**Insurance, Verification, and Enforcement Services:**

**A Role for Multilateral Organizations**[*]

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## Abstract

This paper analyzes risk-sharing arrangements between countries when there is uncertainty about the realization of a key performance variable. The realization of the performance variable is a country's private information, and the cost of verifying performance differs across countries. We derive the conditions under which forming a coalition for risk sharing purposes dominates autarky when verification costs are borne by all members of the coalition. We also derive the optimal insurance contract for a coalition. On the one hand, risk sharing enables countries to smooth consumption. On the other hand, heterogeneous verification costs among countries generate a deadweight loss in consumption. In addition, when these costs are "publicly" borne by all members via a common pro rata share, this cost sharing introduces a negative externality into the optimal contracting problem, and results in moral hazard. We study a particular policy often used by multilateral agencies to address this problem known as "conditionality transfer." We show that this policy mitigates the negative externality problem inherent in problems with publicly borne, heterogeneous verification costs.

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## 1. Introduction

The recent crisis in East Asia is an indication of the extent to which a country's economy can be subject to wide fluctuations. The crisis also demonstrates the vulnerability of a country to adverse shocks. For example, in 1998, real GDP growth for Indonesia was −14 percent. This compares with a growth rate of 8.2 percent in 1995 and 8 percent in 1996 (cf., IMF (1998a)). Furthermore, within three months (from November 1997 to January 1998), the Indonesian Rupiah depreciated by about 65 percent. Adverse shocks to an economy can take other forms such as natural disasters, financial crises, or fiscal crises. These shocks can be devastating, especially for small and poor countries. Indeed, the severity of shocks may cause a country to emerge from being a "development miracle" to a "development disaster" (cf., Parente and Prescott (1993)). The upheaval in Asia has also intensified the provocative debate on the rationale for the existence of multilateral agencies such as the IMF. Most often arguments made in favor of or against the existence of such organizations have been based on either moral or political grounds with little economic foundation. This is surprising since these organizations have been around for decades and play a crucial role in the international economy.[1] As Krueger (1997, p. 20) puts it, "to date, efforts to develop a rationale for the roles of the International Financial Institutions consistent with the international economic realities of the 1990s have been few."

One objective of this paper is to address the lack of economic theory in the analysis of multilateral agencies.[2] We analyze the role of multilateral organizations in economies with two features. First, insurance and asset markets are incomplete and idiosyncratic risk exists. Second, information about a random variable that agents would like to insure is asymmetric and costly to acquire. The rationale for forming a multilateral organization arises from the existence of moral hazard and externalities that are inherent in risk sharing arrangements with private information. We consider a costly state verification model with the following features: Countries know the distribution of a key performance variable, which we interpret as a consumption good for simplicity. However, the performance variable could be any of the other components of aggregate demand: investment, government spending or revenue, or net exports. The performance of individual countries is subject to idiosyncratic risk but there is no aggregate risk.[3] The realization is known only to the country unless costly verification occurs, because data are

[1] Both the IMF and the World Bank have near universal membership. For example, IMF membership has grown substantially, from 40 at its inception in 1940 to 183 in 1998. Further, Fund membership increased by 19 percent between 1990 and 1998 (cf., IMF (1998b)).

[2] See Asiedu and Villamil (1999) for a model where multilateral assistance serves as a catalyst for private foreign investment.

incomplete, inaccurate or can be falsified. Lastly, verification costs differ across countries due to different institutional arrangements.

We derive the conditions under which forming a coalition to share risk dominates autarky, and study the optimal insurance contract for the coalition. An important implication of our model is that the heterogeneous verification costs that result from asymmetric information generate a deadweight loss in consumption. We assume that each country bears a common pro rata share of the total verification costs. This introduces an externality into the contracting problem and leads to moral hazard. The negative externality arises because each country's welfare is decreasing in the monitoring cost of other member countries. Moral hazard arises because the cost of verifying a country's report is shared equally by all countries, and therefore there is little incentive for an individual country to reduce its verification cost. We consider a policy often used by Multilateral Organizations: conditonality transfers (i.e., transfers contingent on changes in government policies).[4] We show that making transfers contingent on the magnitude of a country's monitoring cost mitigates the inefficiencies that result from asymmetric information and thereby increases the welfare of all countries.

Our model differs from the standard costly state verification (CSV) multiple agent models in two respects. First, in most CSV models (e.g., Townsend (1979)) the verification cost is typically modeled as a function of an agent's endowment realization, and therefore the transfer payment.[5] In our model, the verification cost is an exogenous idiosyncratic country specific variable that reflects the credibility or "transparency" of a country's reporting institutions. This verification cost specification corresponds to the heterogeneous costs of verifying the reports made by sovereign countries with differing institutional arrangements.[6] Second, we impose no restrictions on the functional form of the relationship between the cost of verification and transfer payments. In Townsend (1979), agents' verification costs are identical and are strictly increasing in agents' transfer payments. Krasa and Villamil (1994) and Bond (1998) consider a more general specification of verification costs where the costs are arbitrary, idiosyncratic, bounded, positive functions of the transfer payments. In contrast, in this paper we focus on a contracting problem where verification costs are heterogeneous and publicly borne (i.e., each country bears a common pro rata share of the total verification costs). We derive two main results. First, we characterize the form of the optimal multilateral insurance contract and derive a restriction on costs that must be

[3] Chart 10 in Parente and Prescott (1993, p. 12) indicates that the average annual compounded rates of change in wealth relative to the U.S. level for a 102 country data set during 1960-85 was approximately symmetric. Thus, countries face idiosyncratic but not aggregate risk.
[4] See Rodrik (1995) for a detailed discussion of conditionality lending.
[5] Bond and Crocker (1997) present a CSV model where the verification cost is endogenous. In their model, agents' may manipulate their verification cost in order to obtain more favorable insurance settlements.
[6] See Calomiris (1994) for a discussion of different types of information disclosure in the U.S. versus Japan and Germany stemming from fundamentally different capital market institutions.

satisfied for a multilateral arrangement to dominate autarky. Second, we study a particular policy known as "conditionality transfer" that mitigates the negative externality problem inherent in problems with this cost structure.

The remainder of the paper is as follows. Section 2 provides a brief description of the operations of multilateral agencies that are relevant to our work. In section 3 we present the model, analyze how risk sharing is compromised when countries have private information and characterize the optimal insurance contract for a coalition. Section 4 discusses the role of multilateral organizations in mitigating the inefficiencies that arise from asymmetric information. Section 5 provides rough estimates of the cost of verification for forty countries and section 6 concludes.

## 2. Operations of Multilateral Organizations

In this section we describe two important aspects of multilateral activities: financial assistance and monitoring services.[7] Multilateral organizations such as the IMF maintain a pool of funds to help member countries that are experiencing a temporary macroeconomic imbalance. This important role of the Fund is characterized by Article I (v) of the Articles of Agreement:

> To give confidence to members by making the general resources of the Fund temporarily available to them under adequate safeguards, thus providing them with the opportunity to correct maladjustments in their balance of payments without resorting to measures destructive of national or international prosperity . . .

Our analysis focuses on multilateral assistance in situations where macroeconomic imbalance is caused by an exogenous shock such as a natural disaster[8] or a decline in the price of major exports.[9] Thus we do not consider circumstances where the imbalance is caused by "bad" policies. We assume that the loss resulting from the adverse shock is not perfectly observable and is known only by the country. Consequently, there is an incentive for countries to overstate their losses. This assumption is consistent

[7] See Masson (1995), Rodrik (1995) and Krueger (1997) for an analysis of the functions of multilateral organizations. We ignore other forms of multilateral finance such as developmental lending and technical assistance.
[8] A number of countries have received assistance from the IMF during a natural disaster. For example, Pakistan drew from the Fund in 1992 when it experienced floods, Jamaica in 1989 when it had a hurricane and Ecuador and Mexico in 1987 and 1986 respectively, when they experienced an earthquake (cf., IMF (1998b)).
[9] This is likely to occur in countries with less diversified exports or countries that rely on primary goods as a major source of foreign exchange.

with empirical data. Johnson and Blomqvist (1996) and Varjonen (1994) find that some countries under-report their incomes in order to receive multilateral assistance.[10]

As is common in countries in models with asymmetric information, we include an incentive compatibility constraint in our model that induces truthful reporting. As a consequence of this constraint, the multilateral agency verifies the reports of countries that claim low performance (as a result of the adverse shock). This prevents high performance countries from posing as low performance countries in order to receive financial assistance. A country's report is verified by monitoring and surveillance activities such as analyzing country reports, auditing national accounts and statistical records, etc. Indeed, monitoring and information gathering form a crucial aspect of multilateral operations. The objective is to obtain information about the true economic and financial situation of member countries.[11]

Clearly, monitoring cost will be lower for countries with transparent economies and stronger institutions. We capture the differences in institutions by modeling the verification cost as a country specific variable that reflects the credibility or "transparency" of a country's reporting institutions. In Section 5 we provide estimates of the verification cost for 40 countries.

## 3. The Model

Our objective is to provide a model with minimal mathematical complexity that analyzes risk-sharing arrangements among a group of risk averse countries when a key performance variable is privately observed only by the country itself unless costly verification occurs. Below we describe the economy, characterize the optimal insurance contract for a coalition, and study a particular policy intervention that results in Pareto improvements. Ageneral analysis of this problem is complex because multilateral contracts are interdependent and private information can cause the constraint set to be non-convex. Krasa and Villamil (1994) use measure theoretic tools to show that the optimal contract is multilateral debt in the sense that monitoring occurs only in low realization states. Unfortunately, their model is cumbersome for policy analysis. We restrict attention to a much simpler but more tractable environment, and use the model to analyze a particular policy used frequently by multilateral institutions – conditionality transfer. We discuss in the final section how the model can be generalized.

### 3.1. Description of the Economy

[10] For example in 1992, Tanzania reported a per capita income of $110. However, an estimate by the World Bank indicated that the GDP for that year should have been 65 percent higher than reported (cf., Varjonen (1994)).

[11] In April 1998, the Interim Committee of the IMF adopted the Code of Good Practices on Fiscal Transparency. This code increases the integrity of the information disclosed by countries to the Fund by requiring that member countries use transparent and widely accepted accounting methods when preparing reports (cf., IMF (1998a)).

We assume the world economy consists of n small countries, two consumption goods, X and Y, and two periods. Each country has access to a production technology that is used in producing good X. Let $x_i$ be the quantity of good X produced by country *i* using technology $\theta_i$ (i.e., $x_i = x(\theta_i)$). The production technology embodies country specific assets such as capital, labor and infrastructure that affect productivity and growth. We make three assumptions about good Y. First, the amount of good Y country *i* receives, $y_i$, is exogenous and random. Second, $y_i$ takes on two discrete values, a low value, $\underline{y}$, with probability $p$, and a high value, $\bar{y}$, with probability $(1-p)$. Third, there is no aggregate risk about $y_i$. In period 1, country *i* produces $x_i$ of good X and receives an exogenous amount, $y_i$, of good Y. Consumption occurs in period 2. Note that there is uncertainty about $y_i$ and no uncertainty about $x_i$. Prior to period 1 countries can sign contracts to diversify their consumption risk. Thus, uncertainty about $y_i$ provides an incentive for countries to form a coalition to share consumption risk with other countries.

The information conditions are as follows. The realization of a country's $y$ is not perfectly observable and is known only by the country unless there is verification. If verification occurs, the actual realization is made known without error. Following Townsend (1979), we assume that verification is costly in that when a country is verified, it forfeits some specified amount of consumption (by paying for verification) and this amount *disappears* from the model. Let $f_i$ be the cost of verifying the $y$ reported by country *i*. Assume $f_i$ is exogenous and varies by country. Let $t_i$ denote the transfer of output from country *i* to the coalition. Transfer payments may be negative (indicating a payment from the coalition to country *i*) or positive (indicating a payment from country *i* to the coalition). If country *i* is verified, it forfeits $f_i$ and makes a transfer contingent on the true value of $y$.

All countries have identical preferences represented by an additively separable utility function, defined by $U(x(q_i), y_i) = v(x_i) + u(y_i)$.[12] Assume that $v(.)$ and $u(.)$ are strictly increasing, continuous, twice differentiable, strictly concave and exhibit normality in consumption. We now analyze risk sharing arrangements among a group of countries (i.e., a coalition) that wish to insure themselves against receiving a low realization, $\underline{y}$, and characterize the optimal incentive compatible multilateral

[12] Note that a country's welfare is determined by some exogenous factor and the country's production technology. This indicates that two countries that receive the same amount of exogenous consumption good, $y$, may attain different utilities. This specification of the utility function captures the idea that a country has some control over its welfare and that country conditions are important.

insurance contract (i.e., a contract for the coalition). We limit our analysis to deterministic verification.[13] Since there is no uncertainty about good X, our analysis of risk sharing shall focus on good Y. However, we consider both consumption goods when we discuss welfare.

### 3.2. The Problem and its Solution

We first define a multilateral contract and an incentive compatible contract for multiple agents and show that verification occurs only when the low realization occurs (cf., Krasa and Villamil (1994), pp. 170-171). We then state an information constrained optimization problem whose solution characterizes the optimal insurance contract.

**Definition 1**. *A multilateral contract with deterministic verification for each country,* $i = 1,...,n$ *is a pair* $(t_i, S_i)$*, where* $t_i(.)$ *is a net transfer function for country i, with* $t_i : R^n \rightarrow R$ *and* $S_i$ *is a set of realizations announced by country i for which verification occurs with probability one.*

**Definition 2**. *A collection of multilateral contracts* $(t_i, S_i)$*, with deterministic verification is incentive compatible if* $S_i = \overline{S_i}$ *and* $t_i = \overline{t_i}$ *for every* $i = 1,...,n$*, where* $(t_i, S_i)$ *denotes the pre-state contractual commitment and* $(\overline{t_i}, \overline{S_i})$ *denotes the post-state outcome.*

**Claim 1**. *Under an incentive compatible contract with deterministic verification, verification occurs only for low realizations. Further, the transfer function* $t_i(.)$ *is equal to some constant,* $a$*, when no verification occurs*.

***Proof***: Under an incentive compatible agreement, countries truthfully report $y$. Since there are only two states (high and low realizations), the relevant operative constraint is to prevent a high realization country from posing as a low realization country. This implies that a country is verified if it reports a low realization. Thus, $S_i = \underline{y}$ and $S_i^c = \overline{y}$ for all *i*, where $S_i^c$ is the non-verification set. Furthermore, since

[13] Krasa and Villamil (1999) give precise conditions under which deterministic verification is optimal in a costly state verification model, even when stochastic verification is possible. See also Boyd and Smith (1994) who show that the empirical gain from using contracts with stochastic monitoring is negligible in a CSV model.

all countries receive $\bar{y}$ in the non-verification state, they all make equal transfers to the coalition. Therefore the transfer function in the high realization state equals some constant, $\alpha$.[14]

Since verification reveals the true $y_i$, a contract that ensures that country *i* asks for verification when $y_i$ falls in the verification region (i.e., receives a low realization) is incentive compatible. Therefore, the transfer plus verification cost must be less than $a$ when $y_i = \underline{y}$. Below, we define incentive compatibility in the context of our model. This definition is a special case of lemma 5.1 in Townsend (1979).

**Definition 3**. *A contract with a transfer payment function* $t_i(.)$ *is incentive compatible if and only if* $t_i(.)$ *equals some constant, a, when* $y_i = \bar{y}$ *and satisfies* $t_i + f_i < a$ *for* $y_i = \underline{y}$.

We now specify the problem of a coalition of countries whose members wish to insure against having a low realization, $\underline{y}$. We first assume away any informational problems so as to obtain two important benchmark cases against which we can compare our main results: (i) Consumption allocation under autarky (which is easy to improve upon) and; (ii) Full information consumption allocation (which cannot be attained when agents have private information).

### 3.21 A Benchmark Case: Optimal Allocations under Full Information and Autarky

The expected utility under autarky of each country from consuming good Y is given by $\bar{u} = pu(\underline{y}) + (1-p)u(\bar{y})$. Since $u$ is continuous, it follows from the intermediate value theorem of calculus that there exists some level of consumption, $y_a^*$, such that $y_a^* \in (\underline{y}, \bar{y})$ and $u(y_a^*) = \bar{u}$. Then $y_a^*$ is the amount of Y consumed under autarky. Under full information, a country's $y$ is observed by all countries. Hence countries can sign contracts contingent upon $y$ and thereby completely diversify their idiosyncratic consumption risk. Let $y_u^* = p\,\underline{y} + (1-p)\bar{y}$. Then under a full information insurance agreement, each country agrees to pay to the coalition the amount $(\bar{y} - y_u^*)$ in the event that its $y$ is

[14] The result also follows trivially from the fact that transfer payments cannot depend on information that is known to only one agent (cf., Townsend (1979)).

high, and to receive $(y_u^* - \underline{y})$ if $y$ is low. In this way, each country is sure of consuming the *unconstrained* optimal level, $y_u^*$, with certainty.

### 3.22 Optimal Allocations under Private Information

Claim 1 shows that the determination of the monitoring set is trivial when there are two states.[15] Thus, we need only characterize the optimal transfer allocations, $t_i$ and $a$, where $t_i$ is the transfer to country *i* from the coalition in the bad state (i.e., when $y_i = \underline{y}$) and $a$ is the transfer to the coalition in the good state (i.e., when $y_i = \bar{y}$). In the bad state, a country, *i*, receives output $\underline{y}$, pays a verification cost $f_i$, and receives a transfer $t_i$ from the coalition. In the good state, a country receives output $\bar{y}$, and transfers a fixed amount, $a$, to the coalition. The expected utility of country *i* from consuming good Y is therefore given by $pu(\underline{y} - t_i - f_i) + (1-p)u(\bar{y} - a)$.

The coalition has a standard objective. Choose Pareto efficient transfer allocations, $t_i$ and $a$, to maximize the weighted average of the countries' expected utilities, $W(.)$, subject to three constraints:[16] (1) consumption must be non-negative in each state; (2) the expected sum of the transfers is less than or equal to zero (aggregate feasibility); and (3) countries truthfully report their output (incentive compatibility). For simplicity, we shall assume a utilitarian welfare function (i.e., all countries are given equal weights).

**Problem 1**. Choose $t_i$, $i = 1,...,n$ and $\alpha$ to maximize

$$W = p\sum_{i=1}^{n} u(\underline{y} - t_i - f_i) + n(1-p)u(\bar{y} - a),$$

subject to:

$$\underline{y} - t_i - f_i \geq 0, \text{ for } i = 1,...,n, \text{ and } y_i = \underline{y}, \qquad (1)$$

$$\bar{y} - a \geq 0, \text{ for } i = 1,...,n, \text{ and } y_i = \bar{y}, \qquad (1')$$

[15] Krasa and Villamil (1994, Theorem 1) show that the monitoring set is a lower interval for arbitrary non-atomic distributions of random variables $Y_1, \ldots, Y_n$, where $F^i$ is the distribution of $Y_i$, with support $[m,\infty)$, $m>0$, and $F^n$ is the joint distribution.

$$p\sum_{i=1}^{n} t_i + n(1-p)a \le 0, \tag{2}$$

$$t_i + f_i < a \quad \text{for} \quad i = 1,...,n, \text{ and } y_i = \underline{y}. \tag{3}$$

Note that the non-negativity constraint on consumption (1) has already been imposed by substitution. Also note that fixed verification costs may cause the solution set to be non-convex. When the solution set is non-convex, the solution to Problem 1 does not easily follow from the first order conditions.[17] In Claim 2, we show that the solution to Problem 1 follows from the first order conditions.

**Claim 2**. *The set of feasible transfer allocations is convex and the solution to Problem 1 follows from the first order conditions.*

***Proof***: Clearly, the only binding constraint is the aggregate feasibility constraint, (3). Further, for large *n*, the regularizing effects of aggregation of $t_i$ will generate a (nearly) convex valued set, even when each individual transfer component is non-convex by a standard argument.[18] This implies the set of feasible transfer allocations is compact and convex. The result follows from Weierstrauss' Theorem since the utility function is continuous and strictly concave.

The regularizing effect of aggregation occurs when *n* is large. Thus, forming a coalition has the useful technical benefit of "convexifying" the solution set.

We now specify the solution to Problem 1.

**Proposition 1**. The transfer allocations, $t_i$ and $\alpha$, that solve Problem 1 have the following characteristics:

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[16] Since $x_i$ is independent of $t_i$ and $\alpha$, and utility is additive separable in $x_i$ and $y$, maximizing W produces the same result as maximizing $\Sigma U(x_i, y)$.

[17] Townsend (1979, p. 272) notes that "with a fixed verification cost, the analysis is more tedious." For the two agent model, he appeals to the Rothschild and Stiglitz increasing risk argument. However, for the multiple agent problem, he considers only the case where the verification cost function is expressed as a continuously differentiable, convex function of the transfer function.

[18] See Mas-Collel *et al* (1995, p. 147) for a discussion of convexification and the regularizing effect of aggregation.

(i) High realization countries make transfers to the coalition (i.e., $\alpha > 0$ when $y_i = \bar{y}$) and low realization countries receive transfers from the coalition (i.e., $t_i < 0$ when $y_i = \underline{y}$).

(ii) Transfer payments from high realization countries to the coalition are an increasing function of the verification costs of member countries (i.e., $\alpha$ is increasing in $f_i$, for $i = 1,...,n$).

(iii) A transfer payment from the coalition to a low realization country, *i*, increases with country *i*'s verification cost and decreases with the verification costs of other countries (i.e., $(-t_i)$ is increasing in $f_i$ and decreasing in $f_j$ for $j \neq i$).

***Proof***: The first order conditions for Problem 1 yield:

$$p\sum_{i=1}^{n} t_i + n(1-p)a = 0 \tag{6}$$

$$u'(\underline{y} - t_i - f_i) = u'(\bar{y} - a), \text{ for all } i, \tag{7}$$

Using (6) and (7) and solving for $t_i$ and $\alpha$ yields:

$$t_i = -\left[(1-p)(\bar{y} - \underline{y}) - \frac{p}{n}\sum_{i \neq j=1}^{n-1} f_j + (1 - \frac{p}{n})f_i\right], \text{ for all } i \text{ when } y_i = \underline{y}, \tag{8}$$

$$a = p(\bar{y} - \underline{y}) + \frac{p}{n}\sum_{i=1}^{n} f_i, \text{ for all } i \text{ when } y_i = \bar{y}. \tag{9}$$

Clearly, the results follow from (8) and (9). *Q.E.D.*

Based on Proposition 1, we derive three important results about international risk-sharing and welfare. The results are stated below.

**Result 1**. The optimal multilateral insurance contract has the following features when the cost of monitoring member countries is shared equally by all countries:

(i) The contract provides full insurance (i.e., perfect consumption smoothing across states) to each country.

(ii) Consumption (and therefore welfare) is decreasing in the monitoring cost of member countries.

(iii) Information asymmetry generates a dead weight loss. Further, the dead weight loss is equal to the expected monitoring cost.

***Proof***: The consumption smoothing result follows from (7) and the fact that $u'' < 0$. Furthermore, consumption smoothing implies that the *constrained* optimal level of consumption of good Y is given by $y_c^* = \bar{y} - a$. Substituting for $\alpha$ using (9) yields:

$$y_c^* = y_u^* - \frac{p}{n}\sum_{i=1}^{n} f_i \quad \text{for all countries,} \qquad (10)$$

where $y_u^*$ is the amount of good Y consumed under full information, i.e., the unconstrained optimal consumption. Define $\Omega = \frac{p}{n}\sum_{i=1}^{n} f_i$. Then $\Omega$ is the wedge between the unconstrained and constrained optimal consumption that results from the underlying information asymmetry. Thus $\Omega$ is the dead weight loss in consumption per country[19] that arises as a consequence of the expected monitoring cost incurred by each country. Clearly, consumption is decreasing in the monitoring costs, $f_i$. *Q.E.D.*

**Result 2**. There exists a threshold, $\bar{f}$, such that risk sharing (i.e., forming a coalition) is Pareto superior to autarky if and only if $\Omega \leq \bar{f}$, where $\Omega$ is the expected cost of verification incurred by each country.

*Proof*: It is optimal to form a coalition if a higher expected consumption is attained from coalition membership than in autarky, i.e., $y_c^* \geq y_a^*$. This implies $\Omega = y_u^* - y_a^* \leq y_u^* - y_a^* = \bar{f}$ and the result follows.

[19] The aggregate deadweight loss for the coalition is $n\Omega$.

**Result 3.** The gain in utility from coalition membership compared to autarky increases with ($\bar{y} - \underline{y}$). Further, risk sharing is more beneficial to "poor" countries than "rich" countries.

***Proof***: Define $f(.) = U_c^* - \overline{U}$, where $U_c^*$ and $\overline{U}$ are the expected utilities under coalition membership and autarky respectively. Then, $f(.) = u(y_c^*) - \bar{u}$. To prove the first statement, it suffices to show that $\frac{df}{d\bar{y}} > 0$, and $\frac{df}{d\underline{y}} < 0$. The results follow from the following equations:

$\frac{df}{d\bar{y}} = (1-p)[u'(y_c^*) - u'(\bar{y})]$ and $\frac{df}{d\underline{y}} = p[u'(y_c^*) - u'(\underline{y})]$.

Note that $\bar{y} = p\bar{y} + (1-p)\bar{y} > p\underline{y} + (1-p)\bar{y} - \Omega = y_c^*$ and $u''(.) < 0$.

This implies $u'(\bar{y}) < u'(y_c^*)$. Hence $\frac{df}{d\bar{y}} > 0$. A similar argument holds for proving that $\frac{df}{d\underline{y}} < 0$. To prove the last statement we note that a country's expected utility under coalition membership is given by $U(x(q_i), y_c^*) = v(x_i) + u(y_c^*)$. Also note that a country is "rich" if $x_i$ is high. The result follows from the fact that the percentage gain in utility from coalition membership is given by $\frac{u(y_c^*) - u(y_a^*)}{v(x_i) + u(y_a^*)}$, which decreases with $x_i$.

**Discussion**

Proposition 1 indicates that forming a coalition enables countries to engage in risk sharing. In particular, high realization countries make transfers while low realization countries receive transfers. This is partially consistent with how multilateral organizations such as the IMF operate. Typically countries that experience an adverse shock receive transfers from the IMF. It is important to note that in our model, countries receive transfers because they have experienced an *exogenous* adverse shock (i.e., $y_i = \underline{y}$) and <u>not</u> because they are poor (i.e., have a low $x_i$). For instance, during the recent Asian crisis, the top three borrowers (negative transfers) from the IMF in 1998 were South Korea, Indonesia and Thailand (cf., IMF (1998a)). However, the GDP per capita of these countries during that period was much higher than that of some member countries that did not draw from the fund. Our results also suggest that

since all countries are subject to adverse shocks, "rich" countries (i.e., high $x_i$ countries) may receive transfers from the coalition. It is interesting to note that although recent IMF financial support has been to developing countries, developed countries have in the past borrowed from the Fund. For example, Italy and the United Kingdom drew from the Fund in 1977, after they switched from a fixed to a floating exchange rate (cf., Masson (1995)).[20] Both countries were experiencing balance of payments difficulties in the aftermath of the first oil shock, and the lira and the pound were under severe downward pressure. Thus, coalition formation allows all countries, both rich and poor, to diversify their idiosyncratic consumption risk. The fact that high realization countries make transfers may cause one to question the rationale for them to join the coalition. Recall that countries do not know their type (whether or not they'll receive a high or low realization) ex ante.[21] Therefore uncertainty about shocks and the desire to smooth consumption motivate countries to join the coalition.

Another interesting implication of Proposition 1 is the positive association between a country's monitoring cost and the amount of transfers it receives from the coalition (see Proposition 1, (iii)). At a glance, this result seems contentious since it suggests that the coalition rewards countries with inefficient reporting systems (i.e., high $f_i$ countries). Note, however, that in our model, higher transfers do not translate into higher consumption. Indeed, this has been one of the major criticisms of multilateral agencies. Critics argue that transfers from multilateral agencies have very little, if any impact on the welfare of recipient countries. Our model sheds light on this controversy. First note that perfect risk sharing implies that all countries (irrespective of the transfers they receive or make) consume the same amount of good Y (see Proposition 2 and equation (10)). Also recall that a country's expected utility under coalition membership is given by $U(x(q_i), y_c^*) = v(x_i) + u(y_c^*)$. This suggests that although countries may benefit from risk sharing, a country's utility also depends on country specific policies and country conditions (ie., factors that affect a country's production technology, $\theta_i$).

Result 1 indicates that forming a coalition for risk-sharing purposes cuts two ways. On the one hand, it allows countries to diversify their idiosyncratic consumption risk and thereby smooth consumption across states. On the other hand, since optimal multilateral contracts are *interdependent*, the "fundamental characteristics" of a country (captured by the verification cost in our model) affect the welfare of other member countries. In particular, a country's welfare is decreasing in the monitoring cost of other member countries. This introduces an *externality* into the problem. Result 1 also implies that

[20] Bordo and Schwartz (1998) document IMF lending to developed countries prior to 1970. For example Canada drew from the Fund in 1962; Italy in 1964; United Kingdom in 1964, 1965, 1966 and 1967 and France in 1968.

risk sharing under information asymmetry leads to moral hazard. The moral hazard problem stems from the fact that the cost of verification is shared by all countries as each country pays a fraction, $\Omega$, of the total cost from their consumption allocation of good Y (see equation (10)). As a consequence, there is little incentive for an individual country to reduce its verification cost. This suggests that the verification cost of each country will be higher relative to the level of cost that would occur if each country bore the entire cost of its own verification.[22]

Result 2 derives conditions under which it is optimal to form a coalition. The result indicates that information asymmetry can severely limit the scope for risk sharing. In particular, when the aggregate verification costs are too high, the cost of risk sharing (i.e., the loss of consumption from moral hazard and the monitoring cost externality) exceeds the benefit (i.e., consumption smoothing). This makes coalition formation a sub-optimal outcome. Further, autarky is likely to dominate risk sharing when the difference between the full information consumption allocation, $y_u^*$, and autarky consumption, $y_a^*$, is small (i.e., $\bar{f}$ is small). In this sense critics of multilateral agencies such as the IMF may be right. It is possible that all countries may be better off by not participating in the arrangement, either because the monitoring costs of the Fund's member countries are too high or lower cost methods of providing insurance exist.[23]

According to Result 3, the benefits from coalition membership are greater when the difference between realizations, $(\bar{y} - \underline{y})$, is large. If good Y is interpreted as a measure of wealth disparity across countries per capita, then $(\bar{y} - \underline{y})$ is large and therefore there are substantial benefits to forming a coalition (cf., Parente and Prescott (1993)).[24] Another important implication of Result 3 is that although perfect risk sharing allows all countries to consume the same amount of good Y, "poor" countries benefit more from coalition membership than "rich" countries. This result is consistent with the empirical findings of Obstfeld (1995) and Head (1995).

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[21] Countries know whether or not they are rich or poor (i.e., know $x_i$) but do not know whether or not they will have a low or high realization (i.e., $y_i$ is unknown).

[22] Dekel and Scotchmer (1990) arrive at a similar conclusion regarding the oil industry. In the U.S., the oil industry maintains common resources to clean up oil spills and the cost of any member's spill is shared by all of the members. They find that cost sharing decreases the incentive for care among oil companies and thereby increases the likelihood of a spill. Oil spills result in a decrease in supply and can therefore be profitable.

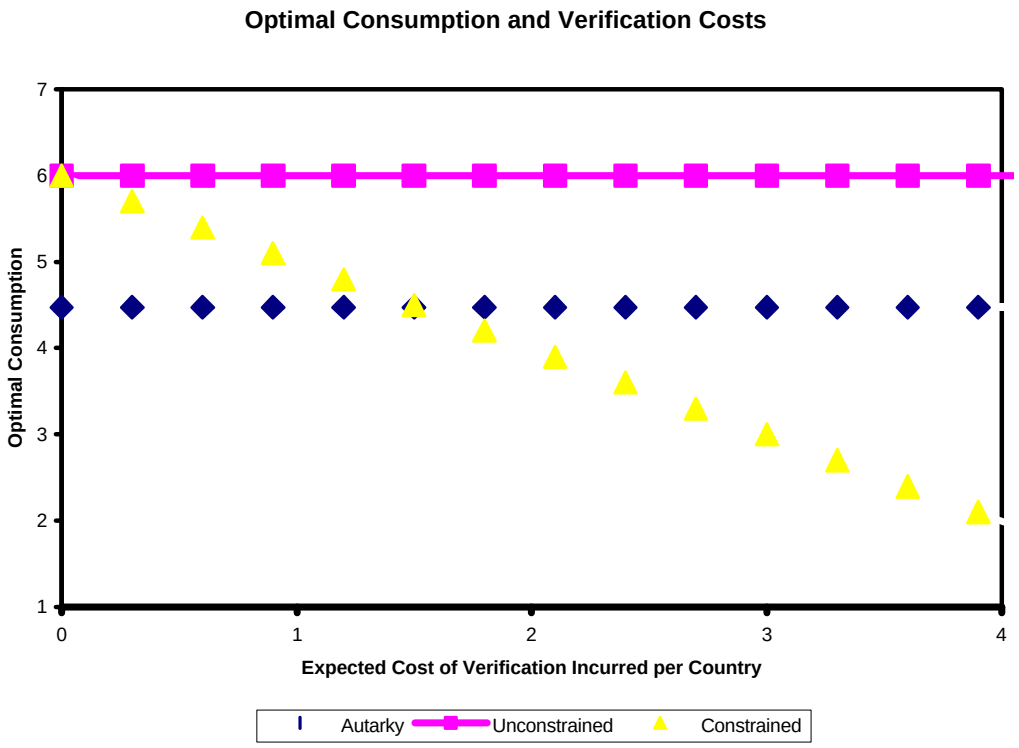
[23] Shiller (1998) proposes markets to trade assets whose payoff depends on a country's GDP. However, he notes that asymmetric information limits risk sharing opportunities.

[24] Parente and Prescott (1993) find a substantial disparity in wealth (measured by GDP per capita) between the countries of the world. They find that in 1985, the richest country, the U.S., was 43 times wealthier than the poorest country, Ethiopia.

We next address the issue of adverse selection, which is important in risk analysis when there is asymmetric information. As shown in a seminal paper by Akerlof (1970), severe adverse selection may lead to the collapse of private markets. We pose two questions: (i) Can high verification cost lead to adverse selection — the tendency for high $f_i$ countries to drive out low $f_i$ countries? (ii) If adverse selection occurs, will it prevent the formation of a coalition for risk sharing purposes? Since each country pays the average of the coalition's verification cost, $\Omega$, countries with low $f_i$ (i.e, $f_i < \Omega$) incur a relatively high cost burden, and therefore pay more than their "fair" share for verification. Further, welfare is decreasing in the verification cost of member countries. These two reasons may cause low $f_i$ countries to exit from the coalition, leading to an adverse selection. We examine the answers to these questions in the next section.

**A Numerical Example**

We now present an example to illustrate Result 1 and Result 2. The parameters used are $\underline{y} = 2$, $\bar{y} = 10$, and $p = 0.5$. Assume $u(y) = \ln y$. Then the amount of good Y consumed under autarky and full information are $y_a^* = 4.47$ and $y_u^* = 6$ respectively and the threshold cost of verification is given by $\bar{f} = y_u^* - y_a^* = 1.53$. This implies that when the expected cost of verification incurred per country, $\Omega$, exceeds 1.53, the expected consumption under autarky exceeds the expected consumption under a coalition thereby making risk-sharing a sub-optimal outcome. We compute consumption under coalition formation, $y_c^*$ (i.e. constrained optimal consumption) for different values of $\Omega$. Our results are summarized in the graph below.




## 4. Policy

Clearly, information asymmetry and high, publicly borne verification costs can limit the scope of risk sharing (i.e., coalition formation). Further, even when it is optimal to form a coalition, these frictions reduce welfare, generate externalities, and can lead to moral hazard. An important question is whether there are policies than can yield Pareto improvements by reducing the inefficiencies associated with these frictions. An obvious policy recommendation is for all countries to reduce their monitoring costs by improving their reporting institutions and making their economies more "transparent." When verification costs are shared by all countries there is little incentive for an individual country to "clean up." As a consequence, the first best solution may be unachievable. An alternative policy is for the multilateral coalition[25] to implement policies aimed at mitigating the inefficiencies that arise from information asymmetry and thereby increase the welfare of all countries.

[25] An important question that arises is whether multilateral agencies such as the IMF have an incentive to behave optimally. We discuss theoretical extensions of our model in but final section but note that in reality the policies adopted by the Fund are heavily influenced by developed countries. This is partly because the Fund is a quota based institution. A member's quota determines its subscription, its voting weight and its access to financing. For example, the total quota share of five countries (out of the Fund's 184 member countries) is about 40 percent. The breakdown is as follows with percentage quota share in parenthesis: U.S. (18.2), Japan (5.7), Germany (5.7), France (5.1), and the U.K. (5.1). This compares with a quota share of 0.002 percent for some member countries (cf., IMF

One such policy that is often used by multilateral agencies is known as "conditionality transfer." This policy promotes transparency and accountability in member countries (i.e., reduces $f_i$)[26] by making transfers contingent on socially optimal reforms.[27] We show in Proposition 2 that a multilateral contract that offers a zero transfer in the low realization state (i.e., $y_i = \underline{y}$) to high verification cost countries can mitigate the moral hazard problem, *partially* internalizes the externality, and increases the welfare of member countries. Under such a contract, high $f_i$ countries obtain a lower expected utility under coalition membership than in autarky.[28]

Conditionality transfer (i.e., making transfers contingent on the magnitude of $f_i$) will have two possible effects: (i) it may cause high $f_i$ countries to "voluntarily" exit from the coalition; or (ii) it may induce a country to decrease its $f_i$. In case (i), the elimination of high $f_i$ countries reduces the dead weight loss in consumption (i.e., results in a decrease in $\Omega$) and thereby improves the welfare of remaining countries. Case (ii) also improves welfare since welfare is decreasing in verification costs of member countries. Further, it mitigates moral hazard since each individual country now has an incentive to independently reduce its $f_i$. We note that either outcome (i) or (ii) is possible, however, (ii) is likely to dominate if a country is "poor" or the difference in the realization of good Y, ($\bar{y} - \underline{y}$) is large. Recall from Result 3 that in both cases the benefits from coalition membership are substantial. Thus, by committing to terminate transfers to high $f_i$ countries, a multilateral agency can reduce the inefficiencies caused by asymmetric information.[29]

Rodrik (1996) has made similar informational arguments to justify the existence of multilateral organizations. He argues that multilateral agencies play two crucial roles: information provision,

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(1999)). Given the skewness of quota shares, it is not surprising that industrialized countries exercise a substantial influence over the Fund's policies.

[26] In recent years, the IMF has increased its effort to enhance transparency and accountability in member countries. For example it adopted the Declaration on Partnership for Sustainable Global Growth in September 1996. In this document the IMF identified "promoting good governance in all aspects, including ensuring the rule of law, improving the efficiency and accountability of the public sector, and tackling corruption" to be essential for helping economies prosper (cf., IMF (1998a)). In the recent Asian crisis the IMF has advised countries to "open up" their financial markets. These are institutional changes that may cause these countries to adopt a more "U.S. style" capital market which inherently involves a higher degree of information disclosure for firms. The IMF has also required countries to disclose certain types of information (e.g., the level of reserves).

[27] For example in April 1999, the IMF agreed to provide Contingent Credit Lines to member countries whose policies meet with IMF approval. In addition, the IMF often suspends, delays or stops lending to countries that refuse to implement the Fund's policy recommendations.

[28] Any contract that offers high $f_i$ countries an expected utility lower than autarkic utility achieves a similar result.

[29] Commitment is always a series issue in intertemporal problems. See Krasa and Villamil (1999) for an analysis of the effects of limited commitment on the optimal contract structure in the costly state verification model.

particularly in terms of monitoring the policies of member countries; and conditionality lending, i.e., lending contingent on changes in government policy. Gordon Brown, Britain's Chancellor of Exchequer also favors conditionality transfers. He states that "I believe this facility (contingent credit lines) will create greater incentives for countries to implement sound policies..." (WSJ April 30, page A 14). In a paper that reviews the functions of the World Bank and the IMF, Krueger (1997, p. 21) also notes that "if one can demonstrate that there are Pareto-superior outcomes or sufficiently large externalities, a clear rationale for (multilateral) institutions could result." We contribute to the discussion on the role of multilateral agencies by providing a model with micro foundations that support these arguments.

**Proposition 2.** A multilateral contract that offers a zero transfer in the low realization state to high verification cost countries (i.e., $f_i \geq \Omega$) increases the welfare of coalition members.[30]

***Proof***: Note that under such a contract, the expected utility of a high verification cost country (i.e., $f_i \geq \Omega$) from consuming good $Y$ is given by $E[u(y)] = pu(\underline{y} - f_i) + (1-p)u(\overline{y} - a)$. Since $E[u(y)] < \overline{u}$, high $f_i$ countries will voluntarily "exit" from the coalition. Excluding high $f_i$ countries from the coalition increases the welfare of member countries since welfare is decreasing in $f_i$.

## 5. Calibration

As previously discussed, verification cost, $f_i$, captures the transparency and credibility of a country's reporting institutions. In Table 1, we present rough estimates of $f_i$ for 40 countries. We use three indicators that evaluate government corruption, the rule of law, and government bureaucracy to measure $f_i$. Each indicator ranges from 1 to 6, a high number indicates a country has credible reporting institutions and a transparent legal framework. We average each indicator over the period 1990-1995 and use the average of the three indicators to construct $f_i$. Table 1 documents the wide variation in $f_i$ for these countries, ranging from a high of 6 for Canada and Netherlands to a low of 0.9 and 1.2 for Zaire and Haiti respectively. The data was obtained from the *International Country Risk Guide*.

[30] **Elizabeth:** There is a problem. In general there is a tradeoff between risk sharing (achieved by adding people to the coalition) and monitoring costs. The argument is in the Oxford paper). This proposition takes account only of the cost saving from kicking out "high cost members." We could: (1) Prove the result in the general case. (2) Assume the coalition is sufficiently big (the gain from one more is zero in terms of risk sharing). What do you want to do? That is, in a sufficiently small coalition if everyone got the bad state the coalition would not be able to make a transfer. The optimal contract promises perfect consumption smoothing. This requires sufficiently many members.

**Table 1**

Verification Cost for Selected Countries

| *Country* | *Corruption* | *Rule of Law* | *Bureaucratic Quality* | *Verification Cost,* $f_i$ |
|---|---|---|---|---|
| *High* $f_i$ *Countries* | | | | |
| Australia | 5.0 | 6.0 | 6.0 | 5.7 |
| Canada | 6.0 | 6.0 | 6.0 | 6.0 |
| France | 5.4 | 5.7 | 6.0 | 5.7 |
| Germany | 5.6 | 5.7 | 6.0 | 5.8 |
| Japan | 5.0 | 5.6 | 6.0 | 5.5 |
| Netherlands | 6.0 | 6.0 | 6.0 | 6.0 |
| Switzerland | 6.0 | 6.0 | 6.0 | 6.0 |
| U.K. | 5.0 | 5.7 | 6.0 | 5.6 |
| U.S. | 5.0 | 6.0 | 6.0 | 5.7 |
| *Medium* $f_i$ *Countries* | | | | |
| Argentina | 3.5 | 3.8 | 3.0 | 3.4 |
| Brazil | 3.7 | 3.7 | 4.0 | 3.8 |
| Cameroon | 3.0 | 2.5 | 4.0 | 3.2 |
| Chile | 3.0 | 4.3 | 3.0 | 3.4 |
| China | 4.3 | 4.2 | 3.1 | 3.8 |
| Ghana | 3.3 | 3.0 | 4.0 | 3.4 |
| Greece | 5.0 | 4.7 | 3.8 | 4.5 |
| India | 2.5 | 2.7 | 4.0 | 3.1 |
| Italy | 3.5 | 5.0 | 4.8 | 4.4 |
| South Korea | 4.3 | 4.3 | 4.8 | 4.4 |
| Malaysia | 4.0 | 3.8 | 3.0 | 3.6 |
| Mexico | 3.0 | 3.0 | 3.0 | 3.0 |
| South Africa | 5.0 | 2.9 | 6.0 | 4.6 |
| Spain | 4.3 | 5.3 | 4.0 | 4.6 |
| Turkey | 3.4 | 3.3 | 3.7 | 3.5 |
| *Low* $f_i$ *Countries* | | | | |
| Bangladesh | 1.4 | 1.8 | 1.5 | 1.6 |
| Burkina Faso | 3.3 | 3.3 | 2.1 | 2.9 |
| Colombia | 3.0 | 1.3 | 4.0 | 2.8 |
| Congo | 3.1 | 2.4 | 2.0 | 2.4 |
| Guatemala | 2.0 | 2.0 | 1.3 | 1.8 |
| Haiti | 1.2 | 1.4 | 1.0 | 1.2 |
| Honduras | 2.0 | 2.7 | 2.0 | 2.2 |
| Indonesia | 2.7 | 3.6 | 2.4 | 2.9 |
| Niger | 3.1 | 2.2 | 2.5 | 2.9 |
| Nigeria | 2.0 | 2.5 | 3.0 | 2.5 |
| Peru | 3.0 | 1.9 | 2.0 | 2.3 |
| Philippines | 2.6 | 2.5 | 1.6 | 2.2 |
| Sierra Leone | 1.3 | 2.3 | 1.5 | 1.7 |
| Togo | 2.0 | 2.3 | 2.0 | 2.1 |
| Zaire | 0.0 | 0.7 | 2.0 | 0.9 |
| Zambia | 3.1 | 2.4 | 2.0 | 2.5 |

Notes: Verification cost, $\phi_i$, ranges from 1 to 6. A low $\phi_i$ implies a high verification cost.

## 6. Conclusion

This paper examines the role of multilateral organizations when insurance markets are incomplete. We consider the case where there is uncertainty and asymmetric information about the realization of a key performance variable, and the cost of verifying a country's performance varies by country. The main results are as follows: (i) Forming a coalition enables countries to completely diversify their idiosyncratic risk and thereby smooth consumption. (ii) Information asymmetry and heterogeneous verification costs among countries generate a deadweight loss in consumption, introduce a negative externality into the contracting problem, and result in moral hazard. (iii) When the verification costs of countries are too high, the cost of risk sharing (i.e., loss in consumption, moral hazard and externalities) exceeds the benefit (i.e., consumption smoothing) thereby making coalition formation a sub-optimal outcome. We then analyze the role of multilateral organizations in mitigating the inefficiencies that arise as a result of private information. We consider a policy often used by multilateral organizations: conditionality transfers (i.e., making transfers contingent on changes in government policies). We show that making transfers contingent on the magnitude of countries' monitoring costs reduces the inefficiencies that result from asymmetric information and thereby increases the welfare of all countries.

Despite the extreme two-state simplicity of our model, a recognizable institution (i.e., a multilateral agency) emerged as an outcome of an explicit optimization problem. Further, it is clear from results in Krasa and Villamil (1994) that the results are robust to economies with risk averse agents, more general non-atomic distributions, and public information disclosure. Hellwig (1998) provides a related framework with risk averse agents and private information disclosure. In this case delegated monitoring is optimal (as in Diamond (1984) and Williamson (1986)). Finally, Shiller (1995) and Bond (1998) have recently argued that other types of instiutional arrangements can lead to Pareto superior outcomes. The relative value of conditionality transfer, versus particular types of state contingent assets (Shiller) or joint liability arrangements (Bond) is an interesting empirical question.[31]

Our results also show that although forming a multilateral organization can be beneficial, it does not render country specific polices irrelevant. The reason is that a country's welfare depends on the country's production technology and policies. This paper contributes to the debate as to whether in this era of globalization there is still a need for multilateral organizations. Obviously, this discussion is important both academics and policy makers. We consider this article as a first step in building a model

[31] Publicly borne verification costs can be interpreted as a type of joint liability arrangement.

that sheds light on the role of multilateral organizations as providers of insurance and verification services.

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