On Central Banks and their Lender of Last Resort Function :

In Defence of "Constructive Ambiguity", But Beware, "Cheap Talk"

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Introduction

Graph 1 represents one of the most nerve-racking situations for any Central Banker. The graph plots the outflow of deposits from the Argentine financial system during the so-called Tequila-Shock of 1995 after the devaluation of the Mexican peso on December 20th of the previous year. Argentina lost $8bn, or roughly 20%, of the deposits in the financial system in a period of only some 4 months[1]. How a Central Bank should react as such a crisis unfolds, although an old question, remains a controversial one. It is this role of Central Banks, as the so-called Lender of Last Resort, which is the focus of this paper.

Graph 1 Here

In general, Central Banks are not very forthcoming in defining their policies with respect to this function very explicitly. Indeed, when Central Bankers make statements about the Lender of Last Resort role they are normally very careful indeed not to make too many promises. However, they do tend to point out a distinction between what might be seen as a problem in an individual bank versus a problem that affects or that might affect the system as a whole. Some Central Banks might indicate, for example, that they would not assist a private bank which had an individual problem, where there was little chance of that problem affecting the system as whole. As an example, in a statement to the US Congress, John P. LaWare, a Member of the Board of Governors of the Federal Reserve System in the US commented,

" ..One can contemplate situations in which uninsured liabilities of failing institutions should be protected....Such a finding would typically be appropriate only in cases of clear systemic risk involving, for example, potential spill-over effects leading to widespread depositor runs, impairment of public confidence in the broader financial system or serious disruption in domestic and international payments and settlement systems....In practice, situations representing true systemic risks are rare.....Unfortunately, the specific considerations relevant to such determinations are not fixed but will vary over time with, for example, the underlying strength of the financial system and the economy.....In our view therefore it is not only prudent but essential that policy makers retain the capacity to respond quickly, flexibly and forcefully to conditions involving extensive risk to the financial system and the economy."[2]

In other words it is felt that the Federal Reserve should have a Lender of Last Resort function, but that this should be only used in those occasions when there are perceived to be systemic risks. An implication is that if an individual bank has problems, and there is no perceived risk of this spreading to the system as a whole, then the Federal Reserve would not assist to protect the shareholders, management or uninsured creditors. The Bank of England has gone a little further than this statement. For example, the Governor,

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[1]See the first edition of the Bulletin of Monetary and Financial Affairs of the Central Bank of Argentina and Kiguel (1995) and Powell (1995) for more detailed analyses of the Tequila Shock in Argentina.
[2]See Federal Reserve Bulletin, July 1991.

Eddie George, stated in a speech in 1993,

".... we do not see it as our job to prevent each and every bank from failing. The possibility of failure is necessary to the health of the financial system, as it is to the efficiency of all other economic activity[3]."

A second implication of these remarks is that bank failure should not be considered necessarily as a failure of supervision. Indeed, it might be argued that it demonstrates precisely the reverse. However, Central Bankers also hedge their bets. Indeed, quoting again the Governor of the Bank of England, he commented in the same speech in 1993,

"...In reaching a decision on support, we take care not to be predictable. Central Bankers have raised unpredictability to an art form, so that the phrase 'Constructive Ambiguity' has become rather popular in our circles. But it is essential that no one - no one - should expect support as a matter of course.... I have to say that there is nothing automatic about our acting as lender of last resort, and even if we decide on support, no bank should assume that it would be immune from penalty" [4]

Of course it is possible that these words are simply idle rhetoric (otherwise known as "Cheap Talk") and that Central Banks do not practice what they preach. It may be that a Central Bank would like to convince banks, ex ante, that they will certainly not be rescued but, when push comes to shove, in fact a Central Bank would not wish to let a perfectly good bank fail.

There are at least two responses to this. First, Central Banks never really know if it is indeed a good bank that needs Assistance or not. Indeed, the fact that it is experiencing an individual problem suggests that mistakes may have been made and if it really is a good bank with an individual problem why can it not find assistance in the private market, why does it need public intervention ? The second response is the problem of moral hazard. If a bank is Assisted then that may create adverse incentives in that bank in particular and also it may be seen as creating a precedent for other banks. Hence, in the future, banks may expect Central Bank assistance and this may alter their strategies today. At best, banks may then chose more risky strategies or at worst managers or shareholders may find ways of diverting resources to their own, and unproductive, ends[5].

In fact, some Central Banks have appeared to live up to their words. For example, although the Bank of England did assist a set of smaller banks during the UK`s painful recession of 1990/1, and it decided to co-ordinate a rescue for Johnson Mathey bank in 1984, it argued that in both cases there were systemic dangers. However, it would not

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[3]Speech given by Eddie George, 18/11/93, London School of Economics.
[4]Ibid.
[5]As Walter Bagehot wrote in 1873, "Any aid to a present bad bank is the surest mode of preventing the establishment of a good bank". Quoted in same speech by Eddie George from Bagehot (1873). For a more general discussion of these moral hazard issues see, for example, Goodhart (1993) and the discussion in Dewatripont and Tirole (1994).

take a game theorist to point out that this is precisely what the Bank of England would say under these circumstances. More compelling is the fact that the Bank of England, decided not to assist either BCCI in 1991 nor most recently Barings in 1995. These events do give support to the statements made by the Governor, especially when it was probably to be expected that the Bank of England would itself come in for some criticism due to these failures

It might be argued that, during the Tequila Shock of 1995, the Central Bank of Argentina also followed the stated policies of both the US Federal Reserve and the Bank of England. Assistance to the banks was provided in the form of repo. operations and rediscounts for illiquidity purposes. Table 1 provides a partial explanation of how the $8bn outflow in deposits was financed and in particular the importance of Central Bank policies including the repo. and rediscount operations together with the reduction in Reserve Requirements.

Insert Table 1

However, assistance was provided on a selective basis depending on the assessment of the institution in question. Again, the Argentine Central Bank has come in for some criticism for this selective policy even though, in general, it received very favourable comments over the management of the crisis[6].

This implies that such selective, or in the words of the Governor of the Bank of England, unpredictable, policy must have some benefits, or at least, that Central Banks must believe that they have benefits. In the first section of this paper we present perhaps the simplest possible model that may be used to illustrate some of the issues raised by Central Bank polices in this regard. In Section 2 a more complex model is developed which incorporates incomplete information. This model can be employed specifically to illustrate why the policy of 'Constructive Ambiguity' may be beneficial. In section 3 some possible further extensions of the model are discussed and section 4 presents a policy debate in the Argentine context. Section 5 concludes.

1. A Simple Model

It is perhaps clear, from the above discussion, that an optimal Lender of Last Resort policy, from the standpoint of the Central Bank, depends on how banks react to such a policy. And in turn banks' strategies will depend on what Lender of Last Resort policy is in place (or what Lender of Last Resort policy they believe to be in place). We are therefore firmly within the realms of 'game theory'.

As discussed above the issues of moral hazard and information are central to this debate.

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[6]Note that although roughly 20% of deposits were lost, only 10 banks were closed representing some 1.4% of total system deposits, figures that compare very favorably indeed with say the bank runs in the US in the 1930's. On Wednesday, May 15th, the President of the Central Bank of Argentina answered questions in Congress on Central Bank policy during the crisis. See his address for a policy statement and see, for example, World Bank (1996), for outside comment on the handling of the Tequila period.

Moral hazard problems can be understood in at least two slightly different ways. First, if we are in normal times, and banks know that assistance will be provided if they have problems, then they may chose more risky strategies or do other things that make failure more likely. Secondly, if we are in a period of stress, and banks know that they will be assisted, then the problem tends to become more exaggerated. In such times, as the probability of failure rises, banks have less and less to lose by choosing more and more risky strategies in an attempt to save their own skins. This is sometimes referred to as "Gambling for Resurrection"[7]. In what follows, we shall only allow banks two strategies which we refer to as either, "Safe" or "Unsafe". Unsafe may imply any of these possibilities.

We shall also consider only two policies for a Central Bank which we refer to as "Assist" or "No Assist". Assistance should be understood as loans from the Central Bank, most likely in the form of rediscount operations before the possible failure of the bank in question. In some sense these operations are subsidised or indeed may simply not be available from the private market (as otherwise Central Bank intervention would play no role). Naturally, Assistance may come with strings attached. For example, as stated by the Governor of the Bank of England, the shareholders and the management and possibly even the non-insured creditors of an 'Assisted' bank may expect to be penalised. However, we will assume that Assistance is a good for the bank whatever strategy the bank is pursuing. Indeed, before the bank has failed it is not obvious that a Central Bank can force Assistance on it, and hence it must be that Assistance is being sought or freely chosen when offered. We can understand this in that in general Assistance should improve the probability of survival and hence in expected terms, net of any Strings attached, banks will indeed prefer to Assisted than not.

It is sometimes stated that rediscounts should be given when a bank has only a liquidity problem but no solvency problem. In this paper we do not discuss further this distinction. Suffice to say that in normal times and especially during a period of stress, a Central Bank may not, and indeed it may be simply impossible to, know, whether a bank has or will have only a liquidity problem or a liquidity and a solvency problem. First, it is likely that a Central Bank will have access to only the balance sheets of the bank and auditors' reports both of which may be subject to errors, ommissions, changes and possibly even fraud. In addition it will have reports from the last inspection but that may have been some time ago and it will have soft information perhaps from other banks or others close to the bank in question. However, it is never obvious how much weight to place on such reports. Second, future solvency depends on the out-turn of exogenous variables (such as interest rates and general loan recovery rates) and the future actions of shareholders and management. Finally, in a period of stress the Central Bank may only have a period of hours to decide on whether to Assist or not. For these reasons, we feel that for the majority of cases when Assistance is sought, there will certainly be a liquidity problem (otherwise why ask for Assistance) and that there is some probability of a solvency problem (otherwise the private market should Assist without Central Bank intervention)

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[7]See Dewatripont and Tirole (1994), p97 for comments on Gambling for Resurrection in the context of the US Savings and Loans crisis and p127 for a theoretical account.

but that the bank does still have the possibility of recovery and potentially of a long-life.

With these antecedents mind, we are now in a position to discuss the simple two person game outlined in strategic form in Figure 1. As described, the Central Bank has two policies, Assist and No Assist and the bank has two strategies, Safe and Unsafe. We shall analyse this game as a game of Simultaneous Play. As in the famous game of the Prisoner's Dilemma this could be interpreted in that both players do in fact play exactly at the same time or that they are confined in their cells and hence do not know what strategy the other has chosen when they are asked to make their choice (in the case of Prisoner's Dilemma, whether to confess or turn against their comrade in crime). In other words, when the bank makes its decision whether to play Safe or not, it does not know whether it will be Assisted and when the Central Bank decides whether to Assist it does not know whether the bank has played Safe or Unsafe.

Insert Figure 1 Here

The payoffs of this game are as follows. We use the outcome No Assist/Safe as the base case and assume that each player receives zero for this result. If a bank plays Unsafe and does not get Assisted we assume that its probability of survival is diminished such that it receives a negative payoff ($-F<0$) and is in a worse position than if it had played Safe given the Central Bank's policy. However, we assume that Assist/Unsafe provides the best outcome for the bank ($R>E>0$). The thinking here is that if it does not have problems it gets a higher return and if it runs into problems, it will get Assisted such that its survival probability is not too bad even though it has played Unsafe. However, we assume that this is the worst outcome for the Central Bank, where an Unsafe bank gets Assisted ($-B<0$). Perhaps the most controversial payoffs are to be found in the last quadrant to be analysed, Assist/Safe. Here we assume that the bank receives a positive payoff (it always prefers to be Assisted than not) but not as high as if it had played Unsafe and got Assisted ($E<R$). It is perhaps not so obvious whether the Central Bank prefers to Assist a Safe bank or not (i.e.: whether $A>0$ or $A<0$).

Suppose that $A<0$, and in other words the Central Bank really would let a Safe bank fail rather than Assist. Then there is a unique Nash equilibrium in pure strategies for this game at Safe/No Assist. In other words if banks play Safe and a Central Bank plays No Assist then each is happy, relative to the allowed alternatives, given the other player's choice. Note that the equilibrium payoffs to the players are (0,0).

Indeed one interpretation of the harsh words of the Governor of the Bank of England is precisely to convince banks that $A<0$ and therefore induce banks to play Safe. But now suppose that this is just Cheap Talk, that banks do not believe it, and that they know that in fact $A>0$. In that case there is no Nash equilibrium in pure strategies to this game. To see this suppose that Safe/No Assist was played. A Central Bank would then prefer to play Assist ($A>0$), but then banks would prefer to play Unsafe ($R>E$). However, then a Central Bank would adopt No Assist ($0>-B$) in which case banks would prefer Safe.

Assuming that this was a reasonable description of the payoffs, and A>0, what would the players actually do ? One response, thanks to a theorem by Nash, is that the players may randomise. In other words, they may play a Mixed Strategy. Some of the time a bank may play Safe and at other times may play Unsafe and some of the time the Central Bank may Assist whist at other times the Central Bank may Not Assist (or an alternative interpretation is that the Central Bank should be unpredictable).

Let q be the probability that the Central Bank would play Assist. It then follows that banks would play safe if:

$$qE > qR - (1-q)F$$

or in other words if q is such that,

$$q = \frac{F}{F + R - E}$$

then banks would be indifferent between playing Safe or playing Unsafe. Similarly, suppose p is the probability that a bank will play safe. The Central Bank would wish to play Assist if,

$$pA - (1-p)B > 0 - (1-q)F$$

Or, in other words it would be indifferent between its two strategies if,

$$q = \frac{B}{A + B}$$

Note that given A,B,E,F>0 and R>E then 0<p,q,<1 and hence the probabilities are well-defined. It then follows that if a Central Bank randomises between its two strategies with probability q and banks randomise between their strategies with probability p as given by the above two equations, then this will be an equilibrium where both players are happy with their mixed strategy given the mixed strategy choice of the other player. In other words, (Assist,q;Safe,p) is a Nash Mixed Strategy Equilibrium. It is straightforward to calculate the equilibrium payoffs from this strategy which turn out to be as follows, { 0, EF/(F+R-E) }. In other words, the Central Bank gets zero but the banks actually get a positive return, slightly better that the strategy (Assist, Safe). This is because, with some probability, the bank is actually getting Assisted whereas in the pure strategy equilibrium above it always plays Safe. If social welfare is then taken as a weighted average of the Central Bank's and the bank's payoff then this Mixed Strategy equilibrium is actually preferable to the pure strategy equilibrium outlined above when A<0.

This first, very simple approach then gives some flavour of the problem facing a Central Bank in its Lender of Last Resort role. Our results indicate that if Central Banks do actually prefer to allow a Safe bank to fail then banks may be induced to play Safe.

However, if Central Banks do not prefer this option, there may be another equilibrium providing banks and Central Banks are being unpredictable. Interestingly it turns out that this equilibrium may actually be superior.

Naturally, this very simple model has severe limitations. In the language of game theory, it is a two-person, simultaneous-play, full-information, one-shot game. It could then be extended in a number of different directions. For example, we could add further players or we could analyse the sequential play version of the game where one player has a first move (dis)advantage. We could also analyse a repeated version of the game in which it might be possible for the Central Bank to discipline banks to induce them to play Safe. However, we chose in this paper to relax the assumption of full-information. In particular, one of the critical issues facing a Central Bank, discussed in the introduction, is how to respond to a bank that asks for Assistance when it is not clear whether there is a Systemic or a Non-Systemic (i.e.: individual) problem or indeed, if that bank did fail whether it might then cause a Systemic problem. In the next section, we extend the model presented above in an attempt to capture this aspect of the problem.

2. Adding Incompleteness

In this section we change a little the story described accompanying the first model above. Suppose that a shock hits the banking community and that a bank comes to the Central Bank seeking Assistance. The Central Bank makes an assessment about whether this shock may have Systemic effects or not but this assessment is not known by the banking community. The Central Bank must then decide whether to Assist or not. Naturally, the Central Bank may say that there was indeed a Systemic risk to justify any Assistance that it might undertake, but we assume that such statements carry little weight with hard-nosed bankers. Banks then decide whether to pursue Safe or Unsafe strategies based on whether they see the Central Bank Assisting or not. It is also interesting to note that Central Banks often try to keep whether they Assist or not or the extent of their Assistance secret. We assume that this is not credible and that in fact banks do know if another bank has been Assisted.

The reason that this game has Incomplete Information is that banks do not know whether the Central Bank feels that there is a Systemic problem or not. Hence banks must attempt to deduce the strategy of the Central Bank from its actions (Assist or No Assist). Naturally, as above, if the banks feel that the Central Bank would Assist if they had a problem (whether individual or systemic) then they would tend to play Unsafe rather than Safe. If, however, banks judge that they will not be Assisted then they would prefer to play Safe. Turning to the Central Bank, we assume that whatever strategy the banks are playing then if the Assessment is that there is a Systemic Risk, then the Central Bank would prefer to Assist rather than not Assist. If on the other hand the problem is clearly an individual one then we assume that the Central Bank will prefer to play No Assist. Furthermore, in the model described, the Central Bank prefers the other banks to play Safe rather than Unsafe. In particular if there is an assessment that there is a Systemic problem

(and therefore the Central Bank plays Assist) and banks are playing Unsafe then this results in the worst payoffs in the game.

In fact, it has been argued that there is no such thing as a game of Incomplete Information. What is meant by this is that any game with incomplete information has a complete information representation. In Figure 2, we illustrate a complete information representation in extensive form, of a game with payoffs with the properties described above.

Insert Figure 2 Here

We start our description at the very central node of this game. First, chance plays a role and a shock hits the banking community. With probability r, in the view of the Central Bank, this shock may result in Systemic problems and with probability (1-r) it is assessed that it is simply an individual shock; Non-Systemic. A bank comes to the Central Bank seeking Assistance and the Central Bank must decide whether to Assist or not based on its assessment of the nature of the shock. After observing whether the Central Bank has Assisted or not then the rest of the banking community decides on whether to follow a Safe or an Unsafe strategy.

In terms of the information sets for this game (illustrated by the dotted lines). The Central Bank knows its own assessment when it decides whether to Assist or not. However, the banks only know whether the Central Bank has Assisted or Not, it cannot observe the Central Bank's assessment directly[8].

A pure strategy equilibrium in this game is a vector with four elements giving the strategies for player 1 in the case of Non Systemic and Systemic assessments and which gives the reactions by player 2, Safe or Unsafe and where each player's strategy is a best reply to the other's.

In fact, given the payoffs of the game described there is indeed a Nash pure strategy equilibrium. This is at (No Assist, Assist, Safe, Unsafe). To see this, suppose there is a non-systemic shock and banks play Safe, clearly a best response to this is to play No Assist. Now suppose there is a systemic shock and banks play Unsafe. Given there is a Systemic Shock the Central Bank's best response is to play Assist. Hence the Central Bank's strategy (No Assist, Assist) is a best response to the strategy of the banks. Now suppose banks see No Assist, their best response is indeed Safe and if banks see Assist, there best response is Unsafe. hence, the banks' strategy (Safe, Unsafe) is also a best response. Note that this equilibrium in pure strategies is also fully revealing in the sense

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[8] It will be appreciated rapidly by those with knowledge of game theory, that this game was inspired by games where there are two players and where Player 2 is not aware of Player 1's Type. For example, in a game devised by Kreps known as "Quiche", men are either "Wimps" (and like eating quiche) or "Tough" (and like drinking beer) and women, who like to bully Wimps, cannot observe men's types directly. It turns out that Wimps may drink Beer to convince women they are tough and so avoid being bullied. See Binmore, K. (1992) for a lively discussion of these games.

that from noting the Central Bank's response, banks can infer correctly the Central Bank's assessment as to whether there was indeed a Systemic problem or not. Finally, consider the welfare effects of this equilibrium. These can be calculated in expected terms easily using the probability of a Systemic shock occurring, r. It turns out that welfare is as follows, (4-3r, 2). As an example, suppose r=2/3. Then, welfare is (2,2). It turns out that this is the only Nash equilibrium in pure strategies for this game.

So, it seems we have invented a simple model after all. But this is not where the story ends. Note, first of all, that this equilibrium contains the worst outcome of all. If the assessment is that there is a Systemic shock, then the Central Bank will Assist and banks will play the Unsafe strategy leading to the worst payoffs in the game ! Although this is then the only Nash equilibrium in pure strategies, it does not appear a particularly palatable one, at least not for the Central Bank.

One strategy would be to commit ex ante to a rule which would effectively disbar the possibility of the central Bank Assisting banks given a Systemic shock. Perhaps a more realistic way of saying this is that an ex-ante rule could be put in place which would be so difficult to change that the pay-off from doing so (and so being able to Assist banks given a Systemic shock) would be so reduced that it would be better not to. If this could be done then it would rule out Assist as a strategy in the case of a systemic shock and a Nash equilibrium might be found in (No Assist, No Assist), (Safe, Safe). This would result in payoffs of (4-2r,2-r). Again, for the special case of r=2/3, this results in payoffs of (8/3,4/3). For the payoffs chosen these results are certainly an improvement for the Central Bank although note that banks are made worse off.

This might be one interpretation of the effect of the 1991 Convertibility Law in Argentina. The Convertibility regime calls for full backing of the monetary base with Central Bank reserves and hence places a limit on the Argentine Central Bank acting as a monetary lender of last resort. This rules out any major rescue of the banking sector by the Central Bank and hence makes any large-scale assistance plainly a fiscal cost and therefore much more transparent. Arguably, therefore the equilibrium (No Assist, Assist) is ruled out. We come back to this point in Section 4 below.

Abstracting from commitments such as Convertibility, the poor nature of the equilibrium in pure strategies might lead a Central Banker to investigate whether there are any equilibria in Mixed Strategies for this game. In fact, Mixed Strategies for this game are somewhat complex and it is simpler to work in Behavioural Strategies. Whilst a Mixed Strategy places a probability against each of a player's pure strategies and hence for the game above is a four element vector for each player, a behavioural strategy assigns a probability to each player's action at each information set. In this game this implies a two element vector for each player. Luckily, due to a theorem from Kuhn, we know that for each Mixed Strategy there is a Behavioural Strategy representation and vice versa. In other words, they both essentially boil down to the same thing; that players randomise but are two different ways of describing the same random play.

To investigate the possibility of a Behavioural Strategy Equilibrium, define the following Behavioural Strategies for Players 1 and 2:

Player 1: The Central Bank

> P(Not Assist at Non-Systemic) = B; and let Q=1-B
> P(Not Assist at Systemic) = b; and let q=1-b

Player 2: The Banks

> P(Safe at Assist) = d
> P(Safe at Non Assist)=D

where P(X) is the Probability of X. We now need to know how Player 2 (the banks) will update their beliefs concerning whether the shock is Systemic or not. We will make the usual assumption, namely that Player 2 is Bayesian. Therefore, Player 2 will calculate that:

$$P(NS \, / \, A) = \frac{P(NS \cap A)}{P(A)} = \frac{P(E)}{P(E) + P(F)}$$

$$P(S \, / \, A) = \frac{P(S \cap A)}{P(A)} = \frac{P(F)}{P(E) + P(F)}$$

$$P(NS \, / \, NA) = \frac{P(NS \cap NA)}{P(NA)} = \frac{P(G)}{P(G) + P(H)}$$

$$P(S \, / \, NA) = \frac{P(S \cap NA)}{P(NA)} = \frac{P(H)}{P(G) + P(H)}$$

Where, A=Assist, NA=No Assist, S=Systemic and NS is Non-Systemic and where E,F,G and H refer to the nodes indicated in Figure 2.

In fact the structure of the game suggests where to look for potential Behavioural Strategy Equilibria. It is clear that if the Central Bank, Player 1, assesses that the shock is Not Systemic, then there is nothing to be gained from playing Assist. This is because we have assumed in the payoffs that the Central Bank prefers not to Assist in the case of a Systemic shock irrespective of whether the banks will play Safe or Non-Safe and when the Central Bank plays Non-Assist, then the banks will play Safe, which is best for the Central Bank, anyway. In the language of the game discussed in Section 2 above, we have set A<0. A more complex possibility would structure the payoffs such that the Central Bank would prefer to Assist so long as the banks were playing Safe. However, in this version of the game, it is clear that when the shock is non-Systemic there is nothing to be gained by the Central Bank vacillating and the Central Bank should play No Assist. Hence, in the

above B=1 and Q=0.

However, in the case of a shock which is considered by the Central Bank as potentially Systemic, things may be a little more complex. Here, the Central bank would like banks to play Safe but if the Central Bank plays Assist, it is clear that banks will respond with Unsafe. Hence, there may be a benefit from the Central Bank randomising at Non-Systemic.

To analyse this further, consider Player 2's position. Suppose that Player 2, sees Non-Assist. It follows that Player 2 will play Unsafe if,

P(S/NA)>P(NS/NA)

From the above updating formulae and substituting in for the probabilities this will be when,

$$\frac{rb}{(1-r)B+rb} > \frac{(1-r)B}{(1-r)B+rb}$$

It follows that a potential Behavioural Strategy Equilibrium will be when Player 2 will be just indifferent between the two strategies or in other words when,

$$\frac{r}{(1-r)} = \frac{B}{b}$$

But we have argued that B=1, and remembering that b=1-q, we can write this condition as,

$$q = 1 - \frac{1-r}{r}$$

This will yield a probability, q, 0<q<1, when r>1/2. If not, given the payoff structure assumed, this particular Behavioural Strategy Equilibrium cannot exist (note that others may very well exist however). Suppose, as we assumed above that this condition is met and that specifically, r=2/3. Then, the potential Behavioural Strategy Equilibrium will be with q=1/2.

Now, consider the position of Player 1, The Central Bank. Player 1 will be randomising at Systemic. Suppose No Assist is played. This is returned with Safe from the banks yielding a payoff of 2 to the Central Bank. So, if the Central Bank is to be indifferent between Assist and No Assist, this must mean that a payoff of 2 is expected from playing Assist. This implies that the probability of the banks playing Safe, p, must satisfy 3p+(1-p)=2. Or in other words, p=1/2.

It follows that there is Behavioural Strategy Nash Equilibrium for this game. If there is a Non-Systemic Shock, the Central Bank should play No Assist and if No Assist is played then banks will respond with Safe. However, if there is a potentially Systemic Shock, then the Central Bank should randomise playing Assist and No Assist with probability 1/2. If banks see Assist, they too should randomise Safe and Unsafe each with probability 1/2.

It is straightforward to calculate the welfare from this equilibrium. It turns out that the Central Bank will expect a payoff of 8/3 whilst the banks will expect a payoff of 3/2. Note that for the Central Bank at least this is a superior outcome than the equilibrium in pure strategies where the Central Bank only expected a payoff of 2. This is because, if there is a Systemic shock it is now, not always the case, that the worst result (.... , Assist), (....., UnSafe) is obtained. Indeed 50% of the time if there is a Systemic shock, banks are lulled into playing Safe. Indeed, the result for the Central Bank equals the expected payoff from the equilibrium that results if (......, Assist) can be ruled out through, say, a Convertibility type Law. However, naturally it is a worse result for the banks who prefer to be Assisted than not, and yet 50% of the time when there is a Systemic shock, they are not Assisted at all.

In conclusion, although this game has a unique Nash equilibrium in pure strategies which includes the worst outcome for the Central Bank, it also has a Nash equilibrium in Behavioural (and hence in Mixed Strategies). Indeed, it turns out for the Central Bank at least that there are some advantages from being unpredictable. We have therefore, it might be argued, arrived at a defence of why Central Bankers like, 'Constructive Ambiguity'. However, which equilibrium will result is not an easy question to answer. Perhaps, the speeches of the Governor of the Bank of England can be interpreted as an attempt to influence which equilibrium is selected.

3. Potential Extensions to the Model

Naturally, the models developed in Section 1 and 2 are very stylistic to focus on a specific point. Here discuss some potential weaknesses and possible extensions of these models.

3.1. The Central Bank wishes to Assist Safe Banks.

As mentioned above, in the payoff structure above it is assumed that the Central Bank would really not wish to Assist a Safe bank in the even of a Non-Systemic shock. In the simple model of Section 2, this was like assuming that A<0. However, suppose a Central Bank did actually wish to help Safe banks even if the shock was not Systemic. In that case, it may follow that there is no equilibrium in pure strategies (as in Section 2) and that there may be a more complex Behavioural Strategy Nash Equilibrium. Indeed, it may follow that the Central Bank would wish to randomise at both Systemic and at Non-Systemic. At Systemic, as above it has something to be gained as it may wish to induce banks to play Safe. At Non-Systemic, it now has something to be gained from playing Assist but once again it wants to induce banks to play Safe. Hence, this more complex

equilibrium may justify total, 'Constructive Ambiguity' rather than just 'Constructive Ambiguity' if the assessment is that the shock may be a Systemic one.

3.2 The Central Bank Can Monitor Bank Strategies

The above model is extreme in the sense that banks chose their strategies unilaterally and the Central Bank has no control whatsoever over what banks do. In fact, the Central Bank also sets prudential regulatory standards and there is also a regime for punishing banks that do not comply with those standards. These regulations are extremely important for conditioning banks' incentives especially when banks hit problems. They may either exacerbate the problem of banks choosing risky strategies (Gambling for Resurrection) or help to reduce it. This problem has been extensively analysed in the literature (see for example, Dewatripont and Tirole 1994). In the model above, we assume that if the Central Bank chooses to Assist, then the Central Bank cannot affect banks' strategies at all which is obviously extreme. If a regime was admitted whereby banks could be monitored accurately and sufficient punishments administered to shareholders and managers, then naturally the Central Bank could Assist in the event of a Systemic shock without any moral hazard problems arising. More realistically, an imporoved model might include imperfect monitoring and a limited range of punishments at its disposal. The Central Bank may still then be concerned about the adverse incentives it was creating.

3.3 Repeated Games

The above simple games presented in Section 2 and 3 are one-shot in the sense that each party only gets to make one decision and then (subject to chance) the payoffs are determined. In a more complex game, this process might get repeated a number of times, or even an infinite number of times. As in game theory more generally, this would open a wide set of possibilities and we know from game theory more generally, that, even if equilibria concepts are agreed, unique equilibria are rare beasts in the land of repeated games. However, to give an idea, a bank that chooses an Unsafe policy might be punished later by the Central Bank playing No Assist in the future if indeed Assistance was sought. However, this might not be credible, in particular if the subsequent shock was potentially Systemic in nature. One challenge would then be to find the path of maximum credible threats and hence the maximum degree of Assistance that might be sustained without banks resorting to Unsafe policies. We leave the further analysis in a repeated game setting as work to be done.

3.4 More Players, More or Less Information

One of the controversial features about the Lender of Last Resort Role of the Central Bank is to understand exactly where is the market failure that might require a public intervention. If there is a purely individual liquidity problem in a good bank then presumably that bank should find the necessary help from other banks in the system. More realistically, any liquidity problem is accompanied by at least a possibility of a solvency problem. Fear of bankruptcy may spark credit-rationing, perhaps due to the moral hazard

that the borrowing bank will again be tempted to 'gamble for resurrection'. This might justify a public intervention, if for example, the Central Bank had at its disposable better monitoring and control technologies than individual banks. A second justification might be that a bank may fear that the liquidity problem of one bank may be transferred to other banks and to itself. For example, a run on deposits in one bank may, through a contagion effect, affect others. However, banks may not be able to decide collectively how to deal with such problems, each hoping that another bank in the system will offer the required Assistance. In other words, there is a collective action problem, in dealing with this contagion. Once again, this might justify the intervention of the Central Bank, to stop the contagion spreading. Third, even abstracting from these problems of control and incentives, other banks may simply not internalise the externalities that their (collective) existence has on the functioning of the economy in general. Hence, the normal defence of the Lender of Last Resort function; protection of the payments system, which banks will not adequately protect left to their own devices.

These arguments have highlighted the role of other banks when one bank runs into problems. For the various reasons outlined the other banks may not wish to Assist the bank in question and hence the Central Bank (or other body) may be justified in acting as Lender of Last Resort. The standard justification for the Central Bank having this role is that it also is equipped with the necessary information and the monitoring (and possibly) control technology through its supervisory role (indeed this is normally the justification for the non-separation of the Central Bank from the supervisory function although we note that in some countries these roles have been separated). However, it is not obvious that the Central Bank always possesses better information than other banks. Indeed, casual empirical evidence suggests that in the case of several notable failures, other banks were perhaps aware of serious problems in the bank under scrutiny before the regulator.

A possible extension to the model above would be to attempt to include these features. For example a bank may first have to decide whether to seek Assistance from the Central Bank or attempt to gain Assistance from other banks. The reaction of other banks may yield information to the Central Bank on the state of the bank and on the nature of the shock to that bank. In a sense the Central Bank might receive two signals of quality of the bank in question. One from its own Superintendency and one from other banks (which was more than just "Cheap Talk"). This might provide the Central Bank with more information than only that from its own resources.

Indeed, this argument suggests that some type of institutional arrangement might be harnessed to make maximum use of the totality of information (and control possibilities) available. One idea that has been proposed is that groups of banks should form clubs ex ante such that each member of the club would first and foremost be able to seek Assistance (up to some limit) relatively automatically from the other members. This would provide an incentive for the members of the club to seek information on other members' activities and find ways of exerting control (in the limit through the possibility of the threat of forced withdrawal from the club). We return to this idea in the Argentine context in the next section.

4. A Discussion of the Structure of the Lender of Last Resort in Argentina [9]

The experience of Argentina in 1995 underlines the importance of maintaining a significant stock of liquid resources, to act as a type of shock-absorber, for banking systems that are subject to Systemic shocks. The Argentine experience demonstrates that at least 20% of the deposits of a banking system can leave in a relatively short period of time (this is less than left the US banking system in the 1930's but over a substantially longer time period).

As discussed in the Introduction, Argentina did indeed have a significant amount of liquidity at its disposal to confront the 1995 Tequila crisis. The shock would have certainly had much more severe effects if this liquidity had not been available. The figures in Table 1 showed that this liquidity came from at least three different sources.

First, the relatively high Reserve Requirements, now reformulated specifically as Liquidity Requirements in Argentina, provided a stock of liquidity of roughly speaking 41% of the fall in deposits during the crisis in 1995[10]. Second, Central Bank repo. and rediscount operations financed about 27%. Third, the increase in external credit lines provided a further 27% of the outflow. In total then Central Bank policies together with external credit lines provided financing for roughly 95% of the fall in deposits and hence helped to limit the fall in credit. Without, this stock of liquidity, many more banks would have had serious problems, perhaps even jeopardising the payments system itself and credit would certainly have fallen further with greater negative effects on the real economy.

At the same time, the Convertibility Law implies that the Lender of Last Resort function of the Central Bank is limited and that essentially the limit depends on the size of the excess reserves that the Central Bank possesses over the size of the monetary base. If for some reason Assistance is required over and above this limit, Convertibility implies that these must be strictly a fiscal liability of the Government. It might be argued that the Fiduciary Funds, created during the crisis in 1995, also played a role in preventing further failures and so to some extent Assisted banks or at least their uninsured creditors (these funds were used with strings attached typically involving the sale or merger of the institution Assisted). These funds were financed by loans from the Global Economic Institutions (GEI's) and from a Government bond issue. It might be argued therefore that the Government and the GEI's also played a role of Lender of Last Resort to the banking system,

It is difficult to judge what is the optimal amount of the total stock of liquidity that is required to protect a system against such a Systemic shock and the total amount is certainly not independent of the structure of the reserve nor other institutional

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[9]This section draws on a discussion document produced in the area of Economics and Finance of the Central Bank of Argentina, Central Bank (1995). See also Caprio et al (1996) for a wider discussion.
[10]See Pou (1995) for a discussion of the role of the Liquidity Requirements in acting as a buffer of external liquidity in the event of a Systemic shock. See the Bulletin of Monetary and Financial Affairs, Second Edition for a description of how the Liquidity Requirements operate in Argentina.

arrangements. For example, in May 1995 Argentina introduced a limited, but obligatory, deposit-insurance scheme fully-funded by the banks which protects investors up to $20,000. This may have an important effect in reducing the probability of a run in the future.

Essentially, the question of the size of the reserve depends on the trade-off between the negative effect on credit supply and the beneficial effect of the reduction in the probability of a run. For example, those in favour of the so-called Chicago, Narrow Banking proposal, suggest that bank deposits should be protected 100% by forcing banks to only invest in highly liquid assets but that risky credit should be provided by other types of financial intermediaries. Whilst this proposal would indeed stop the possibility of bank runs, it would also likely have a strong negative effect on the supply of credit[11]. A100% liquidity requirement stops runs altogether as all depositors know that they will be paid but it seems unlikely that this is an optimum. Reducing the liquidity requirement by a small amount would probably increase credit (given credit would most likely be supply constrained) but only increase the chance of a bank-run a very small amount indeed which would be even more unlikely to provoke a systemic run . The difficult question, however, is to locate the optimum within this trade-off.

In what follows, we will work with the assumption that roughly speaking a 20% total liquidity requirement is needed. The next question is then how should this be structured. The possibilities include (i) resources owned by the banks themselves e.g.: The Liquidity Requirement, (ii) resources controlled by the Central Bank (for repo. and rediscount operations), (iii) resources to come from outside the financial system (essentially Government or foreign source through Government or via private means).

A potential structure is as follows. Currently the Liquidity Requirements on banks stand at 15% on a wide range of bank liabilities. Suppose, that net of resources at the Central Bank that are required to operate the payments system and taking into account that this liquidity may not always be correctly distributed, that this results in a stock of liquidity of 10% of deposits for direct use to confront a Systemic shock. A further 5% might then be forthcoming from Central Bank repo. and rediscount operations leaving a further 5% to come from fiscal resources. For example, based on a deposit base of $40bn (now somewhat low for Argentina, that would imply $4bn being liberated from Liquidity Requirements and $2bn from Central Bank excess reserves and $2bn from fiscal resources).

Each of these sources of funds has slightly different costs (dependent on the return from their alternative uses) and slightly different benefits (the benefit of Liquidity Requirements is constrained because they are legally the property of the banks, whereas the use of Central Bank rediscounts and fiscal resources may be more flexible although, the use of Central Bank resources might be more costly in that it might be perceived that

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[11] Note that for protection against Systemic risk, narrow banks would have to hold foreign liquid assets and not domestic assets otherwise with a Systemic shock which affected the value of the assets held a run would not be prevented.

Convertibility was being put at risk.

The next question is how should these resources be operated. The main message of this paper is that an explicit rule such as Assist if Systemic, Do not Assist if Not Systemic may be inferior to a rule which depends to some extent on, 'Constructive Ambiguity'. First, consider the case of a purely Non-Systemic problem. In fact, this presents little problem and there is a prima facie case that the Central Bank should not intervene at all. However, if for some reason the private market may be seen to be failing, there might then be an argument for Assistance but the suggestion made here is that this should be only through Repo. operations or from releasing (temporarily) that bank's Liquidity Reserve. It is not clear why a Central Bank should otherwise place public money at risk to protect the shareholders, managers, and uninsured creditors of a private bank.

Second, consider the more difficult question of a problem which may be Systemic in nature or which may become Systemic in nature. One possibility is that the funds should be employed in the following order; (i) Repo. Operations of the Central Bank, (ii) Liquidity Reserve of the banking system, (iii) External Fund (Fiscal and/or External), (iv) Rediscount Operations using the Central Bank's excess reserves.

This ordering is designed first and foremost to protect the Convertibility System. The controversial aspect is the use of the External Funds in this ordering and this requires some explanation. Here the idea is that an External Fund of some sort might be created which could also give Rediscount Operations and hence further protect Convertibility. This fund could be a contingent facility or permanent (perhaps funds raised through a bond issue).

It could be a Government sponsored fund or it could be private, perhaps managed by an entity owned by the banking system itself. If it were an actual fund, the sums might be raised by a bond issue with Government guarantee or with a GEI guarantee and Government counter-guarantee. If it were a contingent credit line, this could be from a private international bank or from a GEI with or without a Government counter-guarantee. In fact it is unlikely that a purely private contingent facility would work. If there really was a Systemic problem it is likely that the private counterparty would wish to withdraw from the arrangement precisely when it was most needed. Indeed, a GEI might like to do the same or at least impose strong conditionality on the use of the funds which may or may not be palatable to the Government of the day. For these reasons, GEI's may be wary of any explicit arrangements; they too are worried about the moral hazard.

It would also be important to attempt to define what the policies of the fund would be and in particular how would it arrive at a decision as whether to Assist a bank or not. It is not suggested here that the External Fund should necessarily have the same level of discretion as the Central Bank. Naturally, it would be designed to help institutions only in the event of a perceived possibility of a Systemic problem arising. However, if it had such explicit rules, which might be necessary to guard against the mis-use of the fund itself, then the problem of moral hazard arises.

One potential solution is to employ the idea that the External Fund would only back a group of banks and not an individual bank, and further that the group of banks must first agree to Assist each other in the face of a liquidity problem up to some agreed limit. This would have the advantage that the fund would then only tend to be used when there was a Systemic problem. Secondly, banks would have a greater incentive to monitor themselves and each club should have the power to force a bank to exit (in which case it would lose the protection of the External Fund and be at the mercy of the Central Bank's more discretionary policy). Naturally, however, there are also dangers with this proposal, not least that banks may collude and that therefore it may have anti-competitive features. Naturally, some monitoring would also be required on the part of the Central Bank although on the whole, given the enhanced incentives for self-monitoring it should make the Supervisory role of banks somewhat easier[12].

Naturally, this structure outlined in broad terms for the creation of a Lender of Last Resort under a Convertibility System is just one of a possible number of structures each with its own pros and cons. A great deal of further research is required to work out exactly the details of its operation. Furthermore, this is an area where the details of such programs turn out to be very important indeed.

5. Conclusions

In this paper, we have outlined two simple models that give some flavour of the decision problem of Central Banks in their Lender of Last Resort roles (Section 1 and 2). In the first model, there was no Nash Equilibrium in pure strategies unless a Central Bank really preferred Not to Assist a Safe bank. However, if the Central Bank did wish to Assist Safe banks then there was an Nash Equilibrium in mixed strategies which was actually better for the Central Bank than the pure strategy equilibrium. In other words if the Central Bank was unpredictable in its strategy choice then a superior equilibrium emerged when the Central Bank wished to help a Safe bank. In a more complex game with Incomplete Information, it was found that if the Central Bank was unpredictable then again a superior Behavioural Strategy Equilibrium might result (relative to the unique equilibrium in pure strategies which included the Central Bank Assisting Unsafe Banks). These results give some theoretical basis for why Central Bankers might wish to adopt a strategy of selectivity or even unpredictability. In other words, these results provide a defence of what has been termed, 'Constructive Ambiguity'.

However, the simple models outlined clearly do not do justice to the multi-dimensional decision-problem faced by Central Bankers in this controversial role. In light of this, several extensions are discussed in Section 3. These include adding further players and repeating the game, perhaps with less information. However, it is be expected that these extensions, whilst potentially adding further insights, would not prejudice the results obtained. In Section 4, a discussion was presented of the Argentine case where any

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[12]See Calomiris et al (1995) for a more detailed discussion of a proposal in favour of developing Clubs of banks.

Lender of Last Resort facility must take into account explicitly the restrictions of the Convertibility Regime.

Finally, we wish to end the paper on a political economy conundrum. The paper has given some theoretical support for, Constructive Ambiguity. Taken literally this implies, as suggested by Eddie George, the Governor of the Bank of England, that a Central Bank should take pains to be unpredictable in its role of Assister to the banking sector. We have shown that, under some circumstances at least, this results in a higher payoff to the Central Bank and possibly higher welfare than a predictable strategy. However, the political economy conundrum is how can unpredictability be compatible with accountability, generally defined. To take a more concrete example. Suppose a Central Bank indeed took this advice to heart and was unpredictable in its Assistance strategies with the result that some banks were Assisted and thus survived and some banks were not Assisted and did not survive. Should the Central Bank be forced to explain its actions would unpredictability be seen as a good defence ? Without very firm political backing and ample room for discretion, a non-courageous Central Banker might take the view that maximising social welfare would be too risky an activity if ex post such strategies cannot be defended. Society would then suffer in the sense that it would be more likely that an infererior, although, predictable equilibrium might result.

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GRAPH 1: DEPOSITS IN ARGENTINA

- Monthly Averages -

Y-axis: In billions of dollars (36 to 48)

X-axis: Jul-94, Sep-94, Nov-94, Jan-95, Mar-95, May-95, Jul-95, Sep-95, Nov-95
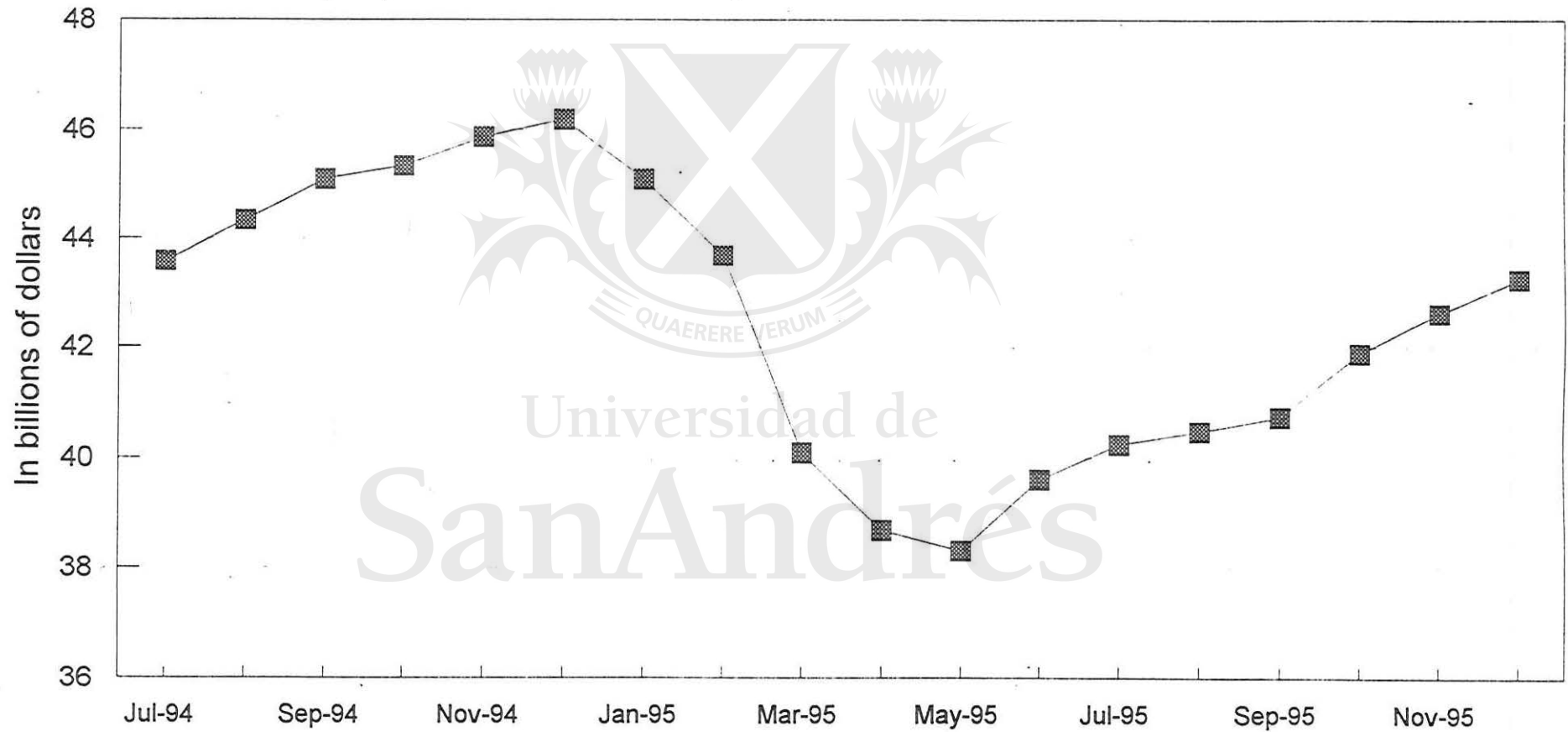
Table 1: Sources of Liquidity during the 'Tequila Effect'
December 1994 - December 1995

Millions of dollars	Total Deposits a	Reserve Maintenance b	Central Bank's Creation of Liquidity		Foreign Lines of Credit e	Total f=b+c+d+e	Difference f+a	Total Credit
			Repos. c	Rediscounts d				
Dec 31 - Feb 28	-2497	2165	369	284	1220	4038	1540	136
Feb 28 - Mar 31	-3608	1296	436	836	326	2894	-713	-1893
Mar 31 - May 31	-1766	-248	-260	497	570	559	-1207	1401
Dec 31 - May 31	-7871	3212	545	1617	2116	7490	-381	-356
May 31 - Oct 31	3570	-1056	-258	-140	-563	-2017	1553	1116
Oct 31 - Dec 31	1367	-645	-1	-147	-470	-1263	103	-393
May 31 - Dec 31	4937	-1701	-259	-287	-1033	-3280	1656	723
Dec-95 - Dec-94	-2934	1511	286	1330	1083	4210	1276	367

Figure 1 : **Constructive Ambiguity : 1**
Central Bank Versus Individual Bank

Central Bank

	No Assist	Assist
Safe	0 , 0	A , E
Unsafe	0 , -F	-B , R

Bank

Figure 2: **Lender of Last Resort: - Incomplete Information Version**