IMF Programme Design & Private Sector Involvement in Crisis Resolution

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Abstract

IMF programmes are frequently criticised for lacking focus and being ineffective in helping maintain private credit lines following a debt crisis. We develop a theoretical model to explore the interlinkages between result-based conditionality and creditor collective action problems. The model highlights the strategic interactions between official and private creditors, and clarifies some of the tradeoffs that underpin the design of IMF programmes. We identify conditions under which official creditors are able to limit the efficiency losses generated by creditor non-cooperation and debtor moral hazard. The circumstances under which official lending is able to 'catalyse' private sector finance are also analysed.

Keywords: Crisis Management; IMF Conditionality; Incentive Theory; Private Sector Involvement

JEL classification: F33; F34

1. Introduction

A feature of recent debate on the international financial architecture has been the growing disquiet about the effectiveness of IMF programmes in the wake of financial crises. A number of critics have questioned whether IMF activities are properly aligned with the interests of its shareholders and the debtor country[1]. And, largely as a response to such unease, the IMF has adopted a set of guidelines with a view to narrowing the scope of structural conditionality and increasing debtor country ownership of programmes[2].

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Two key concerns underpin the criticisms of the IMF's exisiting approach to conditionality. First, the specification of 'micro' policy measures, and the reliance on broad programme reviews (rather than more specific and narrow performance criteria), to monitor performance can potentially lower the incentives for the debtor countries to pursue vital reforms. Goldstein (2000) suggests that large numbers of 'micro' conditions, which require judgments by the IMF about disbursement in the event of partial fulfillment, can lead to signals and incentives becoming muddled. He recommends the IMF engage in 'leaner' structural conditionality, with each condition in the programme being directly related to financial stability and carrying a macroeconomic impact.

Second, an insistence on deep structural reforms that are tangential to the immediate financial crisis can limit the scope for private sector involvement in crisis resolution. Radelet & Sachs (1998) argue forcefully that engendering the view that structural policies are necessary for crisis resolution makes it more difficult to restore investor confidence quickly and initiate short-term debt rollovers. As a result, voluntary private sector 'bail in' as a part of international crisis management becomes more difficult to achieve.

Taken together, these issues highlight the importance of ensuring that IMF programmes improve (a) the incentives of the debtor to voluntarily engage in policy adjustment; and (b) the incentives of the private sector to voluntarily maintain credit lines to a country in crisis. But linking lending to tightly focused performance criteria is not straightforward. With many creditors involved in a sovereign debt workout, there can be conflicting demands on a debtor that affect its ability to meet loan conditions. Moreover, appropriate conditionality must balance the 'controllability' of a performance measure with its 'alignment' to actual outcomes.

Even if performance criteria are well aligned to the pursuit of financial stability, they may be difficult for the debtor to control. Exogenous developments generally lead to demands for waivers by the borrower. For instance, a performance criterion might be a quantative ceiling on central bank net domestic assets for a country operating a managed float. A breach of the ceiling could reflect an easing of monetary policy, or exogenous shocks to money demand or other macroeconomic variables. As noted by the IMF (2001), the uncertainty surrounding performance measures is a key factor behind the use of broadly based programme reviews as a means of assessing debtor country compliance.

This paper develops a theoretical model to analyse some of the strategic interactions between a debtor and its (official and private) creditors following a sovereign debt crisis. We show how non-cooperation between creditors in the debt workout process exacerbates the moral hazard problem posed by the debtor's unwillingness to engage in policy effort. This results in a reduced incidence of rollovers/new money lending by creditors and generates a welfare cost, *ex post*[3]. We identify the circumstances under which IMF lending ameliorates these welfare costs and sharpens incentives – for the debtor to engage in effort, and for lenders to increase rollovers. But we also demonstrate how the ability to do this depends on the focus of the IMF programme, i.e on the tradeoff between alignment and control. The model, thus, explores the interlinkages between creditor collective action problems and result-based conditionality. In so doing, it sheds some light on the factors underpinning the capacity of the official sector to 'catalyse' private sector finance.

Our model builds on recent developments in the literature on incentive theory. Dixit (1996) demonstrates how the power of incentive schemes is lowered when

many principals simultaneously attempt to influence the actions of the agent. And Baker (2000) examines the tradeoffs involved in performance measure design in a setting where a single principal faces an agent capable of many actions/tasks. We combine the features of both models into a single framework and explore its implications. In addition we stress an important stylised fact of crisis management, namely the tendency of the official sector to be first in the provision of emergency credit and to play a leadership role in debt workouts. Debtor countries in trouble typically approach the official community in the first instance. They offer to adhere to the terms of an IMF loan, and then frequently request IMF help in organising voluntary (or concerted) rollovers with private creditors. We, therefore, emphasise the importance of multiple principals moving sequentially – rather than simultaneously – to influence the agent. The assumption that the IMF is a Stackelberg leader among creditors has a marked effect on second-best incentive schemes and, in our context, the *ex post* costs of creditor non-cooperation.

The role played by IMF programmes in ameliorating the problems of disorderly workouts, and in shaping the allocation of adjustment effort, has not received much attention in the literature on IMF conditionality. The impact of IMF programmes on private creditor lending during crisis resolution has also not been considered in detail. Existing work has emphasised the role of conditionality in overcoming time inconsistency problems associated with a debt overhang (e.g Sachs, 1989; Diwan & Rodrik, 1992), and as a commitment technology to help overcome the enforceability problem of sovereign debt (Fafchamps, 1996). Most recently, Marchesi & Thomas (1999) have viewed conditionality as a screening device that allows creditors to distinguish between countries with a high/low willingness to adjust. But IMF programme design has become relevant in the recent debates on private

sector involvement and official sector bailouts – creditor co-ordination issues and result-based conditionality have assumed centre stage[4].

The paper proceeds as follows. Section 2 describes the model, presenting the first best solution as a benchmark for analysis. The implications of debtor moral hazard and creditor non-cooperation are then considered. The important role played by the IMF's first-mover advantage in influencing incentives and welfare is also analysed, and the part played by performance measure design is elucidated. Section 3 examines the circumstances under which the IMF's primacy in the provision of emergency funds results in increased lending by the private sector – so called 'catalytic' finance. A final section discusses some policy ramifications of the model and concludes.

2. The Model

Consider the following stylised description of crisis management. A debtor country approaches its international creditors for assistance following a liquidity crisis. But creditors will only lend in return for adjustment effort. The interests of the official and private sectors in the adjustment effort of the debtor are in conflict – each creditor would like to ensure that the debtor undertakes actions aimed at repaying it ahead of other creditors. The official sector, hereafter the IMF, moves first and offers to provide credit to fill some of the financing gap on condition that the debtor pursues courses of action to regain immediate and longer term debt sustainability. Observing this, private creditors (banks) choose whether or not to rollover or extend credit as part of a 'bail-in'. The combination of official and private money, together with debtor country adjustment effort, fills the financing gap.

In this game, the IMF and private banks can be thought of as two principals indexed $j = f, b$ respectively. The debtor country is the agent and undertakes actions that are not verifiable. Specifically, it controls a three dimensional vector, $\mathbf{a}' = \{a_1, a_2, a_3\}$, which affects the expected payoffs of the two principals[5]. Actions a_1 and a_2 contribute to financial stability, and are aimed at satisfying the IMF. They can be broadly thought of as adjustment policies with immediate and longer-term impacts. Thus, a_1 might involve an exchange rate re-alignment or other macroeconomic policies geared towards immediate stabilisation. And a_2 might reflect structural policies, such as banking and corporate sector reforms, that are slower to take root. Actions aimed specifically at raising money to repay private creditors are represented by a_3, and can be thought of as efforts to raise money for immediate debt repayment (e.g the fire sale of state assets).

Undertaking these actions is costly and the debtor's cost function is assumed to be quadratic[6]. If the debtor is risk averse with mean-variance preferences, its utility will be given by

$$E(L) - \frac{1}{2}[rvar(L) + \mathbf{a}'\mathbf{I}\mathbf{a}], \tag{1}$$

where $L = \sum L_j$ is the aggregate amount lent by the creditors, $\mathbf{I}$ denotes a 3×3 identity matrix, and r is the coefficient of absolute risk aversion.

The output, V_j, received by principal j can loosely be thought of as repayment (or cashflows) and is a function of the agent's efforts and uncontrollable events. We assume this takes a linear form:

$$\mathbf{V}(\mathbf{a}, \boldsymbol{\epsilon}) = \mathbf{H}\mathbf{a} + \boldsymbol{\epsilon}, \tag{2}$$

where $\mathbf{V}$ is a 2×1 matrix of outputs V_j $(j = f, b)$, $\mathbf{H}$ is a 2×3 matrix of marginal

products of actions on outputs, and $\boldsymbol{\epsilon}$ is an error vector reflecting liquidity shocks that is distributed normally with mean zero and variance-covariance matrix

$$\boldsymbol{\Omega} = \begin{pmatrix} \sigma^2_{\epsilon f} & 0 \\ 0 & \sigma^2_{\epsilon b} \end{pmatrix}.$$

In addition, we suppose that the matrix $\mathbf{H}$ is of the form

$$\mathbf{H} = \begin{pmatrix} h_1 & h_2 & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

where the vector $\mathbf{h}'_f = (h_1, h_2, 0)$ is of unit length. In other words, it is only the debtor's actions in dimensions 1 and 2 that affect the payoff of the IMF. So the IMF's repayment, V_f, which stems from the debtor's pursuit of medium-term sustainability, is some weighted average of macro-stabilisation policy (a_1) and structural reform (a_2). By contrast, the repayment, V_b, of the bank is only influenced by action a_3.

Creditors are risk neutral. To keep matters simple, we exclude the possibility that creditors face spillovers resulting from debtor country output. So only the IMF benefits from V_f and only the banks benefit from V_b. Accordingly, the payoff to each creditor is given by $\boldsymbol{\Gamma}_j = \mathbf{z}'_j\mathbf{V}$, where $\mathbf{z}'_f = (1, 0)$ and $\mathbf{z}'_b = (0, 1)$. Therefore the aggregate expected payoff to the creditors is

$$E[\mathbf{z}'\mathbf{V}] - L, \tag{3}$$

where $\mathbf{z} = \mathbf{z}_f + \mathbf{z}_b$ denotes the creditors' unit valuations of the corresponding components of output (repayments).

The problem for each creditor is to design a contract which ensures that the debtor undertakes a stipulated effort in return for the loan. More formally, creditors design linear contracts – a loan consisting of a sure amount, γ_j, plus some

rewards, $\mathbf{m}_j$, for producing more of V_f and V_b at the margin – that induce the debtor to take actions that maximise expected payoffs[7]. This is a direct analogue to the linear contract offered by firms to risk averse workers, i.e a fixed salary plus a bonus component linked to output. So creditor j's lending scheme is given by $L_j = \gamma_j + \mathbf{m}_j'\mathbf{V}$, and the aggregate lending scheme is

$$L = \boldsymbol{\gamma} + \mathbf{m}'\mathbf{V}. \tag{4}$$

Although linear contracts are chosen for analytical tractability, they can be given a ready interpretation. For IMF lending, the sure amount γ_f can be regarded as the initial disbursement of funds in an IMF programme. Subsequent disbursements are related to effort, and released when the performance criteria are satisfied. These can be thought of as the 'bonus' amount $\mathbf{m}_f'\mathbf{V}$. In the case of private lending, the sure amount γ_b can be thought of as the amount of new money lending that is (voluntarily) offered to a debtor following a crisis. Subsequent rollovers, or infusions of new money, to help fill the financing gap are linked to the ability of the debtor to meet loan performance criteria. These can be thought of as the term $\mathbf{m}_b'\mathbf{V}$.

Thus, in the framework above, the focus is on the tradeoff between risk sharing and incentives. The (risk averse) debtor is attracted to 'sure' income, while (risk neutral) creditors would like to condition additional disbursements on outcomes. Creditors must design a contract that offers the sharpest incentives possible, whilst providing the debtor with just enough utility to want to participate in the game. In principal-agent models of this type, the creditors (principals) extract all the surplus. So they choose the γ_j and the marginal reward vectors, $\mathbf{m}_j$, to divide the surplus between them and to ensure that the debtor's participation constraint

is just met.

2.1. The First Best

If adjustment effort can be monitored directly and if creditors can act co-operatively as a single principal, they would offer a contract contingent on the debtor making an effort, $\mathbf{a}$, in return for an aggregate loan, L. The expected return to the creditors will be

$$E[\mathbf{z}'\mathbf{V}] - L = \mathbf{z}'\mathbf{H}\mathbf{a} - L, \tag{5}$$

and the debtor's surplus will be

$$L - \frac{1}{2}\mathbf{a}'\mathbf{I}\mathbf{a}. \tag{6}$$

The interests of all parties are best served by choosing $\mathbf{a}$ to maximise the total surplus, namely the sum of creditor and debtor income:

$$\max_{\mathbf{a}} \ \mathbf{z}'\mathbf{H}\mathbf{a} - \frac{1}{2}\mathbf{a}'\mathbf{I}\mathbf{a}. \tag{7}$$

This yields the first best action

$$\mathbf{a}^* = \mathbf{H}'\mathbf{z}. \tag{8}$$

In other words, the agent's effort is perfectly aligned with the creditors' combined valuation of repayments at the margin, and the incentive scheme has '100 percent power' since $a_1^* = h_1$, $a_2^* = h_2$ and $a_3^* = 1$. In the aggregate lending scheme it is as though $\mathbf{m} = 1$ and $L = \gamma + (V_f + V_b)$, i.e the creditors lend a fixed amount in return for the maximal effort. This provides a useful benchmark with which to compare our main results.

2.2. The Second Best & IMF Intervention

The first best incentive scheme is unlikely to arise for several reasons. First, effort may be unverifiable (and hence unenforceable in a court of law) or extremely costly to monitor. Second, although principals fare better by colluding they may act non-cooperatively if binding arrangements are not possible. Third, it may not be possible to use the values V_j in an incentive plan. For example, it may be difficult for the principal and the agent to agree on a measure of output. Most contracts are based on performance measures that seek to proxy true output. Taken together, these factors combine to lower the power of the incentive scheme presented to the debtor.

The implications of the first two factors are well known (e.g Dixit, 1996; Prendergast, 1999). But the interests of the IMF in medium-term debt sustainability and financial stability mean that it is reliant on proxy performance measures in its relationship with the debtor. We therefore suppose that there exists a vector, $\mathbf{P}$, of performance measures that is also a linear function of the debtor's actions:

$$\mathbf{P} = \mathbf{G}\mathbf{a} + \phi \tag{9}$$

where the matrix $\mathbf{G}$ is a 2×3 matrix of the form

$$\mathbf{G} = \begin{pmatrix} g_1 & g_2 & 0 \\ 0 & 0 & 1 \end{pmatrix}.$$

The vector $\mathbf{g}_f' = (g_1, g_2, 0)$ is of unit length and is the vector of marginal products of the debtor's actions on the IMF performance measure. It is distinct from $\mathbf{h}_f'$, the vector of marginal products of actions on actual IMF outputs. So the IMF uses a distorted performance measure, whereas private creditors base

their incentive contracts on a perfectly aligned performance measure, i.e. the repayment V_b – exactly as before[8]. This means that the aggregate loan contract that is presented to the debtor, $L = \gamma + \mathbf{m}'\mathbf{P}$, depends both on the distorted measure as well as on short-term cash flows. The vector $\boldsymbol{\phi}$ reflects the effect of uncontrollable events on the performance measure. It is distributed normally with mean zero and variance-covariance matrix

$$\mathbf{\Phi} = \begin{pmatrix} \sigma^2_{\phi} & 0 \\ 0 & \sigma^2_{\epsilon b} \end{pmatrix},$$

where the noise in the IMF performance measure is uncorrelated with shocks to short-term cashflows earmarked for private creditors.

In addition to the problem of distorted performance measures, crisis management casts the official sector in a leadership role during debt workouts. Existing literature (e.g Dixit, 1996) usually explores non-cooperative behaviour by principals under the assumption that they simultaneously attempt to influence the agent. But the leadership role means that multiple principals move sequentially, rather than simultaneously, to influence the agent. We model this as a two stage game. In the first stage, the creditors act non-cooperatively and choose their (linear) incentive schemes. The IMF moves first and offers the debtor a loan contract, basing incentives around a performance measure. The private sector creditors follow but, in contrast, offer a loan where subsequent rollovers are based on 'true' output, i.e actual cashflows. In the second stage, the debtor chooses its optimal actions, i.e. adjustment effort, given the aggregate incentive scheme offered. We look for the subgame perfect equilibrium of the creditors' choices.

Proposition 1 *In equilibrium, the second best aggregate incentive scheme with*

performance measure distortions and the IMF as leader is implictly given by

$$\mathbf{z} = (\mathbf{G}\mathbf{H}')^{-1}[(\mathbf{G}\mathbf{G}' + 2r\mathbf{\Phi})\mathbf{m}^* - r^2\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}\mathbf{\Phi}\mathbf{m}_f^*]. \tag{10}$$

Proof. See Appendix 1. ■

We can compare this outcome with the first best above. Suppose there is no performance measure misalignment and that the debtor is risk neutral, i.e. $\mathbf{G} = \mathbf{H}$ and $r = 0$. Equation (10) reduces to $\mathbf{z} = \mathbf{m}^*$ where $\mathbf{z}$ captures the unit valuations of cashflows for the creditors in aggregate, and $\mathbf{m}^*$ is the equilibrium marginal reward promised by the creditors for units of cashflow. For the IMF, $\mathbf{m}_f^*$ reflects disbursements based on programme reviews, while for banks $\mathbf{m}_b^*$ is the incidence of loan rollovers/new money infusion. The debtor's equilibrium choice of effort is given by (equation 25; see appendix 1), so equation (10) can also be re-expressed as $\mathbf{a} = \mathbf{H}'\mathbf{z}$ – the same as in the first best.

But if $r > 0$ there is a tradeoff between risk and incentives, and a wedge emerges between the marginal valuation and marginal reward. If $\mathbf{G}$ and $\mathbf{H}$ are distinct, then rewriting (10) gives

$$\mathbf{z} - \mathbf{m}^* = \underbrace{(\mathbf{G}\mathbf{H}')^{-1}[(\underbrace{\mathbf{G}\mathbf{G}' - \mathbf{G}\mathbf{H}'}_{\text{performance measure misalignment}} + 2r\mathbf{\Phi})\mathbf{m}^*}_{\text{Nash (Simultaneous) Outcome}} \underbrace{- r^2\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}\mathbf{\Phi}\mathbf{m}_f^*]}_{\text{Stackelberg distortion}} \tag{11}$$

The size of the wedge depends on three factors: the degree of creditor non-cooperation, the distortion created by the IMF's first mover advantage, and the extent to which the IMF performance measure is misaligned. We discuss each in turn.

2.2.1. The Effects of Creditor Non-cooperation

If private sector creditors and the IMF could act in unison when the debtor's actions are unverifiable, then the wedge becomes

$$\mathbf{z} - \mathbf{m}^* = (\mathbf{G}\mathbf{H}')^{-1}[\mathbf{G}\mathbf{G}' - \mathbf{G}\mathbf{H}' + r\mathbf{\Phi}]\mathbf{m}^* \tag{12}$$

In the absence of performance measure misalignment, $\mathbf{G} = \mathbf{H}$ and (12) simplifies further to

$$\mathbf{z} - \mathbf{m}^* = r(\mathbf{H}\mathbf{H}')^{-1}\mathbf{\Phi}\mathbf{m}^* \tag{13}$$

As negative values of $\mathbf{a}$ are precluded, $\mathbf{m}^* \geq 0$. And since the matrices $(\mathbf{H}\mathbf{H}')^{-1}$ and $\mathbf{\Phi}$ are positive definite, the wedge $\mathbf{z} - \mathbf{m}^*$ is positive. The creditors' marginal valuation of cashflows exceeds the marginal reward paid to the debtor. Adjustment effort is muted, and the second best outcome reflects a lower incidence of loan rollovers and disbursements. These can be thought of as the *ex post* welfare costs posed by 'pure' debtor moral hazard.

If, on the other hand, the private creditor and the IMF act non-cooperatively and attempt to simultaneously influence debtor behaviour, then the Nash equilibrium can be obtained by equating the creditors' reaction funtions (see appendix 1; equation 34). Absent performance measure misalignments, the wedge becomes

$$\mathbf{z} - \mathbf{m}^* = 2r(\mathbf{H}\mathbf{H}')^{-1}\mathbf{\Phi}\mathbf{m}^*.$$

More generally, if there are n creditors acting simultaneously, the wedge in (13) becomes

$$\mathbf{z} - \mathbf{m}^* = nr(\mathbf{H}\mathbf{H}')^{-1}\mathbf{\Phi}\mathbf{m}^* \tag{14}$$

As stressed by Dixit (1996), the non-cooperative behaviour of creditors magnifies the welfare cost of the debtor moral hazard problem by an amount that is proportional to the number of creditors. By amplifying the effective risk aversion of the debtor by a factor of n, the non-cooperation of creditors tilts the tradeoff between incentives and risk-sharing towards the latter – the power of the aggregate incentive scheme is weakened as the debtor obtains greater 'sure' income or insurance. The intuition is as follows. Each creditor fears that, by rolling over or providing new money, their loans will effectively be 'leaked' by the debtor to repay others at their expense. So rather than rolling over loans in exchange for the debtor meeting payments, creditors prefer to compensate the debtor for any failure to meet the loan obligations of others.

Thus in order to capture as much of the surplus as possible, each creditor strikes a mutually beneficial deal with the debtor. They offer inducements to divert the debtor's attention away from tasks that are primarily of interest to other creditors. Specifically, at the margin, each creditor offers a (positive) payment for the output of greatest concern to him, and 'bribes' the debtor (a negative payment) to dissuade him from undertaking tasks important to others. These inducements effectively act as 'sure income' for the debtor in its relationship with other creditors. As the proof of Proposition 1 shows (see appendix 1; equation 34), a creditor can affect another creditor's marginal choice through the risk premium term $r\mathbf{\Phi}$. The reaction function (34) can be expressed more explicitly as

$$\begin{pmatrix} m_{j_i} \\ m_{j_j} \end{pmatrix} = \begin{pmatrix} -\frac{1}{g_1^2+g_2^2+r\sigma_\phi^2} r\sigma_\phi^2 m_{i_i} \\ \frac{1}{1+r\sigma_{\epsilon b}^2}\left(1 - r\sigma_{\epsilon b}^2 m_{i_j}\right) \end{pmatrix}.$$

As can be seen, if creditor i offers to roll over more at the margin to encourage the debtor to undertake actions that ensure his repayment (the usual positive

bonus coefficient m_{i_i}), then creditor j provides a partially offsetting payment, i.e. $m_{j_i} < 0$. This effectively gives the debtor insurance against bad luck (liquidity shocks) in its dealings with creditor i. By implicitly raising the sure amount γ_i, creditor j induces a lower incidence of rollover/disbursement of new money by creditor i.

The non-cooperation of creditors, thus, generates a negative externality. If a creditor increases the marginal reward to repayment in its own dimension of interest, it raises the expected value of cashflows. But since other creditors offer inducements to reduce repayment in that dimension, the debtor is able to concentrate on other tasks. So the decision by one creditor to increase rollovers at the margin is essentially a payment to other creditors. This leakage of payments to other creditors via the agent makes it unattractive for any individual creditor to offer a loan contract that is tightly linked to effort, i.e. 'high-powered'. In equilibrium, all creditors behave in this fashion. The lack of co-ordination results in insufficient voluntary rollovers/new money and a weaker incentive scheme in aggregate. Table 1 summarises the equilibrium incidence of rollovers and disbursements (marginal rewards) of the simultaneous Nash game, absent any performance distortions, for the case where there are only two creditors[9].

Table 1: Equilibrium Incidence of New Money Disbursements

(Nash Game)

Aggregate:	$\mathbf{m}^{*\prime}_{nash} = \left(\frac{1}{1+2r\sigma^2_\phi} \quad , \quad \frac{1}{1+2r\sigma^2_{\epsilon b}} \right)$
IMF:	$\mathbf{m}^{*\prime}_{fnash} = \left(\frac{1+r\sigma^2_\phi}{1+2r\sigma^2_\phi} \quad , \quad \frac{-r\sigma^2_{\epsilon b}}{1+2r\sigma^2_{\epsilon b}} \right)$
Bank:	$\mathbf{m}^{*\prime}_{bnash} = \left(\frac{-r\sigma^2_\phi}{1+2r\sigma^2_\phi} \quad , \quad \frac{1+r\sigma^2_{\epsilon b}}{1+2r\sigma^2_{\epsilon b}} \right)$

2.2.2. The IMF as First Mover

When non-cooperative creditors move sequentially rather than simultaneously, the expression in (14) must be modified to take into account the effects of the first mover. As shown in the Appendix, the wedge in this (Stackelberg) case in the absence of performance measure distortions is

$$\mathbf{z} - \mathbf{m}^* = 2r(\mathbf{H}\mathbf{H}')^{-1}\mathbf{\Phi}\mathbf{m}^* - r^2\mathbf{\Phi}(\mathbf{H}\mathbf{H}' + r\mathbf{\Phi})^{-1}\mathbf{\Phi}\mathbf{m}_f^*, \tag{15}$$

As can be seen, if the second term in (15) is positive, the presence of a first mover can mitigate the *ex post* inefficiencies generated by the problems of debtor moral hazard and creditor non-cooperation. Simple inspection of the vector $\mathbf{m}_f^*$ does not suffice as it has both negative and positive elements. But since, in our model, the first mover is the IMF we can compare the equilibrium incentive schemes in the Nash and Stackelberg games to identify the circumstances under which the IMF has a welfare increasing role.

Table 2 summarises the equilibrium incidence of new money disbursements in the Stackelberg game with two creditors. If the IMF has a first-mover advantage, it is again able to offer disbursements at the margin in return for outcomes of direct relevance to it. In the Stackelberg equilibrium, this is higher than in the simultaneous Nash game – the denominator is lowered by the amount $(r\sigma_\phi^2)^2$. But the IMF is also able to exploit its first-mover position and pre-empt other creditors by offering inducements in other dimensions. These are again larger than in the contrasting Nash case. In essence, the IMF provides protection against liquidity shocks – it offers compensation against bad luck or failure in meeting loan obligations to private creditors, i.e. the amount V_b. Private creditors also offer the debtor an incentive scheme that entails a higher incidence of new money disburse-

ment/rollovers (relative to Nash) in return for meeting loan terms. And they offer greater compensation to dissuade the debtor from pursuing IMF activities.

Table 2: Equilibrium Incidence of New Money Disbursements (Stackelberg Game)

Aggregate:	$\mathbf{m}^{*\prime}$	$\left(\frac{1}{1+2r\sigma_{\phi}^2-r^2\sigma_{\phi}^4} \quad , \quad \frac{1+r\sigma_{\epsilon b}^2+r^3\sigma_{\epsilon b}^6-r^2\sigma_{\epsilon b}^4}{\left(1+r\sigma_{\epsilon b}^2\right)\left(1+2r\sigma_{\epsilon b}^2-r^2\sigma_{\epsilon b}^4\right)} \right)$
IMF:	$\mathbf{m}_f^{*\prime}$	$\left(\frac{1+r\sigma_{\phi}^2}{1+2r\sigma_{\phi}^2-r^2\sigma_{\phi}^4} \quad , \quad \frac{-r\sigma_{\epsilon b}^2}{1+2r\sigma_{\epsilon b}^2-r^2\sigma_{\epsilon b}^4} \right)$
Bank:	$\mathbf{m}_b^{*\prime}$	$\left(\frac{-r\sigma_{\phi}^2}{1+2r\sigma_{\phi}^2-r^2\sigma_{\phi}^4} \quad , \quad \frac{1+2r\sigma_{\epsilon b}^2+r^3\sigma_{\epsilon b}^6}{(1+r\sigma_{\epsilon b}^2)(1+2r\sigma_{\epsilon b}^2-r^2\sigma_{\epsilon b}^4)} \right)$

The equilibrium incidence of disbursements in the overall lending scheme (the vector $\mathbf{m}^*$) is also shown in Table 2. Provided $r\sigma_{\phi,\epsilon}^2 < 1+\sqrt{2}$, i.e that the debtor is not too risk averse, the marginal disbursement offered by the IMF to undertake its task more than compensates for the marginal inducements offered by the banks, and vice versa[10]. In other words, both elements of the equilibrium aggregate reward vector, $\mathbf{m}^*$, are positive and larger than the corresponding elements in the Nash equilibrium described in Table 1. The wedge $\mathbf{z}-\mathbf{m}^*$ is smaller in the Stackelberg game. Both creditors offer sharper incentives to the debtor in equilibrium, and the incidence of rollovers/disbursements is higher.

These results suggest that the IMF's role as first-mover provider of emergency finance mitigates the efficiency losses brought about by creditor non-cooperation and debtor moral hazard. The intuition is as follows. In the Stackelberg game, the bargaining power over the terms of the exchange between the debtor and its creditors lies entirely in the hands of the first-mover. So the IMF is able to propose a contract that just elicits participation by the debtor *and* the private creditors. This allows the IMF to capture the entire surplus. This is unlike the simultaneous move game where all creditors – official and private – share the surplus. In order

to maximise the captured surplus, the IMF offers to disburse more at the margin and to compensate against liquidity shocks to a much greater extent than it might have done in a Nash game. Since private creditors can only 'break even' they are forced into offering the sharpest incentives possible to ensure that they receive their expected repayments. By assuming a leadership role in the workout and claiming the surplus, the IMF limits the scope for the follower creditors to offer inducements/bribes. The fear that rollovers will 'leak' to others is diminished. So private creditors offer more in the way of infusions of new money, and the sharper aggregate incentives on offer lowers the size of the wedge.

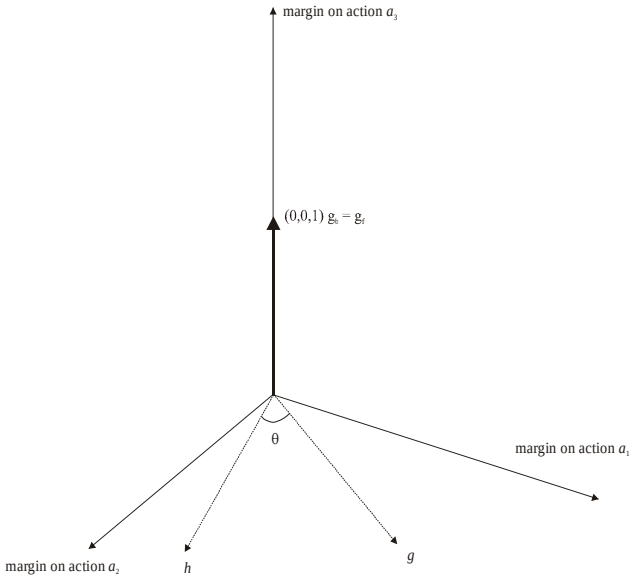
2.2.3. Programme Design

IMF programme measures represent a tradeoff between alignment and control. Following Baker (2000), performance measure alignment can be given a formal interpretation. The degree of misalignment can be described as the angle between a pair of vectors, θ (see Figure 1)[11]. More precisely, it is the angle between the vector of marginal products of debtor actions on the performance measure ($\mathbf{g}_f$) and the vector of debtor actions on actual outputs ($\mathbf{h}_f$). In our model, increased misalignment dilutes the mitigating effects of the IMF's first mover position. It acts like a constant of proportionality on the equilibrium disbursements that are offered in return for the succesful completion of IMF programme conditions. In other words, the numerators of the first elements of the vectors in Tables 1 and 2 are simply multiplied by $\cos\theta$, where the degree of misalignment θ is an angle between 0 and 90 degrees. In the case where the IMF moves first, for example, the creditors reward/punish outputs as in Table 3.

Table 3: Equilibrium Incidence of New Money Disbursements (Stackelberg Game)

Aggregate:	$\mathbf{m}^{*\prime}$ =	$\left(\frac{\cos\theta}{1+2r\sigma_{\phi}^2-r^2\sigma_{\phi}^4} \quad , \quad \frac{(1+r\sigma_{\epsilon b}^2+r^3\sigma_{\epsilon b}^6-r^2\sigma_{\epsilon b}^4)\cos\theta}{(1+r\sigma_{\epsilon b}^2)(1+2r\sigma_{\epsilon b}^2-r^2\sigma_{\epsilon b}^4)} \right)$
IMF:	$\mathbf{m}_f^{*\prime}$ =	$\left(\frac{(1+r\sigma_{\phi}^2)\cos\theta}{1+2r\sigma_{\phi}^2-r^2\sigma_{\phi}^4} \quad , \quad \frac{-r\sigma_{\epsilon b}^2\cos\theta}{1+2r\sigma_{\epsilon b}^2-r^2\sigma_{\epsilon b}^4} \right)$
Bank:	$\mathbf{m}_b^{*\prime}$ =	$\left(\frac{-r\sigma_{\phi}^2\cos\theta}{1+2r\sigma_{\phi}^2-r^2\sigma_{\phi}^4} \quad , \quad \frac{(1+2r\sigma_{\epsilon b}^2+r^3\sigma_{\epsilon b}^6)\cos\theta}{(1+r\sigma_{\epsilon b}^2)(1+2r\sigma_{\epsilon b}^2-r^2\sigma_{\epsilon b}^4)} \right)$

Figure 1: The degree of misalignment



By contrast, performance measure controllability (σ_{ϕ}^2) acts in the opposite direction to alignment. An increase in σ_{ϕ}^2 raises the effective risk premium associated with the IMF task, so the incentive scheme is geared more towards risk-sharing considerations. The debtor prefers the security of sure income to having disburse-

ments linked to outcomes. This weakens the incentive scheme and, as a result, the equilibrium incidence of disbursements is lowered.

In order to evaluate the implications of programme design for welfare, recall that the sum of creditor and debtor expected surplus is given by

$$E(\gamma + \mathbf{m}^{*\prime}\mathbf{P}) - \frac{1}{2}rvar(\gamma + \mathbf{m}^{*\prime}\mathbf{P}) - \frac{1}{2}\mathbf{a}'\mathbf{I}\mathbf{a} + E(\mathbf{z}'\mathbf{V}) - E(\gamma + \mathbf{m}^{*\prime}\mathbf{P}). \quad (16)$$

This provides a ready measure of welfare, and can be re-expressed as:

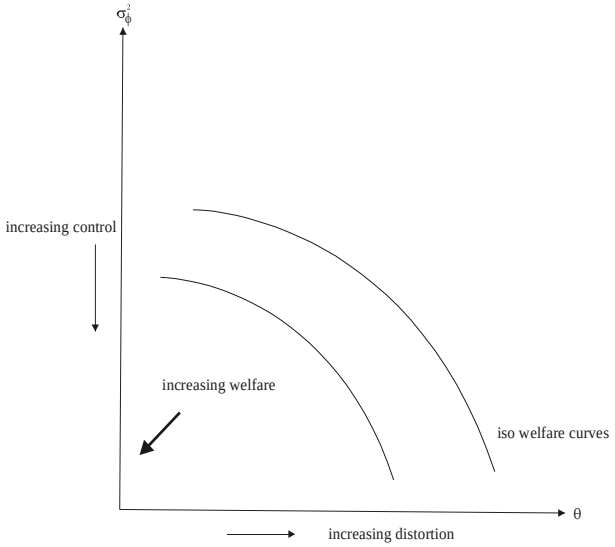
$$W = \mathbf{z}'\mathbf{H}\mathbf{G}'\mathbf{m}^* - \frac{1}{2}\mathbf{m}^{*\prime}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})\mathbf{m}^*. \quad (17)$$

Substituting for the equilibrium incidence of rollovers, $\mathbf{m}^*$, in the Stackelberg game (see Table 2) allows aggregate welfare to be written in terms of the primitive parameters of the model, namely risk aversion (r), performance measure controllability (σ^2_ϕ), performance measure misalignment (θ), and the volatility of short-run cashflows destined for the creditor ($\sigma^2_{\epsilon b}$). Thus

$$\begin{aligned} W \quad = \quad & \frac{\cos^2\theta}{1 + 2r\sigma^2_\phi - r^2\sigma^4_\phi} + \frac{1}{1 + r\sigma^2_{\epsilon b}} + \frac{r\sigma^2_{\epsilon b}(r\sigma^2_{\epsilon b} - 1)}{1 + 2r\sigma^2_{\epsilon b} - r^2\sigma^4_{\epsilon b}} \\ & -\frac{1}{2}\left(\frac{\cos^2\theta(1 + r\sigma^2_\phi)}{(1 + 2r\sigma^2_\phi - r^2\sigma^4_\phi)^2} + \left(1 + \frac{r\sigma^2_{\epsilon b}(1 + r\sigma^2_{\epsilon b})(r\sigma^2_{\epsilon b} - 1)}{1 + 2r\sigma^2_{\epsilon b} - r^2\sigma^4_{\epsilon b}}\right)^2\right) \quad (18) \end{aligned}$$

The trade-off between controllability and alignment can now be illustrated graphically. Figure 2 plots iso-welfare lines (for a given $\sigma^2_{\epsilon b}$) in (θ, σ^2_ϕ) space. As is evident, choosing performance measures that are well aligned (low θ) are attained at the expense of lower controllability (higher σ^2_ϕ) for a given level of welfare. Aggregate welfare increases as the iso-welfare curves move towards the south-west, i.e. when high-control, high-alignment measures are available.

Figure 2: Iso-welfare curves



Our results suggest that welfare improvements are best made when moves towards a more aligned measure are accompanied by policies that increase the scope for the controllability of the performance measure by the debtor. In this context, disclosure policies such as the adoption of international codes and standards may play a helpful role[12]. Adopting internationally accepted best practises for transparency in monetary, fiscal, and financial policies can help prioritise a debtor's actions. They increase the debtor's ability to control the performance measure, and improve the ability of official creditors to monitor debtor actions. In terms of the model, a reduction in σ^2_ϕ lowers the effective risk premium associated with the IMF task for any given degree of programme misalignment, θ. By shifting the focus of the debtor towards incentive considerations, policies that aid the con-

trollability of performance measures increase the incidence of IMF disbursement in equilibrium. Given the first mover advantage of the IMF, the incidence of private sector rollovers is also increased. So disclosure policies that reduce σ_ϕ^2 help mitigate the *ex post* efficiency losses in disorderly workouts. and promote private sector involvement

3. Private Creditor Behaviour

The leadership role of official creditors has implications for the total amount of private credit offered during crisis management. Since the IMF moves first and extracts as much surplus as possible to keep the private creditors in the game, the bank's surplus in equilibrium is given by

$$\mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}^* - \boldsymbol{\gamma}_b - \mathbf{m}_b^{*\prime}\mathbf{G}\mathbf{G}'\mathbf{m}^* = 0. \tag{19}$$

And the amount lent by the bank (see Appendix 2) is

$$\begin{aligned} L_b &= \boldsymbol{\gamma}_b + \mathbf{m}_b^{*\prime}\mathbf{P} \\ &= \boldsymbol{\gamma}_b + \mathbf{m}_b^{*\prime}\mathbf{G}\mathbf{G}'\mathbf{m}^*. \end{aligned} \tag{20}$$

So taking (19) and (20) together implies that the total amount offered by the private creditor in the Stackelberg game is

$$\begin{aligned} L_b^S &= \mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}^* \\ &= \frac{1}{1 + r\sigma_{\epsilon b}^2} + \frac{r\sigma_{\epsilon b}^2(r\sigma_{\epsilon b}^2 - 1)}{1 + 2r\sigma_{\epsilon b}^2 - r^2\sigma_{\epsilon b}^4}. \end{aligned} \tag{21}$$

In the Stackelberg solution, the loan offered by the private creditor is independent of the programme design parameters (θ and σ_ϕ^2). This reflects two factors.

First, the amount lent depends on the bargaining power of the official sector in the debt workout. In the Stackelberg game, the IMF moves early and captures the entire surplus before the private sector makes its lending decision. So bank loans need only be based on the primitive factors underpinning the relationship between the debtor and the bank, i.e r and $\sigma^2_{\epsilon b}$. Second, private creditors attach no weight to the marginal outputs of interest to the IMF, i.e $\mathbf{z}'_b = (0, 1)$. Clearly, if the bank were to value financial stability (the IMF output), the level of private lending would reflect the choice of IMF programme menu.

By contrast when creditors move simultaneously, private creditors share the surplus extracted from the debtor with the IMF – the bargaining power of the IMF in the workout is lower. This means that even if private creditors do not place any weight on IMF output, the size of the total surplus extracted is still a function of θ and σ^2_ϕ. So in the Nash equilibrium, the amount of private lending depends on programme design.

Is the quantum of lending provided by the private sector, L_b, greater in the presence of the (first moving) IMF? If so, it could be argued that the leadership role of the IMF in the provision of emergency finance has a 'catalytic' effect that triggers greater private sector finance as a part of crisis management. The amount of money lent by the bank in the Nash game is given by

$$L_b^N = \frac{-\cos^2\theta(1/4 + 3/4r\sigma^2_\phi)}{(1 + 2r\sigma^2_\phi)^2} + \frac{3/4 + 5/4r\sigma^2_{\epsilon b}}{(1 + 2r\sigma^2_{\epsilon b})^2} \tag{22}$$

In general, it is difficult to compare L_b^N with L_b^S. But if $r\sigma^2_{\epsilon b} < 1 + \sqrt{2}$, $\sigma^2_{\epsilon b} = \sigma^2_\phi$, and $\cos\theta = 1$, i.e if the IMF's performance measure is perfectly aligned, and if the volatility of cashflows is the same across creditors, then $L_b^S > L_b^N$. So if all creditors have access to undistorted performance measures, the presence of

a first mover who extracts the surplus and forces other creditors to sharpen incentives has a 'catalytic' effect. These results suggest that the conditions under which IMF lending mitigates creditor co-ordination problems *and* triggers private sector lending are particularly strong. The bargaining power of the IMF must be significant; programmes must be very well aligned; and debtor control over programme measures must be strong. As performance measure alignment and control diverge from 'true' values, the comparison between lending in the two games is less clear cut. Since equilibrium disbursements at the margin are multiplied by $cos\ \theta$, and since high performance measure risk (high σ_ϕ^2) raises the effective desire for insurance by the debtor, the first mover advantages of the IMF are blunted. The aggregate incentive scheme is weakened and private sector involvement in debt workouts is diminished. So with other parameter values, the catalytic effect of the first-mover provision of funds seems less certain.

4. Policy Implications & Conclusions

In sovereign debt workouts that take place *after* a crisis occurs, an important source of inefficiency is the unobservability of debtor adjustment effort. The strategic behaviour of creditors in seeking to divert debtor effort towards their own ends exacerbates this *ex post* welfare cost. The resulting equilibrium leads to a sub-optimal incidence of rollovers and disbursements of new money. Creditor non-cooperation in the workout process means that private sector involvement in crisis resolution is, at best, limited.

Our analysis suggests that IMF programmes can play a part in limiting efficiency losses and promoting private sector involvement. By assuming a leadership role in debt workouts, the IMF guards against the possibility of credit leaking

from one lender to another via the debtor. This ameliorates the collective action problem of creditors and promotes the incidence of private sector disbursement. Although actual bargaining processes are complex and the ability of official creditors to make 'costless take it or leave it' offers to other parties at the table is limited, our results are suggestive. They highlight the important role played by official sector bargaining strength in crisis resolution. Involuntary arrangements that bind-in creditors and restrict their freedom of action can be viewed as situations where the official sector has all the bargaining power. Formal arrangements such as concerted rollovers, and sovereign debt standstills, are effective precisely because they limit the ability of creditors to offer counter-productive incentives to the debtor in a workout.

In an environment where conflicting creditors compete for the debtor's attention, the actual design of an IMF programme plays an important role in shaping the allocation of a debtor's effort, and influencing the amount of private lending. If IMF programmes have the virtue of being focused and precise, then 'catalytic' effects can take hold. In general, the catalytic effects of IMF lending will depend on how conditionality is aligned to the objectives of financial stability, the weight attached by market participants to such medium term goals and – importantly – the extent to which the official sector can act as first mover. If the leadership role of the IMF is diluted, the strategic interplay between creditors is likely to diminish private sector involvement in crisis management. The adoption of international codes and standards may assist in the pursuit of result-based conditionality by improving controllability, sharpening incentives and, hence, promoting the disbursement of private credit at the margin. And to the extent that well focused and precise performance measures encourage better aligned incentives between

the debtor and the IMF, it could also promote greater country ownership of IMF programmes[13].

Finally, it should be noted that our analysis is static in nature. We do not consider the usual *ex ante* moral hazard problem posed by sovereign debt enforcement. Nor do we consider the forward looking implications of crisis management policies. For example, does emergency official sector finance store up future problems by encouraging over-lending and/or over-borrowing? The dynamic moral hazard implications of crisis management policy and design are an important topic for future research.

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Notes

[1]See, for example, the Meltzer Report (2000), Feldstein (1998), and Goldstein (2000).

[2]The new IMF thinking is embodied in an 'Interim Guidance Note on Streamlining Conditionality'. See IMF (2001) for details, an assessment of the effectiveness of conditionality, and discussion of IMF monitoring tools.

[3]Several recent papers (e.g. Dooley, 2000; Gai *et.al*, 2002) discuss how creditor co-ordination problems result in *ex post* efficiency losses. Unlike these papers, however, we do not consider the tradeoff between these *ex post* losses and the *ex ante* moral hazard problem posed by sovereign debt enforcement. So the initial decision to lend and the terms of these loan contracts are not formally modelled.

[4]See, for example, Mathieson *et.al* (2000), Jeanne & Zettelmeyer (2001), and Khan & Sharma (2001).

[5]The assumption of two principals and three actions is made for expositional clarity. The model can be readily extended to more general cases.

[6]For simplicity, we assume that greater marginal reward to one action does not draw effort away/towards the other. In other words, efforts are independent rather than being substitutes or complements. See Dixit (2000) for a detailed discussion of the implications of complementary efforts in common agency problems.

[7]We thus follow the contract theory literature and focus on the equilibrium in which linear strategies are used by the creditors. But other equilibria, involving

more complex strategies, may also be possible.

[8]Assuming that the private performance measure is perfectly aligned focuses attention on the effects of distortions in IMF programme design. But since debt repayment, V_b is a relatively unambiguous measure, the assumption appears reasonable.

[9]These can be obtained (after some algebra) from the proof of Proposition 1.

[10]If $r\sigma^2_{\phi,\epsilon} > 1 + \sqrt{2}$, the aggregate marginal rewards (i.e the elements of $\mathbf{m}^*$) are negative. Since creditors are unlikely to offer negative disbursements for increased debtor effort, we can rule out these parameter values.

[11]Recall that the private creditors' performance measure coincides with true output, so can described by the unit vector along the z-axis. And since we are assuming the absence of any spillovers, the vectors $\mathbf{h}$ and $\mathbf{g}$ lie along the x, y plane and are perpendicular to the z-axis.

[12]See Clark, A & J Drage (2000) for a detailed discussion of the role of codes and standards in enhancing financial stability.

[13]As noted by Khan & Sharma (2001), and Goldstein (2000), when a country shares with the IMF the objective of the programme, as well as an understanding of the linkages between objectives and actions, it is more likely to be committed to the spirit of the programme.

APPENDICES

APPENDIX 1:Proof of Proposition 1.

The proof is by backwards induction, so we start with the debtor. The debtor receives the aggregate loan, $L = \gamma + \mathbf{m}'\mathbf{P}$, so his surplus from exerting effort $\mathbf{a}$ is

$$E[\gamma + \mathbf{m}'\mathbf{P}] - \frac{1}{2}rvar(\gamma + \mathbf{m}'\mathbf{P}) - \frac{1}{2}\mathbf{a}'\mathbf{I}\mathbf{a} \tag{23}$$

Substituting for (9) and taking expectations gives

$$\gamma + \mathbf{m}'\mathbf{G}\mathbf{a} - \frac{1}{2}rvar(\mathbf{m}'\mathbf{\Phi}) - \frac{1}{2}\mathbf{a}'\mathbf{I}\mathbf{a} \tag{24}$$

Maximising with respect to $\mathbf{a}$ gives

$$\mathbf{a}^* = \mathbf{G}'\mathbf{m}^* \tag{25}$$

Substituting for the agent's optimal effort, the debtor's certainty equivalent income is

$$\gamma + \frac{1}{2}\mathbf{m}'(\mathbf{G}\mathbf{G}' - r\mathbf{\Phi})\mathbf{m} \tag{26}$$

Following Dixit (1996), we consider separately the relationship between each principal and the agent. Continuing to work backwards, we examine what difference it makes when the debtor deals with the private sector. If the private sector did not exist, the debtor's surplus without the private sector loan would be

$$\gamma_f + \frac{1}{2}\mathbf{m}_f'(\mathbf{G}\mathbf{G}' - r\mathbf{\Phi})\mathbf{m}_f. \tag{27}$$

Including the private sector, the debtor's surplus is given by (26), so the addition to the surplus that arises from the relationship with the private sector is

$$\gamma_b + \mathbf{m}_b'(\mathbf{G}\mathbf{G}' - r\mathbf{\Phi})\mathbf{m}_f + \frac{1}{2}\mathbf{m}_b'(\mathbf{G}\mathbf{G}' - r\mathbf{\Phi})\mathbf{m}_b \tag{28}$$

The private sector's expected surplus is

$$E[\mathbf{z}_b'\mathbf{V}] - E[L_b], \tag{29}$$

which, using (2) and (9) and (25) can be re-expressed as

$$\mathbf{z}_b'\mathbf{H}\mathbf{G}'(\mathbf{m}_f + \mathbf{m}_b) - \gamma_b - \mathbf{m}_b'\mathbf{G}\mathbf{G}'(\mathbf{m}_f + \mathbf{m}_b). \tag{30}$$

The private sector's surplus, in the absence of a relationship with the debtor, is given by $\mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}_f$. So the addition to the private creditor's surplus from the relationship is

$$\mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}_b - \gamma_b - \mathbf{m}_b'\mathbf{G}\mathbf{G}'(\mathbf{m}_f + \mathbf{m}_b). \tag{31}$$

The private sector would like to maximise the total bilateral surplus between itself and the debtor, as it can set γ_b so that all of this surplus is transferred to itself. It therefore chooses $\mathbf{m}_b$ to maximise the total increase in its' and the debtors surplus, i.e. (28) + (31)

$$\mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}_b - \frac{1}{2}\mathbf{m}_b'(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})\mathbf{m}_b - \frac{1}{2}r\mathbf{m}_b'\mathbf{\Phi}\mathbf{m}_f \tag{32}$$

The first order conditions of this maximisation with respect to $\mathbf{m}_b$ is

$$\mathbf{G}\mathbf{H}'\mathbf{z}_b + \mathbf{G}\mathbf{G}'\mathbf{m}_f - (\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})\mathbf{m} = 0, \tag{33}$$

which delivers the reaction function of the private sector, given the choice of the IMF in setting $\mathbf{m}_f$, i.e.

$$\mathbf{m}_b^* = (\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}[\mathbf{G}\mathbf{H}'\mathbf{z}_b - r\mathbf{\Phi}\mathbf{m}_f]. \tag{34}$$

As the IMF moves first, it remains to substitute (34) into the IMF's objective function. In other words, the IMF chooses $\mathbf{m}_f$ to maximise

$$\mathbf{z}_f'\mathbf{H}\mathbf{G}'\mathbf{m}_f - \frac{1}{2}\mathbf{m}_f'(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})\mathbf{m}_f - r\mathbf{m}_f'\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}(\mathbf{G}\mathbf{H}'\mathbf{z}_b - r\mathbf{\Phi}\mathbf{m}_f) \quad (35)$$

From the first order conditions, the equilibrium marginal rewards are

$$\begin{aligned}\mathbf{m}_f^* &= [(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi}) - 2r^2\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}\mathbf{\Phi}]^{-1} \\ &\quad \times(\mathbf{G}\mathbf{H}'\mathbf{z}_f - r\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}\mathbf{G}\mathbf{H}'\mathbf{z}_b) \end{aligned} \quad (36)$$

and

$$\mathbf{m}_b^* = (\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}(\mathbf{G}\mathbf{H}'\mathbf{z}_b - r\mathbf{\Phi}\mathbf{m}_f^*) \quad (37)$$

In equilibrium, marginal valuations must be equated with marginal rewards. To get to an expression for $\mathbf{z}$ we need to sum $\mathbf{z_f}$ and $\mathbf{z_b}$:

$$\begin{aligned}\mathbf{G}\mathbf{H}'\mathbf{z} &= (\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})\mathbf{m}_f^* + r\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}\mathbf{G}\mathbf{H}'\mathbf{z}_b \\ &\quad -2r^2\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}\mathbf{\Phi}\mathbf{m}_f^* \\ &\quad +r\mathbf{\Phi}\mathbf{m}_f^* + (\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})\mathbf{m}_b^* \end{aligned} \quad (38)$$

Re-arranging (38) allows us to write

$$\mathbf{z} = (\mathbf{G}\mathbf{H}')^{-1}[(\mathbf{G}\mathbf{G}' + 2r\mathbf{\Phi})\mathbf{m}^* - r^2\mathbf{\Phi}(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})^{-1}\mathbf{\Phi}\mathbf{m}_f^*]. \quad (39)$$

This completes the proof.

APPENDIX 2: Private lending in the Stackelberg and Nash games.

In both games, the creditors extract all the surplus from the debtor, so we can set (26) to zero:

$$\gamma_f^* + \gamma_b^* + \frac{1}{2}(\mathbf{m}_f^* + \mathbf{m}_b^*)'(\mathbf{G}\mathbf{G}' - r\mathbf{\Phi})(\mathbf{m}_f^* + \mathbf{m}_b^*) = 0 \tag{40}$$

But since the IMF acts as first mover in the Stackelberg game, it takes as much surplus as possible leaving the private sector with just enough to remain in the game. So the private creditors' surplus is

$$z_b'\mathbf{H}\mathbf{G}'\mathbf{m}^* - \gamma_b^* - \mathbf{m}_b^{*\prime}\mathbf{G}\mathbf{G}\mathbf{m}^* = 0 \tag{41}$$

Substituting (41) into (40) and rearranging gives

$$\gamma_f^* = -\mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}^* + \mathbf{m}_b'\mathbf{G}\mathbf{G}'\mathbf{m}^* - \frac{1}{2}\mathbf{m}^{*\prime}(\mathbf{G}\mathbf{G}' - \mathbf{r}\mathbf{\Phi})\mathbf{m}^*. \tag{42}$$

Since $L_f^* = \gamma_f^* + \mathbf{m}_f^{*\prime}\mathbf{G}\mathbf{G}'\mathbf{m}^*$, substituting into (42) gives the amount of IMF lending in the Stackelberg game, i.e

$$L_f^{S*} = -\mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}^* + \frac{1}{2}\mathbf{m}'(\mathbf{G}\mathbf{G}' + r\mathbf{\Phi})\mathbf{m}^* \tag{43}$$

Similarly, bank lending in the Stackelberg game is given by $L_b^{S*} = \gamma_b^* + \mathbf{m}_b^{*\prime}\mathbf{G}\mathbf{G}'\mathbf{m}^*$, so we can write

$$L_b^{S*} = \mathbf{z}_b'\mathbf{H}\mathbf{G}'\mathbf{m}^* \tag{44}$$

In the Nash game, the creditors again extract all the surplus from the debtor, as in (40). If the surplus is shared evenly amongst the creditors:

$$\gamma_j^* = -\frac{1}{4}\mathbf{m}_{\mathsf{nash}}^{*\prime}(\mathbf{G}\mathbf{G}' - r\mathbf{\Phi})\mathbf{m}_{\mathsf{nash}}^* \qquad (j = f, b) \tag{45}$$

So, the equilibrium quantity of lending for the bank in the Nash game is

$$\begin{aligned} L_b^{*N} &= \gamma^*_{\mathsf{bnash}} + \mathbf{m}^{*\prime}_{\mathsf{bnash}}\mathbf{P} \\ &= -\frac{1}{4}\mathbf{m}^{*\prime}_{\mathsf{nash}}(\mathbf{G}\mathbf{G}'-r\mathbf{\Phi})\mathbf{m}^*_{\mathsf{nash}} + \mathbf{m}^{*\prime}_{\mathsf{bnash}}\mathbf{G}\mathbf{G}'\mathbf{m}^*_{\mathsf{nash}}, \end{aligned} \tag{46}$$

and the quantity lent by the IMF is

$$L_f^{*N} = -\frac{1}{4}\mathbf{m}^{*\prime}_{\mathsf{nash}}(\mathbf{G}\mathbf{G}'-r\mathbf{\Phi})\mathbf{m}^*_{\mathsf{nash}} + \mathbf{m}^{*\prime}_{\mathsf{fnash}}\mathbf{G}\mathbf{G}'\mathbf{m}^*_{\mathsf{nash}} \tag{47}$$

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