ESCUELA DE NEGOCIOS
Universidad Torcuato Di Tella

CIF

Centro de Investigación en Finanzas

Documento de Trabajo 09/2003

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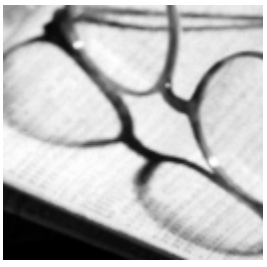


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Liquidity Protection versus Moral Hazard: the Role of the IMF*

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Abstract

This paper develops a simple game between the IMF a county and a set of atomistic private investors. The model is motivated by the case of Argentina. Under reasonable assumptions, the one shot 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" that may be optimal but may break down if the probability of insolvency rises. This implies that countries are likely to deviate in bad times placing the IMF in an "impossible position". It is suggested that the international financial architecture (IFA) remains incomplete.

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

1 Introduction

There has been a long standing joke that the acronym IMF really stands for Its Mostly Fiscal. However, the model in this paper suggests a tension between what might be thought of as, Its Mostly Fundamentals

*We would like to thank Martin Besefamile and Juan Pablo Nicolini for valuable comments and all the attendees of the Economics seminar at the UTDT and of the IMF research department seminar. Andrew Powell would like to thank the IMF for support. Part of this paper was written while Powell was a Visiting Scholar at the IMF in 2002. All mistakes remain our own. Comments welcome to: apowell@utdt.edu

and a Fund that attempts to Impetrate Market Feelings[1]. This tension can also be thought of as that between "moral hazard" versus "liquidity protection". The "moral hazard school" of thought stresses the classic perverse incentive problem created by insurance type interventions in capital markets. Adherents to this school point to the sheer size of IMF led packages, the very low emerging country spreads after the assistance to Mexico in 1995 and the "lending boom" to emerging economies and stress the idea that countries might consider packages as substitutes to safer policies or needed reforms. According to this school of thought, the role of the IMF should then be limited and lending policies and instruments should be designed to reduce moral hazard as far as possible. The resolution of country payments' crises is then seen largely as a problem between the unfortunate country and its private creditors.

In contrast, the liquidity school stresses a set of potential failures in international capital markets. In particular, adherents point to asymmetric information between lenders and borrowers and co-ordination failures between lenders giving rise to problems including multiple equilibria. According to this school, financial markets may be subject to inherent instability, and consequent "sudden stops" or "runs" in capital flows may prove extremely costly for the countries concerned. Indeed, proponents tend to suggest that while countries that suffer such runs may have structural weaknesses that make them more vulnerable to attack, nevertheless the "punishment" is frequently worse than the "crime". According to this view, the Fund may have an important role in stabilizing capital markets allowing them to function more smoothly and ensuring that market prices reflect more accurately country fundamentals. One view is that the IMF should then act as a provider of liquidity to resolve lender coordination problems. Indeed simply the credible promise of liquidity may eliminate the incentives for investors to "run". Other ideas in the literature suggest that the Fund may act directly as a coordinating device affecting equilibrium selection or through its informal powers of persuasion and more formal conditionality, the IMF may affect the perceptions of investors and contain the problem of moral hazard. If information problems are rife, then the IMF may also act as a type of honest broker, again potentially reducing the possibility of unstable outcomes[2].

[1] With apologies to theologeans, to impetrate means to ask something from God - there is a significant discussion in the Catholic church whether sinners can impetrate.

[2] On the issues of moral hazard versus liquidity protection see for example Calvo (2002), Dooley (2000), Haldane and Krug (2000), Eichengreen and Ruhl (2001), Meltzer (forthcoming) and Rubini (2002). Of these authors, Meltzer and arguably Haldane and Krug fall into the 'moral hazard' camp while Calvo is clearly in the 'liquidity school'. Dooley provides the moral- hazard critique of a too easy a debt

These appear to be quite opposite views of the world and hence somewhat difficult to reconcile. However, in this paper a simple model is developed that encompasses both views. Indeed 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 and arguably places the Fund in an "impossible position". While one approach is to criticise particular IMF decisions, the view advanced here is that it is more constructive to consider the structural problem that might lead to an understanding of the policies adopted.

To a large extent, the model and the discussion is motivated by events in Argentina especially through 2001. The tension between the moral hazard school and the liquidity school was particularly evident in the Fund's actions in this case[3]. The pertinent observation is that, given the policies adopted in Buenos Aires the Fund became more and more uncomfortable with continuing its support, but there was also an acute awareness that withdrawal would surely provoke a liquidity run, devaluation and default - the crisis that Argentina was precisely trying to avoid. Powell (2003) analyzes the development of the Argentine crisis and suggests that with a major IMF led support package in place at the end of 2000, Argentina then implemented more risky policies aimed at reviving the real economy but with a decreasing probability of success. 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 by private agents in terms of how they affected the probability of the IMF program continuing. The implementation of an ingeneous system of export subsidies and import tariffs in July 2001, where those subsidies and tariffs were determined by the dollar/euro exchange rate, raised the fear that this might be interpreted by the IMF as a dual exchange rate regime and hence provide the excuse for the IMF to withdraw. This helped provide the trigger for a bank run that was then halted by the IMF package of August 2001. The package halted the bank run but as the economy continued to deteriorate, tax revenues fell and the IMF targets became more difficult to meet, again depositors speculated that the IMF would withdraw and Argentina would default and a full scale run developed again in November sparking a set of bank controls in

resolution and Rubini provides an encompassing discussion that is a good motivation for our model below. Eichengreen and Ruhl (2000) is perhaps the closest model in spirit to ours although the equilibrium of the one stage game is quite different and they do not consider a repetition of the one stage game.

[3]For an interesting account of that relationship see Mussa (forthcoming).

early December. This experience suggests that the IMF plays an important role in coordinating atomistic investors and providing liquidity protection and that IMF withdrawal may be met with a liquidity run of significant proportions.

The analysis presented also suggests that the international financial architecture (IFA) remains incomplete. The theoretical model is used to consider recent proposals such as collective action clauses and bankruptcy procedures. Collective action clauses are found to be ineffective in the context of a one-shot game, potentially useful in the context of a repeated game, but for a range of reasonable parameter values, quantitatively not particularly important. Moreover, it is argued that collective action clauses cannot solve a fundamental problem regarding those unfortunate countries that find themselves nearing default. It is argued that a bankruptcy procedure, properly designed, may offer a country an alternative to adopting a more risky strategy given a "deterioration in fundamentals" and that this might make all parties better off ex ante.

The paper is organized as followings. In Section 2 a simple one shot game is outlined. In the context of that game we are able to analyze interesting questions as to what the form of the equilibria may be, how collective action clauses may affect the form of equilibria and under what conditions the existence of the IMF raises country welfare. Given an assumption regarding IMF preference, we are also able to address the question, under what conditions would the IMF wish the IMF to exist! Unfortunately, however, it is well known that one shot games are wrong in that games are in real life repeated but that at the same time it is always difficult to find a unique equilbrium in a repeated game framework. In section 3, we consider a repetition of the game and address the uniqueness problem by showing that in an interesting region of parameter values the optimum policy for the Fund is a type of "minimum punishment strategy". This result has interesting implications for the debate regarding the international financial architecture which are taken up in the concluding section 4.

2 A model of country, IMF, private sector interactions

In this section, we develop a simple game with three actors; namely 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[4]. In the

[4]We adopt the terminology that the game in this section has three periods. Later, when we consider repeating the game, we refer to these three periods as one stage.

first period, the N private investors offer $\mathbf{1}/N$ 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) stage 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 fixed and exogenous. In fact r_I can be set equal to $\mathbf{1}$ (i.e.: simply returning the capital invested or another amount subject to some, not particularly tight, restrictions)[5]. After the debt contract is offered, there then follows a simultaneous game between the country and the IMF. The simultaneous play is assumed to reflect the fact that countries cannot commit to particular policies. In the case of the IMF it would appear more reasonable to assume that this institution might be able to commit. However, it turns out that it would not want to. In other words for the IMF there is a first-move disadvantage. The view here is then that the country and the IMF should be considered as playing a simultaneous game as the country cannot commit and the IMF does not want to. For simplicity, it is assumed that the country and the IMF have only two choices. The country can play either Safe or Risky and that the IMF can play Assist or no-Assist[6].

First, consider the structure of the game without the IMF. If the country plays Safe, it invests the money extended to it in a project of relatively safe technology. 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

[5]See Jeanne (2002) for an interesting and related model. In that paper the author endogenizes elements of the debt contract but only considers a one shot and not a repeated game. Moroever, the timing is different and in the end moral hazard can be controlled as the country's effort level can be observed before an IMF package is agreed. We suggest here that it is more realistic that the IMF is faced with the decision to assist in the face of a potential run without knowledge of how the country is acting reflecting a country commitment problem.

[6]It is relatively easy to picture the Fund's first mover disadvantage. If the Fund commits to Assist, then the country will choose Risky - we will assume that the Fund will wish to avoid this "moral hazard" outcome. If the IMF does not Assist, then the country may choose Safe but is not protected from the possibility of a liquidity run. In both cases the Fund regrets what it did given the country's choice. If somehow the country could commit, then if the country chooses Risky the Fund would not Assist and we assume that the country would prefer to play Safe as the Fund would then Assist. The problem is that we assume that the country cannot commit so the country might say it will play Safe, get the Fund's Assistance and then play Risky, and of course the Fund will anticipate this.

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 for simplicity that if the country can pay its debts then it will pay its debts. 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 later on.

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. This implies that if the country 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. Later, we develop a condition that show when private investors will always run if the country is unlucky such that in fact there was no multiple equilibrium.[7].

To be more precise, after the simultaneous game between the IMF and the country is played the N private sector investors get to decide whether they want to liquidate their investments early or not. Let us assume that there is a sequential service constraint such that if they decide to liquidate then this occurs randomly on a first come first served basis and hence if there is insufficient resources in total those who are lucky enough to get out first will receive the intermediate payment r_I/N while the country has sufficient funds and the remainder obtain zero. In the case where there are insufficient resources, then ex ante we will assume that each of the N investors has the same probability of being one of the lucky ones who got out first and obtained the interim payment. This means that each investor has the probability b/r_I of receiving the interim payment r_I. Hence the expected return to each investor conditional on the country being unlucky is a return of b. What this boils down to is that, if the country chooses the safe technology, then with probability

[7]Another approach would be to posit that investors select the run or non-run equilibrium depending on a sunspot variable which with a certain probability implies that the run equilibrium will be selected - see Jeanne (2002) for a model incorporating this feature. In practice, in our case, this simply implies adding another parameter. Indeed one interpretation of the probability x would be that it already incorporates this second sunspot- derived probability.

$1-x$ there will be a "pure liquidity run" and the country will end up being insolvent and defaulting with investors getting expected return b in that case, even though if investors had not run, insolvency would have been averted[8]. In this unfortunate case, the country defaults on its contract and suffers a penalty which again we assume is exogenous and equal to F.

On the other hand, if the country plays Risky, it invests in a technology that indeed has a probablity of failure at the end of period 3 and hence there is a probability of insolvency even if the project is maintained until completion. However, this riskier technology also has a probability of a higher return. Suppose that with probability y the project yields a payoff of t and with probability $(1-y)$ a payoff of $-u$ where $t > r, u > 0$ such that with probability $(1-y)$, the country cannot pay its debts if the project is maintained to completion. However, we also need to specify what happens again in the intermediate period. Again let us assume that the project, if liquidated in period 2, returns either a or b 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 now that if it is known that the country only has b available then neither investors, nor the IMF, knows whether the country had chosen the risky or safe technology. Once again we simply assume that if this is the case investors will run. If it was the case that the country had chosen the risky technology, and was unlucky, then of course this liquidity run simply brings forward the default from period 3 to period 2. The only difference is that in this case the liquidity run happened on the road to insolvency, whereas in the case of the safe technology, it might be thought of as a pure liquidity run. However, at stage 2 only the country knows what kind of run it was facing. Again, if the country defaults, it suffers the same default penalty as above.

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 defaulted in period 2.

Now, let us turn to the role of the IMF. If the IMF Assists then this

[8] Of course a more conmplex model might have two continuous distributions for the intermediate payoff from the Safe or Risky technologies and the known resources available in the intermediate period then being a noisy signal of one of those distributions.

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 noted above at period 2, neither the IMF nor the private sector knows whether the country has chosen the risky or the safe technology so it follows that the Stand-by cannot be made conditional on that choice. Further we assume that the amount of the stand-by is fixed at c. We assume that $c > r_I - b$ and that $c > r - u$. These conditions imply that the Stand-by is sufficient to both (a) solve a potential pure liquidity run - in the case that the country plays Safe but has bad luck but also (b) bail out private creditors - if the country is insolvent having played Risky and having had bad luck. It would be useful for the IMF if $r_I - b < r - u$ and the size of the stand-by, c, set such that the IMF could resolve a liquidity problem without providing a full bail out. We will in general assume that this is not the case[9]. 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 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[10].

The IMF is then 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 thinnk about the expected payoffs in the simultaneous game between the country and the IMF at the end of

[9]If the IMF could commit to a size of stand by that solved the liquidity problem but did not provide a full bail out, and a partial default still led to the full assumed cost of default, F, for the country most likely there would be no moral hazard in this model.

[10]While we do not go into details this might be justified in a willingness to pay model where the costs of default on the private sector are greater than the costs of drawing down the Stand-by even though it is known that the IMF will find out that the country has played Risky.

period 1. The country can play either Safe or Risky and the IMF can play Assist or No-Assist. After this nature then plays (good luck versus bad luck) and depending on the outcome of the game and nature the private sector will run or not 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 can be expressed as:

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

   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 here that although the IMF offers the Stand-by, and that is crucial in obtaining the above payoff above avoiding the possiblity of a run, these resources are not actually used.

2. Moral Hazard

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

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

   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. In this case the payoff to the country 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, the country uses up all its available resources and then 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. Here the payoff to the country is given by:

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

   where again if the country is lucky (this time with probabiltiy, y) then the country gets to keep the rewards of the project on completion and pays off private creditors. However, if the country is unlucky, once again there will be a liquidity run (of course there would have been a solvency problem at the end of stage 3 anyway) and the country defaults.

2.2 The IMF's Payoffs

1. 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 like the Moral Hazard outcome and hence has some disutility attached to that particular outcome relative to the country payoff. One way to think about this is that it is only in that case that the IMF's resources actually get used. So, another justification of this idea is that the IMF needs to raise funds to finance the use of its liquidity and hence the parameter reflecting the Fund's disutility for this outcome reflects that financing requirement. This implies that the payoffs for the IMF are very easy to define and are simply:

2. The First Best

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

3. Moral Hazard

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

4. On Your Own

$$B = x(h - r) - (1 - x)F \tag{7}$$

5. 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.

2.3 Equilibria

We suggest here that under reasonable values of the parameters, there is no pure strategy Nash equilibrium to this game. In particular, note that $A > B$, as $xr + (1-x)l > -(1-x)F$. Note that for there to be moral hazard $C > A$. This might be thought of as a condition on the minimum size of a Stand-by, namely: $(c-u)(1-y) > (1-x)l - (yt - xh)$[11]. Note that if there is no moral hazard then there is really no problem in the sense that it turns out that the First Best would be a pure strategy Nash equilibrium. 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 in other words $\lambda > yr + (1-y)(c - u + F)$[12].Finally we assume that $B > D$. If this is not the case, the Worst Case is a pure strategy Nash equilibrium implying that the IMF will not Assist and the country will play Risky. The condition, $B > D$, implies an interesting condition on F, namely that:

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

and we note that $yt > xh$ and $x > y$ is a natural condition implying that the Risky technology is indeed more risky and hence we suggest that for the risky technology to be riskier, the numerator and the denominator of the fraction will both be positive. This expression says that if the cost of default is not high enough, then in fact the Worst Case may be a pure Nash equilibrium. However, much of the recent the literature has stressed that the cost of default is indeed high, perhaps too high, and

[11] A slightly simpler version of the model has $c = u + r$ and $l = r$ in which case this condition can be written as $(x-y)r > -(yt - xh)$ and a sufficient condition for this to be satisfied is $x > y$ and $yt > xh$ which is a natural condition for what is meant by risky versus safe.

[12] We note that if this is not the case then the Moral Hazard outcome may be a pure strategy Nash equilibrium. This is indeed the assumption in Eichengreen and Ruhl (2000). However, given that the IMF decided (eventually) to pull out of both Russia and Argentina this view seems highly questionable. Indeed, 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 as would be suggested according to that equilibrium.

recent proposals on financial architecture reform take this as a starting point[13]. Here we assume that the cost of default is high enough to prevent the Worst Case being a pure strategy Nash equilibrium and hence that this condition is met.

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:

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

which is written in such a way such that it is easy to see that $0 < q < 1$ given the conditions above. The probability that the IMF plays Assist is given by p such that:

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

again written such that it is easy to verify that $0 < p < 1$.

Recently, there has been intensive discussion regarding the role of the IMF. However to date the idea that there is no pure strategy equilibrium to a very basic game of country/IMF interactions has not been suggested. And yet this does appear to be a very real possibility. We note that in the mixed strategy equilibirum there is a positive probability of IMF assistance and the country chosing 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

[13] Of course there are important exceptions. The Meltzer report might be interpreted as considering that countries may need to default at times and implicitly therefore suggests that default costs may not be too high.

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 such investors and hence the return r that they should demand is given by the equation:

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

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 for if this were not the case then lending to the country would certainly be no worse than lending at the risk free rate and might be better, 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 wll 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 $\frac{dq}{d\lambda} > 0$ and indeed this gives one interesting interpretation of what perhaps some recent lobbying activities may have been attempting to achieve[14]. If the IMF's preferences can be altered such that the IMF more strongly dislikes having its resources actually used, then this will, according to the equilbrium of the one shot game, increase the probability that a country will play Safe. This is then perhaps one interpretation of what might be referred to as 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:

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

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

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

respectivley. Now consider what happens to the welfare of the country as the cost of default, F, is decreased - which might be thought of as the introduction of collection action clauses. It turns out that the change in welfare of the country is ambigious. Indeed it turns out to be quite complicated. On the one hand as the cost of default falls, all things being equal, the probability of IMF assistance falls making the country worse off. However, reducing the cost of default also increases welfare as if the country is unlucky and is not assisted then the resulting default is ex post less costly. Finally reducing the cost of default also increases the probabilty of the country playing risky and increases the interest rate that the country is charged by the private sector. The implication of all of this is that there may be an optimum cost of default and in general the optimal cost of default, if chosen by the country, may be different to that if chosen by the IMF. Unfortunately, it appears difficult to get neat analytic solutions but below we investigate these issues in a simulation exercise.

We now turn to the question of whether the IMF should exist. First, consider what would happen if there were no IMF. In this case, assuming

$$F > r + \frac{yt - xh}{x - y} \tag{10}$$

it is easy to show that the country would choose to play Safe and hence the interest rate that the private sector would demand would be given by:

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

It is not obvious whether $r_x < r$ or vice versa and indeed this 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:

$$p < \frac{x - (qx + (1 - q)y)}{1 - (qx + (1 - q)y} \tag{11}$$

which can be thought of as a critical value p_c where it is clear that $0 < p_c < 1$. So 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.

Now we are in a position to develop some particularly simple conditions for whether the IMF should or should not exist. Note that for the country to be better off with the IMF existing, 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 mized strategy equilibrium is just $pA_r + (1-p)B_r$ where $A_r > B_r$ and where the subscript r is simply 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 $r_x > r$. So a very simple sufficient condition is that $p > p_c$.

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 $qB_r + (1-q)D_r$ where again the r subscripts refer to the evaluation of these payoffs with the interest rate, 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 then that for the IMF to have a useful role, it must be the case that $r_x < r$ or $p > p_c$. This is sufficient to improve country welfare and necessary to improve the IMF's welfare. In other words, for the IMF to have a role, the IMF must do something. The characterization here is that if the IMF reduces interest rates such that they are less than the interest rate that would have prevailed without the IMF, then that is necessary for the IMF that the IMF exists and sufficient to increase country welfare. It is interesting that this reduction in interest rates does not just come from "moral hazard" in the sense that, with the IMF, the country may get bailed out, but also because the existence of the IMF reduces the probability of a liquidity run which also results in default in this model.

It turns out that a necessary and sufficient condition that the IMF should exist (for the IMF) is that:

$$r_x > r + \frac{1-q}{x}[F - r - \frac{yt - xh}{x - y}] \tag{12}$$

This says that for the IMF to exist r_x must exceed r by a margin (as $F > r + \frac{yt-xh}{x-y}$was a condition we imposed before in order to ensure that the Worst Case was not a pure strategy Nash equilibrium) which depends on the cost of default, F. 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 is the same as the sufficient condition stated above ($r_x < r$ or equivalently $p < p_c$). However, if the cost of default is higher, then the necessary and sufficient condition for the IMF to exist appears stricter. The existence of the IMF must push the interest rate down further below the interest rate that would prevail if the IMF did not exist. This is intuitive as the model has the IMF

solving a potential liquidity problem but making a potential solvency problem worse (moral hazard) but remember that the IMF bails out the country's solvency problem if it Assists. Now if the cost of default rises, the condition says that for the IMF to be happy playing the one shot game, it must be the case that the IMF pushes down the interest rate more or in other words that the liquidity problem must be worse.

To place this discussion in the terms of the debate surrounding collective action clauses we might posit the following. If currently the cost of default is very high, then the IMF only has a useful role if liquidity problems are very important relative to moral hazard and thanks to the IMF's existence, interest rates are much lower for lending to emerging economies. If this is not the case, then those who argue against the IMF's role may have a point. However, these "moral hazard" school economists should not point to the fact that interest rates are low to make their case. Indeed, the fact that the IMF reduces interest rates is a necessary condition that the IMF should exist even in a model that includes moral hazard! Now, collective action clauses reduce the extent that 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 which will also prove useful in the subsequent sections regarding repeating the game. In box 1 we present a set of parameter values. We find that for these parameter values the probability that the country would play safe, q, is 86% and that the IMF would assist, p, is 58% in the mixed strategy equilibrium. The (net) interest rate that the private sector would charge is 8.5%. We find that the probability S is 94% or on other words that there is a 94% chance that the project (risky or safe) would be carried through to completion and that the private sector would not run and would receive the final payout with the corresponding interest (8.5%). These numbers imply that there is about a 50% chance ($86\% * 56\%$) of the IMF solving a pure liquidity problem and an 8.3% chance ($56\% * 14\%$) that the IMF will assist and the country play Risky (Moral Hazard) and a 3.2% chance ($56\% * 14\% * 40\%$) 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 0.3 as this ensures that the interest rate in the mixed strategy equilibrium is less than the interest

rate without the IMF where the country always plays Safe. As the probability of assistance in the mixed strategy equilbrium is 58%, the condition is satisfied so there is a rationale for IMF existence from the standpoint of the country. However, in this example the IMF's welfare with the IMF existing is lower than the IMF's welfare if the IMF did not exist. In other words, while the IMF lowers the interest rate for the country ensuring that country welfare is increased with the IMF, it does so at too high cost from the standpoint of the probability of using IMF resources and hence IMF welfare.

3 Repeating the game

While our numerical example did not result in a rationale for the existence of the IMF (from the standpoint of the IMF), this is not, of course, the end of the story. In this section we investigate repeating the game described above which we now refer to as the sub-game or one stage of a repeated game. We assume no discounting between the three periods of the sub-game but we do include discounting between the stages (sub-games) of the multi-stage game. As is well known, the literature on repeated games has not tended to offer very robust conclusions due to problems of indeterminacy[15]. However, the game presented has some characteristics that allow us to make some progress. First, we have a reaosnably clear First Best where the country plays Safe and the IMF Assists. This is indeed the best outcome for the IMF. It seems reasonable to think that the IMF's welfare is that of some world social planner. This means that if the players could somehow cooperate to obtain this outcome, then the IMF (world) welfare would be maximized. Second, the game in the previous section has a unique Nash equilibrium. We assume that the only "punishment" available to the IMF in order to attempt to convince countries to "cooperate" and play Safe is playing the mixed strategy of the Nash equilibrium of this game. More specifically, we consider two possibilities. First, we consdier the case where the IMF can play a "grim trigger" strategy forever. In other words, the IMF can say to a country, play the First Best or suffer the alternative of the Nash equilibrium in mixed strategies forever. Second, we consider a slightly more complex case where one of the parameters of the game can change between two values subject to a transition probability matrix. It turns out that, if the probablity of being unlucky and the project failing when the country chooses Risky rises, then the country has a greater incentive

[15] See any standard game theory book - Binmore (1992) provides a lively discussion - and see Fudenberg and Tirole (1986) for technical details and discussion.

to deviate. This implies that there might be a punishment strategy available to the IMF such that cooperation is just assured when this probability is low but even the grim trigger strategy is not enough to ensure cooperation when this probability rises above a critical value. If this is the case, then it may be optimal for the IMF to play a minimum punishment strategy that just ensures cooperation in the "good times" but admits the possibility of deviation in the "bad times" (where the IMF can do nothing except play the mixed strategy of the Nash equilibrium). As this strategy is optimal for the IMF, then this allows us to resolve the problem of indeterminacy at least for a relevant range of paremeter values. We then use this benchmark to consider other possibilities and to discuss implications regarding the international financial architecture.

3.1 The IMF plays a grim trigger strategy

The first specification is attractive for its simplicity and is useful to analyze also as motivation for the next subsection. We 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. This we refer to as the grim trigger strategy. First, note that for the IMF the First Best is indeed the best outcome in terms of its payoffs. Second, note that the payoff in the First Best for the country is better than the payoff in the mixed strategy equilibtrium. This implies that the grim trigger strategy may well be able to support the First Best as an equilibrium outcome[16]. In particular , for the First Best to be supported it must be that, for the country, playing Safe forever and hence 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. Hence:

$$\frac{A}{1-\delta} > C + \frac{\delta W_C}{1-\delta} \tag{13}$$

where δ is the discount factor between the different stages (subgames). As is standard, this equation can be rearranged to show that the First Best is supported when this discount factor is greater than a critical value:

[16] 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.

$$\delta > \frac{C - A}{C - W_C} \tag{14}$$

where we known that both the numerator and the denominator are positive and that $A > W_C$. Hence this critical value for δ is less than unity. After substituting in for the payoffs and some algebra this can also be written as:

$$\delta > 1 - \frac{(1 - x)(l - r + F)}{(1 - y)(c - u - r + F)} \tag{15}$$

where again we know from conditions already imposed that both the numerator and denominator of the fraction are positive. Interestingly we can also rearrange this as a condition on $(1 - y)$. In other words the First Best is only supported if $(1 - y)$ is below a critical value given by:

$$(1 - y)^* = \frac{(1 - x)(l - r + F)}{(1 - \delta)(c - u - r + F)} \tag{16}$$

There is a simple case of this model where the IMF lends just enough to bail the country out ie: $c = r + u$ and $l = r$ (remember also that $c + b > r_I$) and then this expression basically boils down to $1 - y < (1 - x)/(1 - \delta)$ which is less than unity for $\delta < x$. However, in our view, for the IMF to stop the liquidity run it is likely that it would have to provide more than just $c = u + r$ making this condition more easily satisfied.

This analysis shows that, at least subject to this grim trigger, cooperation is feasible and if the parameter values are appropriate then the country will choose Safe and the IMF will Assist. If this is the case then the private sector will demand the risk free interest rate and the existence of the IMF is welfare improving both for the country and for the IMF.

The fact that there is a critical value of $1 - y$ (the probabilty of insolvency if the country plays Risky) is interesting for the following reason. Suppose that a country's fundamentals are deteriorating, then we would expect that $1 - y$ would be rising (and rising faster than $1 - x$, or in other words the risky technology is becoming more risky). This means that at some point it is likely that the country would deviate. Hence it seems likely that a country would deviate as its fundamentals deteriorated but before it actually defaulted.

The intuition behind this result is the following. As a country's fundamentals, as represented by y, deteriorate then if the country did deviate it would expect to be assisted with higher probability ie: $\frac{dp}{dy} > 0$

in the mixed strategy equilibrium. This implies that deviation (playing risky) becomes relatively more favorable despite the fact that if the country does play risky, the probability that the country will be unlucky $(1 - y)$ rises. This discussion however reveals a shortcoming of this simple trigger analysis. If y is fixed, then the above implies cooperation forever or no cooperation forever. If y can change then surely the players should take this into account ex ante. Indeed this would change the payoffs and hence the various parameters of the game.

3.2 A minimum punishment strategy

In considering more complex punishment strategies we are immediately confronted with the problem of indeterminacy in that, as is well-known in game theory, almost anything could happen. However, the structure of the game above suggests that there might be a unique, "minimum punishment strategy" that might actually be optimal for the IMF[17]. Suppose that y can take on 2 values, y_H and y_L and that there is a symmetric probability transition matrix such that the probability of y remaining in the state that it is in is z and of changing state is $1 - z$. In general we might think that $z > 0.5$ to model some persistence in this parameter. We assume for now that the IMF cannot condition its punishment on the currenct state of y. Then, given the structure of the game as analysed above, there is then 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 are not necessarily suggesting that this is a realistic description of what the IMF actually does, however, if we can show that under certain circumstances it may be optimal then it is a useful benchmark to compare other possible strategies that would be definition be sub-optimal.

We also need to think a little bit more about the timing of the model. Let us suppose, first of all, that the IMF cannot punish a country that has not already deviated. This assumption then rules out the possibility that the IMF antcipates deviation and brings forward the "punishment" and ensures that the Moral Hazard outcome is observed for at least one period[18]. Assume that we start in the First Best and that $y = y_H$. The idea is then that there may be some minimum punishment that the

[17] 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. However, the set up here, is quite different.

[18] Mussa (forthcoming) presents an interesting discussion of the relations between Argentina and the IMF explaining why the IMF did not abandon its program earlier which would precisely support this assumption.

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 $y = y_L$). If that is the case, then this minimum punishment strategy would then be an optimal strategy for the IMF.

The equilibrium strategies for the country and the IMF are then as follows:

The Country's Strategy: If the IMF cooperated last period (played Assist) and if $y = y_H$, then the country will cooperate (play Safe) this period. If the IMF cooperated last period and if $y = y_L$, then the country will now deviate (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 (cooperate) or if $y = y_L$ it will again play Risky (deviate).

The IMF: The IMF will cooperate (play Assist) if the country cooperated (played Safe) last period. If the country deviated last period (played Risky), 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[19].

We then define the following:

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

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

where the C/H subscript indicates cooperation when $y = y_H$ and D/L deviation 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 deviating tomorrow (if $y = y_L$ tomorrow).

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

[19] An alternative assumption is that the IMF must actually see the country playing Safe again after the punishment period is over. The minimum punishment strategy is then stochastic as it is the first period after $N*$ periods when $y = y_H$. This introduces some complications to the analysis for very little gain in intuition. Moreover, if the punishment period is suficiently long and the discount factor sufficiently less than one such minor differences in how the punishment is specified will have negligable quantitative effects.

$$V_{D/H} = C_H + \delta(V_{MP/H}) \tag{18}$$

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

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

$$V_{C/L} = A_L + \delta(zV_{D/L} + (1-z)V_{C/H}) \tag{19}$$

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

$$V_{D/L} = C_L + \delta(V_{MP/L}) \tag{20}$$

where $V_{MP/L}$ is the value of the minimum punishment starting at $y = y_L$. It can be shown that:

$$V_{MP/L} = \frac{1-\delta^{N^*}}{1-\delta}(zW_L + (1-z)W_H) + \delta^{N^*}(zV_{D/L} + (1-z)V_{C/H}) \tag{21}$$

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 $y = y_H$.

$$V_{MP/H} = \frac{1-\delta^{N^*}}{1-\delta}(zW_H + (1-z)W_L) + \delta^{N^*}(zV_{C/H} + (1-z)V_{D/L}) \tag{22}$$

For the equilibrium proposed we need to show that:

$$V_{C/H} > V_{D/H} \tag{23}$$

and that

$$V_{C/L} < V_{D/L} \tag{24}$$

The equations (17)-(24) define a highly rescursive system and there are no analytical solutions. However, we can make progress in the following way. Consider applying the grim punishment strategy ie: the mixed strategy equilibrium of the one shot game forever. Now, if such a grim punishment is tough enough to get cooperation at $y = y_H$ but not tough enough to obtain coperation at $y = y_L$ then that is sufficient

for the minimum punishment strategy equilibrium to exist.[20]. In other words, one way to proceed is to 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. It turns out that in this way we can now solve the above systems for regions of the parameters z and δ where the minimum punishment strategy equilibrium exists. More specifically, for the constraint that $V_{D/L} = V_{C/L}$ and setting $V_{MP/L} = V_{G/L}$ and $V_{MP/H} = V_{G/H}$ we find that:

$$\delta = \frac{C_L - A}{C_L - W_L z - W_H(1-z)} \tag{25}$$

Where C_L is the payoff to deviation (the moral hazard outcome) when $y = y_L$[21]. 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 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:

$$\frac{A + (1-z) * \delta(C_L + \frac{\delta}{1-\delta}(W_H(1-z) + W_L z)}{(1 - z\delta)} = CH + \frac{\delta(W_H(1-z) + W_L z)}{1-\delta} \tag{26}$$

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

$$\delta = -M - \frac{\sqrt{(M)^2 - 4(C_H - A)(C_L(1-z) + C_H z - W_H + 2z(1-z)(W_H - W_L)}}{2(C_L(1-z) + C_H z - W_H + 2z(1-z)(W_H - W_L)} \tag{27}$$

[20] This is slightly loose as we have specified the punishment strategy as a number of periods of the one shot game Nash equilibrium mixed strategies. Hence there is an integer problem. However, we will disregard the integer problem for the purposes of this discussion.

[21] 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.

or

$$\delta = -M + \frac{\sqrt{(M)^2 - 4(C_H - A)(C_L(1-z) + C_H z - W_H + 2z(1-z)(W_H - W_L)}}{2(C_L(1-z) + C_H z - W_H + 2z(1-z)(W_H - W_L)} \tag{28}$$

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

$$z = \frac{A(C_H - C_L + W_H - W_L) + C_L W_L - C_H W_H}{(2A - C_H - C_L)(W_H - W_L)} \tag{29}$$

$$\delta = \frac{C_H + C_L - 2A}{C_H + C_L - W_H - W_L} \tag{30}$$

In the appendix (to be completed) we develop conditions where the relevant solutions for z and δ are both between zero and one and where the solution of $V_{C/L} = V_{D/L}$ has a positive slope ($d\delta/dz$ is positive) and the solution of $V_{C/H} = V_{D/H}$ has a negative slope ($d\delta/dz$ is negative). If this is the case at the point of intersection, then we know that there is indeed a range of parameter values where the minimum punishment strategy equilibrium exists. Consider the numerical example introduced before. In this case we can trace out the two boundaries to illustrate the range of parameters where the minimum punishment strategy equilibrium exists:

The Graph in the text (Figure 3) 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 $0 < z < 1, 0 < \delta < 1$ and with the expected slopes. To the right of this intersection between the two curves is then the region where the minimum punishment strategy exsts and is optimal. To the right of the intersection, above the upper curve, 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 $y = y_H$.

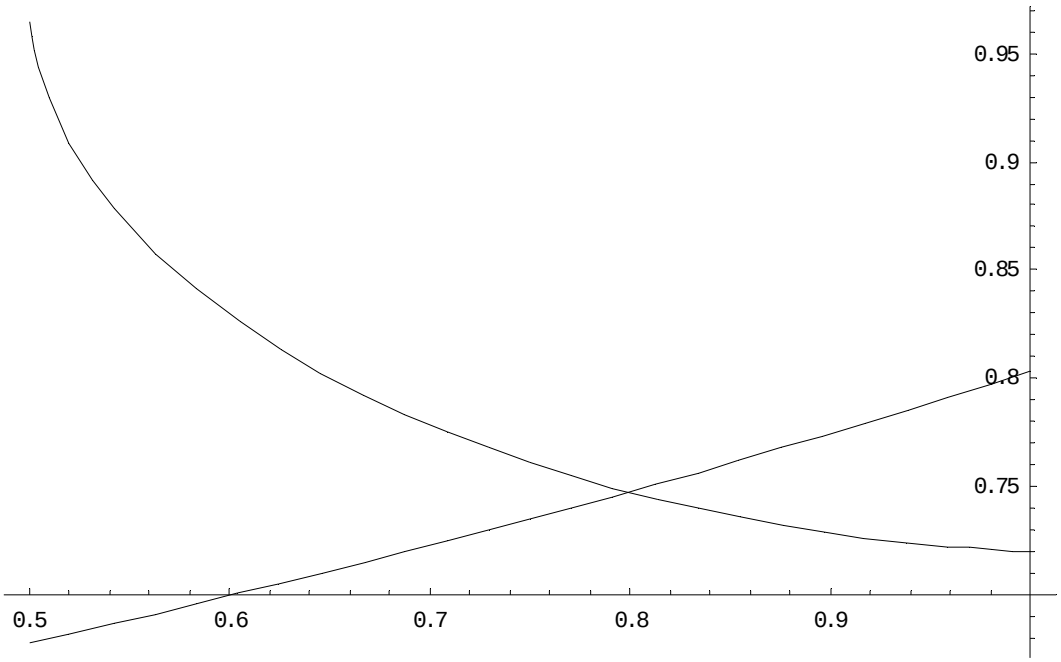

Figure 1:

4 Concluding Remarks

In the one stage game described above there is a unique Nash equilibrium. However, this equilibrium is one in mixed rather than pure strategies. Remember also that even if the IMF wished to commit to a strategy before the country plays, it would not want to. There is a first-mover disadvantage for the IMF. Moreover, it seems reasonable to suppose that the country cannot commit - otherwise the whole discussion of moral hazard is quite irrelevant. What this implies is 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 only equilibrium in the one stage game is where it only assists with some probability in order to keep countries guessing and hence reduce the moral hazard problem. If cooperation cannot be supported, then whether the IMF should exist or not (from the standpoint of the IMF) appears a very open question. If the IMF did not exist, then the model suggests countries will play Safe but may suffer liquidity runs. If the IMF always assisted it would solve the problem of the liquidity runs but at the cost of moral hazard. Given the mixed strategy equilibrium, where the IMF assists with some probability, the IMF has a role if the

problem of liquidity runs is large relative to the problem of moral hazard. If the interest rate that would prevail, without the IMF, were less than that with the IMF's existence, then this suggests that moral hazard is the graver problem and this is a sufficient condition that the IMF has no constructive role. For the IMF to have a constructive role, it must reduce interest rates. This would then suggest that the liquidity protection was important relative to the moral hazard. We note that this discussion is at odds with the standard view that low interest rates, as a result of IMF actions, is a sign of moral hazard and hence a potential problem.

If cooperation can be supported then it is, of course, much more likely that the IMF has a constructive role to play. In particular, if the IMF can play a "grim trigger strategy" and countries are relatively patient, then cooperation may be supported and the IMF can solve the liquidity problem without introducing moral hazard at all. However, evidence suggests that the IMF does not play a grim trigger as while assistance has been withdrawn from countries - presumably because the IMF decided the particular country had adopted a set of policies that should not be supported - assistance has been subsequently put back in place after policies changed. Unfortunately, as is well known, in repeated games there is a chronic problem of indeterminacy of equilibria. Here, we assume that the only punishment available to the IMF is to play the unique Nash equilibrium of the one stage game. So, depending on how much punishment the IMF can inflict (how many periods of the mixed strategy equilibrium are played to punish), the opportunities for cooperation may be large or small. If the IMF cannot punish at all, or can only punish for one or two stages, then the parameter values where cooperation is supported will be much more limited.

However, it is also the case that as some parameters of the model change, then the incentives for cooperation alter. In particular, perhaps somewhat counter-intuitively, as the probability of being unlucky rises, so too does the probability of being assisted in the mixed strategy equilibrium and this implies that there is a greater incentive to deviate. In the game considered above, if the probability of being unlucky in the case of Risky play rises, it may be the case that even with the grim trigger punishment strategy, cooperation cannot be supported. This then gives rise to the possibility that there is an optimal "minimum punishment" regime whereby 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 deviates under a different set of parameter values. As detailed, under this strategy profile, deviation will tend to occur when the probability of being unlucky if the country plays Risky

(and hence the probability of insolvency) rises.

This is not necessarily a realistic description of what the IMF actually does but as it may be an optimal strategy it is a useful benchmark. An interesting implication of this benchmark is that countries are likely to deviate before they default as when the probability of insolvency rises, the incentives to deviate increase and it is only after deviation that the IMF withdraws and default is possible. Hence the prediction of this case is that if the risk of insolvency rises, countries may tend to deviate, the IMF will respond with the mixed strategy equilibrium and countries, if they are unlucky, will then default during the "minimum punishment" period.

One aspect of this strategy profile 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 $y = y_H$. However, it might be suggested that the IMF should condition its punishment on the realization of y. In other words suppose the risk of insolvency rises, should the IMF punish more or less? If the IMF could credibly commit to punishing more, then cooperation might be supported for longer. However, it seems difficult to argue that the IMF should punish more when the risk of insolvency has risen. After all, this is simply a parameter of the model and outside the country's control. Why should the IMF punish a country more that has deviated when insolvency risk is higher? Indeed one might expect the IMF to punish a country less severely as insolvency risk increases. If this is the case then cooperation will be supported only under a stricter set of parameter conditions, and deviation may occur more frequently. We therefore think that while the minimum punishment strategy profile may appear to be somewhat special case, the idea that countries will deviate as insolvency risk increases is true more generally under reasonable strategy profiles.

This discussion implies that the IMF is in a very awkward position. If we start from the situation of a country cooperating, it means that if for some reason insolvency risk increases, a country may deviate and the IMF may have to respond with punishment ie: the mixed strategy play of the one period game. And as we have mentioned, the country if it is unlucky will then default within the punishment period. Of course within the mixed strategy play of the punishment period, the country may default as a consequence of a pure liquidity run or a liquidity run preempting insolvency - as under the mixed strategy equilibrium there is a probability of the country playing Safe, playing Risky and of the

IMF assisting or not assiting.

This sequence of events suggested by this analysis mirrors closely those related to Argentina, especially during 2001 and 2002. Arguably (see Powell 2003 for a detailed account), Argentina and the IMF "co-operated" during most of the 1990's and a major assistance package, known as the "blindaje", was arranged in late 2000. Argentina then went through 3 economy ministers in as many months as a political scandal regarding spending cuts highlighted the political limits to fiscal adjustment. Powell (2003) suggests that at that point Argentina deviated and the IMF became increasingly uncomfortable with the policies adopted. Some may put the date of deviation earlier (not enough public sector savings during the "good times") or later (with a massive bond swap in May or in November 2001 with an attempt to control interest rates and dollarize the financial system), changing the details of the story but not the main message. It might be argued that with three Economy Ministers in as many months, the IMF had a decision to make; either withdraw or support Argentina strongly. However as Argentina adopted more risky heterodox policies in an attempt to, "get the economy moving", the impression was that the IMF vacillated. The IMF became increasingly uncomfortable assisting given this policy direction but was also acutely aware that if it did withdraw it would likely cause a massive liquidity run that would have prompted a major crisis and default. Each policy development in Argentina was greeted by an analysis of whether this would be approved of by the Fund and if not whether the Fund would withdraw. It was rumoured that an ingeneous export subsidy and import tax policy that used the dollar/euro exchange rate to fix the leves of taxes and subsidies might be interpreted by the IMF as a dual exchange rate policy and hence provoke the end of the IMF program. This then helped to spark a bank run as bank depositors realized that if the Fund withdrew and default loomed, banks' exposure to Government assetts implied that depositor confiscation was likely. In fact the bank run of July/August 2001, was halted by an IMF package. This package has been criticized and indeed was labelled by Mussa (2002) as the worst decision that the IMF has ever made. Unfortunately the bank run did serious damage to the real economy and things got worse rather than better until the IMF finally withdrew in late November heralding another bank run that then forced the authorities to implement a set of banking controls. The controls were deeply unpopular and helped topple the Government. The new Government defaulted but after only a couple of weeks was out of power and the subsequent Government defaulted and "pessified" domestic dollar contracts in the financial system and elsewhere.

In the case of Argentina, the IMF found itself exactly in the difficult position between attempting to deliver liquidity protection but fearing moral hazard as depicted in the theoretical analysis above. Moreover the reaction of the private sector to the rumours of IMF withdrawal and then the August IMF package halting a major bank run, backs up quite closely the role of the IMF as suggested in the model as one of coordinating the private sector.

However, the deeper point suggested by the analysis is that the international financial architecture remains incomplete. On the one hand, a lack of cooperation between countries and the IMF may result in a mixed strategy equilibrium and it is questionable whether such an outcome would back strongly the role of the IMF. On the other hand, while cooperation leading to the First Best may well provide a strong justification for the IMF's existence, cooperation may break down if the probability of insolvency rises, placing the Fund in a very difficult position indeed. 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 and help avoid a situation where a country chooses to soldier on regardless, perhaps only to make things worse[22]. The game above potentially allows us to think through how generous or tough such a mechanism should be. Roughly speaking, the 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. On the other hand, the SDRM should never be more generous than the First Best. However, naturally the game would have to be adapated as if an SDRM mechanism were put in place that satisfied these constraints then the private sector would anticipate this outcome ex ante, and fix interest rates accordingly and the country would anticipate that outcome in thinking about when to deviate.

This is not the place for a detailed discussion of the SDRM proposals as they stand (that would deserve another paper), suffice to say that it is not clear that the proposals on the table would satisfy these constraints. In thinking about the Argentine case, we are saying that at the time that Argentina started to adopt more and more risky strategies, then to

[22]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 (2001) and (2002) and Rogoff and Zettelmeyer (2002) for a review and historical background. See also Bolton (2003) for motivation considering corporate bankruptcy procedures.

have reduced the final costs of the crisis, an SDRM should have been just preferred for Argentina than the course of action taken. Put crudely, for this to have been the case, we would suggest that it would have had to have given a reasonable probability of the Government of the day surviving through the application of that mechanism. This implies a reasonably generous mechanism and it is not clear that the actual SDRM being discussed would have resulted in that outcome. However, having said that it may still be the case that an SDRM would have helped had it been available. It may not solve the underlying problem developed in this paper, but it may still increase ex ante welfare for the parties concerned if it, for example, reduced the probability or magnitude of liquidity runs as the IMF withdraws after deviation.

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