Liquidity Protection versus Moral Hazard: the Role of the IMF*

Andrew Powell and Leandro Arozamena
Business School, Universidad Torcuato Di Tella

Abstract

A game between the IMF a country and atomistic private investors is motivated by recent crises including Argentina. The one stage game has no Nash equilibrium in pure strategies. Considering an equilibrium in mixed strategies, conditions are derived on whether the IMF should exist. A "cooperative first best" may be supported in a repeated game by a "minimum punishment strategy" but breaks down as the probability of insolvency rises. Countries are likely to deviate in bad times placing the IMF in an "impossible position". The international financial architecture (IFA) remains incomplete.

Key Words: International Monetary Fund, International Financial Architecture, Sovereign Default.

JEL Classification: F33, F34, G20

1 Introduction

Recent crises in Latin America have highlighted the problem of sudden stops in capital flows and the large costs for the countries concerned[1].

*We would like to thank Martin Besfamille, Juan Pablo Nicolini and seminar attendees at the Universidad Torcuato Di Tella, the IMF and conference participants at the University of California at Santa Cruz. Special thanks are due to Joshua Aizenmann and Paolo Pesenti for detalied comments. Andrew Powell would like to thank the IMF and the Brookings Institute. All mistakes remain our own. Comments to: apowell@utdt.edu

[1]In particular see Calvo and Rheinhardt (1999).

It is difficult in practice to draw a clear distinction between sudden stops driven by fundamentals and pure liquidity "runs". Given the potential large swings in private capital flows, the role of the IMF in the region is particulartly important, but also particularly complex. If the Fund feels uncomfortable with a country's policy mix and withdraws support, this is likely to provoke a capital flow reversal with serious consequences. On the other hand, if it does not withdraw, it may be accused of supporting unsustainable policies and provoking moral hazard. The IMF has been much criticised of late but there is less analysis of the strategic problem the Fund faces in attempting to support good policies versus the repurcussions of the Fund withdrawing on large and volatile private capital flows.

Broadly speaking, there are two schools of thought. The "moral hazard school" stresses the perverse incentive problem created by insurance type interventions in capital markets. Adherents point to the sheer size of IMF led packages, the low emerging country spreads after the Mexican 1995 rescue and stress the idea that countries might consider packages as substitutes to safer policies or reform. A second school, we name the liquidity school, stresses a set of failures in capital markets; asymmetric information between lenders and borrowers and co-ordination failures between lenders giving rise to problems including multiple equilibria. According to this view, financial markets are inherently unstable. An IMF promise of liquidity may then solve lender coordination problems and eliminate the incentives for investors to "run"[2].

These two schools appear difficult to reconcile but in this paper a simple model is developed that encompasses both. Runs may be a result of fundamental or pure liquidity concerns although, at the time of

[2] Arguably Meltzer (forthcoming) and Haldane and Krug (2000) fall into the moral hazard camp while Calvo (2002) sides more with the liquidity school. Eichengreen and Ruhl (2001) provide a model where moral hazard wins through and Ghosal and Miller (2003)'s model has a similar tension between creditor coordination and moral hazard as in our case. They consider a mixed strategy equilibrium where creditors behave randomly. Their concern is more on CAC's and SDRM's and less on the role of the IMF and they do not consider a multi-stage game. Shin and Morris (2003) and Corsetti et al (2003) have a different timing to ours in a one stage game and suggest the IMF may not provoke moral hazard at all. We discuss these papers further below.

the run, it is not known which. The IMF can provide protection against pure liquidity runs but at the cost of moral hazard. It is suggested that, as both schools are right, it is precisely the tension between them that makes the task of the IMF so difficult.

To a large extent, the model and the discussion are motivated by events in Argentina leading up to the crisis at the end of 2001. The tension between the moral hazard school and the liquidity school was particularly evident. Given policies adopted in Buenos Aires, the Fund became uncomfortable with continuing support (moral hazard), but there was also an acute awareness that withdrawal would provoke a liquidity run, devaluation and default - the crisis that Argentina was precisely trying to avoid (liquidity protection).

With a major IMF led support package in place at the end of 2000, Argentina implemented more risky policies aimed at reviving the real economy but with a decreasing probability of success - these policies included a subsidy plan for exports and relaxing banking regulations in an attempt to implement active monetary policy under the currency board[3]. In March 2001, with the resignation of the second economy minister in as many months, there is a strong argument that the IMF had a decision to make; either support strongly or withdraw. But the perception was that the IMF vacillated. Policy developments in Argentina were assessed in terms of whether they would lead to IMF withdrawal. The implementation of an ingeneous system of export subsidies and import tariffs, raised the fear that this might be interpreted by the IMF as a dual exchange rate regime and hence provide the excuse to end the program[4]. This helped provide the trigger for a bank run. The run was halted by the IMF package of August 2001. However, the economy continued to deteriorate, tax revenues fell, IMF targets became unrealistic and depositors speculated again that the IMF would withdraw. A final run sparked a set of bank controls in early December.

This sequence of events backs up the assumption that the IMF plays

[3]See Powell (2003) for more details

[4]This July 2001 policy used subsidies and tariffs determined by the dollar/euro exchange rate

a significant coordinating role. Moreover, it supports the conclusions of the analysis; that with an IMF program in place, Argentina had incentives to adopt more risky policies as the situation deteriorated (moral hazard) and that the IMF responded by vacillating between continuing support or withdrawing. The analysis also suggests that the international financial architecture (IFA) remains incomplete. The theoretical model is used to consider recent proposals such as collective action clauses (CACs) and a bankruptcy procedure for countries (Sovereign Default Restructuring Mechanism- SDRM).

The paper is organized as followings. In Section 2 a simple one shot game is outlined. In section 3, we consider a repetition of the game and address the uniqueness problem by showing that in a region of parameter values the optimum policy for the Fund is a type of "minimum punishment strategy". Section 4 concludes.

2 A model of country, IMF, private sector interactions

We develop a simple game with the IMF, a country and a large number, N, of small private investors. The game has 3 periods, and the timeline is depicted in Figure 1[5]. In the first period, the N private investors offer $1/N$ via a debt contract to the country. We do not seek to explain why this partricular contract is used here, we take that as a given. We assume that if any individual private investor wishes to liquidate her position at the end of the second (intermediate) period she may and in that case the contract stipulates that she should be paid an intermediate payment, r_I/N, otherwise the contract pays r/N at the end of the second period. Later we will solve for r to make the interest rate endogenous but r_I will remain exogenous. We discuss below the implications of different levels of r_I. [6]. After the debt contract is offered, there then follows a simul-

[5]The terminology is that the game has three periods. Later, we refer to these three periods as one stage in a multi stage game.

[6]Jeanne (2002) endogenizes elements of the debt contract in a one stage game where moral hazard can be controlled as the country's effort level can be observed before an IMF package is agreed.

taneous game between the country and the IMF. Simultaneous play is assumed to reflect the fact that countries cannot commit to particular policies. Arguably, the IMF may be able to commit but it turns out it would not want to; it has first-mover disadvantage. For simplicity, it is assumed that the country and the IMF have only two choices. The country can play either Safe or Risky and the IMF can play Assist or no-Assist[7,8].

Figure1 Here

First, consider the structure of the game without the IMF. If the country plays Safe, it invests the money extended to it in a technology that is relatively safe. This technology implies that if the project is maintained until stage 3, then there is no possibility of "country insolvency". We assume that for the safe technology there is a probablity x at the end of period 3 that the project returns h and a probability $1-x$ that the project returns l where $h > l > r$. The safe technology then implies no risk of insolvency. Moreover, we assume that if the country can pay its debts then it will. In this sense the model is an "ability to pay" model. The difference between ability to pay and willingness to pay is not the focus of this game and indeed it makes little difference to what follows which approach is chosen given certain conditions on the cost of default which we address below.

While the safe technology implies no risk of insolvency if the project is maintained until stage 3, the country may be subject to a "pure liquidity problem". If the project is liquidated in period 2 we assume that the project returns either a with probability x or b with probability $1-x$, where $a > r_I > b$. We assume that it is known whether the country has a or b available for repayment[9]. This implies that if the country

[7] It is easy to see the Fund's first mover disadvantage. If the Fund commits to Assist, then the country will choose Risky. If the IMF does not assist, the country may chooses Safe. In both cases the Fund regrets what it did given the country's choice.

[8] The label Safe, refers to the fact that a country investing in the Safe technology has a zero probability of a solvency problem whereas this is not true of a country investing in the Risky technology. However, the Safe technology is not altogether Safe as it turns out that the country may still be subject to a pure liquidity run and hence default.

[9] However, whether the country chose Safe or Risky is private information of the

is unlucky, then the atomistic investors, that know that only $b < r_I$ is available if the project is liquidated, may have an incentive to run. In general there is a multiple equilbrium problem here. We will assume in what follows that if there is a multiple equilibrium, investors will run.[10,11]

To be more precise, after the simultaneous game between the IMF and the country is played, the N private sector investors decide whether to liquidate their investments early. We assume a sequential service constraint such that on liquidation payments are on a random first come first served basis. Those who are lucky will receive the intermediate payment r_I/N while the country has sufficient funds and the remainder obtain zero. We assume that ex ante each of the N investors has the same probability of being one of the lucky ones and obtain the interim payment. Each investor then has the probability b/r_I of receiving the interim payment r_I and the expected return to each investor conditional on the country being unlucky is b. Hence, if the country chooses the Safe technology, with probability $1-x$ there will be a "pure liquidity run" and the country will default and investors obtain an (expected) return of b, even though if investors had not run, default would have been averted. We assume that a country that defaults suffers an exogenous penalty equal to F.

On the other hand, the Risky technology results in the possibility of insolvency even if the project is maintained until completion but also has a probability of a higher return. Suppose with probability y the project yields a payoff of t and with probability $(1-y)$ a payoff of u where $t > r > u$ such that with probability $(1-y)$, the country cannot pay its debts if the project is maintained to completion. We assume again that the project, if liquidated in period 2, returns either a or b

country

[10]Investors might select the run or non-run equilibrium depending on a sunspot variable - see Jeanne (2002) for a model incorporating this feature. In practice, this simply implies adding another parameter. Indeed one interpretation of the probability x would be that it already incorporates this second sunspot- derived probability.

[11]Later, we develop a condition that shows when private investors will always run if the country is unlucky such that there is no multiple equilibrium.

with the probabilities, y or $(1-y)$ respectively. As before, it is known whether the country can obtain a or b if the project is liquidated at that stage. Note then that all know how much the country has available in the intermediate period, but only the country knows which technology was adopted[12]. As above, if only b is available then investors will run and the country will default. The difference is that in this case the run happened on the road to insolvency, whereas in the case of the Safe technology, it was a pure liquidity run. Only the country knows what kind of run it faces. As before, if the country defaults, it suffers the same default penalty, F[13].

Regarding the returns of the Risky and Safe technologies, we will assume that $yt > xh$ and that $x > y$. The second inequality implies that the probability that the Risky technology is successful is less than the probability that the Safe technology is successful. The first inequality implies that, conditional on success, the return on the Risky project is higher than that of the Safe project. We consider that these are natural conditions for what is meant by Risky and Safe[14].

In period 3, everything is revealed and debts are paid if they can be paid. At the end of period 3, everyone knows how the country played (Risky or Safe) and everyone knows whether the project returned the higher or the lower return appropriate to the technology selected. If the country has the resources to pay off its debts, then it is assumed that it will do so. However, we note that the country cannot arrive at period 3 with insufficient resources. In that case, the country would have already

[12] A more complex specification might be with two continuous distributions for the intermediate payoff from the Safe and Risky technologies and the known resources available in the intermediate period then being a noisy signal on those distributions.

[13] In order for the country to want to pay its debts if it can, formally we require that $F > r$. We will generally assume that this is the case. In the spirit of Dooley and Verma (2003), following Bolton and Scharfstein (2000), otherwise a country may be insolvent and simply cannot pay its debt. Another specification would have F as a function of country income (due to the increased cost of sanctions, the possibility of attaching assets or for political motives) such that for $F(y(t)), F(y(h)), F(y(l)) > r$ but $F((u)) < r$ and hence a country defaults in period 3 if it prefers not to repay in the spirit of a "willingness to pay" model.

[14] These assumptions are consistent with the expected return on each technology being equal and the Risky technology a mean preserving spread of the Safe, but are less restrictive.

defaulted in period 2.

Now, let us turn to the role of the IMF. If the IMF Assists then this is taken to mean that the IMF offers the country an irrevocable Stand-by which the country can use in the intermediate or final period of the game. As the IMF does not know whether the country has chosen the Risky or Safe technology, the Stand-by cannot be made conditional on that action. Further we assume that the amount of the Stand-by is fixed at c. An interesting issue is whether a Stand-by can be designed that solves the liquidity problem but does not lead to a "bail out" in the case that the Risky technology fails (we refer to this as an efficient Stand-by). This is possible if $r - u > r_I - b$. It seems natural to think that $u > b$, if not why would the country carry the project through to the final period? An efficient Stand-by then requires $r_I < r$. If $r_I = r$, this is akin to the country having to roll over the whole debt in the intermediate period. An efficient Stand-by is then impossible. If $r_I = 0$, this is akin to a two period debt contract with no intermediate payment and hence, by definition, there is no liquidity problem. This suggests the IMF might insist on $r_I < r + b - u$, (which might be thought of as a minimum length of debt maturity) and offer an efficient Stand-by. However, as a country's fundamentals deteriorate, debt maturities will shorten and at some point it appears inevitable that this limit will be breached. We therefore assume that this condition is not met[15].

Consistent with the spirit of this ability to pay model, we further assume that the Stand-by is used only if the country actually needs to use the funds. Hence, if the IMF Assists and the country plays Safe, then it turns out that the Stand-by will be simply preventative in nature. Given that the liquidity is available if the country needs it, this will ensure that the run equilibrium no longer exists and so no run will actually occur and the country will not actually need the IMF's funds. However, if the country chooses the Risky technology and is unlucky, the Stand-by will again protect the country against the run

[15] Another way to think about this point, is that the analysis is of a country where there are serious concerns regarding debt payment capacity and short debt maturities.

equilibrium in the intermediate period and will also protect the country against insolvency at the end of period 3. We assume that the country will then use the Stand-by to pay off (bail out) the private investors.

The bottom line is that IMF is playing a dual role in this model. As the liquidity school would have it, there is a role of the IMF in correcting a type of market failure or externality, namely the possibility of a liquidity run. On the other hand, and in line with the moral hazard school, the IMF also may end up bailing out private sector investors and, as we shall see, thereby creating moral hazard.

2.1 The Country's Payoffs

We are now in a position to think about the payoffs in the simultaneous game between the country and the IMF. The country can play either Safe or Risky and the IMF can play Assist or No-Assist. Then nature plays (good versus bad luck) and depending on the outcome, the private sector may run in the intermediate period. We can then write the expected payoffs for the four outcomes for the Country/IMF simultaneous game. We label these four outcomes: (1) The First Best, (2) Moral Hazard (3) On Your Own and (4) the Worst Case.

1. The First Best

   In the First Best the country plays Safe and the IMF Assists. The payoff to the country is:

   $$A = xh + (1 - x)l - r \tag{1}$$

   where we know that the project is never liquidated early and x is the probabilty of the technology being successful and r is the loan repayment to the private sector (we assume zero discounting between the different stages of the one-shot game). Note that although the IMF offers a Stand-by, these resources are not disbursed.

2. Moral Hazard

This outcome refers to the case where the IMF Assists and the country plays Risky. The payoff is:

$$C = yt + (1 - y)(c + u) - r \tag{2}$$

where c is the cash received from the IMF in the case where the country is unlucky and the project fails.

3. On Your Own

   This outcome is where the country plays Safe and the IMF responds with No Assist. The payoff is:

$$B = x(h - r) - (1 - x)F \tag{3}$$

   where in the case that the country is lucky and the project is successful, the country can pay off its private creditors at the end of the period. However if the country is unlucky, with probability $1 - x$, there is a liquidity run and the country defaults. The cost of default is given by F.

4. The Worst Case

   The Worst Case is when the country plays Risky and the IMF does not Assist. The payoff is given by:

$$D = y(t - r) - (1 - y)F \tag{4}$$

   where again if the country is lucky (with probability, y), the country keeps the rewards of the project on completion and pays off private creditors. However, if the country is unlucky, there will be a liquidity run and the country defaults[16].

2.2 The IMF's Payoffs

We assume that the IMF essentially has the country's best interest at heart but with just one difference. We assume that the IMF does not

[16] Bringing forward a solvency problem in period 3.

like the Moral Hazard outcome and hence has some disutility attached to that particular outcome relative to the country payoffs. We justify this as it is only in this case that IMF resources actually used. The parameter may then be thought of as the cost to the Fund from its own financing requirement. The payoffs for the IMF are then simply:

1. The First Best
$$A = xh + (1-x)l - r \tag{5}$$

2. Moral Hazard
$$C - \lambda = yt + (1-y)(c+u) - r - \lambda \tag{6}$$

3. On Your Own
$$B = x(h-r) - (1-x)F \tag{7}$$

4. The Worst Case
$$D = y(t-r) - (1-y)F \tag{8}$$

   Where λ is the cost to the IMF of supporting a country that plays Risky and potentially needing to draw down on the Stand-by, not for liquidity but for solvency purposes. We illustrate the payoffs in a simple 2*2 matrix in Figure 2.

Figure 2 Here

2.3 Equilibria

We suggest that there is no pure strategy Nash equilibrium to this game. Recently, there has been much discussion regarding the role of the IMF, but the idea that there is no pure strategy equilibrium to a very basic game of country/IMF interactions has not been suggested.

In particular, note that $A > B$, as $l - r > -F$. So this condition is clearly satisifed. Note that for there to be moral hazard $C > A$. This is natural. If the IMF protects the country against downside risk and, conditional on success, the return is higher on the Risky technology than the Safe, then the country will prefer Risky to Safe if the IMF grants a Stand-by. Note that if there is no moral hazard then the First Best would be a pure strategy Nash equilibrium and there is no real problem. It also seems reasonable to assume that λ will be such that the IMF will prefer not to Asisit if the country prefers Risky ($C - \lambda < D$) or $\lambda > yr + (1-y)(c - u + F)$[17].Finally we assume that $B > D$. This condition implies an interesting condition on F, namely that:

$$F > r + \frac{yt - xh}{x - y} \tag{9}$$

We assumed that $yt > xh$ and $x > y$ and hence the fraction in (9) is positive. Note that as x tends to y from above, F has to be large for this condition to be satisfied. In defense of this condition, we note that if it is not satisfied, the Worst Case where countries choose Risky strategies and the IMF becomes irrelevant will be the pure strategy Nash equilibrium which we find unrealistic. Second, much of the recent debate has stressed that the cost of default is indeed very high, and recent proposals on financial architecture reform take this as a starting point. Indeed if the condition is not met, the whole debate on collective action clauses to reduce default costs is totally misguided. We then presume that the condition above is met[18].

It follows that if $A > B, C > A, C - \lambda < D, B > D$ then there is no Nash equilibrium in pure strategies. However, as is well known, there is a unique equilibrium in mixed strategies. It is straightforward to show that in the mixed strategy equilibrium, the country plays Safe with a probability q given by:

[17]If this is not the case then the Moral Hazard outcome may be a pure strategy Nash equilibrium. This is rouhgly the assumption in Eichengreen and Ruhl (2000). However, given that the IMF decided to pull out of both Russia and Argentina this view is questionable. In the case of Argentina, private sector spreads were at 3000 basis points over US Treasuries, 1-2 months before the default - hardly levels expecting another bail-out.

[18]Another way to think of the condition is a restriction on x and y ie: $\frac{x}{y} > \frac{F+t-r}{F+h-r}$.

$$q = \frac{D - (C - \lambda)}{D - (C - \lambda) + (A - B)}$$

where $0 < q < 1$. The probability that the IMF plays Assist is given by p such that:

$$p = \frac{B - D}{B - D + (C - A)}$$

where $0 < p < 1$. We note that in the mixed strategy equilibirum there is a positive probability of IMF assistance and the country choosing Risky (with probability $p(1-q)$) and a possibility that the country suffers a pure liquidity run with probability $q(1-p)(1-x)$ and a possibility that the country suffers a liquidity run because of an underlying problem of insolvency with probability $(1-q)(1-p)(1-y)$.

Now let us consider the returns to the private investors. It follows that they now have a probability of, $S = p + (1-p)(qx + (1-q)y)$ of obtaining the return r (if the country is assisted or if the country is not assisted but is lucky, either with the Safe or Risky technology. However, if the country is not assisted and is unlucky it will only have resources b and will suffer a liquidity run. In that case some lucky investors, b/r_I will obtain the promised intermediate return r_I and the remainder, it is assumed here, will obtain zero. Hence in the case of no IMF assistance and bad luck which will happen with probabiltiy $(1-S)$ the expected return will be $r_I b/r_I = b$. Assume risk neutrality and a perfectly competitive market for investors, the return r that they demand is given by :

$$rS + b(1-S) = r_F$$

where r_F is the risk-free rate. It is easy to show that this can be re-written as:

$$r = r_F + \frac{(r_F - b)(1-S)}{S}$$

It is clear that $(r_F - b)$ must be positive, so this equation says that the return demanded by private sector investors is the risk free rate plus a risk premium. The higher is b, (expected return in the worst case ie: a liquidity run) then the lower is the risk premium. The higher is S, the probability that the private sector will receive the full contractural payment at the end of period 3, then again the lower will be the risk premium. This equation then allows us to investigate how different changes in the underlying parameters might affect a country's risk premium.

One interesting feature is how the probability that a country plays Safe depends on the parameter λ. It is easy to show that $\frac{dq}{d\lambda} > 0$[19]. As the IMF more strongly dislikes having its resources used, then this will increase the probability that a country will play Safe, yielding one interpretation of the activities of "moral hazard school" economists!

Now, consider the welfare of the players. Welfare of the country, W_C, and of the IMF, W_{IMF}, are given by:

$$W_C = pA + (1-p)B$$

$$W_{IMF} = qB + (1-q)D$$

respectively. It turns out that as the cost of default, F, is reduced - which might be thought of as the introduction of collection action clauses (CACs) - change in country welfare is ambigious. As the cost of default falls, the probability of IMF assistance falls, the probability that the country plays Risky increases and the interest rate charged by the private sector rises. However, if the country actually defaults this is less costly. The implication is that there may be an optimum cost of default - although the optimal cost of default, for the country, will be different to that chosen by the IMF!

Now consider whether the IMF should exist! If there were no IMF, assuming $F > r + \frac{yt-xh}{x-y}$, the country would choose to play Safe and hence the interest rate that the private sector would demand would be given by:

[19] In fact $\frac{dq}{d\lambda} = \frac{A-B}{(B-D+C-A)^2}$

$$r_x = r_F + \frac{(r_F - b)(1-x)}{x}$$

Whether $r_x < r$ turns out to depend on the paremeters of the model. It is clear from the equations above that $r_x < r$ as $x > S$, and this turns out to be the case if:

$$p < \frac{x - (qx + (1-q)y)}{1 - (qx + (1-q)y} \tag{10}$$

which can be thought of as a critical value of the probability, p_c where it is clear that $0 < p_c < 1$. If the probability of IMF assistance is greater than this critical value then the interest rate that the private investors will demand will be less given the existence of the IMF than otherwise. Note that this is more likely the larger is x relative to y and as x tends to unity.

For the country to be better off with the IMF, the welfare in the mixed strategy equilibrium (with interest rate r) should be greater than B_{r_x} where this indicates the payoff B but calculated with the interest rate demanded by the private sector equal to r_x.The welfare of the country in the mixed strategy equilibrium is just $pA_r + (1-p)B_r$ where $A_r > B_r$ and where the subscript r is to remind us that these payoffs are evaluated at interest rate, r. A sufficient condition that the IMF improves the welfare of the country is then very simply that $r_x > r$ or $p > p_c$.

Now, consider whether the IMF would prefer that the IMF did not exist! The IMF welfare without the IMF is just B_{r_x} whereas the welfare of the IMF in the mixed strategy equilibirum is $qB_r + (1-q)D_r$. As $D < B$, a sufficient condition that the IMF should not exist (for the IMF), is that $r_x < r$ or equivalently $p < p_c$. In that case the IMF would prefer that the IMF did not exist. The conclusion is that for the IMF to have a useful role, $r_x < r$ or $p > p_c$. This is sufficient to improve country welfare and necessary to improve the IMF's welfare. Only an active IMF that intervenes with at least a certain probability and reduces interest rates sufficiently then has a role. We note that simplistically pointing to low emerging market risk spreads as evidence of "moral hazard" is then misguided: it is only if the IMF reduces interest rates that the IMF has a valid role!

The necessary and sufficient condition that the IMF should exist (for the IMF) is that:

$$r < r_x - (1-q)\frac{(x-y)}{x}[F - r - \frac{yt - xh}{x-y}] \tag{11}$$

This says that for the IMF to have a role r must be less than r_x by a (positive) margin that increases with F[20]. Relating this to the debate on collective action clauses, if currently the cost of default is very high, then reducing the cost of default through CACs implies that this condition is less strict increasing the set of parameter values for which the IMF should reduce interest rates to ensure that the IMF has a useful role. However, if collective action clauses reduce the cost of default too much, then the equilibrium of the one shot game is no longer in mixed strategies but rather becomes the Worst Case pure strategy equilibrium where the country plays Risky, the IMF does not assist and the IMF has no role.

It is helpful to present a numerical example. In Figure 3 we present a set of reasonable parameter values. We find that for these parameter values the probability that the country would play safe, q, is 78% and that the IMF would assist, p, is 68% in the mixed strategy equilibrium. The (net) interest rate that the private sector would charge is 15%. We find that the probability S is 94% ie: there is a 94% chance that the private sector would not run and would receive the final payout of 15%. These results imply that there is about a 53% chance ($78\% * 68\%$) of the IMF solving a pure liquidity problem and a 15% chance ($68\% * 22\%$) that the IMF will assist and the country play Risky (Moral Hazard) and a 3% chance, ($68\% * 22\% * 20\%$) chance that the IMF will bail out a country that has adopted a Risky strategy and has been unlucky. In this case, we find that the critical probability for IMF existence, from the standpoint of the country, is that p should be greater than 30% as this ensures that the interest rate in the mixed strategy equilibrium is less than the interest

[20] If the cost of default is just equal to the critical value to ensure the mixed strategy equilibrium ($F = r + \frac{yt-xh}{x-y}$), then the necessary and sufficient condition reduces to the sufficient condition. However, if the cost of default is higher, then the necessary and sufficient condition for the IMF to exist is stricter.

rate with no IMF. As $p = 68\%$, the condition is satisfied. If the IMF did not exist, the gross interest rate that the private sector would charge in the country with these parameters (in the On Your Own outcome of the game) would be 1.3125 (calculated as $1.05 + 1.05 * (0.2/0.8)$). The right hand side of equation (12), evaluated with with these parameters yields 1.3087 and so we find that the necessary and sufficient condition that the IMF should exist, for the IMF, is just satisfied!

Figure 3 Here

However, we find that the IMF would not always wish the IMF to exist. In the graph illustrated we keep the same basic parameters that imply that the interest rate charged by the private sector with no IMF, remains at 1.3125 and vary F and λ. In general we find that high values of λ and lower values of F support the existence of the IMF. Interestingly, a tougher IMF that places a high weight on the use of its funds, has a greater chance having a valid role.

3 Repeating the Game

In this section we investigate repeating the game described above which we now refer to as one stage of a multi-stage game[21]. The literature on repeated games has not offered robust conclusions on strategies, due to problems of indeterminacy, but in order to seek conclusions on the international financial architecture it appears important to make an attempt as a one stage game is clearly a poor representation of complex country/IMF dynamic relations[22]. The one stage game does have characteristics that, with some additional assumptions, allow us to make some progress.

Note that the First Best is the best outcome for the IMF and is better than the unique mixed strategy equilibrium (MSE) for the country. This

[21] We assume no discounting between the three periods of the sub-game but we do include discounting between the stages of the multi-stage game.

[22] And while the folk theorem tells us about payoffs, it tells us little about strategies. See Binmore (1992) for a lively discussion and Fudenberg and Maskin (1986) for technical details and discussion.

implies that the IMF may seek to gain the cooperation of the country to obtain the First Best under the threat that otherwise the outcome will be the MSE. More specifically, we consider two possibilities. First, we consider a "grim trigger" strategy, ie: the IMF's threat is the MSE forever. This is a useful exercise for what follows. Second, we consider the IMF playing a minimum punishment strategy (MPS). We are not necessarily suggesting that these are realistic description of what the IMF actually does, however, we claim that the MPS may be optimal and it is a useful benchmark. Moreover, certain characteristics of the equilibrium carry over to a wider range of strategies and we claim that those characteristics closely match relations between Argentina and the IMF and that there are interesting implications for the international financial architecture.

3.1 The IMF plays a grim trigger strategy

We first presume that the IMF can offer the country the First Best coupled with the threat that if the country deviates to play Risky, then the IMF will respond with the Nash (mixed strategy) equilibrium forever[23]. For the First Best to be supported it must be that, for the country playing Safe forever and obtaining A each stage, is preferred to deviating and obtaining C in one stage and then obtaining the welfare from the Nash equilbrium, W_C for the rest of time[24]. Hence:

$$\frac{A}{1-\delta} > C + \frac{\delta W_C}{1-\delta} \tag{12}$$

where δ is the discount factor between the different stages. As is standard, this can be rearranged to show that the First Best is supported when a country is sufficiently patient:

[23] We do not analyze here whether the IMF would actually wish to implement the grim trigger strategy forever once the country had deviated. We assume that this is the case because, for example, the IMF is dealing with many countries at the same time and is concerned about its reputation.

[24] We assume that the IMF can only punish on having seen deviation not on the possible anticipation of deviation.

$$\delta > \frac{C - A}{C - W_C} \tag{13}$$

where $C > A > W_C$ and this critical $\delta < 1$. Substituting in for the payoffs and some algebra this can be written as:

$$(1 - y) < \frac{(1 - x)(F + l - r)}{(1 - \delta)(F + u + c - r)} \tag{14}$$

A critical value of $1 - y$ (the probabilty of insolvency) is interesting as if a country's fundamentals are deteriorating, we would expect $1 - y$ to be rising. Hence a country would tend to deviate as its fundamentals deteriorate. The intuition behind this result is that with deteriorating fundamentals, a country would expect to be assisted with higher probability in the MSE ie: $\frac{dp}{d(1-y)} > 0$. While this discussion is of interest, it reveals a shortcoming of the analysis, as if y could change, surely the players would take that into account ex ante. In the next section we take account of this and show that the IMF may then wish to adopt a minimum punishment strategy.

3.2 A minimum punishment strategy equilibrium[25]

Suppose that y can take on 2 values, y_H and y_L ($y_H > y_L$) and that there is a symmetric probability transition matrix such that the probability of y remaining in its current state is z and of changing state is $1 - z$[26]. There is now a possibility that the IMF may wish to adopt a punishment strategy that (just) ensures cooperation if $y = y_H$ and admits the fact that the country will deviate if $y = y_L$.We maintain our assumption that the IMF cannot punish a country that has not actually deviated and we also assume for that the IMF cannot condition its punishment on the current state of y. In particular this rules out the IMF punishing a country more if its fundamentals are weaker.[27]. Assume that we start in the

[25] The minimum punishment strategy is associated with Green and Porter (1984) - see also the discussion in Tirole (1988), section 6.7.1 pages 262-265.

[26] We might consider $z > 0.5$ suggesting persistence.

[27] Mussa (forthcoming) presents an interesting discussion of the relations between Argentina and the IMF explaining why the IMF did not abandon its program earlier

First Best and that $y = y_H$. There may be some minimum punishment that the IMF can apply (which we will specify as a minimum number of periods, N^*, of the mixed strategy Nash equilibrium of the one-stage game), that ensures that it is in the best interest of the country to continue to play the First Best if $y = y_H$ but that there is no alternative to deviation if $y = y_L$ (in other words even if the IMF played the mixed strategy Nash equilibrium of the one stage game forever - the grim trigger -then that would not be enough to ensure cooperation at $y = y_L$). This minimum punishment strategy would be an optimal strategy for the IMF, in the sense that it would yield the best outcome as often as possible at a minimal punishment cost. The equilibrium strategies for the country and the IMF are then as follows:

1. The Country's Strategy: If the IMF played Assist and $y = y_H$, then the country will cooperate (play Safe) this period. If the IMF played Assist last period and $y = y_L$, then the country will defect (play Risky). If the country played Risky (and the IMF played Assist) last period then the Country will play Safe and Risky according to the mixed strategy equilibrium of the one shot game for N^* periods after which, if $y = y_H$ it will return to playing Safe or if $y = y_L$ it will again play Risky.

2. The IMF: If the country played Safe last period, the IMF will play Assist (cooperate). If the country played Risky last period, then the IMF will play Assist and No Assist according to the mixed strategy equilibrium of the one shot game for N^* periods. The following period the IMF will play Assist.

We then define the following:

1. The value function of cooperating when $y = y_H$

$$V_{C/H} = A + \delta(zV_{C/H} + (1 - z)V_{D/L}) \tag{15}$$

where the C/H subscript indicates cooperation when $y = y_H$ and

which would precisely support this assumption.

D/L defection when $y = y_L$. What this says is that the value of cooperating today when $y = y_H$ is the payoff from this period, A, plus the discounted value of cooperating tomorrow (if $y = y_H$ tomorrow) and defecting tomorrow (if $y = y_L$ tomorrow).

2. The value function of defecting when $y = y_H$

$$V_{D/H} = C_H + \delta(V_{MP/H}) \tag{16}$$

where the MP subscript indicates the minimum punishment and $V_{MP/H}$ is the value function of the minimum punishment strategy starting at $y = y_H$.

3. The value function of cooperating when $y = y_L$

$$V_{C/L} = A_L + \delta(zV_{D/L} + (1-z)V_{C/H}) \tag{17}$$

4. The value function of defecting when $y = y_L$

$$V_{D/L} = C_L + \delta(V_{MP/L}) \tag{18}$$

where $V_{MP/L}$ is the value of the minimum punishment starting at $y = y_L$.

It can be shown that:

$$V_{MP/L} = \frac{1-\delta^{N^*}}{1-\delta}(zW_L + (1-z)W_H) + \delta^{N^*}(zV_{D/L} + (1-z)V_{C/H}) \tag{19}$$

where W_L is the payoff to the country in the mixed strategy equilibrium with $y = y_L$ and W_H the payoff in the mixed strategy equilibrium when $y = y_H$.

$$V_{MP/H} = \frac{1-\delta^{N^*}}{1-\delta}(zW_H + (1-z)W_L) + \delta^{N^*}(zV_{C/H} + (1-z)V_{D/L}) \tag{20}$$

For the equilibrium proposed we need to show that:

$$V_{C/H} > V_{D/H} \tag{21}$$

and that

$$V_{C/L} < V_{D/L} \tag{22}$$

The equations (17)-(24) define a recursive system with no analytical solution. However, we can make progress by considering applying the grim punishment strategy studied in the previous section. If the grim punishment is tough enough to get cooperation at $y = y_H$ but not tough enough to obtain coperation at $y = y_L$ then the minimum punishment strategy equilibrium exists and we claim it is optimal at least in the class of strategies that involve repetitions of the MSE of the one stage game as punishment[28]. Hence, we replace the $V_{MP/L}$ and $V_{MP/H}$ with $V_{G/L}$ and $V_{G/H}$ (where the G subscript is for grim) and then investigate the region of parameter values where (23) and then (24) just hold. Solving the above system for regions of the parameters z and δ where the minimum punishment strategy equilibrium exists, or more specifically, considering the constraint $V_{D/L} = V_{C/L}$, setting $V_{MP/L} = V_{G/L}$ and $V_{MP/H} = V_{G/H}$ we find that:

$$\delta = \frac{C_L - A}{C_L - W_L z - W_H(1-z)} \tag{23}$$

Where C_L is the payoff to deviation (the moral hazard outcome) when $y = y_L$[29]. This equation then gives a boundary of critical values of δ for different values of z such that the grim punishment strategy just allows cooperation when $y = y_L$. When δ exceeds this critical value then cooperation at $y = y_L$ becomes feasible and hence the minimum

[28] We have specified the punishment strategy as a number of periods of the one shot game Nash equilibrium mixed strategies. Formally there is then an integer problem that we disregard.

[29] We note that A the payoff to the country and the IMF in the First Best is the same whether $y = y_H$ or $y = y_L$ as the country is playing Safe and the interest rate charged by the private sector is the risk free rate as the country is cooperating and the IMF is Assisting implying a zero probability of default.

punishment strategy equilibrium breaks down. For the condition $V_{D/H} = V_{C/H}$ and setting $V_{MP/H}$ =$V_{G/H}$ we find that:

$$\frac{A + (1-z) * \delta(C_L + \frac{\delta}{1-\delta}(W_H(1-z) + W_L z)}{(1-z\delta)} = CH + \frac{\delta(W_H(1-z) + W_L z)}{1-\delta} \tag{24}$$

which yields a quadratic solution for δ in terms of z as follows:

$$\delta = -M \pm \sqrt{\frac{(M)^2 - 4(C_H - A)(C_L(1-z) + C_H z - W_H + 2z(1-z)(W_H - W_L)}{2(C_L(1-z) + C_H z - W_H + 2z(1-z)(W_H - W_L)}} \tag{25}$$

where:

$$M = C_H(1+z) + C_L(1-z) - W_L(1-z) - W_H z$$

and where C_H is the payoff to deviation (the moral hazard outcome) when $y = y_H$. We find in numerical simulations that the second root tends to return values of $\delta > 1$, so we focus our attention on the first root.

Interestingly, the two schedules intersect and we find simple expressions for δ and for z,in terms of the parameters at that point of intersection:

$$z = \frac{A(C_H - C_L + W_H - W_L) + C_L W_L - C_H W_H}{(2A - C_H - C_L)(W_H - W_L)} \tag{26}$$

$$\delta = \frac{C_H + C_L - 2A}{C_H + C_L - W_H - W_L} \tag{27}$$

In the appendix we provide a condition such that the solutions for z and δ are both between zero and one and where the minimum punishment strategy equilibrium exists. To illustrate, consider a numerical example where we trace out the two boundaries as functions of z and δ and mark where the MPS equilibrium exists:

Figure 4 Here

Figure 4 plots the two boundaries (with z on the X-axis and δ on the Y-axis) and as shown they do indeed intersect in the space $0 < z < 1, 0 < \delta < 1$. To the right of this intersection between the two curves is the region where the minimum punishment strategy exsts and is optimal. Above this region, cooperation has become feasible at $y = y_L$ and hence a punishment strategy that also ensures cooperation at that point may be preferred and below the lower curve cooperation is infeasbible even with the grim trigger strategy at $y = y_H$.

4 Implications for the International Financial Architecture

In this concluding section, we relate the results to Latin America and implications for the international financial architecture. In the one stage game there is a unique Nash equilibrium, but in mixed rather than pure strategies. This implies that if cooperation cannot develop, the IMF is in a difficult position. On the one hand, the Fund would like to provide liquidity protection and stabilize capital markets but on the other hand it fears moral hazard. The equilibrium is where it assists with some probability less than one in order to keep countries guessing and reduce the moral hazard problem. One interpretation is that when policy makers stress the importance of a case by case approach or central bankers speak in favour of construtive ambiguity, they are in fact admitting the need for a mixed strategy[30].

Two recent papers (Morris and Shin (2003) and Corsetti et al (2003)) suggest that the IMF by providing liquidity support may be catalytic in promoting reforms rather than there being an inevitable tension between the two. There are key differences between their approach and that analysed above. First, both papers employ a "global game technology" with a lack of common knowledge and thus the models have a unique equilibrium where investors run or stay depending on a signal on a fun-

[30] There are perhaps two interpretations of the constructive ambiguity doctrine, (1) an incomplete contracts view ie: that the world is just too complex and (2) unpredictability as in a mixed strategy to attempt to reduce problems of moral hazard.

damental. Second, the timing of the one stage game is different in that the IMF gets to see the country's action (an effort level) before the IMF decides whether to support and this happens before the intermediate period when the private sector may run. In this more optimistic view of the world, if the IMF offers a judicious amount of finance coupled with sufficient country effort (that also increases resources in the intermediate period) then a run may be prevented. Compared to a world with no IMF, the reforms the country must undertake to prevent the run on its own may be too costly and hence the IMF may indeed be catalytic. However, two issues in the timing in the one stage game appear critical, (a) does country effort really increase resources in the time-scale of a private sector run or does country reform only affect country solvency in the final period and (b) does the IMF know what the country's effort level is before assistance is granted? These two papers have optimistic assumptions on these two issues whereas the analysis presented in this paper takes a more pessimistic view making the role of the IMF a more difficult one.

Moving to the repeated game, if cooperation can be supported then the role of the IMF, at first sight, appears less problematic. However, as the probability of insolvency rises, so does the probability of being assisted in the mixed strategy equilibrium and so does the incentive to deviate. This then gives rise to the possibility that there is an optimal "minimum punishment strategy" where the IMF plays a number of periods of the mixed strategy equilibrium to (just) ensure cooperation under one set of parameter values but then the country defects under a different set of parameter values. Under this strategy profile, defection will occur when the probability of insolvency rises.

This equilibrium is a useful benchmark. One aspect is that it is assumed that the IMF adopts the same "minimum punishment" whether the country deviates at $y = y_H$ or $y = y_L$ (the higher and lower values of being lucky under Risky play). This minimum being defined as the number of stages of the mixed strategy equilibrium that just ensures cooperation if $y = y_H$. It seems difficult to argue that the IMF should punish more when the risk of insolvency has risen, so this seems reasonable. While the minimum punishment strategy profile may appear a special case, the idea that countries will tend to deviate as insolvency risk increases is common to all strategy profiles with this characteristic. If countries deviate to more risky play as insolvency risk rises then the IMF will be put in an extremely awkward position just as experienced in Argentina. In the case of Argentina, the IMF found itself exactly in the difficult position between attempting to deliver liquidity protection but, as discomfort with the policy environment grew, the interpretation offered here is that it vacillated between continuing support and being about to withdraw consistent with the mixed strategy equilibrium.

However, the deeper point suggested by the analysis is that the international financial architecture remains incomplete. Recently, Anne Krueger and others have suggested that the introduction of an SDRM (sovereign debt restructuring mechanism), by providing a cleaner way to restructure obligations, may tempt countries into defaulting earlier[31]. The game above allows us to think through how generous or tough such a mechanism should be. To solve the underlying problem, an SDRM mechanism would need to be sufficiently generous to tempt countries into choosing that mechanism rather than deviation at the point where otherwise the country would have deviated. In our view, an SDRM that would have have tempted the Argentine Government to have chosen that route in early 2001 would have had to have been a very generous one, perhaps more generous than the SDRM's as proposed. The more general point however is that further creative thinking appears required to complete the international financial architecture. The current situation implies that countries may "gamble for rescurrection" before they default and the IMF will find itself in an extremely awkward position attempting to provide liquidity protection but fearing moral hazard and vacillation is the equilibrium response. This does not imply that Latin American countries will be able to enjoy the benefits of international cap-

[31] Krueger (2002) for example notes that, "Indeed, it (debt restructuring) is so painful that sovereigns typically put off the day of reckoning beyond the point when there are any reasonable prospects of the situation correcting itself." On the SDRM proposals see IMF (2003) and Rogoff and Zettelmeyer (2002) for a review and historical background.

ital markets without the dangers of instability such as runs and sudden stops.

5 Appendix

We show in this appendix that the condition

$$\frac{A - W_L}{C_L - A} < \frac{A - W_H}{C_H - A} \tag{28}$$

is necessary and sufficient for existence of a range of values of z and δ where the minimum punishment strategy is optimal. What this condition implies is that the punishment that the IMF can impose relative to the temptation of deviation is less in the bad state of nature relative to the same in the good state. This appears a natural condition and one that we find generally accepted for different parameter values.

First, we establish that the value of z given by (26) is lower than one. Expanding both the numerator and the denominator of (26), it follows that the former is lower than the latter whenever

$$AC_H - AC_L < C_H W_L - C_L W_H - AW_L + AW_H$$

or, equivalently,

$$A(C_H - W_H - C_L + W_L) < C_H W_L - C_L W_H$$

Adding and substracting $C_H C_L$ to the right-hand side yields

$$A(C_H - W_H) - A(C_L - W_L) < C_L(C_H - W_H) - C_H(C_L - W_L)$$

and then

$$\frac{C_L - W_L}{C_L - A} < \frac{C_H - W_H}{C_H - A}$$

which is equivalent to (28).

The region where the minimum punishment strategy will be like that shown in Figure 4 if, at $z = 1$, the value of δ corresponding to (23) is larger than the one given by (25). At $z = 1$, (23) turns into

$$\delta = \frac{C_L - A}{C_L - W_L} \equiv \delta'$$

while (25) yields

$$\delta = \frac{C_H - A}{C_H - W_H} \equiv \delta''$$

It is easy to check that $\delta' > \delta''$ holds if and only if (28) is satisfied.

6 References

Binmore, K., 1992. Fun and Games: A Text on Game Theory. D.C. Heath, Lexington, MA.

Bolton, P. and D. Scharfstein, 1996. Optimal debt structure and the number of creditors. Journal of Political Economy, 104 (1), 1-25.

Calvo, G., 2002. Explaining sudden stop, growth collapse and BOP crisis: the case of distortionary output taxes. Paper prepared for Annual IMF Research Conference, Mundell Fleming Lecture, November 7, 2002, and mimeo, Inter-American Development Bank, Washington, DC.

Calvo, G. and C. Rheinhardt, 1999. When capital inflows come to a sudden stop: consequences and policy options. Mimeo, University of Maryland.

Corsetti, G., B. Guimares and N. Roubini, 2003. International lender of last resort and moral hazard: a model of the IMF's catalytic finance. Mimeo, Yale University, available on http://www.econ.yale.edu/~corsetti/euro/imf.pdf

Dooley, M., 2000. Can output losses following international financial crises be avoided? NBER Working Paper, No 7531.

Dooley, M. and S. Verma, 2003. Rescue packages and output losses following crises. In: Dooley, M. and J. Frankel (Eds.), Managing Currency Crises in Emerging Markets. NBER, Chicago.

Eichengreen, B. and C. Ruhl, 2000. The bail-in problem: systematic goals, ad hoc means. Mimeo, Unversity of California at Berkeley.

Fischer, S., 1999. On the need for an international lender of last resort. Journal of Economic Perspectives; 13(4), 85-104.

Fudenberg, D. and E. Maskin, 1986. The folk theorem in repeated games with discounting or with incomplete information. Econometrica, 54(3), 533-556.

Gavin, M. and A. Powell, 1998. Domestic and international lender of last resort: constructive ambiguity and cheap talk. Mimeo, Central Bank of Argentina.

Gavin, M. and A. Powell, 1999. Should the international lender of resort be privitized? Mimeo, Central Bank of Argentina.

Gay, P., S. Hayes and H. Shin, 2001. Crisis costs and debtor discipline: the efficiency of public policy in sovereign debt crises. Mimeo, London School of Economics.

Ghosal, S. and M. Miller, 2003. Coordination failure, moral hazard and sovereign bankruptcy procedures. Economic Journal (April), 113 (487), 276-304.

Green, E. and R. Porter, 1984. Non-cooperative collusion under imperfect price information. Econometrica, 52(1), 87-100.

Haldane, A. and M. Krug, 2000. The resolution of international financial crises: private finance and public funds. Mimeo, Bank of England. Available on www.bankofengland.co.uk

IMF 2003. Report of the managing director to the International Monetary and Finance Committee on a statutory sovereign debt restructuring mechanism. April 2003. available on www.imf.org/ external/np/omd/2003/040803.htm

Krueger, A., 2002. Sovereign Debt Restructuring Mechanism: One Year Later. Speech at the Banco de Mexico's Conference on Macroeconomic Stability, Financial Markets and Economic Development. Mexico City, November 12. Available on www.imf.org

Morris, S. and H.S. Shin, 2003. Catalytic Finance: When does it Work? Cowles Foundation Discussion Paper 1400, Yale University, available on http://faculty-gsb.stanford.edu/wilson/E608_2003/Papers/ Applications/Morris-Shin,CatalyticFinance.pdf

Mussa, M., forthcoming. Argentina and the Fund: from triumph to tragedy. In Gilbert, C.L. and D. Vines (Eds.), The IMF and the International Financial Architecture. Cambridge University Press, and available on www.iie.org

Powell, A., 2003. Argentina's avoidable crisis: bad luck, bad economics, bad politics, bad advice. In: Collins, S. and D. Rodrick (Eds.), Brookings Trade Forum 2002, pp.1-38.

Powell, A., forthcoming. Countries in payments' problems: what can the IMF do? In: Gilbert, C.L. and D. Vines (Eds.), The IMF and the International Financial Architecture, Cambridge University Press, and available on www.utdt.edu.

Rogoff, K. and Zettelmeyer, J. 2002 Bankruptcy procedures for sovereigns: a history of ideas 1976-2001. IMF Working Paper No 02/133

August 2002. Available on www.imf.org

Roubini, N., 2000. Bail in, burden sharing, private sector involvement in crisis resolution and constructive engagement of the private sector. A primer: evolving definitions, doctrine, practice and case law. Mimeo, Stern School of Business, New York University.

Tirole, J., 1988. The Theory of Industrial Organization. MIT Press, Cambridge, MA.

Figure 1: The Time Line

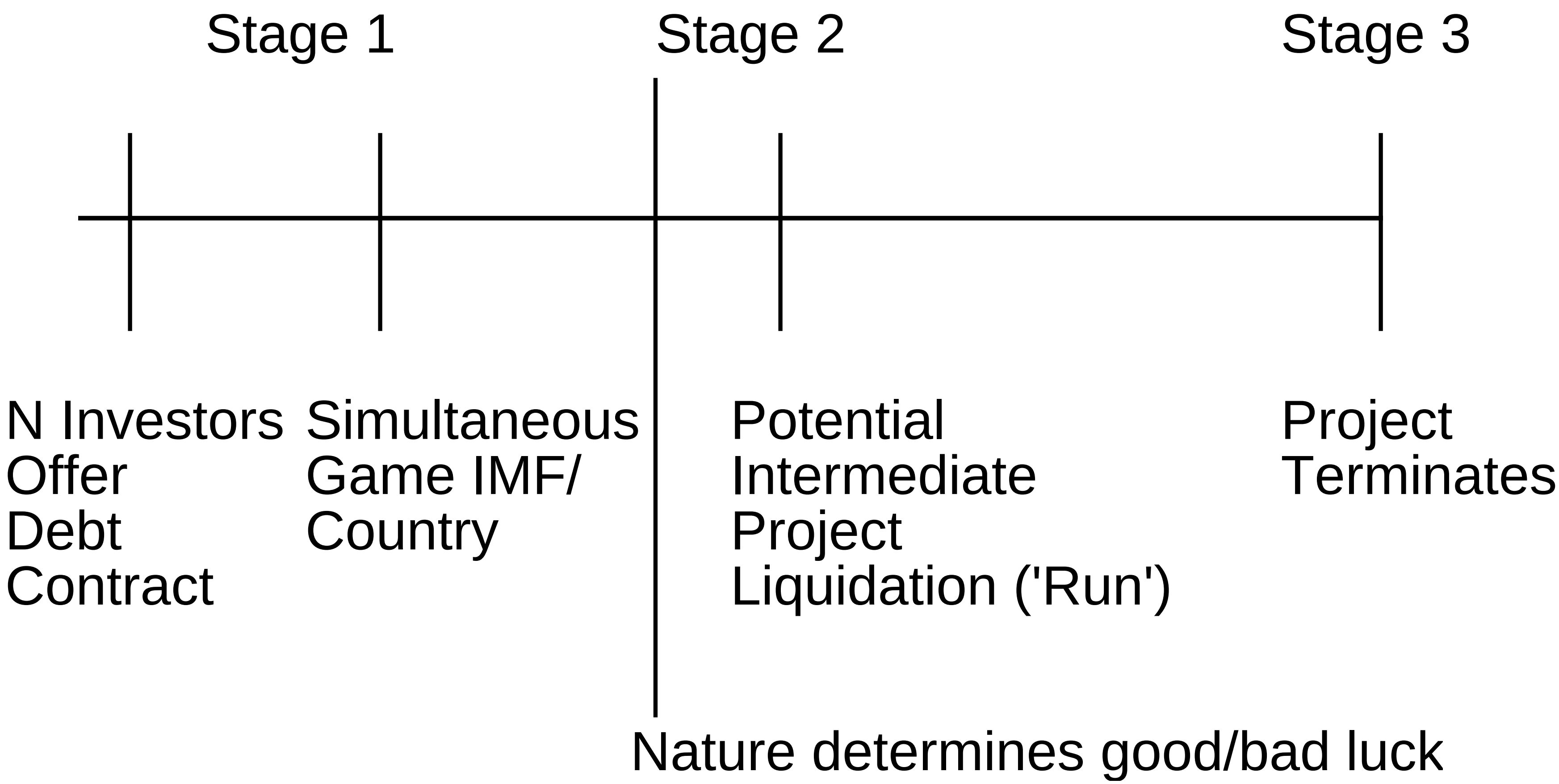


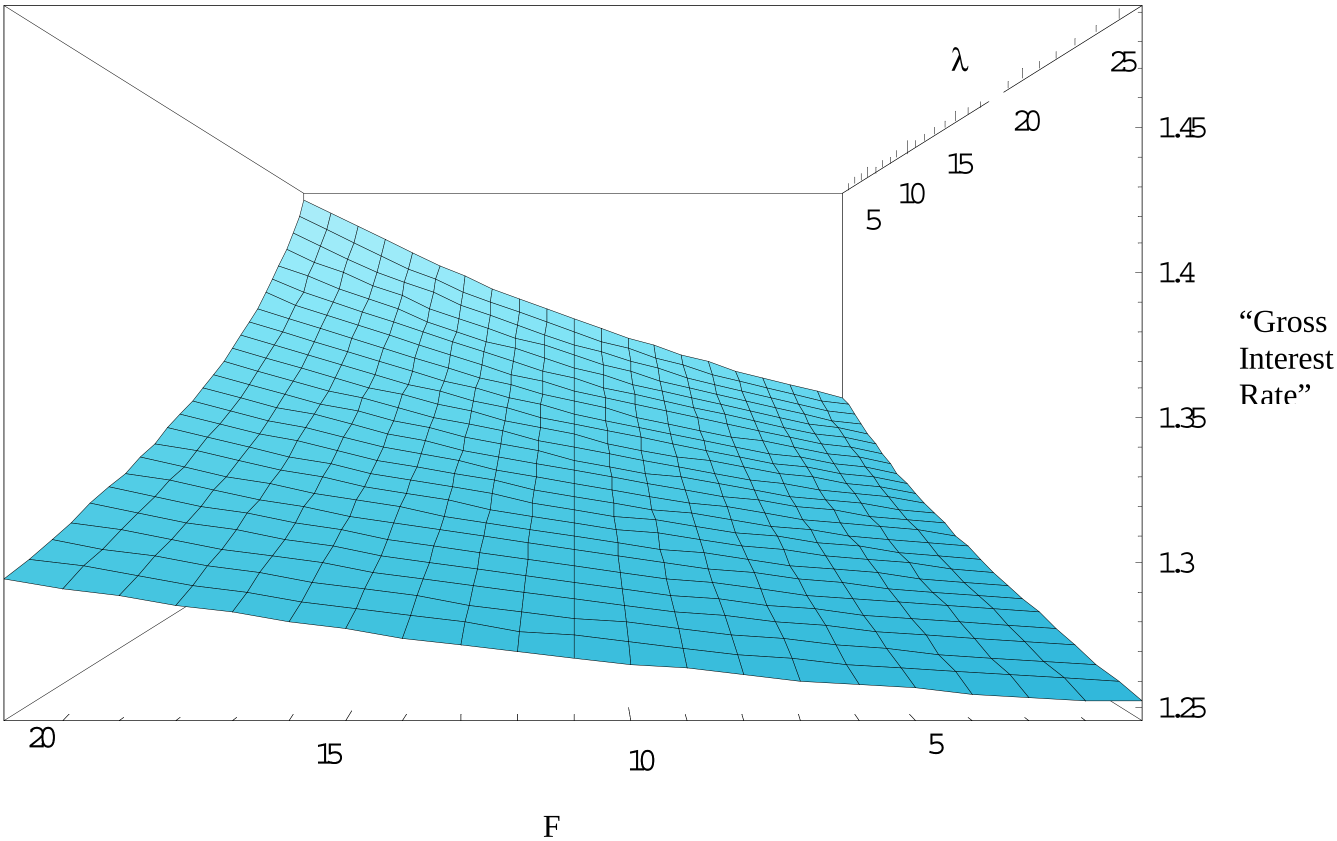
Figure 2: Country & IMF Payoffs

		IMF	
		Assist	No Assist
Country	Safe	First Best (A,A)	On Your own (B,B)
	Risky	Moral Hazard (C,C-λ)	Worst Case (D,D)

A,B,C,D>0, & A>B, C>A, D> C-λ, B>D

No Pure Strategy (Nash) Equilibrium

Figure 3: Conditions under which the IMF should exist
(x=0.8, y=0.4, h=1.5, l=1.25, t=3.25, u=0.0, F=5, λ=5, R_f=1. c=1.2, b=0.0)



IMF should exist for "gross interest rate" < 1.3125

Figure 4: Minimum Punishment Strategy Region