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Dedicated to the memory of P. C. Mahalanobis

ON THE SUDDENNESS OF INTERNATIONAL DEBT CRISES

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SUMMARY. The causes and suddenness of international debt crisis and existence of excess supply of credit in the pre-crisis situation are theoretically investigated in this paper from a formal game-theoretic point of view.

1. INTRODUCTION

Even in mid-1991, India was known to be a *good investment.* International banks and financial institutions considered it safe to lend money to India. As a consequence India faced an abundant supply of international credit and could borrow more than it needed to. Then, suddenly, this began to change. By January 1992 virtually all supplies of international credit had dried up and, with even the non-resident Indians pulling money out of their deposits, the country was plunged into a crisis. There were causes alright – there was political instability in India and there was the Gulf War, resulting in large fuel import bills and a fall in exports – but the crisis turned out to be larger than what can be attributed directly to these causes. The above causes may have pulled a trigger, but, after that, the crisis seemed to propel itself. When one lender stopped lending, others considered it unsafe to lend. With all the lenders shying away from lending, it indeed did become unsafe to lend. India did finally manage, narrowly, to avert default but there can be no denying that she had come precipitously close to that.

India is not alone in this experience. It has been seen, time and again, that in developing countries international debt crises come on very suddenly. From confronting an excess supply of credit a nation can within months or even weeks find itself caught up in an acute foreign-exchange shortage situation.

In India this recent experience has led many commentators to suggest that we should cease to take short-term international credit and, in fact, try to do virtually without having to rely on international lenders. Such a prescription is akin to recommending that a bank should be closed down because of the risk of a bank run.

International credit is an essential part of a nation's development process. Especially for Third World nations with non-convertible currency, such as ours,

international credit is a necessary ingredient for international trade and a spur to growth.

Hence the right reaction to crises of this kind is not to shun international credit but to try to understand it so that we can avert future crises. This is a large research agenda in development economics and I plan to address only a slender part of it in this paper.

(A) How can we explain the existence of excess supply of credit in the pre-crisis situation ?

(B) Why do international debt crises so often come on so suddenly ?

The recent literature on international debt seems to be quite silent on these two matters. Indeed the concern is with how we could have an excess *demand* for credit in equilibrium (see, e.g. Krugman, (1985), Eaton, Gersowitz and Stiglitz, (1986)). The reason for this is that most of this literature has emerged in response to the massive Latin American debt crisis of 1982. And indeed in the post-crises situation most Latin American countries faced the problem of credit shortage rather than credit glut. This was, therefore, the stylized fact that the existing literature seemed to be concerned with.

My question (A), however, relates to a pre-crisis context. The answers I give to (A) and (B) here are not new. In Basu (1991) I had tried to answer (A) and (B) by constructing a formal model. What is novel in the present paper is that the argument is now cast in a formal game-theoretic mould.

In Basu (1987) I tried to explain why doctors prefer to have persistent excess demand for their services instead of raising their fees. The same idea has been expressed by Becker (1991) in trying to explain why restaurants often prefer to live with excess demand instead of raising the price of their servings. Casting these ideas in game-theoretic terms reveals the essence very simply. This also means that the implicit equilibrium notion used in the earlier models show up as if under a magnifying glass.

In brief, the aim of this paper is to theoretically investigate the causes of international debt crises and to explain the suddenness of the onset of such crises; hopefully a better understanding can help us avert the problem in the future.

2. THE MODEL

Suppose there are three potential lenders, called 1,2, and 3. Each of these lenders can either lend one unit of money or nothing. These two actions will be denoted by T and N – *to lend* and *not to lend.*

There is one borrowing country that needs one unit of (international) money. We may assume that the country is considering the construction of a new oil rig, which costs 1 unit of money. More money or less money is of no use to the borrower. The country wants to keep the interest rate as low as possible.

The interaction between the borrower and the lender is viewed as a two-period game. In period 1 the borrower announces the interest he is willing to pay for the borrowed money. This amounts to issuing bonds with a fixed interest rate. In period 2 each lender decides whether it wants to lend or not. In other words, the lenders decide whether they want to buy the bonds or not.

How attractive it is from the lender's point of view to lend depends on the interest rate announced by the borrower and also on whether others are willing to lend or not. As explained in Basu (1991) this latter assumption is very reasonable in international credit markets. These markets are characterized by severely imperfect information and it boosts the confidence of the lender to see that others (who may have some private information) are willing to lend. In addition, if several banks or nations are lending to certain country it may be easier for you to pull out your money when you want to since the borrower can borrow from someone else to repay your debt.

Keeping this in mind, let us denote the game that the lenders play in period two by $G(i)$. The game in period 2 depends on the interest rate, i, announced in period 1, hence for each i we have a distinct game, $G(i)$ in period 2. The payoffs in this game $G(i)$ are described in the payoff-matrix below:

$G(i)$:

	T_2	N_2
T_1	$x_1(i), x_2(i), x_3(i)$	$y_1(i), 0, y_3(i)$
N_1	$0, \quad y_2(i), y_3(i)$	$0, \quad 0, z_3(i)$
	T_3	

T_2	N_2
$y_1(i), y_2(i), 0$	$z_1(i), 0, 0$
$0, \quad z_2(i), 0$	$0, \quad 0, 0$
N_3	

In $G(i)$, lender 1 chooses between rows, 2 between columns and 3 between matrices. In each box the left-hand number is 1's payoff or income, the next number is 2's payoff and, the right-hand number is 3's payoff. Thus if player 1 chooses N_1, 2 chooses T_2 and 3 chooses N_3, 1 gets 0, 2 gets $z_2(i)$ and 3 gets 0. The reader should verify that in this game $x_j(i)$ is lender j's payoff from lending when two other player lend; $y_j(i)$, when one other player lends; and $z_j(i)$, when no one else lends.

In keeping with the above discussion, it will be assumed that

(1) $x_j(i), y_j(i), z_j(i)$ rises as i rises and

(2) $x_j(i) > y_j(i) > z_j(i)$.

(1) says that a higher interest rate is better for the lender, and (2) says that each lender is better off lending if the number of other lenders rise.

I shall now show that it is possible to have an equilibrium in the full two-period game where the interest rate is such that all three lenders want to lend. So there is a glut of credit since the borrower needs only 1 unit. If i is lowered by the borrower all lenders end up refusing to lend. If this was so only in the

case where all lender were identical (that is, $x_1(i) = x_2(i) = x_3(i)$; $y_1(i) = y_2(i) = y_3(i)$; $z_1(i) = z_2(i) = z_3(i)$) this would be uninteresting. It can however be shown that even if all players have different preferences, there may exist a unique interest rate below which *all* lenders simultaneously exit from the market[1]

The equilibrium notion that will be used here is subgame perfection. In the context of a simple game like the above one the idea of subgame perfection is easy to understand. Consider a strategy profile $(i^*, s_1^*, s_2^*, s_3^*)$ where i^* is an interest rate and s_j^* is lender j's action. Hence s_j^* is either T_j or N_j. Distorting terminology only slightly we can say that $(i^*, s_1^*, s_2^*, s_3^*)$ is a *subgame perfect equilibrium* if (s_1^*, s_2^*, s_3^*) is a Nash equilibrium of $G(i^*)$ and, for every interest rate i, there exists a Nash equilibrium (s_1, s_2, s_3) in $G(i)$ such that the borrower prefers outcome $(i^*, s_1^*, s_2^*, s_3^*)$ to (i, s_1, s_2, s_3). Since the borrower's aim is to borrow one unit at as low an *interest rate as possible*, this means that $i^* \leq i$ and either $s_1^* = T_1$ or $s_2^* = T_2$ or $s_3^* = T_3$ is true[2].

Now consider this example:

$$\begin{array}{lllllll} x_1(i) & & & & & = & i - 0.1 \\ x_2(i) & = & y_1(i) & & & = & i - 0.2 \\ x_3(i) & = & y_2(i) & = & z_1(i) & = & i - 0.3 \\ & & y_3(i) & = & z_2(i) & = & i - 0.4 \\ & & & & z_3(i) & = & i - 0.5 \end{array}$$

Suppose now that the borrower sets $i = i^* = 0.3$. Check that (T_1, T_2, T_3) is a Nash equilibrium of $G(i^*)$. To see this, note that at (T_1, T_2, T_3) player 1 gets 0.3-0.1 = 0.2. Hence he cannot do better by deviating to N_1 which gives him zero. Likewise for players 2 and 3.

If $i < 0.3$, the only Nash equilibrium is (N_1, N_2, N_3). Hence the borrower will never lower i below 0.3. To see how exits occur in a cascade, suppose $i = 0.29$. Then from (T_1, T_2, T_3) player 3 would deviate to N_3. Once player 3 makes such a deviation, player 2 would be better off not lending. Once both players, 3 and 2, decide not to lend, player 1 gets $x_1(0.29) = -.01$ by lending. hence he would also prefer not to lend.

In equilibrium not only is there an excess supply of credit, but there is an inherent instability, because a slight disturbance can result in all sources of credit to dry up[3]. Suppose we start from the equilibrium in the above example. So $i^* = 0.3$ and all countries are willing to lend. Now suppose in period 2,

[1]The formal game is a little different from the one being described in words because, in the end, all those who want to lend may not succeed in lending because it is the borrower who finally decides whom to borrow from among the ones who choose to lend. The other (potential) lenders end up, with 0. But this makes no substantial difference and could have been written into the formal game by expending extra energy. In keeping with a life-long principle, I leave this to others.

[2]If, for all i, the Nash equilibrium $(s_1, s_2, s_3) = (N_1, N_2, N_3)$, then in equilibrium the borrower chooses any i and no lending occurs.

[3]For related works on cascades and herd behaviour, see Bikhchandani, Hirshleifer and Welch (1992) and Banerjee (1992).

because of some external change, the benefit from lending decreases by a little less. That is, all the payoffs in $G(i)$, above, become whatever they were earlier *minus* ε. No matter how small ε is, all lenders will cease to lend in period 2 as a consequence of this external change.

It should be emphasised that the example above is not a special case and one can look for large classes of parameters where the equilibrium is of the above kind – characterised by excess supply and fragility. One such class under which this will be true is:

$$\begin{aligned} \min\{x_1(i), x_2(i), x_3(i)\} &> \text{mid}\{y_1(i), y_2(i), y_3(i)\} \\ &> \max\{z_1(i), z_2(i), z_3(i)\} \end{aligned}$$

where mid $\{a, b, c\}$ is the middle largest number among a, b, c, with this broken arbitrarily. If this restriction is true then there will be excess supply in the subgame perfect equilibrium.

3. Conclusion

In markets, where one seller's benefit from selling a product depends on the existence of other willing sellers, there may be both excess supply in equilibrium and instability in the form of sudden shortages in supply. This was demonstrated by constructing a formal two-period game. While the model does give some insight into the suddenness of debt crises, of the kind that India faced in 1991, it does leave open questions. Suppose, for instance, that payoffs in the above example are disturbed in the manner discussed in section 2. That is, every lender's payoff is smaller by a small fixed factor. It is true that this will immediately cause a contraction in supply. But the question must arise why the borrowing country cannot raise the interest rate and regain the confidence of the lenders ? Within the confines of my model the borrowing country can do exactly that, but we know that in reality it takes time to regain confidence.

To understand reality, we must recognise that payoffs in the above game are *ex ante* or perceived payoffs. It is entirely possible to argue that if, starting from a certain prevailing interest rate, a crisis sets in and, then the interest rate is revised upwards, the perceived payoff of the lenders will not be the same as the one that would occur if the interest rate had been the higher one to start with. In other words, in a more sophisticated model we would require payoffs to depend not merely on the prevailing interest rate but on the history of crises and interest rates. In that case it may be possible to explain why if a nation raises the interest rate following a crisis it may fail to attract lenders who would have come if the higher interest rate was anyway there and not set in response to a crisis. Such a model would, of course, require the introduction of explicit dynamics; and that may well be the next step forward from where the above model leaves off.

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