Can foreign currency deposits prop up a collapsing exchange-rate regime?

Paul Mizen *

Department of Economics, University of Nottingham, University Park, Nottingham, NG7 2RD, UK
Bank of England, UK
CEPR, UK

Accepted 1 July 1998

Abstract

The Flood and Garber [Flood, R.P., Garber, P.M., 1984. Collapsing exchange-rate regimes: some linear examples. Journal of International Economics 17, 1–13] speculative attack model is extended to consider whether the authorities could forestall an exchange rate collapse by encouraging foreign currency holdings by domestic residents. Deposits of foreign currency could be held at home or abroad, although domestic residents have a home country preference other things equal. The paper considers the consequences of a required reserves policy on domestically located deposits, which the authorities use to supplement official reserves to defend the exchange rate. Despite initial findings that suggest the life of the regime can be lengthened in this way the paper shows that such a policy does not postpone a collapse but actually hastens it. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Speculative attack; Currency substitution; Currency crisis

1. Introduction

The Mexican crisis threw up some important new issues concerning speculative attack models that had not been dealt with in the original papers by Krugman (1979) and Flood and Garber (1984) or extensions by Willman (1988) and Agenor
et al. (1992), Garber and Svensson (1996). In Mexico, sterilization of foreign exchange intervention was an important feature, yet existing models neither recognized it nor acknowledged the active role of the government in its implementation. Another linear example by Flood et al. (1996) in a non-monetary model was required to extend the analysis of the original models to account for sterilization. That paper generalized the model of speculative attacks to deal with the case in which assets were treated as imperfect substitutes and the government could offset the effects of the fixed exchange rate policy on the domestic economy through sterilization. This was the first step towards exploring the active role of government in speculative attack models.

This paper continues along the same lines, specifying an active role for the government by allowing it to have influence over domestic residents’ decisions to hold domestic or foreign currency deposits. The paper acknowledges both the existence of domestically owned and located foreign currency deposits and the role of the government in managing them through the central bank. Introducing foreign assets into the choice set available to domestic residents, we consider whether the collapse of a fixed exchange-rate regime can be postponed by encouraging domestic residents to hold their foreign currency denominated assets in domestic, as opposed to foreign, financial institutions. Although a number of countries have introduced policies to encourage the repatriation of foreign currency deposits coupled with a required reserve policy to alleviate short-term monetary and exchange rate pressures, surprisingly, the role of foreign currency deposits on such crises has not been analyzed in previous work.

The government is given the option of encouraging domestic residents to hold foreign currency deposits in the domestic banking system where it is able to introduce a central bank policy of required reserves. The paper determines the optimal responses of domestic residents with respect to the portfolio allocation and location of currency and the optimal policy in the light of the required reserve ratio. The results show that although the initial analysis, based the central bank’s asset and liability position, appears to show that such a policy is supportive of the external position of the central bank, its impact on the timing of the collapse is in fact detrimental.

The structure of the paper is as follows. Section 2 introduces the foreign sector and Section 3 considers the implications of domestic foreign currency deposits for the timing of the collapse. Section 4 concludes.

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1 To indicate the popularity of this policy the developing countries which have allowed foreign currency deposits in the domestic banking system include Argentina, Bolivia, Mexico, Peru and Uruguay in Latin America; Albania, Bulgaria, Croatia, the Czech republic, Hungary, Poland and Romania in Eastern Europe; and Estonia, Latvia, Lithuania, Russia, and the Ukraine in the former Soviet Union (see Calvo and Vegh, 1992; Mizen, 1996; Mizen et al., 1996; Savastano, 1992; Savastano, 1996; Sahay and Vegh, 1996 for further details).
2. Introducing the foreign sector

The context in which speculative attacks were first put forward was the model by Flood and Garber (1984), which utilizes the monetary model of the exchange rate, represented as follows:

\[ M_t = \beta S_t - \alpha S_t, \]  

(1)

where \( S_t \) is the nominal exchange rate and \( M_t \) is the money supply. Through the central bank accounting identity the money supply, comprising domestic credit, \( D_t \), and reserves, \( R_t \), can be written as:

\[ M_t = D_t + R_t. \]  

(2)

The model can be used to show how the exchange rate, reserves and money stock adjust under a speculative attack. By assuming perfect foresight and a fixed exchange rate the result follows that reserves decline at the same fixed rate as domestic credit expands. The fixed exchange rate regime can only be sustained if reserves are used to support it, but the finite reserves are depleted at a constant rate each period, equal to the rate of domestic credit expansion, \( \mu \). If the initial level of the central bank’s reserves is known, it is possible for speculators to determine how long the exchange rate can be sustained at its fixed rate before reserves run out. When reserves reach zero the exchange rate will be forced to float at a level consistent with the fundamentals and will jump to its new floating value. However, since we assume that speculators arbitrage away any profitable opportunities arising from an exchange rate jump, the collapse of the regime comes before this point when the shadow exchange rate is equal to the fixed rate.

Evaluating the shadow exchange rate using (1) and equating the exchange rate with the official rate speculators can work out the time of collapse, \( t_c = [(\beta S - D_t)/\mu] - (\alpha/\beta) \), which can also be written as a function of the initial level of reserves. The collapse of the fixed exchange rate will be postponed if the central bank can supplement its stock of initial reserves and it will be brought forward if it increases the growth of domestic credit, \( \mu \).

An observation that can be made about the original model of speculative attacks is that it does not include foreign assets held by domestic residents. The holding of foreign currency deposits by domestic residents in domestic banks is a commonplace feature in the economies to which the speculative attack literature is relevant, however. Domestic residents do make choices between foreign currency and domestic currency and they also make decisions on location. If domestic residents exchange domestic for foreign currency holdings and deposit them abroad, it is likely to increase the vulnerability of the exchange rate regime.

Nevertheless, if domestic residents decide to hold foreign currency the government may be able to improve its external position by creating incentives to ensure that deposits remain in domestic financial institutions. So long as the foreign currency is held at home the central bank could implement a policy of required
reserves which would divert some foreign currency back to the central bank to bolster the official reserves used to defend the fixed exchange rate. We consider how the speculative attack model would need to be extended to allow for the existence of foreign currency deposits held by domestic residents and central bank policy of reserve requirements.

First of all, we consider the decisions of domestic residents. It is assumed that inflation, associated with the expansion of domestic credit, and the possibility of exchange rate collapse gives domestic residents an incentive to hold foreign currency in order to store wealth, but restrictions in the domestic economy require that some domestic money is held to conduct certain domestic transactions. We assume that a liquidity decision determining the proportion of wealth to be held in the form of money (as opposed to bonds) has already been made, and that the domestic resident faces a lower order decision to decide the proportions of liquid balances to be held in domestic currency and foreign currency. At the point of a regime collapse the domestic resident would wish to be holding foreign currency since they would avoid a reduction to real wealth, which a depreciation entails.

Once we allow for the possibility that domestic residents can also exercise their choice over location of foreign currency deposits, the date of collapse of the regime could be brought forward through domestic residents’ efforts to relocate their wealth into foreign currency deposits abroad. Whilst the central bank may recognize the detrimental effects of relocation of deposits abroad and can take emergency measures to make foreign currency deposits illegal this has rarely prevented residents from finding ways to move money abroad through parallel markets (see Agenor et al., 1992). It is far more desirable, and realistic, that the central bank should recognize the influence that reserve requirements have on the portfolio allocation and location decisions of domestic residents and adjust them accordingly. Thus we allow for interaction between central bank required reserve policy and domestic portfolio decisions.

If domestic residents choose to hold foreign currency deposits domestically (DFCDs) this will not diminish the purchase of foreign currency, or avoid the pressure on the fixed exchange rate which arises from it, but the central bank will be able, if it imposes required reserves, to use the DFCDs to supplement its own foreign currency reserves and defend the exchange rate. By this mechanism DFCDs could be stabilizing in the event of a speculative attack, since they enable the authorities to defend the exchange rate for longer and put off the day of collapse.

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2 We assume that currency substitution is asymmetric and that domestic residents hold foreign currency but foreign residents do not hold domestic currency. Domestic residents can choose to hold foreign currency domestically or abroad, and have a preference for a domestic location other things being equal.
The choice variable for the domestic authorities is the fraction of DFCDs held as required reserves in the domestic banking system, given as a proportion, $\delta$, of the total balances. We assume that the government declares the level of required reserves, $\delta$, which is fixed for all time, and the private sector then determines the initial level of domestic money balances, DFCDs and foreign currency holdings abroad, as a proportion of its portfolio.  

In terms of the asset and liability position of the domestic central bank, the assets of the central bank are comprised of domestic credit, $D_t$, international reserves, $R_t$, and the additional required reserves on DFCDs, $\delta S_t F_t^d$. On the liability side there are the required reserves on domestically located foreign assets, $\delta S_t F_t^d$, and domestic assets, $eM^D$, plus currency in circulation, $M^C$.

\begin{center}
\begin{tabular}{ll}
\textbf{Assets} & \textbf{Liabilities} \\
$D_t$ & $M^C$ \\
$R_t$ & $eM^D$ \\
$\delta S_t F_t^d$ & $\delta S_t F_t^d$
\end{tabular}
\end{center}

Since normal accounting practice includes required reserves on foreign exchange as part of recorded international reserves, we supplement the international reserve assets with required reserve in our model. The proportion of foreign currency deposits held as reserves supplements the central bank’s own reserves of foreign currency and the domestic money supply is:

$$M_s = D_t + R_t + \delta S_t F_t^d$$

(4)

In what follows we consider how the government’s choice of $\delta$ affects the domestic residents’ holdings of DFCDs and through it the sustainability of the exchange rate regime. It becomes apparent that the choice of $\delta$ is just as important as $\mu$ since it influences the rate of decline in central bank reserves and hence the timing of the collapse.

3. Models of speculative attack with foreign currency deposits

The portfolio allocation decision of domestic residents between domestic money, DFCDs and foreign currency located abroad is determined by a shopping

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3 In order to make the results comparable with the original Flood and Garber model, we invoke perfect foresight in the model. As a result, there is no possibility that the authorities could set a low required reserve ratio with the intention of surprising the domestic residents later on with an unexpected increase in the ratio. In this context it is not unreasonable to suggest that the authorities set an optimal required reserve ratio at the outset and domestic residents then determine their portfolio allocations.
cost model of money services based on Ratti and Jeong (1994) and Agenor and Khan (1996). Domestic residents maximize the utility from consumption in a world where a fraction of real resources, \( V \), must be devoted to facilitate shopping transactions. The function itself is a convex function of money services, \( V = (MS) \), where \( \partial V/\partial MS < 0 \) and the money services function is itself dependent on the productivity, or liquidity services yielded, by different currencies according to 

\[
MS = MS[M_r/P_r, (S_rF_r^a)/P_r, (S_rF_r^d)/P_r] \text{ where } F_r^a \text{ is the foreign currency held by domestic residents abroad, } S_r \text{ is the official exchange rate, } P_r \text{ is the domestic price level and }
\]

\[
\frac{\partial MS}{\partial \left( \frac{M_r}{P_r} \right)} , \quad \frac{\partial MS}{\partial \left( \frac{F_r^a}{P_r} \right)} , \quad \frac{\partial MS}{\partial \left( \frac{F_r^d}{P_r} \right)} > 0.
\]

Total assets held by domestic residents (in real terms) are given by 

\[
A = (M_r/P_r) + (B_r/P_r) + (S_rF_r^a/P_r) + (S_rF_r^d/P_r) + (S_rB_r* / P_r), \text{ where } B_r \text{ and } B_r* \text{ are nominal stocks of domestic and foreign bonds respectively. The asset accumulation equation is then } A = y - c[1 - V()] - \pi(M_r/P_r) + (i - \pi)(B_r/P_r) + (i - \pi - \pi)(S_rB_r* / P_r) - (S - \pi)(S_rF_r^a/P_r) + (S_rF_r^d/P_r)] \text{ which represents saving from income plus the returns to each asset in domestic currency units using } \pi \text{ as domestic inflation.}
\]

Domestic residents maximize the utility from consumption, discounted at the rate \( \theta \), is 

\[
U = \int_0^\infty u(c)e^{-\theta t} dt, \text{ assuming } u' > 0, u'' < 0, \text{ subject to constraints (7) and (8). In what follows we assume that the money services function is Cobb–Douglas of the following form } MS = (M_r/P_r)^\alpha(S_rF_r^a/P_r)^\gamma(S_rF_r^d/P_r)^{(1-\gamma)}.
\]

The money services yielded by foreign currency balances depends on \( \gamma \) but since the domestically located balances are subject to required reserves the money services are reduced as \( \delta \) rises. This implies that the services yielded by DFCDs are negatively related to \( \delta \), which reflects the fact that as a greater proportion are diverted to the central bank through the required reserve ratio the lower are the liquidity services which the DFCDs offer. Ultimately, confiscation removes all liquidity services.

The proportions of \( F_r^a \) and \( F_r^d \) relative to \( M_r \) depend upon the weights in the money services function, which indicate the monetary services offered and depend on \( \delta \). \[ \begin{align*}
\frac{S_rF_r^a}{M_r} &= \frac{\gamma\delta}{\alpha}, & \frac{S_rF_r^d}{M_r} &= \frac{\gamma(1-\delta)}{\alpha}, & \frac{F_r^d}{F_r^a} &= \frac{1-\delta}{\delta}
\end{align*} \] (5)

\[ ^4 \text{In this model we assume that the currency held abroad can be exchanged through official sources and that there are no capital controls. Introduction of a parallel market for foreign exchange would merely add a premium which would reinforce the home location preference other things being equal.} \]
We know that the total foreign currency holdings by domestic residents $F_t^X = F_t^a + F_t^d$ therefore we can show that

$$F^d = (1 - \delta) F^X$$

(6)

Hence, if $\delta = 0$ then $F_t^d = F_t^X$ and all foreign currency held by domestic residents is located in the domestic financial system; if $\delta = 1$, which amounts to complete confiscation, then $F_t^a = F_t^X$ and $F_t^d = 0$. The government has the choice of $\delta$ at the outset, which is crucial. A higher $\delta$ dissuades domestic residents from locating foreign currency in domestic financial institutions, but that which is located at home is subject to a higher required reserve ratio. Hence, the central bank’s choice of $\delta$ influences the portfolio allocation of domestic residents as well as the proportion of DFCDs which are diverted to the central bank. In effect, if we consider $\delta$ as a tax on the liquidity services offered by foreign currency located in domestic financial institutions it seems there is a Laffer curve which the central bank can exploit to maximize $\delta S^d F^d$. A choice of $0 < \delta < 1$ appears to improve the reserve position of the central bank and hence allows the exchange rate regime to last longer.

Further analysis of the model shows, however, that this initial conclusion is incorrect. This is because domestic residents achieve their portfolio choices by purchasing foreign currency from the government thereby reducing international reserves. Domestic residents acquire foreign currency under a fixed exchange rate regime through the central bank which stands ready to supply foreign currency at the fixed exchange rate. Therefore, choices which lead to higher balances in foreign currency lead to changes to the capital account which are funded out of reserves so that

$$\dot{F}^X = C_A - \frac{\dot{R}}{S}$$

(7)

which is simplified to $\dot{F}^X = -\dot{R}/\delta S$ by normalizing the current account to zero.

It is now apparent that when domestic residents hold foreign currency the authorities are forced to reduce their official reserves by an equivalent amount because the exchange rate is fixed. Even if the foreign currency is subsequently deposited in domestic banks the central bank retrieves only a proportion $\delta(1 - \delta)$ in required reserves, the remainder is lost to the authorities and cannot be used to prop-up the exchange rate regime.

We can now calculate the effect of domestic residents’ foreign exchange holding on the rate of decline in reserves and the timing of the collapse. Using (1) and using (4) whilst noting that the exchange rate is fixed gives:

$$\beta S = (D_t + R_t + \delta S F^d)$$

(8)

Taking the time derivative of (8) and using $\dot{D} = \mu$ with the time derivative of (5), gives an expression for the change in reserves as $\dot{R}_t = -\mu/[1 - \delta(1 - \delta)]$. The
reserves decline in proportion to the relative expansion of domestic credit and inversely with the required reserve ratio, \( \delta \). The rate of decline of reserves rate is now a function of more than just domestic credit expansion in the domestic economy. The domestic credit expansion in the domestic economy must be scaled by the denominator, which depends on the proportion of required reserves, \( \delta \). Any choice of \( \delta \) between zero and one by the authorities causes reserves to fall faster. When \( \delta \) is equal to zero or one the rate of decline in reserves is minimized at the level given in the original Flood and Garber model.

The consequence of a faster rate of decline of reserves will be a shorter time to the collapse of the regime. This can be calculated using (9) evaluated where \( R_s = 0 \).

\[
S_t = \lambda_0 + \lambda_1 M_t 
\]  

(9)

Substituting (4) into (9) and taking the time derivative gives \( \frac{dS}{dt} = \lambda_1 \mu \) where it can be shown that \( \lambda_0 = \alpha \mu / \beta \) and \( \lambda_1 = 1 / \beta \). Substituting back into (8) gives \( \beta S = D_0 + \delta S F_0^d + \alpha \mu \). Using \( D_2 = D_0 + \mu t \), \( F_t^x = F_0^x + (1/\beta) \mu/(1 - \delta(1 - \delta)) t \) and \( F_t^y = F_0^y + [(1 - \delta)/(\beta \mu/(1 - \delta(1 - \delta))) t] \) calculated from the dynamics of reserves and foreign currency holdings, where a subscript zero denotes an initial value of the stock, by substitution and rearrangement the timing of the collapse is shown to be

\[
t_c = \frac{\beta S - (D_0 + \delta S F_0^d)}{\mu} - \frac{\alpha}{\beta} \]

(10)

The timing of the collapse is dependent on the initial values of domestic credit, and foreign currency holdings by domestic and foreign residents. The term in square brackets is the same as the Flood and Garber model when \( \delta \) equals zero or one, hence, setting the required reserve ratio equal to one (full confiscation) and zero (no required reserves) are the limiting cases. Imposing a 100% reserve requirement is no better than a 0% requirement in terms of lengthening the life of the exchange rate regime since in both cases \( \delta S, F_0^d = 0 \) and \( \Omega = 1 \).

If the central bank attempts to use required reserves on DFCDs to improve its external position it actually makes matters worse since the numerator inside the square brackets is smaller and \( \Omega < 1 \) when \( 0 < \delta < 1 \), implying a faster time to collapse than in the Flood and Garber case. A value of \( \delta \) in this range implies that the shadow exchange rate rises at a steeper rate and hence precipitates a collapse at an earlier date than when \( \delta \) equals zero or one because it takes a value equal to the fixed rate sooner.
4. Conclusions

The paper introduces domestically located foreign currency deposits into a model of speculative attack in the tradition of Flood and Garber to consider whether these deposits can prop up a collapsing exchange rate regime. This extends the original Flood and Garber model to allow the government to respond to the consequences of portfolio diversification under speculative attack. The initial analysis suggests that the authorities can benefit by requiring reserves on domestic residents’ foreign currency deposits held in domestic banks. Use of these required reserves by the central bank to defend the fixed exchange rate would appear to offer the possibility of an extension to the life of the regime. Further consideration of the source of the foreign currency deposits, however, suggests that by responding in this way the authorities would increase the rate of decline in reserves and hasten the day of collapse. This result emerges because domestic residents’ portfolio allocation decisions are influenced by the government’s announced required reserve ratio.

Acknowledgements

This paper was written while the author was a Visiting Scholar in the Research Department of the International Monetary Fund. The author is grateful for comments from Pierre-Richard Agenor, Rod Falvey, David Fielding, Eric Pentecost and Miguel Savastano. The opinions are those of the author and not necessarily of the Bank of England or the International Monetary Fund.

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