How can the IMF catalyse private capital flows? A model

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Working Paper no. 215

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This paper represents the views and analysis of the author and should not be thought to represent those of the Bank of England. I am grateful to Andrew Haldane, Victoria Saporta, Hyun Song Shin, David Vines, Garry Young and two anonymous referees for their constructive comments.

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The Bank of England's working paper series is externally refereed.

ISSN 1368-5562

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Abstract

This paper presents a model to explain how IMF programmes can catalyse private capital flows following a financial crisis, a concept that was at the heart of the IMF's strategy for dealing with capital account crises in the late 1990s. In the model, the IMF lends funds below the prevailing market interest rate and it is this subsidy that induces the borrowing country to exert adjustment effort to avoid default. By preventing default, future marginal rates of return on investment are kept high, thereby encouraging private capital flows. The IMF may also have a signalling role if it has superior information about debtor type and can affect the interest rate charged in the immediate aftermath of a crisis. In practice, however, IMF programmes based on the catalytic approach have been disappointing and actual private capital flows have been considerably below those projected. Therefore, the paper also considers how capital flows derived from the model are sensitive to the assumptions made. The paper concludes by discussing the policy implications of the analysis for IMF programme design.

Key words: International Monetary Fund, crisis resolution, catalytic finance.

JEL classification: F32, F33, F34.

Summary

In the past decade, the IMF has been confronted by crises in member countries with very large external financing needs (Mexico in 1995, Thailand, Indonesia and Korea in 1997, Russia in 1998 and repeated crises in Turkey, Brazil and Argentina). The IMF responded to these capital account crises by providing financial support that was very large by historical standards, but only partially filled the countries' gross external financing needs. In deciding the amount of financial support to provide, the IMF was caught between two competing objectives. On the one hand, the IMF is a credit co-operative and cannot put too much of its members' resources at risk by lending substantial amounts to an individual member. On the other hand, a significant contributing factor in capital account crises is a loss of financial market confidence because external creditors do not believe a country has sufficient foreign reserves to repay its debts. A financial package within normal IMF limits may have done little to restore market confidence during the above crises.

In these cases, the IMF argued that its lending would have a catalytic effect on private capital flows and programmes of this type became known as the 'catalytic approach'. The catalytic approach was endorsed by the International Monetary and Finance Committee of the IMF in September 2000 and became a key component of the IMF's strategy to resolve capital account crises. Despite its importance, however, the catalytic approach was only loosely defined. It was generally taken to mean that a combination of limited IMF financial support and a country's adherence to a credible programme of reform would catalyse private sector capital inflows (or reverse capital outflows) sufficient to fill the remaining financing gap. An IMF loan would signal that a country's policies were sound and this would provide the incentive for creditors to invest.

As well as being loosely defined, there is very little theoretical literature to support the concept of catalytic financing. This paper fills part of this gap. A two-period model is developed to examine how a country faced with a capital account shock chooses between policy adjustment, borrowing from the market and defaulting. Which combination of these the debtor chooses influences the amount of private capital flows. The analysis shows that, if the shock is severe, the cost of policy adjustment exceeds the benefit of avoiding default and private capital flows will be low. If the IMF provides bridging finance below the market interest rate, it can tip the balance of the debtor's incentives in favour of policy adjustment. Assisted by the IMF, the debtor avoids default and private capital flows are catalysed.

Empirical evidence and IMF staff analysis, though, have shown that IMF projections of private capital flows during an IMF programme have been overly optimistic. The analysis in this paper suggests two reasons why this might be the case. First, structural reforms implemented at the behest of the IMF may only have long-term pay-offs and be subject to considerable uncertainty. Therefore, private capital flows may return over a longer period than contained in IMF projections. Second, capital flows can be considerably lower if the borrower's commitment to reform is lower than expected.

Several policy implications can be drawn from this analysis. First, IMF programmes based on catalytic finance are most likely to succeed when shocks are relatively mild. Second, there is a much greater risk of programme failure when the policy reform agenda is lengthy. The IMF should be wary of programmes that require extensive conditionality. Third, if catalytic programmes fail, capital flows are often well below the amounts projected - if programmes fail, they do so in a major way. Finally, when projecting capital flows in a catalytic finance programme, the IMF needs to be convinced that reforms will genuinely increase the marginal productivity of investment. When the catalytic approach is not feasible, the IMF should consider carefully the relative merits of alternative policies such as standstills or debt restructurings.

1 Introduction

In the past decade, the IMF has been confronted by crises in member countries with very large external financing needs (Mexico in 1995, Thailand, Indonesia and Korea in 1997, Russia in 1998 and repeated crises in Turkey, Brazil and Argentina). These have posed difficult policy questions for the IMF because the original Bretton Woods framework was designed for a world with largely closed capital accounts. In such a world, a member faced with a balance of payments problem originating from a current account deficit could borrow from the IMF to provide '*them with the opportunity to correct maladjustments ... without resorting to measures destructive of national or international prosperity*' (Article I v, IMF (1993)). Since a financing gap from a current account deficit was likely to be small relative to GDP (except in extreme circumstances), the IMF could fill a projected financing gap in full.

With open capital accounts, however, gross external financing needs are potentially very large. Foreign reserves can be exhausted very quickly if a country is unable to maintain international capital market access and has to use them to redeem the principal on maturing bonds and the withdrawal of bank loans. This can be exacerbated if domestic residents rush to protect their capital by investing overseas. If immediately available reserves are not sufficient to fill the potential external financing gap, the country faces a multiple equilibria problem because *expectations* about the supply of international private capital become crucial. If foreign investors hold their nerve and agree to roll over forthcoming obligations, then all creditors gets paid while the country has time to put in place corrective policies. If creditors rush to be paid first and trigger a financial crisis, then the costs of the crisis can fulfill the expectations that caused the rush in the first place. Models of financial crisis with multiple equilibria have been a standard element of the literature since Obstfeld (1996).(1)

To overcome this multiple equilibria problem, some have called for the IMF to be made a genuine lender of last resort analogous to a central bank's role in forestalling bank runs (Fischer (1999)). In such a model, the IMF would stand ready to fill completely the gross external financing need of a country facing a liquidity shock. Analogous to the arguments for a central bank, the mere presence of a lender of last resort is enough for creditors to roll over debts with the result that the funds never actually have to be provided.

(1) See also Chang and Velasco (1999) and Chui, Gai and Haldane (2002).

But turning the IMF into a lender of last resort has had very little support from the main shareholders of the IMF. On theoretical grounds, shareholders worry that it would create severe moral hazard problems because debtors may take riskier policy options if they know the IMF will protect them from potential liquidity crises (see Calomiris (1998)).[(2)] In a domestic context, a central bank can offset these moral hazard incentives by demanding collateral from a bank, changing the management and removing shareholder equity, options which are unavailable to the IMF. On practical grounds, shareholders of the IMF are unwilling to risk its capital base to make acting as a lender of last resort a credible commitment.

If the IMF cannot act as a lender of last resort, it needs some other way to produce programmes in which the potential external financing gap is fully filled. In most of the capital account cases of the late 1990s, the IMF relied on the so-called 'catalytic approach' (see Ghosh *et al* (2002)). This approach is explained on the IMF's web site as follows:[(3)] '*In most cases, the IMF, when it lends, provides only a small portion of a country's external financing requirements. But because the approval of IMF lending signals that a country's economic policies are on the right track, it reassures investors and the official community and helps generate additional financing from these sources. Thus, IMF financing can act as an important lever, or catalyst, for attracting other funds. The IMF's ability to perform this catalytic role is based on the confidence that other lenders have in its operations and especially in the credibility of the policy conditionality attached to its lending*' (IMF (2002)).

Ghosh *et al* expand this slightly by arguing that '*[i]n a prototypical 'confidence crisis', the link between official financing and current account adjustment may be different from the traditional trade-off in IMF-supported programmes. Instead of a smooth trade-off between adjustment and financing, there could be a strong catalytic effect of official financing and policies such that, if the combination of official financing and policies is strong enough to restore market confidence, the official financing package would, ex post, likely be superfluous*' (page 8).

Unfortunately in practice, programmes based on a strong catalytic effect have proved disappointing. The empirical evidence is surveyed in Bird and Rowlands (2002) and Cottarelli and

(2) If debtors are hit by pure (unforeseeable) liquidity shocks and the IMF can commit to lend only in these cases, then there will be no moral hazard effects (see Haldane, Irwin and Saporta (2003)). The debtor moral hazard argument requires that shocks are forseeable and avoidable.

(3) The concept of the 'catalytic approach' has evolved over time (see Cottarelli and Giannini (2002)).

Giannini (2002). They failed to find evidence in support of a positive catalytic effect - the impact of IMF lending on capital flows is either insignificant or negative. Ghosh *et al* examine the eight capital account crises in the late 1990s and admit that IMF projections of catalytic finance have been overly optimistic, suggesting that scope for the use of programmes based on the catalytic approach may be narrower than previously thought.

For such an important concept, there is also very little theoretical literature. Cottarelli and Giannini surveyed what there is and identified five possible channels through which IMF programmes might catalyse private capital flows.

- Economic performance could improve because IMF technical assistance contributes to better **policy design**. (4)
- The IMF may have access to more **information** and its involvement could signal that the state of the economy is better than private investors fear. (5)
- IMF **conditionality** can act as a precommitment device that the government will maintain better policies. Investors can lend in advance of actual implementation because the IMF polices conditionality. (6)
- Having an IMF programme could act as a **screening** device between types of sovereign debtors because IMF reforms are onerous and only members with genuine commitment to reform would apply. (7)
- IMF finance provides **insurance** for private creditors that they will be paid if a member gets into financial difficulties making them more willing to invest. (8)

None of these papers cited by Cottarelli and Giannini provide an explicit model of the catalytic effect or examine the circumstances in which it might apply. Recent papers by Morris and Shin (2003) and Corsetti, Guimaraes and Roubini (2003) take a step in this direction. Morris and Shin

(4) Based on Bird and Rowlands (1997).
(5) Based on Rodrik (1996).
(6) Drawing on analysis of the time-inconsistency problem in economic policy making (see Sachs (1989), Masson and Mussa (1995), Rodrik (1996), Dhonte (1997), Fischer (1997), Cottarelli and Giannini (1999) and Federico (2001)).
(7) Based on Marchesi and Thomas (2001).
(8) This is a variant of the lender of last resort mechanism because insurance may prevent a self-fulfilling run (see Haldane (1999), Zettelmeyer (2000) and Miller and Zhang (2000)).

argue that the IMF can still resolve the multiple equilibrium problem of self-fulfilling liquidity runs even though it cannot precommit to fully fund the potential external financing gap. In their model, only partial financing is required to convince sufficient (heterogeneous) creditors to switch strategies from fleeing to staying to prevent a liquidity crisis. By forestalling a liquidity run, the debtor is also induced to exert more policy effort which provides a further incentive for short-term creditors to roll over their debts. This virtuous interaction between private sector capital flows and debtor effort enables a limited IMF contribution to catalyse a larger private sector response. However, this only occurs over a narrow range of outcomes and over another region, IMF finance acts as a substitute rather than a complement to private sector capital flows. Over this latter region, the IMF's involvement is counterproductive because it induces moral hazard by discouraging the debtor from exerting adjustment effort.

Corsetti, Guimaraes and Roubini use a similar framework but with a different move order. In their model, the debtor exerts adjustment effort before the rollover decision by private creditors. Adjustment effort raises the expected value of production and reduces the *ex-ante* probability of crisis but is politically costly to implement. Corsetti *et al* find very similar results to Morris and Shin. If the probability of crisis without adjustment effort is greater than 50%, then IMF liquidity support that encourages private creditors to roll over their loans and forestalls a liquidity crisis induces the debtor to exert adjustment effort. The IMF has a catalytic effect directly through the provision of financial support which allows the debtor to avoid early liquidation costs and indirectly through the positive effect on private creditors incentives to roll over. On the other hand, if the probability of crisis is less than 50% without adjustment effort, then IMF support is a substitute for adjustment effort and less is undertaken.

The behaviour of short-term creditors, though, is only part of the story because short-term flows make up only a portion of private capital flows to EMEs. This paper complements Morris and Shin and Corsetti *et al* by focusing on the effect of IMF programmes on the incentives of longer-term creditors. IMF finance positively affects the trade-off for a debtor between exerting adjustment effort and defaulting. By avoiding the costs of defaulting, the productivity of investment is higher and the private sector is more willing to provide longer-term finance. This channel can be augmented if the IMF can provide a positive signal about the debtor's type which gives the private sector greater confidence about the commitment to exert adjustment effort.

The paper is set out as follows. Section 2 constructs a model of a country facing a potential capital account crisis and considers how the debtor's policy choices and private sector capital flows change with and without IMF involvement. Section 3 explains how the 'failure' of IMF finance to catalyse private capital flows can result from small errors in parameters assumed for the model. Section 4 discusses the policy implications of the model and Section 5 concludes.

2 Model

Countries facing looming financial crises approach the IMF for assistance because they believe the alternative of trying to resolve the situation alone is worse. Without access to official finance and a potential external financing gap, countries are faced with several choices. They can either default, reduce the current account deficit by adjusting domestic demand or take measures to increase capital inflows.[9] If a shock is small, countries can adjust domestic demand relatively easily and will choose that option. If a shock is large, adjustment may be excessively costly and the country will prefer to default. These options are still available when the country decides to approach the IMF. Therefore to understand how IMF intervention makes a difference, we need to explore the circumstances in which countries approach the Fund and how this changes incentives. Section 2.1 presents a model of crisis resolution without the involvement of the IMF and Section 2.2 considers how the outcomes change when it is. Section 2.3 extends the model to consider the effect of introducing of asymmetric information about debtor type.

2.1 A world without the IMF

This subsection sets up a model of a country that can suffer a balance of payments crisis but must solve the problem without the possibility of a loan from the IMF. The model examines a country with no initial resources which has two periods of production. In the first period, the country borrows k_1 capital from international creditors at interest rate r to invest in a risky project where gross output is given by

$$y_1 = \alpha E k_1 \qquad \textbf{(1)}$$

α is a random productivity variable distributed uniformly over the interval [0, 1] and E is effort exerted by the debtor.[10] In this context, debtor effort means supply-side policy measures to

(9) This paper does not cover the important issue of whether measures to constrain demand such as fiscal contraction and higher interest rates harm incentives for capital inflow.
(10) Federico (2001) considers the role of policy effort in the aftermath of a capital account crisis in more detail.

improve productivity such as labour market reform or privatisation of state-owned enterprises. The parameter α is revealed before effort is chosen and, for convenience, the amount the country borrows, k_1, is assumed to be fixed. The debtor contracts to repay international creditors $(1+r)k_1$ at the end of period 1 so the net return to the country from the project is

$$NR = [\alpha E - (1+r)]\, k_1 \qquad \textbf{(2)}$$

If this is negative, the country faces a potential balance of payments shortfall because there are no other resources and the country must either borrow against second-period output or default. NR is most likely to be negative and the country face a balance of payments problem if the productivity shock is bad and α is low. But as a result of the timing of the game, the debtor has the option to exert effort sufficient to ensure the project has a positive return. The minimum value of effort consistent with an ability to repay is

$$\bar{E} = \frac{(1+r)}{\alpha} \qquad \textbf{(3)}$$

which gets very large as α becomes very small. Full repayment without borrowing is only feasible if $E \geq \bar{E}$.

Unlike the first period, [11] second-period gross output is assumed to be deterministic and is given by

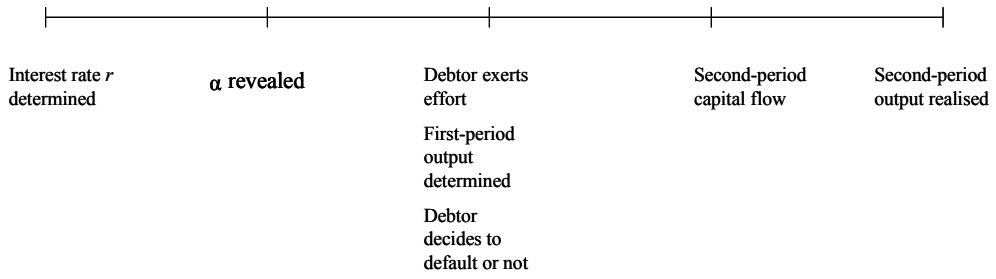
$$y_2 = \begin{cases} k_2 + E^{\lambda} k_2^{\gamma} & \text{if the debtor repays} \\ k_2 + (1-\pi) E^{\lambda} k_2^{\gamma} & \text{otherwise} \end{cases} \qquad \textbf{(4)}$$

There are partial decreasing returns to capital and investment so $0 < \lambda < 1$ and $0 < \gamma < 1$.[12] A key assumption is that the effort level E is the same as in the first period. In reality, of course, effort is not a once-for-all decision but this assumption is intended to capture the fact that actions taken to resolve a crisis can have longer-run consequences on output. The effort decision can also be thought of as a commitment to an agenda of reform.[13]

Parameter π is a penalty paid if the debtor defaults on repayment of k_1 at the end of period 1. The penalty for defaulting is a reduction in the productivity of effort and capital but this cost can be interpreted very broadly if necessary. It is intended to capture the general increase in the cost of doing business in a post-default world. These costs can be directly related to the sovereign default

(11) The change in the production function between the two periods is used for analytical convenience only and the precise form of the specification does not alter the thrust of the results.
(12) Since the productivity of the capital stock is also a function of effort, to ensure a decreasing overall return to effort, which is essential to solve the model, requires $\gamma + \lambda < 1$.
(13) Some method of enforcing E in the second period is what Dhonte has in mind for the role of IMF conditionality in catalysing private finance.

Chart 1: Timeline of the game



through the effect on the domestic banking sector and the payment system (as discussed by Dooley (2000)) or the broader reputational costs of default because it signals a willingness to renege on other sovereign obligations such as wages and pensions (see Cole and Kehoe (1996)). Alfaro and Kanczuk (2002) find quantitative evidence that output costs of default are important in sustaining a repayment equilibrium.

The amount of capital invested in period 2 is denoted by k_2.[14] It is assumed for convenience, at this stage, that there is an enforcement mechanism in the second period which makes the debtor repay which is not available in the first period. Since effort is known, default is ruled out and production is not subject to uncertainty, loans will only be made which are guaranteed to be repaid. Therefore, all lending to the debtor in period 2 is risk-free and can be borrowed at the risk-free rate ρ.[15]

Chart 1 summarises the timing of the game. There are two decision points. First, creditors decide what interest rate to charge on first-period loans taking into account the probability of default. Second, debtors decide how much effort to exert once the productivity of the project has been revealed. The level of effort simultaneously determines whether the country defaults or not and the amount of second-period output. The ramifications of default are taken into account when deciding on the effort to exert.

The model is solved by working backwards and considering the debtor's effort decision. Putting in

(14) This model assumes that the debtor borrows all the capital that flows to the country. But this is only a modelling convenience and the effect of effort on capital flows could be extended to include attracting FDI.
(15) The absence of uncertainty is also assumed for analytical convenience so that creditors and the debtor can make fully informed decisions in the second period. In reality, there is likely to be considerable uncertainty about the extent of debtor effort, the impact of this effort and the willingness of creditors to invest. This uncertainty would affect the expected payoffs of the creditors and debtors in a mutually adverse way and lower the volume of second-period capital flows.

effort to raise productivity is assumed to be costly. For example, governments find it politically difficult to introduce labour market reform or sell state-owned enterprises, particularly when the economy is performing poorly. In the model, the debtor incurs a constant marginal disutility, ϕ, per unit of effort to offset the reward from net output. Given the structure of the game, the debtor has three options to consider.

- The first option is to put in sufficient effort to repay out of first-period output. The debtor's utility over the two periods conditional on the strategy of fully repaying is[16]

$$W_R = [\alpha E - (1+r)]\, k_1 + E^{\lambda} k_2^{\gamma} - \rho k_2 - \phi E \qquad \textbf{(5)}$$

  noting that

$$k_2 = \left(\frac{\gamma\, E^{\lambda}}{\rho}\right)^{\frac{1}{1-\gamma}}. \qquad \textbf{(6)}$$

  Equation **(5)** is a function of effort and a set of exogenous or pre-determined variables. The debtor will choose the welfare-maximising level of effort E_R^* which can be substituted back into equation **(5)** to create a maximum schedule of welfare conditional on the value of α. If the debtor repays, there is no balance of payments problem and debtor welfare is $W_R(E_R^*)$.
- The second option is to borrow against second-stage output at the interest rate ρ. Welfare in the case that the debtor borrows to repay (denoted B) is

$$W_B = [\alpha E - (1+r)]\,(1+\rho) k_1 + E^{\lambda} k_2^{\gamma} - \rho k_2 - \phi E \qquad \textbf{(7)}$$

  which is maximised at E_B^*, noting that $\alpha E_B^* < (1+r)$.[17] There is an equivalent schedule $W_B(E_B^*)$.
- The third option is to default. Consistent with there being no collateral in international sovereign borrowing and sovereign immunity, it is assumed the debtor keeps first-period output if it decides to default so the only disciplining mechanism to enforce repayment is the opportunity cost of lower second-period output.[18] Welfare in the case that the debtor defaults (subscript D) is

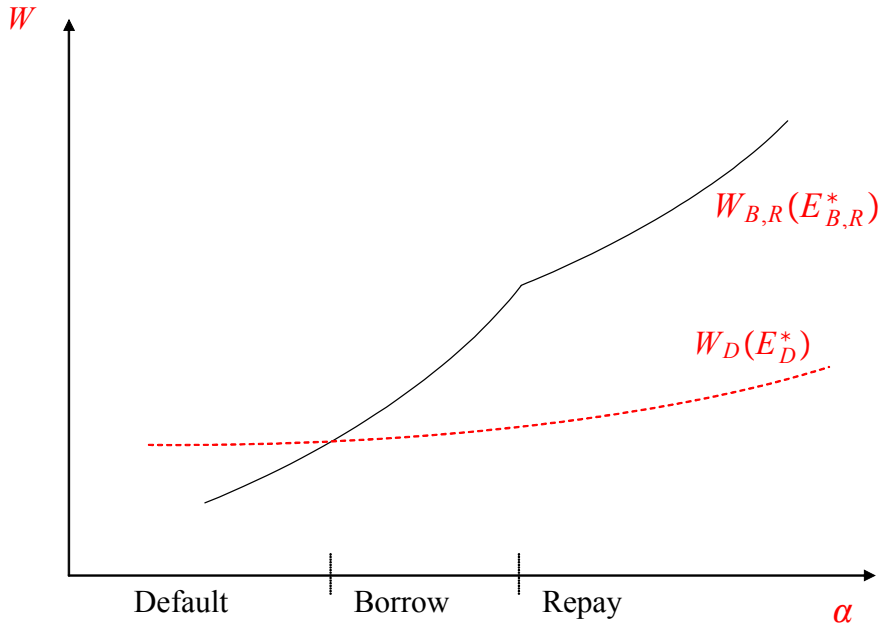
$$W_D = \alpha E k_1 + (1-\pi) E^{\lambda} k_2^{\gamma} - \rho k_2 - \phi E \qquad \textbf{(8)}$$

  where

$$k_2 = \left(\frac{\gamma\,(1-\pi) E^{\lambda}}{\rho}\right)^{\frac{1}{1-\gamma}} \qquad \textbf{(9)}$$

(16) For convenience, there is no rate of time preference. This does not alter the substance of the results.
(17) If there was a rate of time preference which equalled the risk-free rate of interest, the welfare schedules of borrowing and repaying would be identical at this stage. The structure is used to make the incorporation of an IMF interest rate easier.
(18) This is a point emphasised by Dooley (2000), among others.

Chart 2: Default, borrow or repay



and this is maximised at E^*_D. There is therefore a schedule $W_D(E^*_D)$.

Not all of these welfare schedules are feasible for particular values of α. Specifically, since the debtor cannot repay if $E^*_R < \bar{E}$, the schedule $W_R(E^*_R)$ is not defined for $E < \bar{E}$. Similarly, the debtor will not borrow once it can afford to repay, so $W_B(E^*_B)$ is not defined for $E > \bar{E}$. Splicing these curves together is the maximum feasible welfare conditional on avoiding default and is denoted $W_{B,R}(E^*_{B,R})$. As illustrated in Chart 2 the intersection of the $W_{B,R}(E^*_{B,R})$ schedule with $W_D(E^*_D)$ determines when the debtor will prefer to default. [19]

The last step is to establish the equilibrium interest rate on first-period loans. It is assumed that creditors are risk neutral and will charge an interest rate in order to receive an expected return equal to their rate of time preference, ρ. Creditors are repaid in full on first-period loans in the 'repay' and 'borrow' regions over α but receive nothing in the event of default. Creditors know from the structure of the game that the debtor will default up until the point at which utility from repaying is equal to the utility of borrowing: $W_B(E^*_B) = W_D(E^*_D)$. The annex demonstrates that this equality results in a mapping from the first-period interest rate to the trigger value of α at

(19) For extreme values of the parameters, the $W_D(E^*_D)$ schedule may only intersect the $W_{B,R}(E^*_{B,R})$ after the kink (ie the debtor will only fully repay or default) or may never intersect at all, in which case the debtor would never be able to borrow in the first place. These are not interesting cases.

which the debtor switches to default. Since α is uniformly distributed over [0, 1], this trigger value of α, $\hat{\alpha}$, is also the probability of default. Creditors chose $\hat{r}$ such that

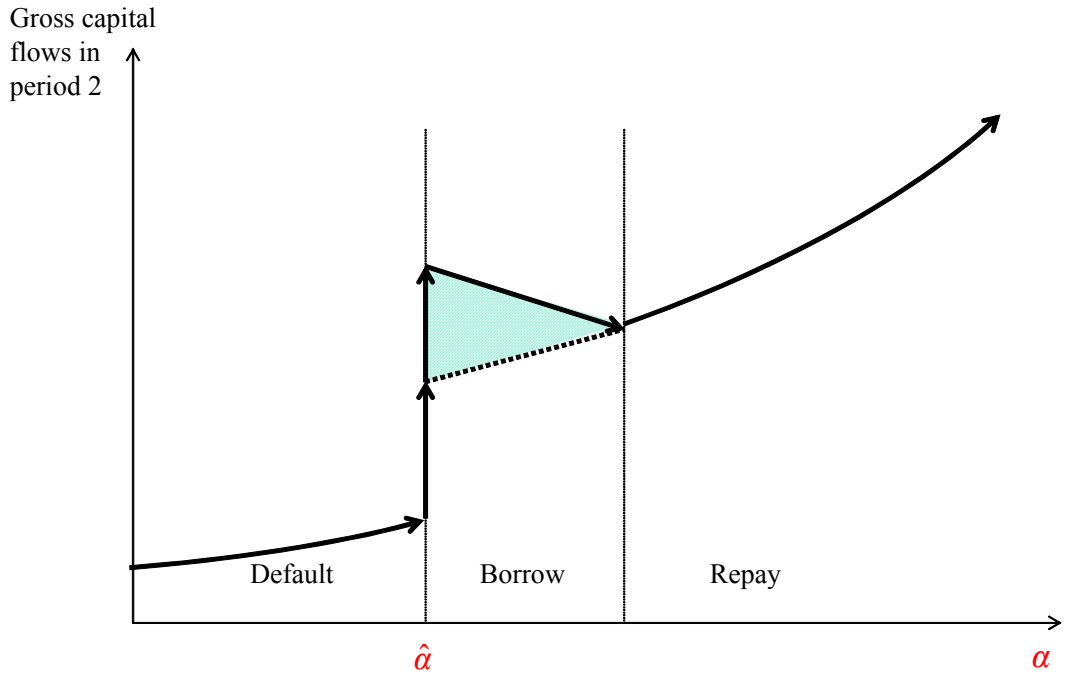
$$\hat{r}.(1 - \text{probability of default}) \equiv \hat{r}.(1 - \hat{\alpha}(\hat{r})) = \rho \qquad \textbf{(10)}$$

This completes the solution to the game in the absence of the IMF which can be summarised, in chronological order, as follows. Creditors set the first-period interest rate on a fixed amount of borrowing. Nature randomly selects the productivity of this investment which can be augmented by debtor adjustment effort. For high values of productivity, the debtor has an incentive to put in effort and can easily repay first-period loans. As a consequence, productivity is high in the second period and capital inflows are large. For low values of productivity, the effort necessary to avoid default is too great relative to the benefit of high productivity in the second period and the debtor decides not to repay. As a result, capital inflow in the second period is low. For intermediate values of productivity, the debtor can put in enough effort to safely borrow to meet the shortfall in the first period between output and loan repayments. By avoiding default, the debtor keeps productivity high in the second-period and consequently a high level of capital flow. The pattern of gross capital flows across α is illustrated in Chart 3. When α is low and the debtor decides to default, gross capital flows are low. As α increases, even when the debtor defaults, the debtor exerts more effort and second-period capital flows increase gradually. There is a step jump in capital flows at the value of α at which the debtor decides to borrow rather than default. This occurs for two reasons. First, the country borrows to meet the first-period shortfall which is illustrated in the shaded area. Second, capital borrowed for second-period investment is higher because of the additional effort exerted to avoid default and the higher second-period productivity from avoiding default. Notice that the amount the debtor needs to borrow to meet the first-period shortfall is diminishing as α increases until eventually net first-period output is positive and the debtor fully repays. Capital borrowed for second-period output continues to rise with α because of the additional effort exerted by the debtor.

2.2 A world with the IMF

The model without the IMF in Section 2.1 assumed that the market would provide bridging finance at the risk-free rate right up until the point at which the debtor would prefer to default. In reality, private creditors will charge progressively higher interest rates as fundamentals deteriorate because of the rising risk of default. The higher the rate of interest charged by the market, the less

Chart 3: Gross capital flows in period 2



incentive the debtor has to put in adjustment effort to avoid default which feeds back to the interest premium charged and so on. In extreme cases, the market might be completely closed to the debtor and it is forced into default. These crises are avoidable if a large lender can provide bridging finance at a low interest rate. The IMF performs this role by lending at an interest rate just over the cost of capital but with preferred creditor status which reduces the risk of non-repayment. IMF programmes based on the catalytic approach assume that a combination of IMF bridging finance and debtor adjustment provides an incentive for private creditors to lend. This section explains one channel of how this catalytic effect might come about. In this model, the IMF can provide emergency bridging finance in the event of a potential shortfall in first-period output at an interest rate below the market rate. Since it has been assumed that the market lends at the risk-free rate, the IMF would need to lend at below the rate of time preference. In reality, in a world in which future repayment prospects are not certain (as they are modelled here), the IMF only needs to lend with a lower risk premium than private creditors to have the same effect. (20)

Since the emergency lending rate is not relevant for utility in the event of default or full

(20) This is in large part attributable to the IMF's *de facto* seniority but there is also an element of subsidy involved. For estimates of the upper bound of this subsidy see Jeanne and Zettelmeyer (2001) and the associated discussion.

repayment, equations **(8)** and **(5)** are unchanged. Equation **(7)** changes to

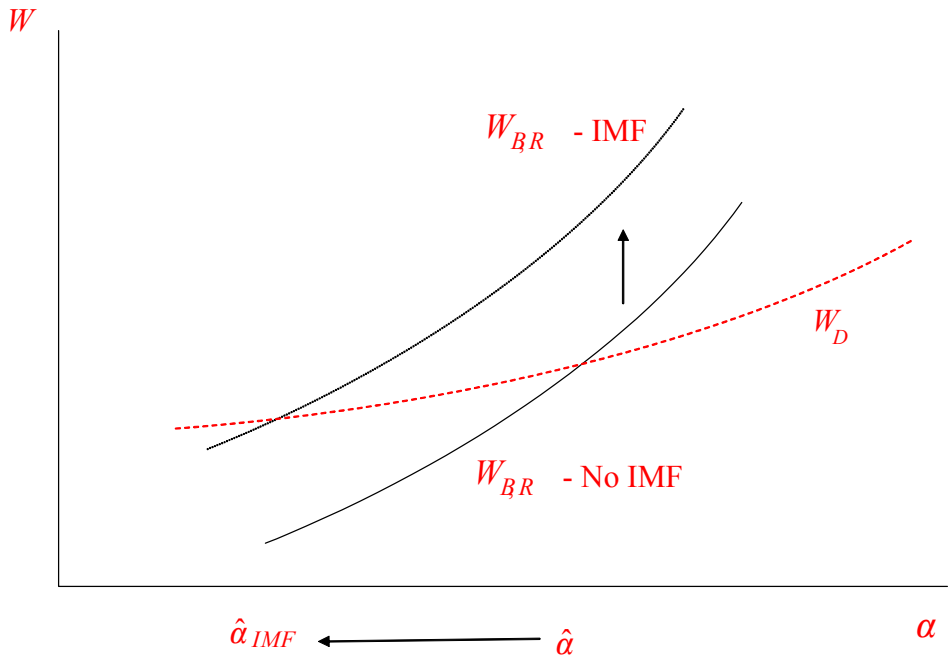
$$W_{B,IMF} = [\alpha E - (1+r)]\,(1+\bar{\rho})k_1 + E^{\lambda}k_2^{\gamma} - \rho k_2 - \phi E \qquad \textbf{(11)}$$

where $\bar{\rho} < \rho$ is the IMF's lending rate. Note that the IMF is only providing bridging finance and capital for second-period production must be borrowed at market rates. The model is solved in an identical way to the world without the IMF. The debtor chooses its utility maximising level of effort across α to create a $W_{B,IMF}(E^*_{B,IMF})$ schedule and compares this with $W_D(E^*_D)$ and $W_R(E^*_R)$. It is demonstrated in the annex that a comparison of $W_{B,IMF}(E^*_{B,IMF})$ and $W_D(E^*_D)$ results in a lower trigger value for default, $\hat{\alpha}_{IMF} < \hat{\alpha}$. Therefore, IMF subsidised lending can prevent default over a range of adverse productivity outcomes because the subsidy induces the debtor to put in sufficient effort when it otherwise would not. However, the IMF cannot prevent all crises even if it lowered its interest rate to zero. This is because debtor effort required to avoid default increases exponentially as α falls whereas the subsidy is bounded because $\bar{\rho}$ cannot fall below zero. Obviously, because a lower value of $\bar{\rho}$ produces an upward shift in equation **(11)**, debtor utility is raised over the range in which the debtor borrows. It has the further effect of lowering the first-period interest rate r which also improves debtor welfare. This occurs because there is a lower trigger value for default, increasing the *ex-ante* probability of repayment and lowering the risk premium incorporated into the interest rate.

An unintended consequence of subsidised lending by the IMF is a lower level of effort than would otherwise be the case over the region in which the debtor would and could have borrowed from the private market anyway.[21] (Debtor effort is clearly higher over the region in which the debtor would otherwise default.) This form of moral hazard occurs because effort directly affects the size of the deficit in the first period and because borrowing is less expensive, the country is less concerned by the size of the deficit. As a result, the debtor has less incentive to put in effort. Lower effort, in turn, contributes to a higher level of welfare for a given productivity outcome. This is illustrated in Chart 4. The gap between welfare with the IMF and without is directly related to the size of the subsidy on the loan interest rate. Clearly, if the IMF lent at the same rate as the market, there would be no difference in welfare because in this model the debtor is indifferent to the identity of the creditors. The higher the subsidy provided by the IMF, the greater the welfare to the debtor and the lower the effort it exerts relative to the situation without the IMF over the range in which it would have avoided default anyway.

(21) The details are in the annex. An identical result is obtained by Morris and Shin (2003).

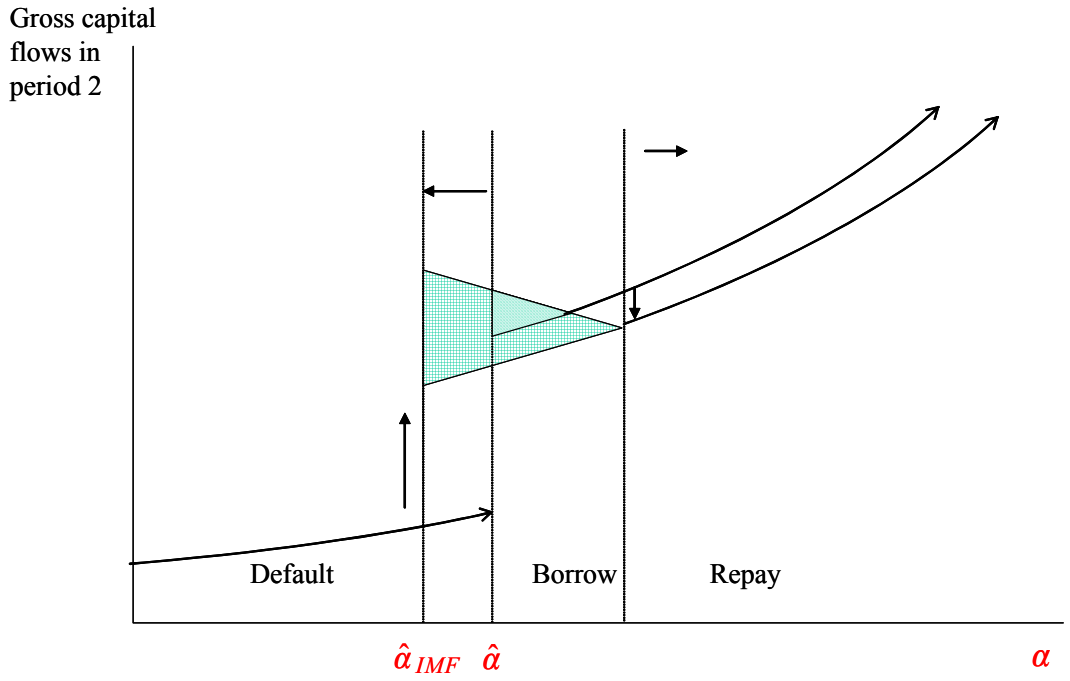
Chart 4: Welfare - with and without the IMF



If there are externalities from debtor effort, for instance it could provide greater security for the loan or there may be spillovers from effort in one country to performance of its neighbours (for example the impact on Uruguay of the crisis in Argentina), the IMF may prefer that the debtor exerts more effort than the debtor would voluntarily choose under the new incentive structure.(22) Or the IMF may wish to offset the moral hazard resulting from its intervention. In this case, can the IMF demand additional policy effort in return for lending? Put another way, can the IMF impose conditionality on its loans beyond the effort level the country chooses when it is maximising welfare? Chart 4 illustrates that it can. A country will accept any 'effort-for-money' contract that makes it better off than the welfare it receives without the involvement of the Fund. This is any region above the 'welfare - no IMF' and 'welfare - default' lines in Chart 4. But it is worth noting that there are two limits on the ability to impose greater conditionality. With a minor shock (α high), 'excess', conditionality is limited by the size of the interest subsidy. The larger the subsidy, the more conditions can be applied before the debtor decides it would be better off rejecting and borrowing from the market. If the shock is bad (α low), then the constraint is the point at which the debtor would prefer to default. Obviously, at the point at which 'welfare - IMF' intersects with 'welfare - default', $\hat{\alpha}_{IMF}$, the IMF cannot insist on additional conditions because it would trigger default instead. In this situation, the IMF has little leverage over the decisions of the

(22) Federico (2001) argues that conditionality can remove moral hazard by making the debtor's participation constraint bind.

Chart 5: Gross capital flows in period 2 - with the IMF



debtor even though its involvement makes a difference between having or avoiding a financial crisis.

The effects of IMF intervention on capital flows in this model, the 'catalytic effect', are illustrated in Chart 5. The IMF rather than the private sector now provides the bridging finance to meet a shortfall on first-period output (the heavily shaded area). As outlined above, the subsidised finance from the IMF induces the debtor to exert more effort to avoid default over a wider range of fundamentals (α falls to $\hat{\alpha}_{IMF}$). Over this range, the greater effort exerted by the debtor and higher productivity maintained by avoiding default are translated into higher second-period capital flows from the private sector which is the step up in gross capital flows at $\hat{\alpha}_{IMF}$. But the debtor has less incentive to exert effort over the range at which it would previously have borrowed anyway from the private sector. With lower effort, the first-period shortfall is larger than it would have been (the lightly shaded area) so the loan from the IMF is larger than the bridging loan that would have been provided by the private sector for the same value of α. This lower effort is reflected in the rightward extension of the borrowing regime and the lowering of the second-period investment flow.

2.3 Catalytic finance with uncertainty about debtor type

Up to now, it has been assumed that all participants have complete information. In practice, though, foreign creditors are likely to know less about the policy preferences of the debtor than the debtor itself or possibly the IMF. This informational asymmetry could be particularly acute during a financial crisis when debtors are faced with tough policy choices. Faced with this uncertainty, creditors may be cautious in their lending decisions or charge a high risk premium which could have adverse effects on debtor incentives. If the IMF has better information about the debtor's policy preferences, it could improve welfare by signalling this through its lending decisions.[(23)] This channel for possible catalysis of private capital flows is considered in this section.

It is assumed here that there are two types of debtors: good and bad. Good debtors behave as before but bad debtors will always default on the interest payments on period two borrowings.[(24)] It will be assumed that in the total population of debtors, half are good and half are bad. Furthermore, debtor type is not observed by creditors and there is no mechanism by which the debtor can signal its type to creditors. To make things interesting, it will be assumed that the timing of events is altered slightly from that depicted in Chart 1. Second-period capital flows still occur after the debtor has exerted effort, but E is not revealed to creditors until *after* these flows have taken place. So the effect of this change is to introduce uncertainty into the creditors' second-period lending decision. The revelation of E obviously also reveals the debtor type but it is too late for any decisions to be changed. The timing of events is now.

1. The first-period interest rate is determined.
2. Nature draws α which is common knowledge to all and debtor type is revealed to the debtor.
3. The debtor exerts effort and announces what it wishes to borrow (b_2) in the second period at interest rate r_2.
4. Creditors supply second-period funds.
5. Debtor effort is revealed (simultaneously revealing first-period output) and the debtor has the option to default on first-period loans. If the debtor chooses not to default, first-period loans are repaid. Second-period output is determined by these choices.

(23) The costs and benefits of the IMF signalling debtor type is considered in more detail in Gai, Hayes and Shin (2002).
(24) For convenience, it will be assumed that there is still some way to enforce the payment of principal.

6. Good-type debtors repay second principal and interest; bad-type debtors repay only principal.

The solution, as before, begins with a consideration of the world without the IMF. The only modifications to equations **(5)** to **(9)** are that the second-period interest rate is yet to be determined - replacing ρ with r_2. The same decision-making process as previously is then followed. The good debtor works out its optimal choice of effort under the three strategies - default, borrow and repay - conditional on α and then chooses the strategy with the highest state contingent welfare. Since the good debtor pays interest plus principal in the second period, it has no incentive to over-borrow, so the second-period capital flow will still be determined by setting the marginal return on second-period capital equal to the second-period interest rate.

The bad debtor, on the other hand, would like to borrow as much as possible in the second period because the marginal product of capital will always be positive and because it defaults on the interest payments, the effective cost of capital is zero. However, by demanding more capital than the good debtor would do with the same value of α, the bad debtor would immediately reveal its type which would be self-defeating. Since creditors always lose on lending to bad-type borrowers, if they can identify type, then bad debtors would be unable to borrow. Therefore the bad debtor can do no better than mimic the behaviour of a good debtor under the same circumstances. This information can be used to price second-period loans. Creditors will be faced by the borrowing demands of a good-type debtor across the range of α. There is a 50% chance that the borrower is a good debtor who will pay back $k_2(1 + r_2)$ and a 50% chance the borrower is bad and will only repay k_2. Therefore, a risk-neutral creditor seeking an expected rate of return ρ, will charge an interest rate $r_2 = 2\rho$.

The good debtor behaves exactly as the debtor in the earlier analysis. If 2ρ is substituted for ρ in equations **(5)** to **(9)**, it can be seen immediately that welfare is lower and second-period capital flows are lower whether the debtor repays or defaults. What happens to the value of α at which the good debtor switches between borrowing to repay and defaulting is effectively the reverse of the case of lowering the interest rate with the intervention of the IMF, although in this case the higher interest rate also raises borrowing costs for second-period capital investment as well. Therefore the value of α at which the debtor switches is raised and default occurs with a higher frequency.

Given this structure, the bad debtor has no choice but to request exactly the same flow of second-period borrowing as the good debtor for the value of α. Even though a bad debtor would like to borrow more, it cannot because it would reveal its type and receive nothing. Conditional on this given amount of second-period borrowing and the value of α, the bad debtor has to decide how much effort to exert. Although it is not immediately obvious, the bad debtor will choose exactly the same effort level as the good debtor. In effect, the bad debtor gets a lump-sum increase in welfare by not paying and this does not affect the marginal incentives to exert effort. Therefore, in all other respects except final repayment, the bad debtor behaves exactly the same as a good debtor. Crucially, the bad debtor will default at the same values of α as the good debtor.

The overall effect of introducing asymmetric information into this problem is that the frequency of default rises and the interest rate required on first-period loans increases. Increasing the first-period interest rate reinforces the disincentive to exert effort to avoid default.

The IMF can intervene as in the perfect information case and reduce the *ex-ante* probability of default. But in a world with information asymmetry and assuming that the IMF can better distinguish between good and bad debtors than private creditors, the catalytic effect can be strengthened. For example, if the IMF is completely accurate and only provides bridging loans to good debtors, then the second-period interest rate will revert from 2ρ to ρ (because bad debtors receive nothing and lending is now risk free). By removing the risk premium on second-period lending, more capital flows to the debtor and the *ex-ante* probability of default falls again. Good debtors revert back to the perfect information world and bad debtors are locked out.

If the IMF has a known probability of making a mistake, η, then the second-period interest rate for a good debtor will be

$$r_2^G = \frac{\rho}{1-\eta}$$

and a bad debtor will be charged

$$r_2^B = \frac{\rho}{\eta}$$

Assuming η is sufficiently low, the bad debtor will still be locked out of private capital markets. It would be interesting to investigate how private sector beliefs on type might change in a repeated game setting. If the IMF were initially given the benefit of the doubt, the catalytic effect of lending would be high. But if a member repeatedly seeks and receives assistance, private creditors may come to doubt the accuracy of the IMF's signal, weakening the strength of the catalytic effect.

3 Why might programmes based on catalytic finance fail?

Unfortunately for the theory, programmes based on a strong catalytic effect have proved disappointing. The most detailed assessment of the empirical evidence is by Bird and Rowlands (2002) who conclude that '*to the extent that there is a catalytic effect,..it appears to be weak and partial and dependent on the countries and capital flows involved as well as the nature of Fund involvement... Any generalisation must be viewed with caution. However, it does appear that large-scale empirical research provides little support for the idea of strong, consistent and positive catalysis'* Cottarelli and Giannini survey the available literature and conclude that '*None of the papers surveyed finds evidence of strong catalytic effects, although some of them find the existence of moderate catalytic effects... [T]here are indications that, to the extent that catalytic effects exist, they are diminishing over time, are weaker for countries that experience a series of Fund-supported programmes, and are weaker under crisis situations.*' Closer to home, Ghosh *et al* admit that IMF projections of catalytic finance have been overly optimistic suggesting that scope for the use of programmes based on catalytic finance may be narrower than previously thought. This section examines why this might be the case.

If the IMF had a completely accurate model of the economy and had perfect information about debtor type, then the IMF could calibrate the amount of finance and conditionality exactly and programmes would never fail. The IMF and the debtor would observe the productivity outcome α and debtor type. If $\alpha < \hat{\alpha}_{IMF}$, the trigger value for default, then the IMF would not lend. If $\alpha > \hat{\alpha}$, the IMF knows that the debtor would be willing to borrow from private creditors to avoid default if necessary and therefore the IMF does not need to offer to lend. If $\hat{\alpha}_{IMF} < \alpha < \hat{\alpha}$, then only IMF lending at a subsidised interest rate can prevent a crisis. With complete knowledge of the parameters, the IMF lends exactly the amount necessary to fill the *ex-ante* financing gap and can accurately forecast the amount of private sector capital flows. It would also be able to determine exactly how much excess conditionality it could demand.

In the real world, these parameters are not known with certainty. Equation **(6)** shows that catalysed capital flows are dependent on the marginal rate of return to policy effort. So the IMF may be surprised by the small size of actual capital flows if it overestimated the impact of policy measures. For instance, there may be very little additional incentive to invest in a country because it has an independent central bank or removed some import tariffs.

The model also assumed that there was only one adjustment effort choice which covered both first-period and second-period output. In reality, adjustment effort by a debtor involves a number of separate decisions about which reforms are politically feasible and which ones are not. Each separate reform would have a different effect on output. Nevertheless, there is a sense in which debtor countries do commit to a reform agenda when they borrow from the IMF. Any IMF programme has a sequence of conditions which the debtor must meet before the next instalment of money is released. These conditions are set out when the programme is first agreed. In this sense, when a country signs an agreement with the IMF it is binding itself to a single sequence of reforms which can be considered a single adjustment choice. But one reason why IMF programmes fail is that policy effort weakens over time, particularly after the IMF has released the bulk of the money. If private creditors are not convinced that programme conditionality will be enforced, they may apply a discount to commitments on future policy effort and not be willing to invest immediately. Private creditors may prefer to wait and see whether reforms are implemented. In the context of the model, this has a reinforcing negative effect. By reducing the reward for effort, there is less incentive for debtors to incur the pain of adjustment. Private sector caution may be reinforced if investors are not convinced that the IMF has superior information about debtor type or if geopolitical motives force the IMF to falsely signal the country is a good debtor. The less convinced the private sector is about the accuracy of the IMF signal, the higher the compensation demanded by private creditors and the lower the capital flows in the second period. This would likely be the case if the country is a repeat borrower from the IMF or is seeking augmentation of an existing programme. The private sector is likely to become increasingly suspicious that a borrower is a bad debtor if it has a sequence of low output.

The catalytic effect is generally interpreted as a mutually reinforcing virtuous cycle of boosting confidence, rising private capital flows and increasing adjustment effort. The factors mentioned in the previous paragraph explain how this reinforcement mechanism may be weaker than the IMF had originally hoped. More serious, though, is if the IMF lends when the debtor is not genuinely committed to policy reform and the virtuous cycle cannot even begin. Since the IMF lends at a subsidised interest rate, the debtor always has an incentive to borrow from the IMF before it borrows from the market. If the Fund does mistakenly lend when $\alpha < \hat{\alpha}_{IMF}$, then the country defaults regardless because it is not incentive compatible to put in sufficient effort to fully repay. Second-period capital is now given by equation **(9)** which factors in default. Not only is this lower than what is projected in the programme (equation **(6)**) but *private* capital flows are lower by the

amount provided by the IMF. In these cases IMF finance is simply a substitute for private capital. Moreover, the size of the financing gap in the first period will be larger than contained in the IMF projections because the level of effort is lower.

4 Policy implications

There are two key results from this analysis of the catalytic effect and its potential failings. First, it is very easy to overestimate the size of the catalytic effect. The catalytic effect as modelled here relies on mutually reinforcing increases in debtor adjustment effort, creditor confidence and private capital flows. If the feedback effect is strong, the catalytic effect can be large, but if there is one weak link, the feedback effect is significantly undermined. Therefore, to build a programme relying on the catalytic effect requires considerable confidence in *all* the links in the chain. The risk of being wrong on any of the links needs to be factored into IMF programme design. Second, the catalytic approach will not always work. For a range of the fundamental shock, IMF intervention is simply a substitute for private capital because the debtor cannot be induced to exert more effort. There is a step change in effort levels at the value of the fundamentals at which the debtor switches between repaying and defaulting. On one side of the switching value there is a catalytic effect and a strong increase in private capital flows and just on the other side there is no catalytic effect. Thus there is a fine dividing line between success and failure of the catalytic effect. The IMF must be careful that it only relies on the catalytic effect in circumstances in which it will work. For example, it is less likely to work for repeat borrowers. The IMF also needs to consider the effects its own decisions on conditionality can have. The more conditions the IMF imposes beyond those the debtor would voluntarily choose, the greater the risk that the debtor will prefer to default. Rather than contributing to the success of a programme, excessive conditionality can weaken the probability of success.

Both of these results point to another result. Relying on the catalytic effect has polar outcomes. If the catalytic effect occurs, there will be a significant increase in private capital flows. If the catalytic effect fails, it fails badly. Failed programmes based on the catalytic effect can have substantial costs for countries trying to cope with a capital account crisis. If IMF loans and private sector capital flows do not fill the *ex-ante* financing gap, the debtor is forced to make greater domestic adjustment or default. Ghosh *et al* note that domestic adjustment had to be considerably greater than anticipated in recent capital account cases because of the failure of the catalytic effect.

The catalytic approach to IMF programming was a central component of the 'Prague framework'. The International Monetary and Finance Committee communique from the meetings in Prague of September 2000 stated: '*In some cases, the combination of catalytic official financing and policy adjustment should allow the country to regain full market access quickly. The Committee agrees that reliance on the catalytic approach at high levels of access presumes substantial justification, both in terms of its likely effectiveness and of the risks of alternative approaches.*' In essence, the catalytic approach enabled the IMF to approve programmes in which the Fund's contribution was only a portion of the *ex-ante* financing gap. The analysis in this paper and the available empirical evidence suggests that these cases will be relatively few. Therefore, the IMF will have to consider alternatives to the catalytic approach. The IMFC communique continues: '*In other cases, emphasis should be placed on encouraging voluntary approaches, as needed, to overcome creditor coordination problems*.' There is little evidence, though, that creditors will reach voluntary agreements to roll over their exposures - most rollover agreements that have been reached have required strong moral suasion by the official sector. Recent initiatives to encourage the wider use of collective action clauses in bonds are consistent with this spirit of relying on voluntary approaches to resolving creditor coordination problems, although these focus on cases when a debt restructuring is necessary rather than the general case of liquidity shortage. The Prague framework concludes that: '*In yet other cases, the early restoration of full market access on terms consistent with medium-term external sustainability may be judged to be unrealistic, and a broader spectrum of actions by private creditors, including comprehensive debt restructuring, may be warranted to provide for an adequately financed program and a viable medium-term payments profile. This includes the possibility that, in certain extreme cases, a temporary payments suspension or standstill may be unavoidable.*' Temporary payment standstills and debt restructurings are not without risks themselves and may impose considerable costs on the debtor but an implication of this analysis is that they may need to be considered more frequently because the preconditions for the catalytic effect to work are fairly strict.

5 Conclusion

This paper has explored a model of how IMF lending to countries facing a financial crisis can catalyse private capital flows. The model explained how the subsidy element of IMF lending will induce a country to exert adjustment effort to avoid default when hit by an adverse shock. If forced to borrow at market rates, the country is faced by an adjustment effort that is too costly for

it to implement and it will prefer to default. By avoiding default and a financial crisis, the marginal product of capital is kept high in the country which in turn supports high levels of private capital flows. It is by this channel that in theory the IMF catalyses private finance.

Empirical evidence and IMF staff analysis, though, has shown that projections of private capital flows have been overly optimistic. The model presented in this paper suggests two reasons why this might be the case. First, private capital flows are sensitive to the marginal impact of reform effort on the productivity of investment. Structural reforms implemented at the behest of the IMF may only have long-term pay-offs and be subject to considerable uncertainty. Therefore, private capital flows may return over a longer period than contained in IMF projections. Second, capital flows can be considerably lower if the borrower's commitment to reform is lower than expected. This is less of a concern if the shock is mild and reforms required are mild. But as the size of the shock rises and the burden of adjustment necessary to avoid default becomes increasingly onerous, there is a risk that programmes are provided when the level of commitment is not sufficient. In these circumstances, there is a step change in the level of effort exerted. To avoid the cost of default, the debtor is willing to put in significant effort but once this is too high and default is inevitable, the marginal rewards to effort are lower and the debtor exerts considerably less. With lower reform effort, capital flows are correspondingly low. In effect, capital flows can have quite different polar outcomes from only slight differences in initial conditions.

The analysis yields a number of policy implications. First, IMF programmes based on catalytic finance are most likely to succeed when shocks are relatively mild. Second, there is much greater risk of programme failure when the policy reform agenda is lengthy. The IMF should be wary of programmes that require extensive conditionality. Third, if catalytic programmes fail, capital flows are well below the amounts projected - if programmes fail, they fail substantially. Finally, when projecting capital flows in a catalytic finance programme, the IMF needs to be convinced that reforms will genuinely increase the marginal productivity of investment. When the catalytic approach is not feasible, the IMF should consider other approaches such as standstills or debt restructurings even though these may impose considerable costs of their own.

Appendix A: Determining the first-period interest rate

When deciding whether to repay, borrow or default, the debtor compares maximum utility from each strategy (assuming it is feasible) for a given value of α. Since all else is fixed or known at the time, this is a straightforward maximisation problem. In the case of borrowing, the debtor sets the marginal improvement in welfare with respect to effort

$$\frac{\partial W_B}{\partial E} = \alpha(1+\rho)k_1 + \frac{\lambda}{1-\gamma} E^{\frac{\lambda+\gamma-1}{1-\gamma}} \left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\gamma}} (1-\gamma) - \phi \qquad \textbf{(A-1)}$$

equal to zero. This gives

$$E_B^* = \left\{ \frac{\lambda \left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\gamma}}}{[\phi - \alpha(1+\rho)k_1]} \right\}^{\frac{1-\gamma}{1-\lambda-\gamma}} \qquad \textbf{(A-2)}$$

A similar maximisation problem in the context of default gives

$$E_D^* = \left\{ \frac{\lambda \left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\gamma}} (1-\pi)^{\frac{1}{1-\gamma}}}{[\phi - \alpha k_1]} \right\}^{\frac{1-\gamma}{1-\lambda-\gamma}} \qquad \textbf{(A-3)}$$

Note that for effort to be defined, $\phi - \alpha k_1 > \phi - \alpha(1+\rho)k_1 > 0$. Substituting equation **(A-2)** into **(7)** simplifies to

$$W_B = \left(\frac{\lambda}{\phi - \alpha(1+\rho)k_1}\right)^{\frac{\lambda}{1-\lambda-\gamma}} \left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\lambda-\gamma}} (1-\gamma-\lambda) - (1+r)(1+\rho)k_1 \qquad \textbf{(A-4)}$$

This gives utility over the borrowing region solely in terms of exogenous variables, r and the productivity parameter. A similar maximisation problem yields a function for utility over the region of default

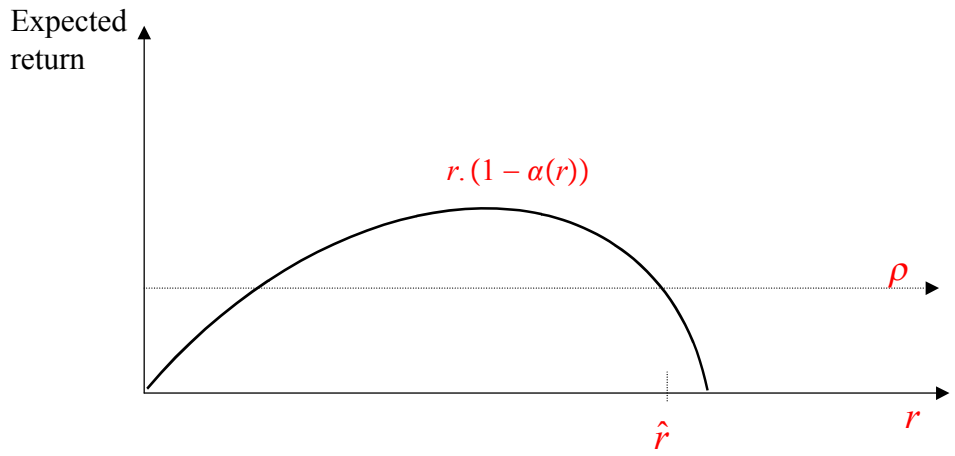
$$W_D = \left(\frac{\lambda}{\phi - \alpha k_1}\right)^{\frac{\lambda}{1-\lambda-\gamma}} \left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\lambda-\gamma}} (1-\gamma-\lambda)\,(1-\pi)^{\frac{1}{1-\gamma-\lambda}} \qquad \textbf{(A-5)}$$

which is independent of the value of r. The debtor will borrow to repay up until the point at which $W_B = W_D$. This can be re-arranged to

$$(1+r)(1+\rho)k_1 \left(\frac{\rho}{\gamma}\right)^{\frac{\gamma}{1-\lambda-\gamma}} \left(\frac{1}{1-\gamma-\lambda}\right) \lambda^{\frac{1-\lambda-\gamma}{\lambda}} = \left(\frac{1}{\phi - \hat{\alpha}(1+\rho)k_1}\right)^{\frac{\lambda}{1-\lambda-\gamma}} - (1-\pi)^{\frac{1}{1-\gamma-\lambda}} \left[\frac{1}{\phi - \hat{\alpha}k_1}\right]^{\frac{\lambda}{1-\lambda-\gamma}} \qquad \textbf{(A-6)}$$

Although it is a complicated equality, for given exogenous parameters, it maps the first-period interest rate on the left to a default value of α on the right. Since α is uniformly distributed over [0, 1], the trigger value of α, $\hat{\alpha}$, is also the probability of default. Therefore to ensure that they receive an expected return equal to the risk-free rate, creditors chose $\hat{r}$ such that $\hat{r}.(1-\hat{\alpha}(\hat{r})) = \rho$.

Chart 6: Determining the first-period interest rate



Note that $r.(1-\alpha(r))=0$ at two points; when $r=0$ and when r is sufficiently large that $\alpha(r)=1$, ie the interest rate is so high that the debtor can never repay. Therefore, $r.(1-\alpha(r))$ will equal ρ at two values of α.[25] One intersection will occur at a low rate of interest with a low rate of default and another at a higher interest rate and a high probability of default as illustrated in Chart 6. The higher rate is stable, the lower rate unstable.

(25) Obviously if ρ is very high, it need never intersect at all.

Appendix B: How the probability of default falls with the involvement of the IMF

Over the region in which the debtor borrows from the IMF, it maximises equation **(11)** with respect to effort. This yields

$$E^*_{B,IMF} = \left\{ \frac{\lambda \left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\gamma}}}{\phi - \alpha(1+\bar{\rho})k_1} \right\}^{\frac{1-\gamma}{1-\lambda-\gamma}} \qquad \textbf{(B-1)}$$

Note that ρ in the numerator remains the same because this reflects borrowing for second-period capital stock rather than emergency finance. As a result,

$$W_{B,IMF} = \left(\frac{\lambda}{\phi - \alpha(1+\bar{\rho})k_1}\right)^{\frac{\lambda}{1-\lambda-\gamma}} \left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\lambda-\gamma}} (1-\gamma-\lambda) - (1+r)(1+\bar{\rho})k_1 \qquad \textbf{(B-2)}$$

Setting $W_{B,IMF} = W_{D},_{IMF}$ yields

$$(1+r)(1+\bar{\rho})k_1 \left(\frac{\rho}{\gamma}\right)^{\frac{\gamma}{1-\lambda-\gamma}} \left(\frac{1}{1-\gamma-\lambda}\right) \lambda^{\frac{1-\lambda-\gamma}{\lambda}} = \left(\frac{1}{\phi - \hat{\alpha}_{IMF}(1+\bar{\rho})k_1}\right)^{\frac{\lambda}{1-\lambda-\gamma}} - (1-\pi)^{\frac{1}{1-\gamma-\lambda}} \left[\frac{1}{\phi - \hat{\alpha}_{IMF}k_1}\right]^{\frac{\lambda}{1-\lambda-\gamma}} \qquad \textbf{(B-3)}$$

It is clear, given the parameter restrictions and for a fixed value of r, that $\bar{\rho} < \rho$, lowers the left-hand side. On the other hand, $\bar{\rho} < \rho$, raises the right-hand side.[26] The equilibrating mechanism is a fall in α. Consider first a fall in α for a given value of r. The derivative of the right-hand side with respect to $\hat{\alpha}_{IMF}$ can be written as

$$\frac{(1+\bar{\rho})}{\phi - \hat{\alpha}_{IMF}(1+\bar{\rho})k_1} \left(\frac{k_1\lambda}{1-\lambda-\gamma}\right) \left\{ \left[\frac{1}{\phi - \hat{\alpha}_{IMF}(1+\bar{\rho})k_1}\right]^{\frac{\lambda}{1-\lambda-\gamma}} - (1-\pi)^{\frac{1}{1-\gamma-\lambda}} \left(\frac{1}{\phi - \hat{\alpha}_{IMF}k_1}\right)^{\frac{\lambda}{1-\lambda-\gamma}} \right\}$$
$$+ \frac{\phi\bar{\rho}}{\left(\phi - \hat{\alpha}_{IMF}k_1\right)\left(\phi - \hat{\alpha}_{IMF}(1+\bar{\rho})k_1\right)} \left(\frac{k_1\lambda}{1-\lambda-\gamma}\right) (1-\pi)^{\frac{1}{1-\gamma-\lambda}} \left(\frac{1}{\phi - \hat{\alpha}_{IMF}k_1}\right)^{\frac{\lambda}{1-\lambda-\gamma}} \qquad \textbf{(B-4)}$$

We know from the parameterisation restrictions that the left-hand side of equation **(B-3)** is strictly positive, so, therefore, is the right-hand side. One can see that equation **(B-4)** is positive because the right-hand side of equation **(B-3)** is positive. Therefore the derivative of the right-hand side of equation **(B-3)** with respect to $\hat{\alpha}_{IMF}$ is positive. Since we are trying to lower the right-hand side to balance the effect of $\bar{\rho} < \rho$, $\hat{\alpha}_{IMF}$ needs to fall for a given value of r. But a fall in $\hat{\alpha}_{IMF}$ for a given value of r violates equation **(10)**. Intuitively, a fall in the probability of default for a given rate of interest will give a return greater than the rate of time preference. So r will need to fall. But

(26) The derivative of the right-hand side with respect to $\hat{\rho}$ is $\frac{\lambda}{1-\lambda-\gamma}\alpha k_1 \left[\frac{1}{\phi-\alpha(1+\hat{\rho})k_1}\right]^{\frac{1-\gamma}{1-\lambda-\gamma}} > 0$.

this will lower the left-hand side of equation **(B-3)** even further, reinforcing that the equilibrium value of $\hat{\alpha}$, $\hat{\alpha}_{IMF}$ will be lower in the presence of the IMF than without.

Appendix C: Debtor effort is lower

The effort levels chosen over the range in which the debtor borrows with and without the IMF are given by equations **(B-1)** and **(A-2)** respectively. Subtracting one from the other yields

$$E_B^* - E_{B,IMF}^* = \left[\lambda^{\frac{1-\gamma}{1-\gamma-\lambda}}\left(\frac{\gamma}{\rho}\right)^{\frac{\gamma}{1-\gamma-\lambda}}\right]\left[\left(\frac{1}{\phi-\alpha(1+\rho)k_1}\right)^{\frac{1-\gamma}{1-\lambda-\gamma}} - \left(\frac{1}{\phi-\alpha(1+\bar{\rho})k_1}\right)^{\frac{1-\gamma}{1-\lambda-\gamma}}\right] \quad \textbf{(C-1)}$$

Provided $\phi - \alpha(1+\bar{\rho})k_1 \geq 1$, which is a trivial extension of the requirement noted above that $\phi - \alpha(1+\bar{\rho})k_1 \geq 0$, and recalling that $\frac{1-\gamma}{1-\lambda-\gamma} > 1$, it follows that $E_B^* > E_{B,IMF}^*$.

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