implies that type-2 depositors know exactly what the returns to foreign exchange speculation will be, conditional on the weight of speculation. The weight of speculation will depend on the actions of other type-2 depositors.

In general type-2 agents will choose the first option (no withdrawals) if the expected returns on the banking contract are superior to the returns on domestic or foreign currency . A necessary *but not sufficient* condition for this is that $\theta_s^{'} > \theta^{*}$, as we shall see below. Agents will choose the second option (withdraw and hold cash) only if there is bad news about the banking system and good news about the exchange rate. They will choose the third (withdraw and speculate) if the news about the exchange rate is sufficiently bad relative to the news about the banking system. Multiple equilibria can arise, however, because the individual agent is uncertain what the others will do. For some values of z, the decision whether to abandon the peg depends on the weight of speculation, in which case the peg will be abandoned if all type-2 agents withdraw and speculate, but not if they do not.

We make the following assumptions about the extreme values of z:[4]

1) $C(0, 0)>V$; in the worst state of fundamentals even if type-2 depositors do not attack the currency the government's payoff from defending the peg is negative. This means that the peg can be abandoned even if all type-2 deposits remain in the bank. Denote by $\underline{z}$ the value of z that solves $C(0, z)=V$. The peg is abandoned whenever $z \leq \underline{z}$.

[4] With other assumptions, some of the possible solutions to the model described below would be an empty set.

2) $C((1-\pi)D, 1)<V$; in the best state of fundamentals the peg is maintained even under the maximum amount of speculative pressure. Denote by $\bar{z}$ the value of z that solves $C((1-\pi)D, z)=V$. The peg is maintained for all $z \geq \bar{z}$.

3) $u(c_{2H}^*)<u\left(c_1^* \frac{e}{f(0)}\right)$; in the worst state of fundamentals type-2 depositors always withdraw their deposits and attack the currency, no matter how good the signal about the banking system is. Denote by z^* the value of z that solves $u(c_{2H}^*)=u\left(c_1^* \frac{e}{f(z^*)}\right)$;

The last restriction in conjunction with the definition of θ^* implies that for each element in $[z^*, 1]$ there exists an element $\theta(z)$ in $[\theta^*,1]$ such that $Eu(c_2^*(\theta(z))=u\left(c_1^* \frac{e}{f(z)}\right)$; where $\frac{d\theta(z)}{dz}<0$. In words, as long as the expected returns to the banking contract are sufficiently high ($>\theta^*$) and the fundamentals (z) not too weak, for each signal about the banking system there exists a state of fundamentals such that type-2 depositors would be indifferent between attacking the currency and waiting for their deposits to mature, conditional on the peg being abandoned.

It is convenient to discuss separately the situations where there is always a run on the bank, whatever the value of z ($\theta_s^{'}<\theta^*$), and where this is not the case ($\theta_s^{'}>\theta^*$). We begin with the former.

3.2.1. Low Expected Returns to the Bank Contract

The following table shows the payoffs of type-2 agents conditional on their actions and the state of fundamentals when $\theta_s^{'}<\theta^*$. Essentially, since there is always a run on the bank in this case, the expected returns to the bank contract have no bearing on the exchange rate outcome. As shown graphically in the lower halves of Figures 1 and 2,

(a) if $z<\bar{z}$, the government abandons the peg, whereas

(b) if $z>\bar{z}$, the government maintains the peg.

PEG:	DO NOT ATTACK	ATTACK
DEFENDED	$u(c_1^*)$	$u(c_1^*)$
ABANDONED	$u(c_1^*)$	$u\left(c_1^* \frac{e}{f(z)}\right)$

3.2.2. High Expected Returns to the Bank Contract

The following table shows the payoffs of type-2 agents conditional on their actions and the state of fundamentals assuming that $\theta_s^{'} > \theta^*$. This case is more complex for two reasons. One is that the expected returns to the banking contract, although positive, may still be less than the returns to holding foreign currency. The other is the possibility of multiple equilibria arising from uncertainty about whether other type-2 depositors will withdraw their deposits and attack the currency, forcing the abandonment of the peg, or not.

PEG	DO NOT ATTACK	ATTACK
DEFENDED	$Eu(c_2^*(\theta_s^{'}))$	$u(c_1^*)$
ABANDONED	$Eu(c_2^*(\theta_s^{'}))$	$u\left(c_1^* \frac{e}{f(z)}\right)$

We need to consider two cases that depend on the exact values of z^* and $\underline{z}$. The following proposition describes all possible equilibria that are also shown graphically in the upper halves of Figures 1 and 2.

<u>Case 1</u>: $\underline{z} < z^*$

(a) if $z < \underline{z}$ the government abandons the peg with certainty and type-2 depositors attack the currency with a bank run as the consequence of their decision;

(b) if $\underline{z}<z<z^*$ there are two self-fulfilling equilibria depending on depositors' expectations on other depositors' actions; either type-2 depositors withdraw their deposits and attack the currency and the peg is abandoned as a consequence or the type-2 deposits remain in the bank and the peg is maintained as a consequence;

(c) if $z^*<z<\bar{z}$ there are two sub-cases:

(i) $\theta_s^{'}<\theta(z)$: as in case (b) above there are multiple equilibria,

(ii) $\theta_s^{'}>\theta(z)$: type-2 deposits remain in the bank and the peg is maintained as a consequence;

(d) if $z>\bar{z}$ the government defends the peg with certainty and type-2 deposits remain in the bank.

<u>Case 2</u>: $\underline{z}>z^*$

(a) if $z<z^*$, the government abandons the peg with certainty and type-2 depositors attack the currency with a bank run as a consequence of their decision;

(b) if $z^*<z<\underline{z}$ the government abandons the peg with certainty and type-2 depositors either

(i) attack the currency if $\theta_s^{'}<\theta(z)$ with a bank run as a consequence of their decision, or

(ii) do not attack the currency if $\theta_s^{'}>\theta(z)$ and type-2 depositors remain in the bank;

(c) if $\underline{z}<z<\bar{z}$ there are again two sub-cases:

(i) $\theta_s^{'}<\theta(z)$: there are multiple equilibria depending on depositors' expectations on other depositors' actions;

(ii) $\theta_s^{'}>\theta(z)$: type-2 deposits remain in the bank and as a consequence the peg is maintained, and

(d) if $z>\bar{z}$ the government defends the peg with certainty and type-2 depositors do not attack the currency and the government defends the peg.

These results are best explained by considering different values of z in Figures 1 and 2. If $z < \underline{z}$, the exchange rate always floats, even if speculative pressure is at its minimum. At the other extreme, if $z > \bar{z}$, the peg is always maintained, even if speculative pressure is at its maximum. If z is in the intermediate region, then the outcome depends on the weight of speculative pressure, which in turn depends on the expected returns to the banking contract. If $\theta_s^{'} < \theta^*$, then there is always a run, which causes the exchange rate to float whenever $z < \bar{z}$. If, on the other hand, $\theta_s^{'}$ is sufficiently high (and $z > z^*$), there is no run, and (provided that $z > \underline{z}$) insufficient speculative pressure to cause the peg to be abandoned (as in Figure 1). If $\theta_s^{'}$ is somewhat lower than this and $z > z^*$, or for any high value of $\theta_s^{'}$ if $z < z^*$ (in both cases assuming that $z > \underline{z}$ and $\theta_s^{'} > \theta^*$), then type-2 depositors' returns are maximised if they run, causing abandonment of the peg. If, however, not all of them run, the weight of speculative pressure may not be sufficient to cause the peg to be abandoned, in which case their returns are less than if they had kept their deposits in the bank. Thus in this case the optimum strategy for an individual type-2 depositor depends on her expectations of other depositors' actions.

The model shows that the stability of the banking system does not just depend on $\theta_s^{'}$, and likewise that the maintenance of the exchange rate peg does not just depend on z. For certain values of z, expected returns to the banking contract may be high enough to keep agents invested in illiquid assets, thus reducing speculative pressure to a level where the peg will be maintained, whereas it would have been abandoned had there been a run on the bank. Expressed in reverse form, a banking crisis may cause a currency crisis that would not otherwise have occurred (this is true for z slightly less than $\bar{z}$, and $\theta_s^{'} < \theta^*$, since with minimum speculative pressure the peg would be maintained right down to $z = \underline{z}$). Conversely, the attractions of currency speculation may be such as to induce a run on the bank even though the expected returns on the bank contract are superior to those on domestic currency (as in the upper left corner of Figures 1 and 2). In these cases, a currency crisis may cause a banking crisis. Indeed, in the ME region of Figures 1 and 2, both of these phenomena occur. *Either* there is no currency crisis and no banking crisis, *or* there is both, even though the banking contract yields positive expected returns.

4. Suspension of Convertibility

One option, in the event of a bank run, is to suspend the convertibility of bank deposits into cash, once bank reserves are exhausted (Diamond and Dybvig, 1983; Engineer, 1989; Gorton, 1985). In the absence of exchange rate considerations, suspension may be attractive because, when deciding to participate in a run, type-2 depositors ignore the liquidation costs, each hoping to arrive at the bank before resources are exhausted and therefore not to suffer any of these costs. In other words, the returns to the banking contract may be higher than the liquidation value, but insufficiently high to stop type-2 depositors from running. In that case suspension of convertibility would be socially optimal (and would raise the utility of type-2 depositors as a whole) *if* it could be guaranteed that the depositors who did succeed in withdrawing money in period 1 were all of type 1. Unfortunately that is not possible, because individual types cannot be identified by the bank, so suspension traps the funds of some type-1 individuals until period 2, reducing their utility to zero. This loss has to be set against the gains to type-2 individuals from ensuring that the long-term technology is not liquidated.

As Miller (1996a) has pointed out, however, where bank deposits are used to finance currency speculation, suspension of convertibility may make the difference between an exchange rate peg surviving a speculative attack and not surviving it, by reducing the weight of speculative funds behind the attack. In this section, we analyse this possibility in the context of our model. We assume that depositors arrive at the bank to withdraw funds in a random order. Therefore, if all depositors attempt to withdraw in period 1, and an amount W is paid out, πW will be paid out to type-1 depositors to finance immediate consumption and $(1-\pi)W$ to type-2 depositors. Provided that $W < D$ (the total liquidation value of the bank), suspension reduces speculative pressure in the event of a run (from $(1-\pi)D$ to $(1-\pi)W$).

Denote by $\bar{z}_{susp}$ the value of z such that $C((1-\pi)W, z)=V$. It is clear that $\bar{z}_{susp} < \bar{z}$. Then we have the following result: suspension of convertibility increases the range of fundamentals where the government successfully defends the peg. In addition when the expected returns to the banking system are high, suspension of convertibility reduces the range of fundamentals where the currency is unstable (multiple equilibria). The proposition follows from the arguments previously presented in relation to Figures 1 and 2. In the case of suspension the vertical line that previously intersected the horizontal axis at $\bar{z}$ shifts to the left.

Suppose now that there is a banking authority that is charged with maximising the welfare of bank depositors, ignoring any gains which type-2 depositors may make in the currency market. That is to say, the banking authority is concerned only with the utility value of the depositors on the assumption that (if they are type-2 depositors) they store what they receive from the bank in period 1 until period 2. In a standard bank contract model, runs would not occur (ruling out sunspot panics) if $\theta_s^i > \theta^*$, and would occur with certainty if $\theta_s^i < \theta^*$, in which case suspension is a policy option. The banking authority would then have to consider whether the potential gains to type-2 depositors from suspension (which arise so long as the banking contract yields higher expected returns in period 2 than its liquidation value) outweigh the utility losses of type-1 depositors whose funds are trapped in the bank, and who are therefore unable to consume in period 1. Without specifying the precise weights attached to the utilities of the two types of depositors, without loss of generality we can denote the value of θ at which the authority is just indifferent between suspension and non-suspension in these circumstances as θ^{**}. Then the banking authority will suspend in all cases where there is a run and $\theta > \theta^{**}$. If $\theta^{**} > \theta^*$, suspension will never happen in the standard model as there is no reason for any depositor to run.

Now consider the banking authority's problem in the model developed in this paper. Bank runs do not occur only at low values of θ_s^i. They can take place even at very high values of θ_s^i, provided that z is sufficiently low. As in the standard model, the authority will suspend payments whenever $\theta > \theta^{**}$. Figure 3 depicts the possible solutions for the case where $\underline{z} < z^*$ (as in Figure 1). As drawn, Figure 3 assumes that $\theta^{**} < \theta^*$. The outcomes may be listed as follows:

Case 1: If $\theta < \theta^{**}$, there is never any suspension, so nothing is changed.

Case 2: If $\theta > \theta^{**}$, then there are various sub-cases:

(a) if $z < \underline{z}$, convertibility is suspended but the currency still floats;

(b) if $\underline{z} < z < z^*$, convertibility is suspended provided that at least one type-2 depositor runs; whether the currency floats or pegs depends on how many (if any) type-2 depositors withdraw their funds in period 1 before convertibility is suspended;

(c) if $z^* < z < \bar{z}_{susp}$, convertibility is suspended provided that at least one type-2 depositor runs; whether the currency floats or pegs depends on how many (if any) type-2 depositors withdraw their funds in period 1 before convertibility is suspended; in the same cases of very high θ as in Figure 1, type-2 depositors prefer not to run and the peg is maintained;

(d) if $\bar{z}_{susp} < z < \bar{z}$, the peg is maintained with certainty but convertibility is suspended if at least one type-2 depositor runs; in the same cases of very high θ as in Figure 1, no type-2 depositors run because they anticipate that the demand for foreign currency will not be sufficiently high (given that the banking authority will suspend convertibility) for the government to abandon the peg;

(e) if $z > \bar{z}$, there is never a run and the peg is maintained with certainty.

In cases 2(b) and 2(c), there are still effectively multiple equilibria. In these cases, if a proportion k of type-2 depositors participates in a run, and suspension takes place as soon as it is clear that at least one type-2 depositor is running (with (1- k) of type-2 depositors staying behind to reap the higher payoff in period 2) then the fraction of funds available for speculation is $k(1-\pi)\pi c_1/[\pi + k(1-\pi)]$, assuming that everyone who attempts to do so has an equal chance of successfully withdrawing before suspension. Given k, the lower the value of z, the more likely that the currency will float. When θ and z are relatively high, so that we are close to the boundary of the (P, N) region in Figure 3, then there is more risk in running, because the gains from running (conditional on the peg being abandoned) are relatively small compared to the potential losses (conditional on it being maintained). The probability that a run is large enough to precipitate abandonment of the peg thus has to be viewed as high for running to seem attractive. The opposite situation obtains when θ and z are low (close to the boundary of the (F, R) or (F, S) region). Consequently it seems likely that k will be a decreasing function of both θ and z, and that the probability of the peg being abandoned will be also.

We have assumed that the banking authority is not concerned with the exchange rate. Nevertheless case 2(d) shows that for a certain range of z values the suspension of convertibility of bank deposits will be sufficient to maintain a peg that would otherwise have been abandoned.

5. Conclusions

If bank deposits are potentially available for currency speculation, then there is an interaction between the stability of the banking system and that of a currency peg. Bad news about the banking system, causing a run, may provide the liquidity necessary for a successful speculative attack on the currency. Alternatively, high expected returns from currency speculation may destabilise an otherwise sound banking system. Miller (1996b) interprets the experience of the United States in the early 1890s in this vein. Another example would be the final weeks of Argentina's currency board. Uncertainty about whether other bank depositors are going to withdraw and participate in a speculative attack means that there is a region of multiple equilibria, in which there are either no crises (nobody runs because they do not expect others to do so, and therefore they expect the peg to hold) or twin crises (everybody runs because they expect others to do so, forcing the exchange rate to float).

Suspension of convertibility of bank deposits can rescue a sound banking system threatened by the temptations of currency speculation. If the fundamentals are sufficiently bad, suspension will not prevent the currency from floating. If the fundamentals are sufficiently good, suspension can ensure the successful defence of the peg. In the intermediate range of the fundamentals, the outcome depends on agents' expectations of other depositors' actions, even in the case of suspension, because the weight of currency speculation depends on type-2 depositors' share of the funds withdrawn from banks in period 1, which in turn depends on the proportion of them participating in the run.

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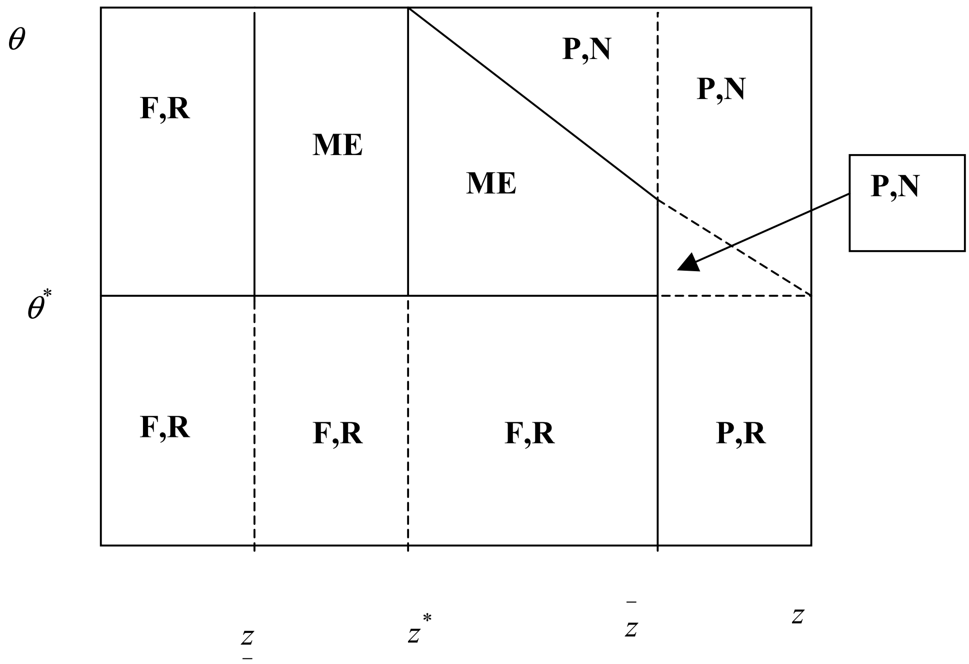
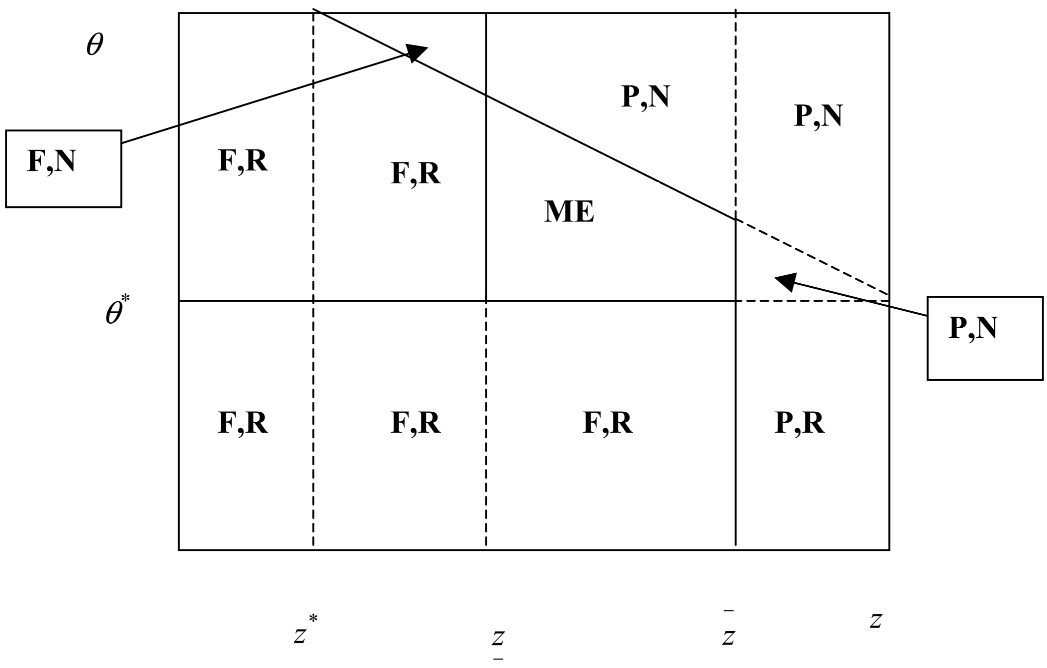
<u>Figure 1</u>: Equilibria for the case $\underline{z} < z^*$



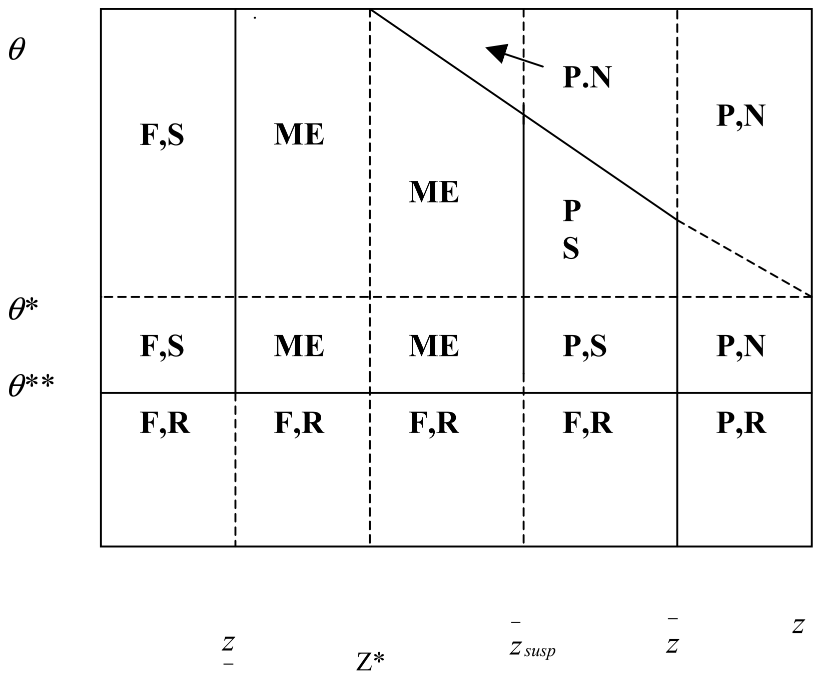
Notes: F (float): the government abandons the peg, P (peg): the government defends the peg, R: bank run, N: no bank run, ME: multiple equilibria; in the area above the diagonal $\theta_s^{'} > \theta(z)$.

<u>Figure 2</u>: Equilibria for the case $\underline{z} > z^*$



Notes: F (float): the government abandons the peg, P (peg): the government defends the peg, R: bank run, N: no bank run, ME: multiple equilibria; in the area above the diagonal $\theta_s^{'} > \theta(z)$.

Figure 3: Equilibria with suspension of convertibility for the case $\underline{z} < z^* < \bar{z}_{susp}$



Notes: F (float): the government abandons the peg; P (peg): the government defends the peg; R: bank run with no suspension; N: no bank run; S: bank run with suspension; ME: multiple equilibria; in the area above the diagonal $\theta_s' > \theta(z)$.