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VARIETIES OF CAPITAL-MARKET CRISES

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*/ I have benefitted from comments by Saul Lizondo, Nora Lustig, Enrique Mendoza and Michael Mussa, and workshop participants at the IMF and MIT. This paper is part of a project on Shocks and Growth sponsored by the Inter-American Development Bank, Washington, D.C.

"It is to be noticed that the position of a country which is preponderantly a creditor in the international short-loan market is quite different from that of a country which is preponderantly a debtor. In the former case, which is that of Great Britain, it is a question of reducing the amount lent; in the latter case it is a question of increasing the amount borrowed. A machinery which is adapted for action of the first kind may be ill suited for action of the second." Keynes (1924, p. 18)

I. Introduction

The recent currency turmoil in Latin America has brought home the fact that in this post-modern world of high capital mobility, countries are being disciplined, and their "noses" occasionally twitched, by the anonymous capital market. Wall Street has become as much a presence in democracies as the median voter. One view of the situation--I would dare to say, the prevalent view among economists--is that Wall Street gets into your hair because you are running an unsustainable economic program and crises are bound to happen. An elegant rendition of this view is the balance-of-payments model in Krugman (1979)

Another polar view is that countries are at the mercy of the capital market (see Flood and Garber (1986) and, especially, Obstfeld (1986) which focuses squarely on this issue). If investors deem you unworthy, no funds will be forthcoming and, thus, unworthy you will be. Despite the appeal of this view in the popular press, however, this point of view has not made a significant dent into the profession's conventional wisdom (which is still dominated by the Krugman model) yet.[1]

This paper attempts to bring under one roof these two views, putting special emphasis on balance-of-payments crises, and to offer some new policy-relevant examples. Section II reviews Krugman's model under the assumption that after the balance of payments crisis, the fiscal deficit is entirely financed by the inflation tax. Section III introduces domestic banks and discusses the implications of having a "lender of last resort." Examples are shown in which this new feature either speeds up the crisis or contributes to macro risk or confusion.

Section IV brings in the capital market by examining the case in which public debt is issued in order not to lose international reserves in the short run. It is shown that the "bonds trick" could backfire by bringing forward the balance-of-payments crisis, or by eventually generating higher inflation. More interestingly, however, it is shown that the outcome may depend on bond-holders' expectations--Wall Street comes into your living-room not just as a perceptive accountant, the accountant's expectations now *do* matter.

Section V shows that even though the source of all problems is the fiscal deficit, the latter may behave in a confusing way. An example is developed from "first principles" in which a balance of payments crisis is preceded by a period of fiscal balance. Such balance is obtained as a result of the private sector's running a current account deficit which, in turn, is provoked by the expectation that the exchange rate policy is unsustainable (and it is!). This example reveals the fallacy of the view--associated with the names of Nigel Lawson and E. Walter Robichek--that all is well if the fisc behaves.

Section VI changes gears and considers the possibility that "crises" are provoked by international investors themselves even in the absence of radical changes or fiscal disequilibrium. Models are developed in which it is rational for individuals to be highly sensitive to "news," especially when portfolios are highly diversified. As a result, massive reallocation of funds take place on just the hint that a given country is a better or a worse investment prospect. The paper argues that the equilibrium outcome could be highly detrimental to the welfare of local or "home" factors. This point is further nailed down by examining a case in which sudden capital outflows could cause real damage.

Section VII concludes with some policy implications and suggestions for further research.

II. Krugman's Model

The standard theory of balance of payments crises is predicated on the assumption that the fiscal stance is inconsistent with exchange rate policy. A canonical example is provided in Krugman (1979) and will be briefly outlined here.

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[1] The view that foreign capital could be de-stabilizing or counterproductive is not new. See, for example, Díaz-Alejandro (1989).

The exchange rate is assumed to be fixed if there are enough reserves to sustain the value of the domestic currency (i.e., if reserves are above or at their "critical" level, which we assume to be zero); otherwise, exchange rates are allowed to float freely. Furthermore, the government is assumed to run a fiscal deficit which is fully monetized. (The latter, as will be seen, turns out to be a crucial assumption.) Assuming perfect capital mobility, no uncertainty, and perfect foresight, the domestic interest rate is equal to the international one during the fixed-rates phase, and to the international interest rate *plus* the rate of devaluation, during the floating-rates phase.

Let the demand for real monetary balances function be denoted by $L(i)$, $L'(i) < 0$, where i is the domestic nominal interest rate. Assuming PPP and no international inflation, we can identify the domestic price level with the exchange rate E. Let the government run a fiscal deficit which is fully financed by the central bank. Denoting the deficit

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in real terms by d, and the stock of international reserves at the central bank by R, we have:[2]

[2] In what follows, it is assumed, for simplicity, that either international reserves earn no interest or that the deficit d is inclusive of interest on reserves.

during the fixed-rates regime. This is so because the demand for money (monetary base in the present example) in real terms is constant at level $L(i^*)$, where i^* denotes the international interest rate. Equation (1) states that credit to government will result in reserves loss because the additional flows of domestic money that it entails are not demanded by the public. Given PPP, excess money supply cannot result in higher prices. Thus, there is no *internal* mechanism to get rid of excess money supply at equilibrium. But there exists an *external* mechanism, i.e., exchanging excess money for international reserves--which is the implication of equation (1).[3]

Equation (1) is an important building block in Krugman's model but not its "clincher," which actually is showing that the loss of reserves will take a steep plunge down to their critical level exactly at the time the system switches from fixed to floating exchange rates (hereon referred to as "switch time"). This is so for the following reasons.

First, after reserves are exhausted the mechanism implied by equation (1) will not be available. Thus, the *external* mechanism for getting rid of excess money will no longer be operative. However, since the exchange rate is allowed to float, prices will now be able to rise in line with currency devaluation. Let the inflation rate (equal the rate of devaluation, due to PPP) be denoted by p. Then, at steady state during the floating-rates phase, we have:[4]

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[3] Individuals may want to invest these funds in the capital market or increase their expenditure depending on factors that the present discussion need not be specific about. However, see Section III below.

[4] In case the following equation has more than one solution, we will assume that the economy settles to the one exhibiting the lowest p.

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In other words, flow seignorage from money creation is used to finance the fiscal deficit which, of course, requires the inflation rate to be positive, implying an abrupt jump in the domestic nominal interest rate at switch time. Hence, as the economy switches to the floating-rates regime, the demand for money takes a precipitous fall.

Krugman argues that (in the continuous-time version of the model) under perfect foresight the exchange rate cannot jump at any time because, if it did, individuals would be able to reap unbounded arbitrage profits (recall the assumption of perfect capital mobility). Thus, at switch time the exchange rate exhibits no appreciation or depreciation.

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Therefore, at switch time--which sooner or later has to arrive given the constant drain on reserves implied by equation (1)--we have:

A typical Krugman balance-of-payments crisis is depicted in Figure 1. Reserves are steadily lost during the period from 0 to *T* when reserves reach level ? *R*. At that point in time, there is a run against domestic money and reserves fall down to zero (i.e., a balance of payments crisis takes place). After time *T*, reserves remain at zero and inflation is positive (and constant, due to our steady-state assumptions).

The most remarkable feature of a Krugman crisis is the sudden loss of reserves at time *T* even though individuals have perfect foresight and, thus, nobody is taken by surprise. Therefore, the model has the ability of rationalizing, in a perfect-foresight context, an often-observed feature about balance of payments crises, namely, a speculative attack on the currency leading to the abandonment of fixed exchange rates.

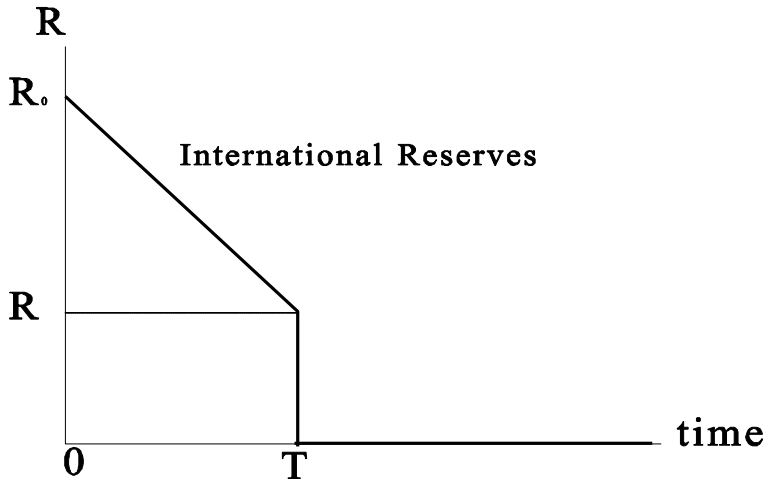

Figure 1. Krugman Crisis

III. Hidden Bonds: The Financial Trap

The recent Mexican crisis has once again shown that the financial sector could significantly contribute to the timing of a balance of payments crisis. It does so, though, in a way that is easy to miss by policymakers, and becomes evident only after the crisis is set in motion. A typical scenario involves a capital-inflows episode in which part of the inflows are channelled through the banking system. In the case of Mexico, for example, M2 divided by the exchange rate more than doubled in the period of 1990 to 1993, even though output grew by much less.

If depositors believe that the central bank will operate as lender of last resort, they will have little incentive to monitor the quality and characteristics of bank loans. In particular, they will not be concerned by the existence of a mismatch of maturities whereby loans exhibit longer maturities than deposits. At the same time, if bank managers share the same belief, they are likely not to offer attractive conditions for long-term deposits given that, as a general rule, interest rates are an increasing function of maturity. Thus, this incentive structure gives rise to the type of maturity mismatch mentioned above.

Therefore, as M2 rises a central bank which, implicitly or explicitly, operates as lender of last resort would *de facto* be acquiring short-term obligations. Under those circumstances, a bank run would force the central bank to issue high-powered money to bail out banks. Thus, for example, in terms of Krugman's model the loss of reserves at switch time (equation (3)) would be augmented by the bailout.

Consider the following simple example. Money is just high-powered money like in Krugman's model but we now introduce banks which liabilities (deposits) are pure bonds generating no *liquidity*. Bank deposits are denominated in the local currency. Thus, assuming no operations costs and no reserve requirements, a competitive perfect-foresight equilibrium (with no default) implies that loan interest rate = deposit interest rate = international interest rate = i^* (before switch time), and i^* + p (after switch time).

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Let the initial stock of deposits be zero. We assume that a new plot of land is discovered, requiring tractors to till it. Hence, profit maximization implies that tractors will be imported until their price-adjusted marginal productivity equals the international interest rate. Let the real sums involved be denoted by Z. Funds are intermediated through the banking system which, say, extends an infinite-maturity loan to buy those tractors at the above-mentioned variable interest rate, financed by instant maturity deposits yielding the same interest rate.[5] A bank run is defined as a situation in which depositors withdraw their entire stock of deposits and buy international reserves. For this to be possible, the central bank provides the necessary high-powered money in exchange for the entire banks' portfolio.

Hence, after a bank run, condition (2) above becomes:
Compared to the previous example, the fiscal deficit is now reduced by the yield on the original bank loan, i.e., Zi^*. Furthermore, equation (3) takes now the following form:

[5] A more detailed model should endogenize this maturity structure. However, the latter should not be hard in a context where the central bank provides free deposit insurance.

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Interestingly, the effect of a higher Z is ambiguous because, by (2'), it reduces the fiscal deficit and, thus, inflation after switch time is lower. The latter implies, by (3'), that the fall in the demand for money at switch time is smaller. Therefore, by (3'), the loss of reserves at switch time is subject to two opposing forces: (a) a negative force represented by the increase in the demand for money after switch time and (b) a positive force represented by the higher Z.

We will now highlight the case in which the direct effect of Z dominates. This would clearly be the case if $i^* = 0$ because, by (2'), inflation after switch time is not affected by Z. Thus, by continuity, one can show that an increase in Z will increase the switch-time fall in reserves *if the international interest rate is sufficiently small*.

Since equation (1) still holds, Figure 1 remains valid for the present analysis. In particular, it is clear from the Figure that switch time is smaller (i.e., T is smaller) the larger is the switch-time loss of reserves (i.e., $?R$). Therefore, we have shown an example of an endogenous bank run associated with the "good news" of higher land productivity (and higher capital inflows). The bank run speeds up the timing of the balance of payments crisis.

The above analysis has left several loose ends. For example, why would there be a bank run? Banks offer competitive interest rates and, thus, no depositor gains by fleeing the domestic system. The problem is that *if there were a bank run* the banking system would have not enough liquid resources to meet its obligations. This triggers the central bank to act as lender of last resort, which prompts a loss of international reserves as shown above.[6]

[6] This analysis bears some resemblance to Diamond and Dybvig (1983) . However, their bank-run story is essentially non-monetary and relies on technological constraints. In their discussion, the lender of last resort (cum a fiscal authority who is able to raise lump-sum taxes) is part of the solution, whereas here it is part of the problem.

We defined a bank run as complete depletion of bank deposits. What if only a share n is withdrawn at switch time? If no further bank runs are anticipated, this will affect the timing of the crisis, but not the central message of this section, namely, that the existence of a central bank ready to operate as lender of last resort could change and, conceivably, bring forward a balance of payments crisis. However, if n is arbitrary and/or bank runs occur in several stages, a multiple-equilibrium situation would arise, suggesting that the existence of a lender of last resort could contribute to macro risk if not sheer confusion.[7]

[7] Bank runs and, thus, the effect of bank deposits on the timing of balance of payments crises would not exist if banks could credibly offer an interest rate on deposits slightly higher than the ones derived from the zero-profit condition. In our setup, the latter would imply that banks would run at a loss, an unsustainable situation unless banks receive outside subsidies. However, since government is likely to be the one providing such subsidies, the timing of the crisis would once again be affected by the presence of banks through the generation of a higher fiscal deficit.

IV. Deficit Coverup: Domestic Debt

In many instances, countries attempt to mask the loss of reserves before the balance of payments crisis by issuing domestic debt.[8] This masking operation is aided by the convention--adopted by the IMF, for example--whereby domestic debt is not taken into account (as a negative item) in computing *net* international reserves.

Let us assume that government finances the fiscal deficit by issuing short-maturity domestic debt.[9] Let the real

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stock of domestic debt be denoted by *b*. Therefore, equation (1) is now replaced by:

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[8] This strategy was very common in Latin America during the 1980s after the Debt Crisis. See, for example, Fernandez (1991) and Rodríguez (1994).

[9] In the Latin American experiments noted in the previous footnote, domestic debt was made highly liquid by intermediating it through the banking system. Thus, another way of modelling this type of debt is equating it to interest-bearing money. In the text, however, we will stick to the assumption of pure bonds.

In this fashion, international reserves R need not change as a result of the budget deficit. However, domestic debt will accumulate without bound and transversality-type conditions will not be satisfied.

For the sake of concreteness, let us assume that the government will not renege on its domestic debt. Thus, assuming government debt to be of instant maturity (a close approximation being overnight repos), the government will be ready to exchange bonds for cash on a par basis at any time. Consider now Krugman's scenario in which the exchange is fixed unless it can no longer be sustained by the central bank.

Clearly, equation (4) cannot hold forever because the government is paying debt with debt. Assuming a constant international interest rate, i^*, the present discounted value position of the government equals $b_0 + d/i^*$. The latter is a positive number--i.e., government would be "spending beyond its means"--if initial government debt is zero (which we assume to make this example comparable to the previous one).

Suppose that in the event of a balance of payments crisis the government will stop issuing domestic debt and

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will finance the fiscal deficit (including service on the domestic debt) by means of seignorage. Thus, after the crisis, equation (2) becomes:
where b_{T+}denotes the stock of bonds at time T *after* bond redemption at time T (more on this later).

We will now show that, under the present circumstances, the timing of the speculative attack and its inflationary consequences are functions of the amount of bonds that will be redeemed at switch time. The latter is a decision that lies with speculators and may not be pinned down by "fundamentals" (see, however, the discussion at the end of this subsection). Therefore, masking reserve losses by issuing government bonds may put policy even more at the mercy of whimsical market sentiments.

To illustrate, we will examine two polar cases: (1) all bonds are redeemed and (2) no bond is redeemed at switch time. Consider, first, the case in which all bonds are redeemed at switch time. Then, inflation after T will have to be just enough to finance the fiscal deficit d, which implies that equation (2) holds also for this case and, hence, inflation after crisis is the same as before. However, reserve loss is larger because in addition to the drop in the demand for money--same as before--individuals are assumed to redeem their bonds in their entirety.

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More formally, by equation (4), and recalling that $b_0 = 0$, we have:
At switch time, the loss of reserves must be equal to the initial level, R_0, because by assumption the central bank has lost no reserves during the fixed-rates phase. By a similar argument as in Krugman (1979), one can show that the equality condition in previous sentence is a necessary condition for an equilibrium. If reserves were positive after the attack, then money holders would have made a mistake because nominal interest rates would fail to rise as expected. On the other had, if reserves were not enough for the attack, then speculators would have made a mistake--they should have staged the attack earlier--a situation which is not compatible with perfect foresight.

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More formally, the switch-time condition discussed above is as follows:
The right-most expression is reserves left over after accounting for the drop in the demand for money. The latter must equal the stock of bonds accumulated up to time T, b_T, since the whole stock of bonds will be redeemed in exchange for international reserves at switch time.

It is interesting to compare switch times with and without bonds. It is easy to verify, by equations (1), (3) and switch-time condition for the Krugman case (no bonds) $R_T = ? R$, that the expression corresponding to condition (7) for the Krugman case is as follows:

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The R.H.S. of equations (7) and (8) are the same, which implies that the balance of payments crises occurs earlier with than without bonds.

In sum, if individuals redeem their entire stock of bonds at the time of the balance of payments crisis, then inflation after the crisis is the same than in Krugman's case, but the crisis occurs earlier. Covering up the loss of reserves by issuing domestic debt is certainly effective in showing constant reserves during the fixed-rates period, but high inflation takes over earlier. In the present setup the only one that gets fooled by the bonds trick is government because individuals fully anticipate the consequences of this kind of action. Furthermore, it is easy to derive this kind of model from a utility-maximization framework[10] and show that welfare is unambiguously reduced when bonds are used (and are totally redeemed at switch time) instead of fully monetizing the fiscal deficit.[11]

Let us now consider the polar case in which no bond is redeemed at switch time. Thus, the fall in reserves at switch time satisfies equation (3) above. The switch-time condition is $R_0 = ?R$, determining p. The same condition for Krugman case is $R_T = ?R$. Hence, since by Figure 1 $R_T < R_0$, inflation in Krugman case is less than in the case in which bonds are issued to cover the fiscal deficit during the fixed-rates phase, and bonds are not redeemed at switch time. However, issuing bonds could be an effective device for postponing the balance of payments crisis.

The above analysis could be criticized because it does not offer an explanation of why, when the speculative attack takes place, the government cannot instantly refinance some of the bonds being redeemed. For example, if the rate of inflation implied by equation (5) is less than the one that maximizes revenue from the creation of money, then the government could in principle refinance part of the bonds being redeemed at time T and cover the additional debt service by higher future inflation, i.e., government could borrow against additional future seignorage. Under those conditions, the timing of the speculative attack would be uniquely determined and correspond to the situation in which inflation maximizes seignorage. Moreover, one can show that this solution is identical to the one we earlier identified with the

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[10] For example, a Sidrauski-type model where utility is separable in consumption and real monetary balances.

[11] However, in the unrealistic case in which reserves earn the same interest rates as domestic bonds then, under full bond redemption, social costs and the timing of crisis would be the same as in Krugman's model.

case in which there is no bond redemption at time T.

However, the other solutions with partial or total bond redemption would still make economic sense if investors are confident about their knowledge of the demand for money around the time of the crisis (essentially the knowledge necessary for the timing of a Krugman crisis) but are much more uncertain about the demand for money over the longer run. The latter is necessary to assess if the government will be able to service bonds left over after the crisis, i.e., b_{T+}. Thus, b_{T+} could be interpreted as reflecting investors' estimates about the maximum present discounted seignorage (net of fiscal deficit d) after the crisis. Given the high volatility and unpredictability of the demand for money in crisis-prone countries, investors' estimates of maximum present value seignorage is likely to be largely idiosyncratic.

A disturbing implication of the above analysis is that equilibrium determination depends, strongly, on speculators' expectations. Furthermore, in a more realistic scenario where speculators cannot perfectly read the minds of the other speculators, the nature of equilibrium will be very sensitive to "new" information emanating from "the market," as opposed to "fundamentals." A balance of payments crisis will continue displaying catastrophic results, but the latter will occur in a milieu of incessant rumor which (1) leaves the government and economic policy on the sidelines, and (2) can hardly be argued to be welfare enhancing.

V. Variable Fiscal Deficit: The Talvi Effect [12]

The above examples assumed that the fiscal deficit is constant through time. Recent experience, however, suggests that crisis-prone economies display wide variations in their fiscal deficits, the latter widening sharply after a balance of payments crisis takes place (see Talvi (1994)). A typical pattern is for expenditure (particularly, consumption) to expand during the fixed-rates phase (or, more generally, during the exchange-rate-based stabilization period, see Kiguel and Liviatan (1992)), followed by a sharp decline after the crisis. Thus, to the extent that tax revenue increases with expenditure, the fiscal stance improves before the crisis and deteriorates sharply afterwards.

Consequently, it is possible for variable d (i.e., fiscal deficit) to be time varying and show a marked increase after switch time T. We will illustrate this by an example in which $d_t = 0$, for $0 \# t < T$, and $d_t = D > 0$, afterwards, where D is a positive constant. Thus, in this example there would be no obvious sign of fiscal imbalance prior to the balance of payments crisis.

As in Calvo (1986), let us assume the existence of a representative individual (total population is normalized to unity) whose time-separable utility depends on consumption, and displays a constant discount rate equal to the international interest rate. Let c and m indicate consumption and real monetary balances held by the representative individual. Assuming (1) a cash-in-advance type constraint, $c = m$, (2) constant endowment income y, (3) existence of a consumption tax rate, t, proportional to total consumption and constant over time, (4) no other taxes, (5) constant government expenditure g, and (5) that the individual holds money as the only type of wealth at time zero, the representative's individual budget constraint takes the following form:

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[12] This section has greatly benefitted from discussions with Ernesto Talvi who tackles a similar issue in Talvi (1994).

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Therefore, letting $u(c)$ denote the instantaneous-utility index, the first order condition for utility maximization

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is:[13]
where ? is the (constant) Lagrange multiplier.

We will now construct the example so as to yield no fiscal deficit during the fixed-rates period.

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During fixed exchange rates, inflation is zero. Thus, equation (10) boils down to:
After the crisis, inflation will be constant and higher (its level denoted by p^H, superscript H standing for "high"); thus,

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for $t > T$, equation (10) boils down to:
By (10 a) and (10 b) it is clear that consumption during fixed rates will be higher than after the crisis. Thus, their

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corresponding levels will be denoted by c^H and c^L, respectively (H and L standing for "high" and "low").

For zero fiscal deficit during the fixed-rates phase, we must have:
Furthermore, because of the proportionality between consumption and money holdings, after-crisis condition (2) above implies:

The budget constraint for the country as a whole requires that the present discounted value of private and public consumption equals the present discounted value of endowment income plus initial international reserves. In the present case, where individuals are assumed to hold no international bonds at time 0, the latter takes the following form:

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[13] Function u is assumed to be increasing, strictly concave and twice differentiable.

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Consider the case in which the instantaneous utility index is logarithmic and, thus, $u(c) = log\ c$. Then, by

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equations (10 a), (10 b) and (12), we have:

Recalling the cash-in-advance constraint, the fall in the demand for money at time T equals $c^H - c^L$. Therefore, to ensure that at time T international reserves are fully depleted, we assume initial international reserves $R_0 = c^H - c^L$. Thus, plugging the latter in equation (13), and recalling that the zero-fiscal-deficit condition (11) during the fixed-rates phase implies that $c^H = g/t$, we can solve for c^L in equation (14) and, using the latter, solve for switch time T in equation (13). Thus, at time T international reserves are fully depleted, and the high-inflation period begins.

Notice that the above solution is unique and, thus, the fixed-rates regime would not be sustainable. To gain further intuition, let us consider the possibility of the economy not suffering a balance of payments crisis. Thus, inflation will be constant over time, implying, by conditions (10) and (13) that consumption will be constant over time and equal to $y - g + i^* R_0 < c^H$. Since, by equation (11), high consumption c^H raises enough revenue to drive the fiscal deficit to zero, the no-crisis consumption, i.e., $y - g < c^H$, will result in a positive constant fiscal deficit, implying that reserves will eventually reach zero (recall equation (1)).

Thus, the above example demonstrates the possibility that a balance of payments crisis of the Krugman type will take place *even though there is no fiscal deficit during the fixed-rates period*. This does not mean the absence of basic fiscal problems. Rather it signifies the absence of imbalance from conventional fiscal accounts which do not take into account this cyclical pattern.

Nigel Lawson and E. Walter Robichek have eloquently espoused the theory that government should not worry if the private sector runs current account deficits, as long as there is no fiscal deficit. The above type of example shows how wrong this view could be. In the example, there is no fiscal deficit during the fixed-rates phase because of a consumption boom which is fueled by individuals' expectations that the exchange rate policy is unsustainable!

VI. Bonds-Led Speculative Attacks

In all previous examples, the key factor behind balance-of-payments crises was fiscal disequilibrium. Bonds added serious complications, and variable deficits were shown to make fiscal disequilibrium more difficult to detect. However, a key message emanating from the examples is that to prevent future crises, government will be well-advised to lower its fiscal deficit.

The models that will be discussed in this section represent a complete change of perspective, because they show that the basic cause of a balance of payments crisis may be lenders' behavior. For instance, in one of the examples, as lenders go into panic, loans are not rolled over, countries are forced into costly, badly designed tax systems to carry out the necessary "adjustment" and, as a result, the economy suffers *real* damage (e.g., productivity loss, more tax evasion and corruption, etc.), validating the fears that initially led lenders to withdraw their loans.

1. Financial Diversification and Lenders' Information. Both diversification and information are desirable features for an investor. The former because of risk-aversion considerations, and the latter for the obvious reason that a better knowledge of an asset's characteristics makes for a better investment decision, at least at the micro level. However, there may be a significant tradeoff between the two.

The discussion will be confined to countries and central points will be illustrated by means of an essentially one-period example. Suppose there are J countries each indexed by j. We assume that there are investment projects in each and every country.[14] For country j its investment project has return r^j, a random variable. For simplicity, we will

[14] In this section there is no need to be more specific about the nature of those projects.

assume that if investors do not spend resources in learning more about a specific country, or information filters through the grapevine, *r*'s are perceived i.i.d. with mean ? and variance s^2. Thus, a risk-averse investor will allocate equal amounts of his wealth across all countries. Hence, assuming without loss of generality, that he has one unit of wealth (in terms of output, say), expected return and variance will be ? and s^2/J, respectively.

We will now show that diversification exacerbates "herding" behavior by making investors more sensitive to "market" news or rumors. In what follows we assume that the representative individual's Von Neumann-Morgenstern utility, *U*, is quadratic in the portfolio's return.

Suppose the investor hears a credible rumor that country 1's return has a new mean value *r*, different from ?, although its variance is still equal to s^2 like all other countries, and its distribution is independent from that of each and

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every other country. Let ? be the share of his portfolio devoted to countries 2, 3, ..., *J*. Obviously, whatever amount is invested in the latter set of countries, its allocation will be constant across them. Thus, the portfolio's expected return is

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Moreover, portfolio variance satisfies:

They could range from foreign direct investment to the purchase of government bonds.

Given the quadratic-utility assumption, expected utility, *EU*, can be represented as a linear function of

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expressions (15) and (16) as follows:

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Therefore, maximizing utility (17) with respect to ? (i.e., the portfolio share of countries other than country 1) yields the following first-order condition:

The above results are all we need to make our first central point. Let us consider the benchmark case in which starting from a situation where country 1 is ex ante identical to all other countries, information filters down to investors that the expected return in country 1 is slightly different from that of the others, ?, while all the other conditions still hold (e.g., equality of variance across countries). Then, the change in portfolio composition can be computed taking the

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implicit derivative of ? with respect to *r* in equation (18), i.e.,

Prior to the new information, investment in country 1, as a proportion of total investment, was 1/*J*. Therefore, by making *J* sufficiently large, the change in investment funds allocated to country 1 as a proportion of the original investment as a result of the new information could be made arbitrary large. Identifying the number of countries, *J*, with opportunities for diversification, we can then conclude that *as the opportunities for diversification increase, the impact of "news" on the allocation of investment funds (relative to initial allocation) grows without bound.*

Let us now introduce the possibility of getting better information. Consider the case in which by spending a fixed sum ? in learning about country *j*, independently of the amount invested, an individual would be able to know the actual realization of r^j before choosing his portfolio, $j = 1, 2, \ldots J$. Suppose the investor's wealth is one unit of output. Without loss of generality, we will analyze the net return from spending ? to learn about r^1.

As usual, it will be convenient to go backwards and start at the point when r^1 is revealed. Since the latter is known with perfect certainty, we will denote it by *r*, as before. In contrast to previous example, however, the variance on the return in country 1 is now, by definition, zero. Using the above apparatus, one can show that for interior

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solutions, the share invested in countries $j = 2, 3, \ldots J$, is given by the following expression:

Ruling out short sales, if $r \geq ?$, then investment would be fully concentrated on country 1. This is as expected, because we have assumed that there is no uncertainty about country 1's return. On the other hand, the maximum feasible

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value for ? is 1. Let r_{min} be the value of *r* for which ? in equation (20) equals 1. Then,
Thus, interior solutions hold if $r_{min} < r < ?$. Furthermore, if $r \leq r_{min}$ then ? = 1, while if $r \geq ?$ then ? = 0. Finally, r_{min} is an increasing function of the degree of diversification, *J*, and converges to ? as *J* grows without bound.

We will now argue that the benefit derived from knowing *r* eventually declines as the number of diversification opportunities, *J*, increases. This is the key for the argument that more diversification opportunities eventually imply

lower incentives for information gathering.

By (21), in the limit as *J* becomes very large, information gathering will only payoff (not taking into account the costs of collecting information, ?) , if $r \geq ?$.[15] By the above discussion, however, for small *J*, information gathering will payoff even though $r < ?$ (but as long as $r \geq r_{min}$). Furthermore, in all cases, information gathering pays off if $r > ?$. Thus, (1) if expost $r > ?$, utility is the same for the high as for the the low-diversified investor and (2) if expost $r < ?$, then only the low-diversified investor has a chance to gain from having invested in information about country 1. Therefore, noticing that expected utility increases with diversification opportunities (i.e., *J*), the marginal gain from information-gathering eventually falls off as diversification opportunities rise.

In sum, we have shown, in reverse order, that (1) *highly diversified investors have lower incentives to learn about individual countries than investors with few opportunities to diversify* and (2) *investment to or away from a given country could be highly sensitive to news in a world in which investors are highly diversified*.

[15] If *J* is large but less than infinity, information-gathering will of course be valuable (abstracting from cost ?) for r in the interval $r_{\min} < r < ?$. However, since $r_{\min}$ converges to ? as *J* grows without bound, the probability of $r_{\min} < r < ?$ goes to zero as *J* diverges to infinity. Hence, we can disregard the above open interval in our computations as *J* becomes very large (not just at the limit).

The above characteristics of a highly-diversified-investors world looks fearsome: diversification encourages ignorance and, in that context, frivolous rumors could result in massive capital flows from the perspective of an individual country. Of course, an optimist would likely be able to find a "world" welfare function under which those massive reallocations are socially optimal. However, although holders of internationally mobile capital or highly tradable goods may not suffer from these swings, those engaged in the production of local, or "home," goods could see their fortunes change radically depending on the funds' direction.[16] In addition, fiscal revenue is likely to be an increasing function of capital flows. Hence, their variability would have a negative impact on welfare if, for instance, the government faces convex tax-collection costs.[17] Thus, even before introducing direct detrimental effects from the variability of capital flows, a case could be made that herding behavior under highly-diversified portfolios may have seriously detrimental effects on the welfare of individual countries.

The problem of capital-flows variability becomes more obvious if investment decisions have an effect on expected rates of return. This topic will be the subject of next subsection.

2. Additional Costs from the Variability of Capital Flows.[18] Consider a three-period, one-good, non-monetary world in which the government issues $b_0 > 0$ units of public bonds in period 0. Let x_t, $t = 1, 2$, denote tax revenue in period t net of government expenditure. We assume that bonds mature in one period, and denote the interest rate in period t by z_t, $t = 0, 1$. Furthermore, bonds issued in period 1, b_1, satisfy:

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[16] For example, assume that investment requires local labor in fixed proportions. Labor supply is infinitely elastic at the "subsistence" wage. Thus, a sudden stoppage of capital inflows may result in a much higher starvation index. This extreme example can easily be relaxed to accommodate home goods which would undergo negative but less dire consequences as a result of a change in the flow of capital.

[17] These types of costs would exist even though investment projects are, say, land and, initially, land is held by investors (allowing us to assume that the costs of portfolio reshuffling fall entirely on investors in the form of capital losses)--if property taxes are proportional to the value of land.

[18] The following example bears the flavor of Calvo (1988). However, equilibrium multiplicity from fundamental budget-constraint considerations, in contrast with Calvo (1986) in which a key ingredient is the government's policy response function.

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Thus, in the last period revenue has to be raised to fully service the outstanding debt, i.e.,

We will assume that the opportunity cost of funds is revealed at the time 0 and, without loss of generality, we assume it to be constant through time. Combining equations (22) and (23) and, once again, denoting the (constant) international interest rate by i^*, the overall budget constrain faced by government takes the following familiar form: Thus, if revenue raised in periods 1 and 2 are not functionally connected (other than through budget-constraint equation (24)), then government can choose the optimal configuration of revenues, x, to maximize some social welfare function.

In order to analyze the detrimental effects of "runs," we will now assume that revenue raised in period 1 is, after a point, counterproductive to revenue collection in period 2. To simplify, we will postulate that x_1 does not interfere with x_2 if $x_1 \# X$, where X is a given positive parameter; otherwise, if $x_1 > X$, then $x_2 = 0$. This assumption attempts to capture a situation in which the government is able to collect very high taxes in the short run but, beyond a certain point, high taxes seriously undermine the government's future ability to tax. The following three examples provide some motivation.

Take a country who has a tax legislation in place but needs to collect additional taxes unexpectedly. A popular policy under these circumstances is to raise public sector prices. Since these taxes are seen as temporary and directly affect input prices, production and thus capital accumulation decline, resulting in a smaller tax base tomorrow.

Another possible policy reaction is to impose a wealth tax which, unlike the previous case, is in principle non-distorting. However, if the new tax is large enough, firms and individuals would find it to their advantage to under-report their wealth. This may lead individuals and firms also to under-report future income in order not to reveal their previous under-reporting, thus lowering the future tax base.

Finally, let us interpret x_t, $t = 1, 2$, as the difference between taxes and public investment. Thus, x_1 could now go up by simply dropping some public investment projects. Hence, if public investment has a positive effect on private investment, future output will fall, which, once again, will tend to depress the future tax base. This example may be relevant for countries which went through a sharp reduction in public infrastructure investment after the 1982 Debt Crisis (see Easterly (1989)).

By equation (15), if debt is not rolled over in period 1, then revenue in period 1, $x_1 = b_0 (1 + i^*)$, where the equilibrium interest rate (given our earlier assumptions) is just equal to the international one. Suppose $b_0 (1 + i^*) > X$. Then a self-fulfilling run is possible because, if no debt is rolled over, the country could not raise revenue in period 2, and any outstanding debt in period 2 will be defaulted. Thus, there are no incentives to roll over the debt. On the other hand, the first-best equilibrium still exists, so it cannot be claimed that there is anything "fundamentally" wrong with the country. However, if lenders stage a run: (1) the first-best cannot be achieved and, lamentably, (2) ex post no investor will regret having fled. Hence, there is no ex post penalty for the panicky investor, no regrets from having run and, thus, no mechanism is set in motion which might help to prevent the same phenomenon from happening in the future.[19]

[19] In the simple example there is no future beyond period 2. However, the model could be

VII. Concluding Remarks

Casual observation suggests that the two views about capital market crises are relevant, and that they could actually magnify the effects implied by the other. Thus, fiscal fragility may make it more likely for self-fulfilling prophecies to exist. Viceversa, a bonds-led crisis may bring about fiscal imbalance.

The view that capital-market crises may be partly investors' "fault" suggests that standard fiscal tightening advice should be complemented with measures that prevent large variations in capital flows, at least in the short run. One such measure is to lengthen the maturity of public debt. In the previous section's example, this would be the solution to the problem. Let $?_1$ and $?_2$ be the optimal path of tax revenues. Then, the first best could be implemented with probability 1 if debt maturing in period 1 amounts to $?_1$ or less. Furthermore, in the balance-of-payments model of section II.2, lengthening bond maturity will increase crises' predictability.

In a more realistic model, however, the long-maturity solution may be harder to implement because of the following two reasons: (1) economies have an open-ended horizon (not a fixed number of periods), and (2) fiscal revenue is subject to stochastic shocks. These two factors combined imply that it will be unlikely for a country to be in a situation in which non-prearranged funds are needed. Thus, the expectation that the latter may happen (i.e., non-prearranged funds are needed) opens the door for the kind of problems underlined in the text. Under those circumstances, the longer the maturity of a loan, the higher will be the probability of default, both because of revenue-shortage and lenders' panic. Thus, these two factors could reinforce each other to such an extent that interest rates on long-maturity loans become prohibitively high, and it is optimal for the country to bias the maturity structure of public debt towards the short-end of the spectrum--hence opening the economy to capital-market crises.

Public debt takes many forms. One of which is, in practice, bank deposits. Although no country offers unlimited deposit insurance--and some countries insist on not having any--it is hard to find examples where depositors have not received a sizable compensation after a banking crisis. Thus, *de facto* the government becomes partially responsible for bank debt , especially short-maturity debt. Therefore, the above discussion suggests that countries that are subject to capital-market crises should be very cautious about liberalizing the banking system (e.g., lowering reserve requirements), and should give incentives for banks to lengthen deposit maturity.

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extended by assuming a string of three-period economies like the one discussed in the text. Thus, the implication is that country 1000, say, would not be able to avoid a run if investors refuse to roll over the debt, even though everyone had the chance to learn from the experience of the previous 999.

The paper also cautions against premature "bond-engineering" where revenue shortfalls are covered by floating new debt. This policy is very attractive in the short run because there is no need to raise additional taxes and it does not call for a loss of reserves or an increase in inflation. However, the paper has shown that bond-engineering may put the economy at the mercy of the capital market's occasionally whimsical mood.[20]

The problems emphasized in this paper are likely to be more relevant for countries that undergo basic economic restructuring than for those that have a solid "track" record. Optimal capital-market policy should reflect that fact and impose stiff restrictions in the short run followed by their eventual relaxation as stability features, like foreign direct investment and long-maturity instruments, are better and more solidly established.

In closing, it is worth recalling that capital-market crises have a tendency to recur (notably in Latin America). In this respect, theories discussed in this paper have little to contribute. It is somewhat hard, however, to imagine rational governments repeatedly falling into Krugman-type crises. In contrast, theories of lenders-led crises appear to need little additional formalization to generate recurrence. Countries could, of course, take measures to prevent business cycles caused by external factors, but these types of measures are costly--like, for instance, lengthening debt maturity--and a rational government weighing benefits and costs may optimally choose to leave itself open to recurring capital-market shocks.

[20] In this respect, it is somewhat worrisome the fact that some countries--particularly those in Eastern Europe and former Soviet Union republics--are receiving advice from advanced-countries technicians (e.g., retired Bundesbank officials) with the blessings of leading international financial institutions on how to develop a market for government bonds.

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