Optimal IMF Policy with Private Capital Flows

Suman S. Basu*
IMF Research Department

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This paper characterizes optimal IMF policy in an environment with moral hazard followed by adverse selection. In our framework, government actions to improve domestic productivity are not always effective, and the government learns of the success of its actions before foreign investors. Without the IMF, it is not possible for foreign investors to discern the quality of the domestic production sector. There only exists a pooling equilibrium ex post, which leads to low government effort ex ante. Optimal IMF intervention is the solution to a mechanism design problem in the presence of imperfectly informed competitive markets. Optimal IMF policy is structured so as to reveal the government’s private information to foreign investors in a separating equilibrium. Government effort ex ante is high. Countries with weak fundamentals ex post accept IMF transfers and face high interest rates on private capital markets. Countries with strong fundamentals make contributions to the IMF and receive low interest rates from foreign investors.

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1 Introduction

What is the relationship between IMF intervention and country moral hazard? Governments can take actions that reduce the probability of adverse macroeconomic outcomes, but these actions are costly and difficult to observe. If governments know that IMF support is available in the event of macroeconomic crises, they may exert suboptimal effort ex ante to avoid such outcomes. Therefore, IMF policies may induce moral hazard, and this has been a reason for much criticism of the institution.

This paper analyzes optimal IMF policy in an environment with moral hazard followed by adverse selection. Country welfare is determined by both IMF transfers and private capital inflows. In particular, we present a framework where IMF transfers to the worst performing countries ex post actually ameliorates the moral hazard problem ex ante. In the baseline model, government actions to improve the productivity of domestic firms are not always effective, and the government learns of the success of its actions before foreign investors. Without the IMF, it is not possible for foreign investors to discern the quality of the domestic production sector. Therefore, there only exists a pooling equilibrium ex post, which leads to low effort ex ante because the returns to good macroeconomic performance are low.

Now we introduce the IMF. The IMF can structure its crisis intervention policy so as to reveal the government’s private information to foreign investors in a separating equilibrium. The IMF provides limited transfers to countries with poor domestic productivity ex post. These countries face high interest rates on international capital markets. Countries which do not accept transfers are identified as having strong fundamentals and are rewarded with low interest rates on international capital markets. The key result is that IMF transfers to low productivity countries ex post improve the consumption of high productivity countries. The difference between ex post consumption in the high and low productivity states increases, which increases government effort ex ante.

Optimal IMF policy is the solution to a mechanism design problem in the presence of imperfectly informed competitive markets. We allow the IMF to implement redistributive transfers from high to low productivity countries (or vice versa) ex post, subject to both its budget constraint and to the rational expectations condition that foreign investors set prices according to the information revealed in equilibrium. The optimal scheme for the mechanism designer in this context must take into account that the zero profits condition for foreign investors changes as a result of the scheme. Foreign interest rates respond to the separation decision by country governments. The incentives for the government to self-select in a separating equilibrium ex post depend on a combination of the IMF’s policies and the contracts offered by foreign investors. This is central to the result obtained. Countries with weak fundamentals ex post choose to receive high IMF transfers and low private capital inflows, while countries with strong fundamentals choose to refuse IMF transfers because this refusal is associated with high private capital inflows.

So the IMF designs the optimal scheme taking the market structure as given. The specific tool available
to the mechanism designer is a system of redistributive transfers ex post. Can this be implemented by competitive markets instead? Yes. If the government can purchase insurance at actuarially fair rates before its effort decision, then it will choose a level of (partial) insurance that corresponds exactly to the IMF scheme. However, if such contracts are only available after the government’s type is revealed, the government will not purchase the ex ante optimal level of insurance. In this case, the IMF should commit ex ante to a schedule of redistributive transfers.

Finally, we generalize the result of our baseline model that ex ante insurance is welfare-improving because it expands the set of feasible separating equilibria. We consider an amended version of the model where foreign investors have sufficient tools to separate countries ex post even in the absence of IMF intervention, but such separation is associated with output distortions for the country with strong fundamentals. Ex ante insurance still results in an increase in welfare in this framework. In particular, with ex ante insurance it is no longer necessary for output to be distorted ex post for any country in a separating equilibrium. However, we show that it is still optimal to distort output ex post – for moral hazard reasons. The output distortion allows the mechanism designer to increase the gap in consumption between high and low productivity countries ex post, which increases government effort ex ante.

This paper contributes to the literature on IMF intervention and moral hazard. Some empirical evidence on IMF-induced creditor and debtor moral hazard is summarized in Dreher (2004). On the theoretical side, Jeanne and Zettelmeyer (2004) argue that if the IMF provides loans at an actuarially fair interest rate, then it cannot induce moral hazard because any changes in government effort are efficient. The catalytic finance literature proposes a separate channel by which IMF loans may affect country effort (Morris and Shin 2006, Corsetti, Guimarães and Roubini 2006). If IMF intervention reduces the risk of inefficient liquidation of projects ex post, then this sometimes induces governments to exert higher effort ex ante. IMF lending would be associated with private capital inflows. However, the empirical evidence for such a catalytic effect of IMF lending is far from conclusive (Bird and Rowlands 2002, Edwards 2006).

Our characterization of the IMF assumes that all private information is in the possession of the government, and that both the IMF and foreign investors are equally uninformed. The IMF uses its ability to make redistributive transfers, in order to reveal the information of the government to foreign investors. This is a stark characterization of the role of the IMF, and is one of many possible modeling approaches. Jeanne and Zettelmeyer (2004) model the IMF as an institution that can extract higher payments from the country (as a fraction of output) than private creditors. Marchesi and Thomas (1999) examine the role of conditionality in IMF lending. Arregui (2009) models the IMF as having an imperfect monitoring technology that it can use to certify the quality of a country.

The results in this paper have implications for empirical work. We identify an environment such that it is optimal for the IMF to follow a scheme where official and private financing are negatively correlated, and
this correlation is crucial in terms of providing incentives to governments to reveal their type. Therefore, empirical findings affirming this correlation are not evidence for poor IMF policy. Instead, the model predicts that such a scheme should have a strictly limited size of transfers ex post, in order to minimize moral hazard concerns. Furthermore, the model predicts that the full benefits of IMF intervention cannot be discerned by looking solely at IMF program countries. IMF transfers to low productivity countries improves outcomes for high productivity countries, because it enables the latter to reveal their type in equilibrium. Countries that refuse IMF transfers benefit from the existence of the IMF, because the refusal reveals their high productivity and induces high private capital inflows.

This paper proceeds as follows. Section 2 summarizes the baseline model in the absence of the IMF. Section 3 introduces the IMF and analyzes the mechanism design problem described above. Section 4 generalizes our result that ex ante insurance is welfare-improving, in an environment where foreign investors have sufficient tools to separate countries ex post even in the absence of IMF intervention. Section 5 concludes.

2 Model Without IMF

2.1 The Environment

The model has 3 periods. There are four categories of agents: consumers, firms, foreign investors and the government. Each category of agents exists in unit measure, except the government.

Model Timeline The order of events and actions is detailed in the figure below.

<table>
<thead>
<tr>
<th>Period 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government chooses effort level ( a \in [0, 1] ).</td>
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</table>

<table>
<thead>
<tr>
<th>Period 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government learns its type ( p \in {p_L, p_H} ). It is a high type with probability ( a ).</td>
</tr>
<tr>
<td>Foreign investors offer set of lending contracts ( C ), each contract specifying an interest rate ( R ).</td>
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<td>Domestic firms choose lending contract ( C \in C ) and level of borrowing ( k ).</td>
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<th>Period 3</th>
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<td>Output is realized and repayments made to foreigners. All remaining resources are consumed.</td>
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</table>

The effort level \( a \) chosen by the government in period 1 is not observable to other agents. In period 2, the type \( p \) is revealed only to the government and not to other agents. Foreign investors compete in the provision
of loans to domestic firms. Each lending contract specifies the relationship between a foreign investor and a domestic firm. It specifies only the interest rate \( R \), and the firm can freely choose its borrowing level. Firms select their most preferred choice out of the set of offered lending contracts, and choose their level of borrowing \( k \). They invest borrowed funds in their production technology. In period 3, the output of the firms’ production technology is realized. Repayments are made to foreign investors and all remaining resources are consumed.

**Payoffs for Agents** The representative consumer has expected utility given by the expression

\[
E c - \psi(a),
\]

where \( c \) denotes consumption and \( \psi(a) \) is the cost function for government effort level \( a \in [0, 1] \). \( \psi(a) \) is twice differentiable and satisfies: \( \psi'(a) \geq 0, \psi''(a) > 0 \), with \( \lim_{a \to 1} \psi'(a) = \infty \).

The government is benevolent and maximizes the utility of the representative consumer. It chooses \( a \) in period 1 so as to maximize the above expression for expected utility.

Each domestic firm has access to a project in period 2, in which it invests \( k \) units of capital borrowed from abroad. With probability \( p \), the project is successful and yields \( f(k) \) units of output in period 3. The firm repays \( R \) to foreign investors. With probability \( 1 - p \), the project fails and output in period 3 is zero. No payments to foreign creditors can be enforced in this case. \( f(k) \) is twice differentiable and satisfies: \( f'(k) > 0, f''(k) < 0 \) with \( \lim_{k \to 0} f'(k) = \infty \) and \( \lim_{k \to \infty} f'(k) = 0 \). Given \( R \), each firm chooses its capital level to maximize expected profits:

\[
\max_k [f(k) - Rk] \implies f'(k) = R.
\]

By inspection, the firm selects the lending contract \( C \in \mathbb{C} \) that offers the lowest interest rate \( R \).

The probability of project success is independent and identical across firms, so there is no aggregate uncertainty. Total consumption for an economy of type \( p \) is equal to \( p [f(k) - Rk] \). We specify \( p_H > p_L \). The type \( p \) of the country determines the proportion of projects that are successful in period 3.

Foreign investors offer the set of lending contracts \( \mathbb{C} \), each contract specifying the interest rate \( R \). They can lend capital elsewhere at riskless rate \( r \). The zero profits condition for foreign investors can be written:

\[
p^e R - r = 0 \iff R = \frac{r}{p^e},
\]

where \( p^e \) denotes foreign investors’ beliefs about \( p \).

### 2.2 First Best Benchmark

\( a \) and \( p \) are observable to all agents. Solve the model by backward induction.
Consider the actions of agents in period 2. For the high type, foreign investors offer contracts with interest rate \( R_H = \frac{r}{p_H} \), which is low because \( p_H \) is high. Domestic firms accept these contracts and choose \( k_H \) such that \( f'(k_H) = R_H \). Total realized consumption in the economy in period 3 is equal to \( p_H [f(k_H) - R_H k_H] \).

For the low type country, foreign investors offer contracts with interest rate \( R_L = \frac{r}{p_L} \), which is high because \( p_L \) is low. In response, domestic firms choose \( k_L \) to satisfy \( f'(k_L) = R_L \). Total realized consumption in period 3 is \( p_L [f(k_L) - R_L k_L] \). Denote \( F_H = [f(k_H) - R_H k_H] \) and \( F_L = [f(k_L) - R_L k_L] \).

2.3 Imperfect Information Case

Again, solve the model by backward induction. Domestic firms in both high and low type countries choose the lending contract that offers the lowest interest rate \( R \). It follows that foreign investors cannot offer contracts that induce the government to reveal its type.

Proposition 1 There exists no separating equilibrium.

Proposition 2 There exists at least one pooling equilibrium. In any pooling equilibrium, effort level \( a^* < a^{FB} \).

In a pooling equilibrium, foreign investors offer lending contracts with interest rate \( R_P \):

\[
R_P = \frac{r}{a^* p_H + (1 - a^*) p_L},
\]
given their beliefs of the government effort level \( a^* \). Domestic firms choose their capital level \( k_P \) such that \( f'(k_P) = R_P \). Total consumption for an economy of type \( p \) is equal to \( p F_P \), where we denote \( F_P = [f(k_P) - R_P k_P] \). In period 1, the government chooses effort level \( a \) to solve:

\[
\max_a \{a \cdot p_H F_P + (1 - a) \cdot p_L F_P - \psi(a)\} = \max_a \{p_L F_P + a \cdot z^{FB} - \psi(a)\},
\]

where \( z^{FB} = [p_H F_H - p_L F_L] \). The solution to this maximization problem is effort level \( a^{FB} \).

The beliefs of foreign investors are formed via rational expectations. Therefore, the pooling equilibrium is a fixed point for the equations (1) and (2), such that \( a^c = a^* \). It is straightforward to show that such a
fixed point exists, and that \( a^* \in (0, 1) \). It follows that \( R_L > R_P > R_H \) and \( F_L < F_P < F_H \). Furthermore,

\[
\]

\[\iff z^* < z^{FB}.
\]

Therefore, \( a^* < a^{FB} \). Government effort in the pooling equilibrium is below the first best level.

**Proposition 3** The country is worse off ex ante with imperfect information than with perfect observability.

In the pooling equilibrium, capital is misallocated in period 2. The capital level in the high type economy is lower than the efficient level, and the capital level in the low type economy is higher than the efficient level. Since capital misallocation reduces the difference in ex post consumption for high and low type countries, the government finds it optimal to exert less effort than the first best level.

## 3 Model With IMF

### 3.1 The Amended Environment

We model the IMF as an institution that commits to a system of redistributive transfers between countries. In period 2, it offers a menu of redistributive transfers \( T \) to the country. The government then selects its most preferred level of transfers \( T \in \mathbb{T} \). The menu of transfers is pre-announced in period 1 (before the government exerts effort \( a \)), and promised transfers are delivered to the country after output is realized in period 3. The amended timeline is presented in the figure below.

**Figure 2: Timeline with IMF**

<table>
<thead>
<tr>
<th>Period 1</th>
</tr>
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<tbody>
<tr>
<td>IMF announces redistribution scheme that it will offer in period 2.</td>
</tr>
<tr>
<td>Government chooses effort level ( a \in [0, 1] ).</td>
</tr>
</tbody>
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<td>Government learns its type ( p \in {p_L, p_H} ). It is a high type with probability ( a ).</td>
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<tr>
<td>IMF offers menu of redistributive transfers ( T ).</td>
</tr>
<tr>
<td>Government chooses IMF transfer level ( T \in \mathbb{T} ).</td>
</tr>
<tr>
<td>Foreign investors offer set of lending contracts ( C(T) ), each contract specifying an interest rate ( R(T) ).</td>
</tr>
<tr>
<td>Domestic firms choose lending contract ( C \in \mathbb{C}(T) ) and level of borrowing ( k ).</td>
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<td>Output is realized and repayments made to foreigners. IMF transfers are made.</td>
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<td>All remaining resources are consumed.</td>
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The IMF offers the menu of redistributive transfers $T$ to a continuum of ex ante identical countries with independent realizations of $p$. Any transfers made to a country by the IMF must be financed by contributions from other countries. In other words, the IMF’s budget constraint states that the aggregate level of net transfers is zero. This is equivalent to the condition that in period 1, the expected level of transfers to any particular country is zero:

$$E_T = 0.$$  

Foreign investors first observe the government’s choice of the transfer level from the IMF, and then compete in the provision of loans to domestic firms. The set of contracts offered by foreign investors can be conditioned on the transfer level chosen: $C(T) = \{R(T)\}$.

As before, the government is benevolent and maximizes the utility of the representative consumer. It chooses $a$ in period 1 so as to maximize ex ante expected utility. In period 2, the effort cost $\psi(a)$ is a sunk cost and the government knows its true type $p$. It chooses the transfer level $T \in T$ so as to maximize consumption in period 3. It recognizes that its choice can affect the set of contracts $C(T)$ offered by foreign investors to domestic firms.

**Equilibrium Definition** A perfect Bayesian equilibrium for this economy is a set of strategies $\{a, T(p), C(T), k(C)\}$ and a menu of transfers $T$ such that:

1. Government sets $a$ in period 1 to maximize expected utility.
   Government chooses $T \in T$ in period 2 to maximize consumption $c$ in period 3, given private information $p$ and the expected set of contracts $C(T)$.

2. Foreign investors observe $T$ and offer set of contracts $C(T) = \{R(T)\}$ that maximize expected profits given their beliefs $p^e = \mathbb{E}[p|T]$, updated via Bayes’ Rule.

3. Domestic firms choose the contract $C \in C(T)$ and capital level $k$ that maximize expected profits.

4. IMF satisfies its budget constraint. In period 1: $E_T = 0$.

The last condition is needed to ensure that the perfect Bayesian equilibrium is feasible.

**3.2 Mechanism Design Problem**

Given any system of redistributive transfers, there may exist equilibria as defined above. The different equilibria correspond to different patterns of private capital inflows in period 2, and different levels of government effort in period 1. The IMF takes into account that its policies affect the revelation of information in equilibrium, and therefore (via rational expectations) the zero profit conditions of foreign investors. It
also takes into account the effect on government effort. The IMF is benevolent and designs the redistribution scheme to maximize ex ante expected utility of the country.

Therefore, optimal IMF policy is the solution to a mechanism design problem in the presence of imperfectly informed competitive markets. Apply the Revelation Principle to derive the following result. We define $F(p)$ to be the net output of each domestic firm in a country of type $p$ in period 2. $T(p)$ is the transfer received by the country from the IMF.

**Proposition 4** Optimal IMF policy is the solution to the following mechanism design problem:

$$\max_{z,T(p_H),T(p_L)} W = \{ [p_L F(p_L) + T(p_L)] + a \cdot z - \psi(a) \}$$

subject to

$$z = [p_H F(p_H) + T(p_H)] - [p_L F(p_L) + T(p_L)]$$

$$a = (\psi')^{-1} [z]$$

(3)

$$a \cdot T(p_H) + (1 - a) \cdot T(p_L) = 0$$

(4)

$$p_H F(p_H) + T(p_H) \geq p_H F(p_L) + T(p_L)$$

(5)

$$p_L F(p_L) + T(p_L) \geq p_L F(p_H) + T(p_H)$$

(6)

**Pooling equilibria:**

$$F(p_H) = F(p_L) = F_P.$$  

(7)

**Separating equilibria:**

$$F(p_H) = F_H, \ F(p_L) = F_L.$$  

(8)

We have rewritten the objective function in terms of $z$, the difference in ex post consumption between the high type and low type countries. Constraint (3) relates how the government’s optimal effort level is related to $z$. The IMF’s budget constraint is given by equation (4). Equations (5) and (6) are the incentive compatibility constraints for the high and low type governments in period 2. No participation constraint for the country is given. This reflects the assumption that the government must choose out of the menu of transfers offered by the IMF in period 2. Equations (7) and (8) capture the additional constraints imposed on the mechanism designer owing to the presence of competitive markets that are imperfectly informed ex ante. We discuss these next.

**Proposition 5** The set of pooling equilibria the IMF can achieve is the same as in the model without the IMF. The government chooses effort level $a^*$. 

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Pooling equilibria are achieved when foreign investors remained uninformed about the type $p$ of the country when they offer lending contracts. Therefore, they offer the same interest rate $R$ to domestic firms from all countries. The net output of each firm in both types of country is $F_p$. The incentive compatibility constraints for the government in period 2 immediately imply that in a pooling equilibrium, $T(p_H)$ and $T(p_L)$ are equal. Substituting into the IMF’s budget constraint, we obtain:

$$T(p_H) = T(p_L) = 0.$$ 

The proposition above follows by inspection.

Figure 3 illustrates the pooling equilibrium in $(T, F)$ space. The indifference curve of a country of type $p$ is a line with slope equal to $-\frac{1}{F_p}$. $IC_H$ and $IC_L$ denote the indifference curves of high and low type countries respectively. The point $A$ is located at $(0, F_P)$.

![Figure 3: Pooling Equilibrium](image)

Next, we turn to the set of separating equilibria that the IMF can induce.

**Proposition 6** The IMF can induce a continuum of separating equilibria, each corresponding to a particular level of government effort in period 1. The feasible set of effort levels can be described:

$$a \in [\underline{a}, \overline{a}],$$

where we define $\underline{a} = (\psi')^{-1} \{[p_H - p_L] F_L \}$ and $\overline{a} = (\psi')^{-1} \{[p_H - p_L] F_H \}$.

In a separating equilibrium, the type $p$ of the country is revealed in equilibrium. Foreign investors offer lending contracts at interest rate $R_H$ to firms in the high type country and interest rate $R_L$ to firms in low
type country. This explains the expressions for each firm’s net output given in constraint (8). Substituting these expressions into the incentive compatibility constraints and rearranging, we obtain:

\[ [p_H - p_L] F_L \leq z \leq [p_H - p_L] F_H. \]  

(9)

The lower bound for \( z \) is achieved when the incentive compatibility constraint for the high type is binding, and the upper bound is achieved when the incentive compatibility constraint for the low type is binding. These correspond, via equation (3), to a restriction on the set of feasible government effort levels as defined above:

\[ a \leq \alpha \leq \overline{\alpha}. \]

There is a continuum of separating equilibria, each corresponding to a different menu of transfers \( T = \{T(p_H), T(p_L)\} \) offered by the IMF. In equilibrium, \( T(p_L) > 0 \) and \( T(p_H) = -\left(\frac{1-a}{a}\right)T(p_L) < 0 \). Consider the contracts offered by foreign investors in a separating equilibrium. Foreign investors condition the set of contracts offered to firms on the transfer level chosen by the government. If the government chooses transfer level \( T(p_H) \), it is identified as a high type country. Foreign investors offer contracts at interest rate \( R_H \), and net output of each domestic firm is \( F_H \). If the government chooses transfer level \( T(p_L) \), it is identified as a low type country. The interest rate offered is \( R_L \), which means that net output of each domestic firm is \( F_L \).

Figures 4 and 5 illustrate the separating equilibria corresponding to effort levels \( \underline{\alpha} \) and \( \overline{\alpha} \) respectively. Effort level \( \underline{\alpha} \) is achieved when the incentive compatibility constraint for the high type is binding. At the other extreme, effort level \( \overline{\alpha} \) is achieved when the incentive compatibility constraint for the low type is binding. For each of the figures, \( A = (T(p_H), F_H) \) and \( B = (T(p_L), F_L) \).

![Figure 4: Effort level \( \underline{\alpha} \)](image)

![Figure 5: Effort level \( \overline{\alpha} \)](image)

This completes the description of the feasible set of perfect Bayesian equilibria. Which of these equilibria
does the IMF choose? The most preferred outcome within the set of pooling equilibria (if there exists more than one) is the equilibrium with the lowest offered interest rate $R_p$, and hence the highest level of net output $F_p$ per firm. Now consider the set of separating equilibria. Notice that the objective function of the IMF can be written:

$$a \cdot [p_H F_H + T(p_H)] + (1-a) \cdot [p_L F_L + T(p_L)] - \psi(a)$$

which, given the IMF’s budget constraint, reduces to

$$a \cdot p_H F_H + (1-a) \cdot p_L F_L - \psi(a).$$

This is the same objective function that the government faces in the first best case, and the global maximum of this expression is attained for effort level $a^{FB}$. It can be shown that the maximum level of $z$ that the IMF can achieve is below $z^{FB}$. It immediately follows that $\bar{a} < a^{FB}$. The separating equilibrium that maximizes expected utility in period 1 corresponds to the highest effort level possible, which is $\bar{a}$.

**Proposition 7** The optimal allocation is a separating equilibrium with effort level $\bar{a}$, where $a^* < \bar{a} < a^{FB}$. The menu of redistributive transfers $T = \{T(p_H), T(p_L)\}$ offered by the IMF satisfies:

$$T(p_L) = \bar{a} \cdot p_L [F_H - F_L]$$

$$T(p_H) = - \left( \frac{1 - \bar{a}}{\bar{a}} \right) \cdot T(p_L).$$

The incentive compatibility constraint for the low type country is binding.

Optimal IMF policy takes into account that both foreign investors and the government respond to the redistributive scheme $T = \{T(p_H), T(p_L)\}$ offered. In a separating equilibrium, the interest rates offered by foreign investors responds to the government’s choice of $T \in \mathbb{T}$, because this choice reveals the government’s type $p$. Now consider the government’s optimal decision. The incentives for the government to self-select in a separating equilibrium in period 2 depends on a combination of the IMF’s policies and the government’s expectations of contracts offered by foreign investors $\mathbb{C}(T)$ (in equilibrium, the expectations of the government regarding $\mathbb{C}(T)$ are fulfilled). This is central to the result. Countries with weak fundamentals in period 2 choose to receive high levels of IMF transfers. As a consequence, they face high interest rates on international capital markets, which leads to low private capital inflows. Countries with strong fundamentals in period 2 value access to international capital markets more than low type countries. They choose to make contributions to the IMF and thereby receive low interest rates on international capital markets. They enjoy high levels of private capital inflows.

It seems counterintuitive that at the optimum, the IMF should redistribute resources towards countries with adverse realizations of economic fundamentals. However, notice that such redistribution is implemented not to decrease the difference in ex post consumption between high and low type countries, but to increase
it. The IMF induces a separating equilibrium and thereby reveals information about the government’s type to foreign investors. This generates capital reallocation on international capital markets from low type to high type countries in period 2. In turn, this increases the optimal level of effort by the government in period 1.

By inducing a separating equilibrium, the IMF solves the capital misallocation problem in period 2 that is associated with a pooling equilibrium. Within the set of separating equilibria, the IMF chooses the lowest level of redistributive transfers possible, so as to maximize government effort in period 1. The highest level of effort that can be sustained is $\pi$. If redistributive transfers are reduced further with the intention of generating a higher effort level, the difference between ex post consumption of high type and low type countries would be too low to be consistent with a separating equilibrium. In period 2, the low type government would mimic the high type.

It can be proved that $a^* < \pi < a^{FB}$, which establishes the above result. The upper limit $\pi$ on the set of feasible effort levels yields the following corollary.

**Proposition 8** The country is still worse off ex ante than with perfect observability.

### 3.3 Implementation using Ex Ante Insurance Contracts

Can the optimal IMF allocation be implemented using competitive markets? Yes. Suppose that before the government chooses effort level $a$ in period 1, it is able to purchase insurance contracts at actuarially fair rates. An insurance contract specifies payoffs $X(p_H)$ and $X(p_L)$ for high and low type countries respectively. Define $X = \{X(p_H), X(p_L)\}$. After learning its type in period 2, the government reports its type to insurance providers and claims its payoff $X \in X$. Foreign investors observe the government’s report and then offer lending contracts $C(X)$ to domestic firms. The set of contracts offered can be conditioned on the government’s report. The payoffs from the insurance contract are delivered to the government in period 3, after output is realized.

The zero profits condition of competitive insurance providers is given by the expression:

$$a \cdot X(p_H) + (1 - a) \cdot X(p_L) = 0. \tag{10}$$

Equation (10) and the amended versions of the incentive compatibility constraints (5) and (6) together indicate that any allocation achievable by the IMF is also achievable using feasible insurance contracts. Given these constraints, it can easily be verified that the insurance contract that maximizes expected utility in period 1 satisfies:

$$X(p_H) = T(p_H), \quad X(p_L) = T(p_L),$$

where $T(p_H)$ and $T(p_L)$ are the redistributive transfers offered by the IMF at its optimal allocation. The government selects this contract.
**Proposition 9** The optimal IMF allocation can be implemented via ex ante insurance contracts.

It is worth drawing attention here to two features of the result above. Firstly, the insurance contracts are feasible despite the fact that the type of the country \( p \) is not observable to the insurance providers in period 2. The government is induced to truthfully reveal its type in period 2, given the insurance contracts \( X = \{X(p_H), X(p_L)\} \) that it has signed in period 1 and the set of contracts offered by foreign investors as a function of the government’s report, \( C(X) \). Secondly, ex ante insurance is desirable for the country even though the representative consumer is risk neutral. The optimal scheme involves partial insurance, in order to address the adverse selection problem in period 2.

The role of ex ante insurance contracts is explored further in Section 4.

### 3.4 Implementation using Government Debt

An alternative implementation of the IMF optimum can be achieved via issuance of government debt with type-contingent interest rates. Before the government chooses effort level \( a \) in period 1, it can issue debt level \( D \). The debt contract promises repayments \( B(p_H) \) and \( B(p_L) \) for high and low type countries respectively. Define \( B = \{B(p_H), B(p_L)\} \). The government announces its repayment choice after it learns its type in period 2, and delivers the repayments in period 3 after output is realized. Foreign investors observe the government’s announcement and then offer domestic firms the set of contracts \( C(B) \).

Let the riskless interest rate between periods 1 and 2 be zero. The government’s debt issuance problem in period 1 is isomorphic to the IMF’s mechanism design problem, with \( [D - B(p_H)] \) replacing \( T(p_H) \) and \( [D - B(p_L)] \) replacing \( T(p_L) \).

**Proposition 10** The optimal IMF allocation can be implemented via government debt contracts with type-contingent interest rates.

At the optimum, the government decides to pay a higher interest rate on its debt after a good realization of economic fundamentals, and a lower interest rate after the realization of adverse economic conditions. It is optimal for the government to reveal its type because the decision to make high debt repayments is associated with higher private capital inflows. Countries that decide to make low debt repayments ex post face high interest rates on international capital markets.

### 3.5 Timing of Contract Offers and Feasible Effort Levels

Now consider a version of the model with the second period modified as in Figure 6.
Immediately after the IMF offers the menu of transfers $T$, foreign investors offer a set of lending contracts $\{C(T)\}$. Each element of this set specifies the set of lending contracts $C(T)$ that are available to domestic firms if (later in period 2) the government chooses the transfer level $T \in T$. The government observes $T$ and $\{C(T)\}$, and then makes its choice of the transfer level. The equilibrium definition is amended appropriately to take account of the change in timing.

A perfect Bayesian Equilibrium for this economy is a set of strategies $\{a, T(p), \{C(T)\}, k(C)\}$ and a menu of transfers $T$ such that:

1. Government sets $a$ in period 1 to maximize expected utility.

   Government chooses $T \in T$ in period 2 to maximize consumption $c$ in period 3, given private information $p$ and the set of contracts $\{C(T)\}$.

2. Foreign investors offer the set of contracts $\{C(T)\}$ that maximize expected profits, given any transfer level $T$ and their beliefs as a function of $T$, $p^e = E[p|T]$. Beliefs are updated using Bayes’ rule.

3. Domestic firms choose the contract $C \in C(T)$ and capital level $k$ that maximize expected profits.

4. IMF satisfies its budget constraint. In period 1: $\mathbb{E}T = 0$.

What is the effect of this change of timing on the set of feasible equilibria? The set of pooling equilibria achievable by the IMF is unaffected. However, the set of feasible separating equilibria is reduced. Figure 7 presents an example of an allocation which was feasible under the previous timing but not under this one. Consider the timeline in figure 2. If the government expects the set of contracts $\{C[T(p_H)] = \{R_H\}, C[T(p_L)] = \{R_L\}\}$, then it decides to reveal its type as shown before. Given this separation decision, foreign investors find it optimal to offer precisely these contracts. In equilibrium, $A = (T(p_H), F_H)$ and $B = (T(p_L), F_L)$. Now consider the timeline in figure 6. Suppose that the same contracts are offered in period 2. It is then profitable for foreign investors to offer the contract corresponding to point $D$. This is a pooling contract conditional upon acceptance of IMF transfers $T(p_L)$. The amended set of contracts is $\{C[T(p_H)] = \{R_H\}, C[T(p_L)] = \{R_L, R_L - \varepsilon\}\}$, for some $\varepsilon > 0$. Given this set of contracts, both high
and low type governments choose IMF transfers of $T(p_L)$ in period 2, and firms choose the contract offering interest rate $R_L - \varepsilon$. High and low type countries prefer point $D$. The initial allocation is not an equilibrium.

For the model timeline provided in figure 2, points $A$ and $B$ above correspond to the separating equilibrium with the highest level of redistributive transfers. This configuration induces the lowest level of government effort $a$ in period 1. A reduction in the level of redistribution promised by the IMF increases the ex post consumption of the high type country, which makes it more difficult to tempt it to select a pooling contract. However, the reduction in promised redistributive transfers also increases the effort level $a$ in period 1, which reduces $R_P$ (and hence increases $F_P$) in the best feasible pooling equilibria. The latter effect makes it possible to offer a better pooling contract to tempt the high type country. These competing effects yield the following proposition.

**Proposition 11** The modification to the sequence of events in period 2 reduces the set of effort levels consistent with a separating equilibrium. If the feasible set of effort levels is non-empty, it can be described:

$$a \in [a_1, a_2] \cup [a_2, a_3] \cup \ldots \cup [a_{n-1}, a_n],$$

where $a_1 > \underline{a}$ and $a_n \leq \overline{a}$.

The most preferred separating equilibrium is the one that corresponds to the highest level of effort $a_n$.

The modified timing amounts to an additional restriction on the set of contract offers. Given the set of offered contracts, there exists no other contract that, if offered, would both make a positive profit and increase the utility of at least one type of country. This notion of equilibrium is similar to the definition used in Rothschild and Stiglitz (1976). In their framework, the existence of separating equilibria depends upon the relative fractions of high and low types. In our model, the possibility of a deviation using pooling
contracts reduces the feasible set of effort levels. If the feasible set of effort levels is non-empty, the separating equilibrium which induces the highest level of government effort in period 1 is the most preferred. The IMF compares this equilibrium to the pooling equilibrium, and chooses the equilibrium that maximizes expected utility in period 1.

4 Ex Ante Insurance and Separating Equilibria

IMF redistributive transfers can be interpreted as (partial) ex ante insurance, as described in subsection 3.3. In this section we generalize the result that ex ante insurance expands the set of feasible separating equilibria, and thereby improves country welfare. We examine an amended version of the model where foreign investors have sufficient tools to separate countries in period 2 even in the absence of IMF intervention. However, these separating equilibria are necessarily associated with a distortion of output for the high type country. Then we consider optimal policy by the IMF. The possibility of IMF redistributive transfers increases the set of feasible separating equilibria. In particular, the IMF can achieve separation with less distortion of output, and this improves welfare. The optimal allocation still involves some distortion in the output of firms of the high type country. This enables the IMF to increase the difference in ex post consumption between high and low type countries, and this in turn induces higher government effort in period 1.

4.1 Model without IMF

Figure 8 presents the timeline for the model considered in this subsection.

Figure 8: Timeline without IMF

<table>
<thead>
<tr>
<th>Period 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government chooses effort level ( a \in [0, 1] ).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government learns its type ( p \in { p_L, p_H } ). It is a high type with probability ( a ).</td>
</tr>
<tr>
<td>Foreign investors offer set of lending contracts ( { C(\tau) } ).</td>
</tr>
<tr>
<td>Government chooses the tax per lending contract ( \tau ).</td>
</tr>
<tr>
<td>Domestic firms choose lending contract ( C \in C(\tau) ) and level of borrowing ( k ).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output is realized and repayments made to foreigners. All remaining resources are consumed.</td>
</tr>
</tbody>
</table>

In this framework, the government has an additional instrument. It can require that every lending contract from foreign investors to domestic firms in period 2 is associated with a tax payment of \( \tau \) units of
output from foreign investors to the government in period 3. Of course, a requirement of \( \tau < 0 \) corresponds to a subsidy. Foreign investors again compete in the provision of loans to domestic firms, but they can condition the set of contract offers on the government’s taxation decision \( \tau \). Each lending contract specifies an interest rate \( R(\tau) \).

We choose the timing of contract offers described in subsection 3.5, to facilitate comparison with the setup in Rothschild and Stiglitz (1976). The equilibrium definition is amended appropriately from that subsection.

What is the feasible set of contract offers? The zero profits condition for foreign investors can be written:

\[
p^e R k - r k - \tau = 0
\]

\[
\iff \tau = (p^e R - r) k
\]

(11)

where \( p^e \) denotes foreign investors’ beliefs about \( p \) given \( \tau \). Equation (11) determines the level of \( R(\tau) \) consistent with zero profits. Domestic firms select the lending contract \( C \in \mathbb{C}(\tau) \) with the lowest interest rate \( R \). The net output of each domestic firm is given by the expression:

\[
F = f(k) - R k,
\]

(12)

where \( k \) satisfies:

\[
f'(k) = R.
\]

(13)

Equations (11) and (12), together with the restriction (13), describe the locus of the set of lending contracts consistent with zero profits in \((\tau, F)\) space.

For illustrative purposes, let us first characterize the equilibrium in period 2 when all countries are of the same type \( p \). The equilibrium is shown in figure 9. The line \( ZP \) plots the zero profits condition. All contracts to the left of this line are associated with positive profits, and those to the right yield negative profits. The indifference curve of the country is tangent to the zero profits line at point \( A \). This denotes the lending contract with \( \tau = 0 \) and \( R = \frac{\tau}{p} \). The zero profits line is steeper than the indifference curve to the right of this point, and it has lower slope than the indifference curve to the left of it.

Point \( A \) represents the equilibrium allocation. The government chooses the tax payment \( \tau \), which corresponds to the horizontal position of the economy in \((\tau, F)\) space. The choice of lending contracts by domestic firms determines \( F \), and hence the vertical position of the allocation.

Now we return to the model described in the timeline above, with types \( p_H \) and \( p_L \) in period 2.

**Proposition 12** There exists no pooling equilibrium.

**Proposition 13** There may exist a separating equilibrium.

Propositions 12 and 13 are the analogs of the results in Rothschild and Stiglitz (1976). A pooling equilibrium does not exist because the single-crossing property is satisfied by the indifference curves of the
high and low type countries. If a separating equilibrium exists, it takes the form shown in figure 10. The lines $ZP_H$ and $ZP_L$ represent the zero profits conditions for foreign investors lending to firms in the high and low type countries respectively. $ZP_L$ lies everywhere to the left of $ZP_H$. Lending contracts corresponding to points $A = \left( \hat{\tau}(p_H), \hat{F}(p_H) \right)$ and $B = (0, F_L)$ are selected by domestic firms in equilibrium. The incentive compatibility constraint of the low type country is binding, and the net output of domestic firms is distorted for the high type country. The high type country provides a subsidy to foreign investors, who lend to domestic firms at an interest rate lower than the first best interest rate $R_H$. As a result, the net output of domestic firms exceeds $F_H$. Since the subsidy from the country is large enough to ensure that foreign investors satisfy their zero profits condition, the subsidy is welfare-reducing relative to the first best allocation. The ex post consumption of the high type country is lower in the imperfect information equilibrium than in the first best case (represented by point $C = (0, F_H)$).

This separating equilibrium generates a difference in ex post consumption between the high and low type countries, which induces the government to exert effort level $\tilde{a}$ in period 1. This effort level determines the position of the zero profits line for foreign investors who offer pooling contracts, $ZP_P$. For the separating equilibrium described in figure 10 to exist, the line $ZP_P$ must lie everywhere below $IC_H$.

![Figure 9: Zero Profit Line](image1.png) ![Figure 10: Separating Equilibrium](image2.png)

Assume a separating equilibrium exists. Figure 10 illustrates the properties of the equilibrium. The high type country imposes a tax per lending contract of $\hat{\tau}(p_H) < 0$. Each firm faces the interest rate $\hat{R}(p_H) < R_H$ and generates net output $\hat{F}(p_H) > F_H$. As explained above,

$$p_H \hat{F}(p_H) + \hat{\tau}(p_H) < p_H F_H.$$  

The low type country’s allocation is unchanged from the first best level: $\hat{\tau}(p_L) = 0$. Domestic firms face interest rate $R_L$ and produce net output $F_L$. The incentive compatibility constraint for the low type country
is binding:

\[ p_L F_L = p_L \tilde{F}(p_H) + \tilde{\tau}(p_H) . \]

Finally, the effort level \( \tilde{a} \) of the government in period 1 solves the equation:

\[
\max_a \left\{ a \left[ p_H \tilde{F} (p_H) + \tilde{\tau} (p_H) \right] + (1 - a) \cdot p_L F_L - \psi(a) \right\} \\
= \max_a \left\{ p_L F_L + a \cdot \tilde{z} - \psi(a) \right\},
\]

where \( \tilde{z} = [p_H - p_L] \tilde{F}(p_H) \). Notice that since \( \tilde{F}(p_H) > F_H \), this expression also establishes that \( \tilde{a} > \bar{a} \), where \( \bar{a} \) denotes the effort level with optimal IMF intervention in subsection 3.2. However, ex ante expected utility is not necessarily higher under the current setup, since the ex post consumption of the high and low type countries are different from those in the earlier subsection.

### 4.2 Model with IMF

The IMF is introduced into the above framework in the expected manner.

---

**Figure 11: Timeline with IMF**

<table>
<thead>
<tr>
<th>Period 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>• IMF announces redistribution scheme that it will offer in period 2.</td>
</tr>
<tr>
<td>• Government chooses effort level ( a \in [0, 1] ).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Government learns its type ( p \in {p_L, p_H} ). It is a high type with probability ( a ).</td>
</tr>
<tr>
<td>• IMF offers menu of redistributive transfers ( T ).</td>
</tr>
<tr>
<td>• Foreign investors offer set of lending contracts ( {C(T, \tau)} ).</td>
</tr>
<tr>
<td>• Government chooses the IMF transfer level ( T \in T ) and tax per lending contract ( \tau ).</td>
</tr>
<tr>
<td>• Domestic firms choose lending contract ( C \in C(T, \tau) ) and level of borrowing ( k ).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Output is realized and repayments made to foreigners. IMF transfers are made.</td>
</tr>
<tr>
<td>All remaining resources are consumed.</td>
</tr>
</tbody>
</table>

Foreign investors offer a set of lending contracts \( \{C(T, \tau)\} \). Each element of this set specifies the set of lending contracts \( C(T, \tau) \) that are available to domestic firms if (later in period 2) the government chooses the transfer level \( T \in T \) and the tax per lending contract \( \tau \). The government observes \( T \) and \( \{C(T, \tau)\} \), and then makes its choice of the transfer level and the tax. The equilibrium definition is amended appropriately from subsection 3.5. The IMF must satisfy its budget constraint.
Again, optimal IMF policy is the solution to a mechanism design problem in the presence of imperfectly informed competitive markets. Apply the Revelation Principle.

**Proposition 14** Optimal IMF policy is the solution to the following mechanism design problem:

\[
\max_{z,T} \left\{ \left[ p_L F(p_L) + \tau (p_L) + T(p_L) \right] + a \cdot z - \psi (a) \right\}
\]

subject to

\[
z = \left[ p_H F(p_H) + \tau (p_H) + T(p_H) \right] - \left[ p_L F(p_L) + \tau (p_L) + T(p_L) \right]
\]

\[
a = (\psi')^{-1} [z]
\]

\[
a \cdot T(p_H) + (1 - a) \cdot T(p_L) = 0
\]

\[
p_H F(p_H) + \tau (p_H) + T(p_H) \geq p_H F(p_L) + \tau (p_L) + T(p_L)
\]

\[
p_L F(p_L) + \tau (p_L) + T(p_L) \geq p_L F(p_H) + \tau (p_H) + T(p_H).
\]

If equilibria exist they are separating equilibria, with the following properties for any given \( T(p_H) \) and \( T(p_L) \):

(i) If \( p_L F_L + T(p_L) \geq p_L F_H + T(p_H) \),

\[
F(p_L) = F_L, F(p_H) = F_H, \tau (p_L) = \tau (p_H) = 0.
\]

(ii) Otherwise, \( F(p_L) = F_L, \tau (p_L) = 0 \)

and \( (F(p_H), \tau (p_H)) \) solve

\[
\max_{F(p_H),\tau (p_H)} \left\{ p_H F(p_H) + \tau (p_H) \right\}
\]

subject to

\[
p_L F_L + T(p_L) = p_L F(p_H) + \tau (p_H) + T(p_H).
\]

Restriction on the set of feasible \( z \) levels:

\[
z \in [z_1, z_2] \cup [z_2, z_3] \cup ... \cup [z_{n-1}, z_n],
\]

where \( z_1 > [p_H - p_L] F_L \).

We now describe the set of feasible perfect Bayesian equilibria. Consistent with the result in the previous subsection, there exists no feasible pooling equilibrium in period 2. If there exists any equilibria, they must be separating equilibria.

In any separating equilibrium, the net output of each firm in the low type country must be \( F_L \). The government does not impose a tax on lending contracts in equilibrium. Therefore, the ex post consumption of the low type country is equal to \( p_L F_L + T(p_L) \). If the level of redistributive transfers by the IMF is
sufficiently high, then condition (i) is satisfied. This states that if we set the tax per lending contract to zero for both countries, the low type country weakly prefers to reveal its type rather than mimic the high type country. What happens if we allow the high type country to set a non-zero tax $\tau(p_H)$? There cannot exist a separating equilibrium which satisfies condition (i) with a non-zero tax per lending contract in the high type country. The argument proceeds by contradiction. Suppose that there does exist such an equilibrium. Foreign investors can offer a contract with a lower absolute value of the tax, which raises the ex post consumption of the high type country without violating the incentive compatibility constraint of the low type country. Competition between foreign investors ensures that such a contract will indeed be offered.

Therefore, any separating equilibrium that satisfies condition (i) does not exhibit output distortions by either country. Figure 12 illustrates such a separating equilibrium, for the case where condition (i) is satisfied with equality. The lending contracts are plotted in $(S,F)$ space, where we define:

$$S = \tau + T.$$ 

$S$ is the sum of taxes and transfers received by the country. Again, the government chooses the position of the economy on the horizontal dimension. The choice of lending contracts by domestic firms determines the vertical position. Lending contracts corresponding to points $A = (T(p_H), F_H)$ and $B = (T(p_L), F_L)$ are selected by domestic firms in equilibrium. The net output of firms in the high type country is not distorted.

For any separating equilibria where the level of redistributive transfers is higher than in the figure, the government of the high type country does not choose to impose taxes on lending contracts.

Next, we consider separating equilibria which satisfy condition (ii). In this case, the level of redistributive transfers by the IMF is low. Therefore, the incentive compatibility constraint of the low type country is not satisfied when the tax per lending contract is set equal to zero for both types of countries, as illustrated in figure 13. In such a separating equilibrium, the net output of each firm in the low type country is still $F_L$. The government of the low type country does not impose a tax on lending contracts. However, the government of the high type country does choose to subsidize lending contracts in equilibrium, such that $\tau(p_H) < 0$. A corollary result is that $F(p_H) > F_H$. In the figure, $A = (T(p_H) + \tau(p_H), F(p_H))$ and $B = (T(p_L), F_L)$.

Finally, the chosen timing of contract offers effectively places a restriction on the set of government effort levels that are feasible via separating equilibria. For any separating equilibrium, foreign investors consider the option of offering a pooling contract to firms in both types of countries, even if the government decides to accept transfers $T(p_L)$ from the IMF. For the equilibrium to exist, such a pooling contract must be unprofitable. This translates into the condition that the zero profits line for pooling contracts $Z_{PP}$ through $(T(p_L), 0)$ must lie everywhere below the indifference curve for the high type country $IC_H$. This is shown explicitly in figure 12. We assume that it is satisfied for the configuration in figure 13.
Proposition 15 Let the set of feasible effort levels be denoted by $\mathcal{A} = \{a \in [0,1]: |a - a'| \leq r\}$. Define $B_r(a') = \{a \in [0,1]: |a - a'| \leq r\}$.

Assume that $B_{r_1}(\pi), B_{r_2}(\tilde{a}) \in \mathcal{A}$ for some $r_1, r_2 > 0$. Then the optimal allocation is a separating equilibrium with effort level $\tilde{a}$, where $\pi < \tilde{a} < \tilde{a}$. The menu of redistributive transfers $T = \{T(p_H), T(p_L)\}$ offered by the IMF satisfies:

$$T(p_L) = \tilde{a} \cdot \{p_L [F(p_H) - F_L] + \tau(p_H)\}$$
$$T(p_H) = -\left(\frac{1 - \tilde{a}}{\tilde{a}}\right) \cdot T(p_L).$$

The incentive compatibility constraint for the low type country is binding.

For the low type country:

$$F(p_L) = F_L, \quad \tau(p_L) = 0.$$  

For the high type country:

$$F_H < F(p_H) < \hat{F}(p_H), \quad \tilde{\tau}(p_H) < \tau(p_H) < 0.$$  

IMF redistributive transfers increase the set of feasible separating equilibria, and thereby improve ex ante welfare. At the optimum, there will exist a non-zero redistributive scheme $T = \{T(p_H), T(p_L)\}$ together with distortion in the net output of firms in the high type country: $F(p_H) > F_H$. Why? The possibility of ex ante insurance via IMF transfers means that it is no longer necessary for output to be distorted ex post for any country in a separating equilibrium. Therefore in a model with only adverse selection, output is not distorted at the optimum. However, in our framework the effort level chosen by the government in period 1 is endogenous. It is optimal for the IMF to induce a separating equilibrium with a distortion of net output.
for firms in the high type country, because this increases the difference in ex post consumption between high and low type countries. This in turn induces a higher level of government effort in period 1.

The optimal allocation looks like the configuration in figure 13.

To provide intuition for the above result, we describe ex ante welfare changes associated with different policy deviations by the IMF. First, we show that the separating equilibrium in the absence of the IMF, shown in figure 10, is no longer optimal. Consider an increase in IMF redistributive transfers such that the incentive compatibility constraint for the low type country remains binding. This necessarily entails a reduction in the subsidy per lending contract offered by the high type country. Since the subsidy is inefficient, this perturbation causes a first order increase in ex ante expected utility. The reduction in the subsidy does reduce the net output of firms in the high type country, and therefore the government effort level $a = \left( \psi' \right)^{-1} \{ [p_H - p_L] F(p_H) \}$. However, the envelope theorem means that the concomitant reduction in expected utility in period 1 is of second order. IMF redistributive transfers in period 2 improve ex ante welfare by reducing the output distortions necessary in a separating equilibrium.

Some output distortion for the high type country is still optimal because it increases government effort in period 1. Figure 5 illustrates the optimal allocation from subsection 3.2. This allocation is no longer optimal. Consider a reduction in IMF transfers. We ensure that the incentive compatibility constraint for the low type country remains binding, by increasing the subsidy per lending contract offered by the high type country. Notice that the implicit zero subsidy associated with the allocation in figure 5 means that net output of firms is undistorted in that allocation. The envelope theorem establishes that the increase in the subsidy has a second order effect on ex ante welfare. However, the level of government effort in period 1 is suboptimally low for the allocation, and it is increased as a result of the subsidy (since $F(p_H)$ increases). This has a first order beneficial effect on expected utility in period 1.

5 Concluding Remarks

Optimal IMF policy is the solution to a mechanism design problem in the presence of imperfectly informed competitive markets. The IMF implements redistributive transfers between high and low productivity countries ex post, subject to both its budget constraint and to the rational expectations condition that foreign investors set prices according to the information revealed in equilibrium. The zero profits condition for foreign investors changes as a result of the IMF redistribution scheme. The incentives for the government to self-select in a separating equilibrium depends on a combination of the IMF’s policies and the contracts offered by foreign investors. This is central to the description of the optimal allocation chosen by the IMF. Countries with weak fundamentals in the second period choose to receive high levels of IMF transfers. As a consequence, they face high interest rates on international capital markets, which leads to low private cap-
ital inflows. Countries with strong fundamentals in the second period value access to international capital markets more than low type countries. They make contributions to the IMF and thereby receive low interest rates from foreign investors. They enjoy high levels of private capital inflows.

For the baseline model considered, the IMF's redistribution scheme is implemented not to decrease the difference in ex post consumption between high and low type countries, but to increase it. This is achieved by generating capital reallocation on international capital markets from low type to high type countries in the second period. Therefore, government effort is higher ex ante.

IMF redistributive transfers are welfare-improving because they expand the set of feasible separating equilibria. This result holds in an amended version of the model where foreign investors have sufficient tools to separate countries ex post even in the absence of IMF intervention. IMF transfers reduce the output distortions that are necessary for a separating equilibrium to exist ex post. In a model with only adverse selection, output is not distorted at the optimum. However, we show that it is still optimal to distort output ex post – for moral hazard reasons. The output distortion allows the mechanism designer to increase the gap in consumption between high and low productivity countries ex post, which increases government effort ex ante.

Markets can be used to decentralize the IMF's optimal allocation. In particular, the same allocation is obtained if the government can purchase insurance at actuarially fair rates before its effort decision. However, if such contracts are only available after the government's type is revealed, the government will not purchase the ex ante optimal level of insurance. In this case, the IMF should commit ex ante to a schedule of redistributive transfers.

Risk neutrality of the representative consumer simplifies some dimensions of the optimal mechanism design problem. By inducing a separating equilibrium, the IMF solves the capital misallocation problem in the second period that is associated with a pooling equilibrium. This is desirable ex ante under risk neutrality. However, the ex post consumption of the low type country may lie below the level in a pooling equilibrium. In this case, a risk averse representative consumer may prefer the imperfect information allocation to the first best configuration, even from an ex ante perspective. Furthermore, the IMF encounters commitment problems with a concave objective function. Specifically, it is tempted to renege on its schedule of promised transfers ex post, and instead implement more redistribution. Commitment problems under risk aversion are explored further in Netzer and Scheuer (2009).

Our model predicts that the full benefits of IMF intervention cannot be discerned by looking solely at IMF program countries. IMF transfers to low productivity countries improves outcomes for high productivity countries, because they enable the latter to reveal their type in equilibrium. Countries that refuse IMF transfers benefit from the existence of the IMF, because the refusal reveals their high productivity and induces high private capital inflows. This mechanism has implications for empirical work into the effects of
IMF intervention, and for the design of IMF programs (for detailed existing work, see Bird 2001).

6 Appendix: Proofs of Results in the Main Text

Proof of Proposition 1.
Domestic firms’ choice of capital level \( k \) does not depend on the type of the country \( p \). Firms from both types of countries prefer the contract with the lowest offered interest rate \( R \). The interest rate is the only variable of the contract that foreign investors can propose, and there is no communication between the government and foreign investors. Therefore, it is not possible for foreign investors to offer a separating contract. ■

Proof of Proposition 2.
In a pooling equilibrium, foreign investors remain uninformed about the type of the country. Therefore, they offer lending contracts with interest rate \( R_P \) given by expression (1) in the main text, given their beliefs of the government effort level \( a^e \). The government chooses the effort level \( a^* \) in period 1 to maximize expression (2), taking \( a^e \) (and hence \( F_P \)) as given. Define

\[
a^* = \Gamma (a^e)
\]


to be the government’s effort choice in period 1, given foreigners’ beliefs \( a^e \). A pooling equilibrium is defined as the fixed point:

\[
a^* = a^e = \Gamma (a^e).
\]

Now we establish the properties of \( \Gamma (a) \). The first order condition for the government’s maximization problem (2) is:

\[
\psi' (a^*) = z^*
\]

\[
\implies a^* = (\psi')^{-1} [z^*].
\]

(14)

Given the convexity of the cost function, this first order condition identifies the global maximum for expected utility in period 1. Since the cost function is twice differentiable and convex, the government’s effort choice \( a^* \) is continuous and increasing in \( z^* \). Twice differentiability and concavity of the production function establishes that \( z^* \) is continuous and increasing in \( a^e \). Therefore, \( \Gamma (a) \) is continuous and increasing in \( a \).

Even if foreign investors expect the government to exert zero effort, the value of \( z^* \) is positive. From the condition \( \psi'(0) = 0 \) and the property that \( a^* \) is increasing in \( z^* \), we obtain that \( \Gamma (0) > 0 \). If foreign investors expect the government to exert the maximum feasible effort level of unity, the value of \( z^* \) is positive and finite. Since \( \lim_{a \to 1} \psi'(a) = \infty \), we derive \( \Gamma (1) < 1 \).
Therefore, there exists at least one pooling equilibrium. In any pooling equilibrium, \( a^* \in (0, 1) \). \( a^* < a^{FB} \) from the argument in the main text. ■

**Proof of Proposition 3.**

Consider welfare in the pooling equilibrium, which we denote as \( W^* \).

\[
W^* = a^* \cdot p_H F_P + (1 - a^*) \cdot p_L F_P - \psi(a^*).
\]

Add to this expression the expected profits of foreign investors from the pooling contract, which is zero:

\[
W^* = a^* \cdot p_H F_P + (1 - a^*) \cdot p_L F_P - \psi(a^*)
\]

\[
+ a^* \cdot [p_H R_P k_P - r_k P] + (1 - a^*) \cdot [p_L R_P k_P - r_k P]
\]

\[
= a^* \cdot [p_H F_P + p_H R_P k_P - r_k P]
\]

\[
+ (1 - a^*) \cdot [p_L F_P + p_L R_P k_P - r_k P] - \psi(a^*)
\]

By definition:

\[
p_H F_P + p_H R_P k_P - r_k P = p_H f(k_P) - r_k P
\]

\[
= p_H [f(k_P) - R_H k_P] < p_H F_H,
\]

and

\[
p_L F_P + p_L R_P k_P - r_k P = p_L f(k_P) - r_k P
\]

\[
= p_L [f(k_P) - R_L k_P] < p_L F_L.
\]

This establishes that

\[
W^* < a^* \cdot p_H F_H + (1 - a^*) \cdot p_L F_L - \psi(a^*)
\]

\[
< a^{FB} \cdot p_H F_H + (1 - a^{FB}) \cdot p_L F_L - \psi(a^{FB}).
\]

As required. ■

**Proof of Proposition 4.**

This follows immediately from application of the Revelation Principle. For pooling equilibria, foreign investors remain uninformed about the type of the country irrespective of the information revealed by the country to the mechanism designer. Therefore, they must offer a pooling contract:

\[
F(p_H) = F(p_L) = F_P.
\]
For separating equilibria, the type of the country is revealed to foreign investors. Therefore, they offer lending contracts that satisfy their full information zero profit conditions:

\[ F(p_H) = F_H, F(p_L) = F_L. \]

This establishes the result in the text. ■

**Proof of Proposition 5.**

For pooling equilibria, foreign investors remain uninformed about the type of the country. Note that in the model timeline, foreign investors observe the transfer level \( T \in \mathbb{T} \) chosen by the government. We require that foreign investors do not learn the country’s type from their choice of IMF transfers. This requires that \( T(p_H) \) and \( T(p_L) \) are equal. From the IMF’s budget constraint, we obtain:

\[ T(p_H) = T(p_L) = 0. \]

Substituting into the constrained mechanism design problem, we obtain the result required. ■

**Proof of Proposition 6.**

For separating equilibria, foreign investors learn the type of the country. The incentive compatibility constraints may be rewritten:

\[
\begin{align*}
    p_H F_H + T(p_H) &\geq p_H F_L + T(p_L) \\
    p_L F_L + T(p_L) &\geq p_L F_H + T(p_H).
\end{align*}
\]

These expressions yield the equations in the text. ■

**Proof of Proposition 7.**

As shown in the main text, the objective function of the IMF is

\[ a \cdot p_H F_H + (1 - a) \cdot p_L F_L - \psi(a). \]

We know that the unique stationary point and global maximizer of this expression is the effort level \( a^{FB} \).

From the argument in the text, the IMF-induced separating equilibrium that maximizes expected utility in period 1 corresponds to the highest effort level possible, which is \( \bar{a} \). It remains to prove that this equilibrium dominates any pooling equilibrium that the IMF can induce. Notice that


which establishes that

\[ a^* < \bar{a} < a^{FB}. \]
In the proof of Proposition 3, we showed that the welfare in the pooling equilibrium $W^*$ satisfies the following expression:

\[ W^* < a^* \cdot p_H F_H + (1 - a^*) \cdot p_L F_L - \psi(a^*). \]

The desired result immediately follows.

\section*{Proof of Proposition 8}

This follows directly from the argument in the proof of Proposition 7.

\section*{Proof of Propositions 9 and 10}

By inspection.

\section*{Proof of Proposition 11}

The separating equilibrium does not exist if the point $(T(p_L), F_P)$ lies above the indifference curve of the high type country through the allocation $A = (T(p_H), F_H)$. The shape of the feasible set of effort levels follows from the argument in the text. The objective function of the IMF is unchanged from Proposition 7, so the most preferred separating equilibrium is still the one corresponding to the highest level of effort. In this case it is $a_n$.

\section*{Proof of Proposition 12}

This follows immediately from the single-crossing property in the enriched contract space.

\section*{Proof of Proposition 13}

The structure of separating equilibria follows from the single-crossing property. The separating equilibrium does not exist if the point $(T(p_L), F_P)$ lies above the indifference curve of the high type country through the allocation $A = (T(p_H), F_H)$.

\section*{Proof of Proposition 14}

Apply the Revelation Principle. The formulation can then be derived by inspection.

\section*{Proof of Proposition 15}

Suppose that the feasible set $\Lambda$ includes effort levels in a neighborhood around both $\bar{a}$ and $\hat{a}$. Then we can consider perturbations in the feasible set of separating equilibria that correspond to marginal deviations around the effort levels $\bar{a}$ and $\hat{a}$.
First consider the separating equilibrium shown in figure 10, with effort level $\tilde{a}$:

$$W = \tilde{a} \cdot \left[ p_H \tilde{F} (p_H) + \tilde{\tau} (p_H) \right] + (1 - \tilde{a}) \cdot p_L F_L - \psi (\tilde{a}) .$$

Consider an increase in IMF redistributive transfers (and hence a perturbation $dz < 0$) such that the incentive compatibility constraint for the low type country remains binding:

$$dW = \left\{ p_H \tilde{F} (p_H) + \tilde{\tau} (p_H) \right\} \cdot \frac{1}{\psi' (\tilde{a})} \cdot dz + \tilde{a} \cdot d \left[ p_H \tilde{F} (p_H) + \tilde{\tau} (p_H) \right] > 0 .$$

The first term is zero from the envelope theorem, because effort level $\tilde{a}$ is the value that maximizes expected utility in the absence of the IMF. The expression inside the square brackets has the unique stationary point and global maximum at $\tau (p_H) = 0$. The increase in transfers reduces $\tau (p_H)$ towards zero. Therefore, the second term is positive.

Next consider the optimal IMF allocation from subsection 3.2, with effort level $\bar{a}$:

$$W = \bar{a} \cdot p_H F_H + (1 - \bar{a}) \cdot p_L F_L - \psi (\bar{a}) .$$

Consider a reduction in IMF redistributive transfers (hence $dz > 0$) such that the incentive compatibility constraint for the low type country remains binding:

$$dW = \left\{ p_H F_H - p_L F_L - \psi' (\bar{a}) \right\} \cdot \frac{1}{\psi' (\bar{a})} \cdot dz + \bar{a} \cdot d \left[ p_H F_H + d \tau (p_H) \right] > 0 .$$

From the argument in Proposition 7, the first term is positive. The second term reduces to

$$\bar{a} \cdot \left[ - \frac{dz}{p_H (p_H - p_L)} - \frac{dz}{p_H - p_L} \right] = 0 .$$

The envelope theorem establishes that the increase in the subsidy has a second order effect on welfare.

Therefore, the best separating equilibrium has an effort level between $\bar{a}$ and $\tilde{a}$. There exist no pooling equilibria to consider. ■

References


