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RESEARCH ARTICLE

Elizabeth Asiedu · Yi Jin · Anne P. Villamil

Do lack of transparency and enforcement undermine international risk-sharing?

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Abstract This paper studies the extent to which poor institutions compromise risk-sharing. We model a multilateral organization as a social contract that provides insurance to members. Countries *privately* observe the realization of a performance variable with a verification cost that differs across countries, reflecting the "transparency" of institutions. When the level of transparency is exogenous, the optimal contract provides complete expected risk sharing across countries and states. Poor transparency and enforcement reduce consumption and result in insurance rationing. When a country can increase transparency endogenously, this generates an externality and moral hazard. We first characterize the outcome when the multilateral agency can influence members' institutions by choosing the countries' level of effort. Next we derive a tax/subsidy scheme that can induce countries to choose the socially optimal level.

Keywords Contracts · Enforcement · Insurance · Institutions · IMF · International risk- sharing · Multilateral agencies

JEL Classification Numbers D8 · F3

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E. Asiedu · Y. Jin
Department of Economics, University of Kansas, Lawrence, KS 66045, USA
E-mail: asiedu@ku.edu;yjin@ku.edu

A. P. Villamil (✉)
Department of Economics, University of Illinois, Champaign, IL 61820, USA
E-mail: avillami@uiuc.edu

1 Introduction

The literature on international risk sharing is vast. Prominent topics covered in this area include examining the extent to which market imperfections impede risk sharing (see Eijffinger and Wagner 2003 for a survey), estimating the welfare gains from risk sharing (see van Wincoop 1999, for a survey), and explaining why the potential gains from international risk sharing go unexploited (see Lewis 1999, for a survey). In most of the papers, countries diversify their output or consumption risk by engaging in cross-border trade in commodities or financial assets (e.g., bonds or state contingent claims). Such analysis, although useful, has several caveats. First, trade in claims on national income does not exist. Shiller (1993) proposes markets to trade assets whose payoff depends on a country's GDP, but notes that asymmetric information limits risk-sharing opportunities under this mechanism. Second, the analysis has limited relevance for poor countries. Most small and poor countries have poorly diversified economies, tend to engage in little trade, and do not have access to international capital markets.[1] Third, market imperfections, such as information and enforcement problems, seriously curtail the utilization of capital markets for insurance purposes. Obsfeld and Rogoff (1996) analyze the extent to which market imperfections affect private capital markets and conclude that "when there are endogenous imperfections capital markets may still be able to facilitate risk sharing and intertemporal trade, but only to a limited extent" (p. 349).

We contribute to the literature by constructing a model for studying the implications of international risk sharing via a social contract – a group of countries, which we refer to as a multilateral agency, band together to share risk about a key performance variable. In such a setting, risk sharing can be compromised by information asymmetry and enforcement problems: there is no supra-national legal authority that can enforce contracts across borders. These problems are particularly relevant in our setting because the sovereignty status of countries limits the agency's enforcement powers.[2]

The model has the following important features. A key performance variable, which we interpret as GDP for simplicity, is random.[3] The realization of this performance variable is private information, thus countries may misreport their realizations. To ensure truthful reporting, the multilateral agency verifies the information reported but verification is costly (resources, including time, are expended). The cost varies by country and reflects the degree of "transparency" of a country's

[1] For example, over the 5 year period, 1999–2003, only 5 out of the 48 countries in Sub-Saharan Africa (Congo Dem. Rep., Cote d' Ivoire, Nigeria, Uganda and South Africa) issued bonds. Furthermore, the amounts were meager – for Congo and Uganda, the total value of bonds outstanding was less than $4 million (World Bank 2004).

[2] Several papers have examined the extent to which sanctions on host countries can support international lending when enforcement is imperfect. See Asiedu and Villamil (2002) for a review of this literature.

[3] The performance variable can be any part of aggregate demand: consumption, investment, government spending or net exports. We assume that countries pool risk to insure against fluctuations in any of these components, though it is standard in the literature to evaluate variability in output or consumption. Shiller and Athanasoulis (1995) provide two justifications for insuring against fluctuations in GDP: national incomes are measures of total economic welfare and historically fluctuations in real national incomes have been large

institutions.[4] Because there is no supra-national enforcement mechanism, contracts must be self-enforcing. The agency cannot compel participation: a country will join the organization only if the expected consumption from risk sharing is greater than the expected consumption under autarky.

We consider a social contract designed to insure countries against output fluctuations. The literature suggests that forming a multilateral agency for risk sharing purposes (1) leads to welfare improvements which can be quite substantial;[5] (2) is more beneficial to small and less developed countries (Head 1995; Obsfeld 1995; Athanasoulis and van Wincoop 2000); and (3) generates welfare gains that increase as the number of countries that participate in a risk sharing arrangement rises (van Wincoop 1994). We construct our model to be consistent with these facts. We abstract from private insurance because markets for output or consumption insurance do not exist, and note that enforcement and information problems may give a multilateral agency some inherent advantages over a private entity. First, the agency solves the problem of selective default – where a country defaults on an agreement with one private entity and enters into an agreement with another. Second, the degree to which an individual insurance provider can "punish" a sovereign nation for reneging on a contract is limited. In contrast, denying the country membership in a multilateral organization may induce the country to honor its contracts when there are sufficient benefits from membership.[6]. Finally, a multilateral agency can exploit standard economies of scale and scope when verifying reports provided by countries.

In conclusion, we construct a model of a multilateral agency that resembles the IMF in key ways. First, the IMF consists of sovereign nations with different institutional arrangements. Second, membership is voluntary. Third, the IMF provides financial assistance to members that experience temporary macroeconomic imbalances.[7] This role, which we interpret as *insurance*, is characterized by Article I (v) of the Articles of Agreement of the IMF which states

> 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

[4] For example, the time and resources spent auditing a financial report from Canada is less than the resources spent verifying data from Nigeria.

[5] van Wincoop (1999) reports that welfare gains from international risk sharing range from negligible to over 100%. He argues that the widely diverging welfare gains occur because the estimates are sensitive to assumptions made about (1) the implicit risk-free interest rate, (2) the risk-adjusted growth rate, (3) the rate of relative risk-aversion, and (4) endowment uncertainty. Based on reasonable parameters, he concludes that the potential gains from risk sharing are quite substantial.

[6] In addition to the risk sharing benefits, membership in a multilateral organization may make investment more attractive to private investors. See Asiedu and Villamil (2002) for a model where a multilateral agency serves as an enforcement mechanism for private capital flows in an international setting

[7] Our analysis considers multilateral assistance in situations where macroeconomic imbalance is caused by an *exogenous* shock such as a natural disaster or a decline in prices of major exports. Several countries (both developing and developed) have received assistance from the IMF after experiencing exogenous shocks, such as natural disaster or exchange rate shocks. For example, Ecuador and Mexico drew from the fund in 1987 and 1986 respectively, when they experienced earthquakes (cf., IMF 1998b). Italy and the UK obtained assistance in 1977 after switching from a fixed to a floating exchange rate (cf., Masson 1995).

> of payments without resorting to measures destructive of national or international prosperity . . .

Fourth, the IMF verifies the reports of its member countries.[8] Finally, countries sometimes provide inaccurate information to the IMF in order to receive financial assistance. For example, Ukraine received over $100 million in loans from the IMF as a result of false data that it provided in 1997–1998 (see Appendix A for a detailed discussion).

The paper proceeds as follows. Section 2 presents the model. Section 3 characterizes the optimal contract and analyzes how risk sharing is compromised by information and enforcement problems when verification costs are exogenous. Section 4 characterizes the contract when costs are endogenous. Section 5 discusses extensions to the model and Section 6 concludes.

2 The model

The world economy consists of a continuum of countries defined over the interval $[0, N]$, one consumption good, Y, and two periods, labeled zero and one. Date zero consumption yields no utility and consumption occurs in period one. In period zero each country receives a non-random endowment amount, y_0, of good Y. There is uncertainty about the realization of Y in period one. Countries have access to a technology to store the period zero endowment. The amount of good Y country i receives, y_i, takes on two values, $\underline{y}$ with probability π in the bad state and $\bar{y}$ with probability $(1 - \pi)$ in the good state.

Two incentive problems arise. First, when the realization of Y is privately observed (i.e., asymmetric information), the country may overstate its losses. We assume: (1) the report of country i can be verified at cost ϕ_i; (2) if verification occurs, y is publicly revealed; (3) ϕ_i is measured in terms of Y; and (4) verification is deterministic.[9] This framework has three important features: verification induces a deadweight loss, the cost may differ across countries, and the cost is public information with $\phi^i(i) > 0$.[10] If country i is verified, it forfeits amount ϕ_i of good Y and makes a transfer contingent on the true value of y. The heterogeneous costs reflect the transparency of countries' institutions, which reflect different institutional arrangements.

Second, because contracts are signed ex ante and the performance measure is realized ex post, countries in the high state may renege on their period one payment in the absence of an enforcement mechanism. This problem is particularly relevant in our setting because the sovereignty status of countries limits a multilateral agency's enforcement powers. We now derive a constraint which ensures that it is not in the country's interest to renege. Assume that members deposit their endowment y_0 with the agency, and forfeit a share $\gamma \in (0, 1]$ of it to the coalition

[8] Verification services can take several forms. These include IMF economists collecting macroeconomic data, auditing national income accounts and visiting member countries.

[9] Krasa and Villamil (2000) give precise conditions under which deterministic verification is optimal in a costly state verification model, even when stochastic verification is possible. Boyd and Smith (1994) also show that the empirical gain from using contracts with stochastic monitoring is negligible.

[10] This implies countries with lower indices have lower costs and are more transparent.

if they renege.[11] The relevant constraint is when country i gets a good realization and all other countries have a bad realization. If country i reneges, it forfeits γy_0 and consumes $\bar{y} + (1-\gamma)y_0$. If country i does not renege, it receives deposit, y_0, shares the total output, $[\bar{y} + (n-1)\underline{y}]$ with the other countries, and also shares the total verification cost, $\int \phi_{j-\{i\}} \mathrm{d}j \geq 0$. Thus country i will not renege if:

$$\bar{y} + (1-\gamma)y_0 \leqslant y_0 + \frac{1}{n}[\bar{y} + (n-1)\underline{y}] - \frac{1}{n}\int \phi_{j-\{i\}} \mathrm{d}j. \tag{1}$$

Although this constraint varies by country, the operative constraint for the coalition is that of the country with the lowest cost, ϕ_0. Furthermore, the enforcement constraint becomes less binding as γ increases and $\phi_{j-\{i\}}$ decreases. For simplicity we assume that γ =1. Then this member will not renege if

$$y_0 \geqslant \frac{n-1}{n}(\bar{y} - \underline{y}) + \frac{1}{n}\int \phi_{j-\{0\}} \mathrm{d}j. \tag{2}$$

Countries have identical preferences, represented by the utility function, $U(\cdot) = u(y_i)$, where $u(\cdot)$ is strictly increasing, continuous, twice differentiable, strictly concave and normal in consumption. In period zero, a country makes one of two choices:

- Participate in a risk-sharing arrangement with other countries by joining a coalition (i.e., a multilateral agency); or
- Autarky – do not participate in an insurance arrangement.

If a country chooses autarky, it stores period zero endowment y_0. If a country joins the coalition, it signs a contract and deposits y_0 with the multilateral agency.[12] The contract specifies the expected transfers and consumption. A country will join the coalition if the expected utility from membership is as least as great as the expected utility in autarky, $u(y_a)$, where $u(y_a) = \pi u(y_0 + \underline{y}) + (1-\pi)u(y_0 + \bar{y})$.

We now discuss the information conditions. When there is private information, countries can misreport their realizations. The optimal social contract must induce truthful reporting. It is well known that under deterministic verification, this contract has the following features: (1) verification occurs only for low income reports; and (2) fixed payments are made when verification does not occur. Our model has only two states, and therefore verification occurs only when a country reports the low realization, $\underline{y}$.[13] Furthermore, all countries make equal transfers to the coalition when they receive a high realization. In the bad state, country i receives $\underline{y}$, pays verification cost ϕ_i, and transfers t_i to the coalition. In the good state, a country receives $\bar{y}$, and transfers fixed amount, α, to the coalition. In either state, the country gets back its deposit, y_0. Country i's expected utility is

$$U(\cdot) = \pi u(y_0 + \underline{y} - t_i - \phi_i) + (1-\pi)u(y_0 + \bar{y} - \alpha).$$

[11] Penalty γ proxies for loss of access to markets, reputation effects, etc.

[12] The notion of the deposit is partially similar to the allocation of special drawing rights (SDR) by the IMF. Countries are required to deposit a certain amount of money (referred to as SDR) with the IMF. For more about SDR see http://www.imf.org/external/np/exr/facts/sdr.htm.

[13] Krasa and Villamil (1994, Theorem 1) show that the monitoring set is a lower interval for risk averse agents with project returns described by 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. Assuming two states simplifies our analysis but does not change the form of the lower interval contract.

Let $W(\cdot)$ be the sum of members' expected utilities. The multilateral agency chooses transfer allocations t_i and α to maximize $W(\cdot)$. We now characterize the optimal contract when verification costs are exogenous.

3 The benchmark case: exogenous verification costs

In characterizing the optimal contract, we first abstract from informational problems and examine how a lack of contractual enforcement affects risk sharing. We next analyze the case with two frictions: information asymmetry and enforcement problems.

3.1 Optimal allocation: full information

Problem 1 Under full information, no verification occurs (i.e., $\phi_i = 0$). The multilateral agency chooses t_i and α to maximize:

$$W = \pi \int_0^n u[(y_0 + \underline{y}) - t_i]\mathrm{d}i + n(1-\pi)u(y_0 + \bar{y} - \alpha).$$

Subject to the aggregate feasibility constraint: $\pi \int_0^n t_i \mathrm{d}i + n(1-\pi)\alpha \leqslant 0$

The optimal expected transfer allocations are:

$$\alpha^* = \pi(\bar{y} - \underline{y}), \tag{3}$$

$$t_i^* = -\Big[(1-\pi)(\bar{y} - \underline{y})\Big]. \tag{4}$$

The expected optimal (unconstrained) consumption is $y_u^* = \pi(y_0 + \underline{y}) + (1-\pi)(y_0 + \bar{y})$. The participation constraint is given by $y_a \leqslant y_u^*$, and is the same for all countries. If it does not hold, all countries prefer autarky. If it is satisfied, all countries prefer to join the coalition. We assume that the constraint holds. Thus in the absence of informational and enforcement problems, the unconstrained expected welfare is, $W(n) = nu(y_u^*)$. Expected welfare is increasing in n and therefore the optimal coalition consists of all N countries. All countries are willing and able to join the coalition: there is no insurance rationing.

Now consider the case where enforcement is problematic. The constraint is

$$\bar{y} \leqslant y_0 + \frac{1}{n}[\overline{y} + (n-1)\underline{y}]. \tag{5}$$

Let $\bar{n}_e$ be the coalition size for which (5) holds with equality. When contracts are not enforceable, the optimal coalition size will be determined by $\bar{n}_e < N$. Thus, the multilateral agency will limit the coalition size to $\bar{n}_e$ and insurance rationing occurs: $(N - \bar{n}_e)$ countries are excluded from the coalition although they prefer to join. Thus, a lack of enforcement reduces welfare and leads to rationing, even when there is no information asymmetry.

3.2 Optimal allocation: private information

Problem 2 Choose t_i and α to maximize:

$$W = \pi \int_0^n u[(y_0 + \underline{y}) - t_i - \phi_i]\mathrm{d}i + n(1-\pi)u(y_0 + \bar{y} - \alpha).$$

Subject to the aggregate feasibility constraint: $\pi \int_0^n t_i \mathrm{d}i + n(1-\pi)\alpha \leqslant 0$

The optimal expected transfer allocations are now:

$$\alpha^* = \pi(\bar{y} - \underline{y}) + \pi\bar{\phi}(n), \tag{6}$$

$$t_i^* = -\Big[(1-\pi)(\bar{y} - \underline{y}) + \phi_i - \pi\bar{\phi}(n)\Big], \tag{7}$$

where $\overline{\phi}(n) = \frac{1}{n}\int \phi_i \mathrm{d}i$ is the average verification cost. The expected constrained consumption is $y_c^* = y_u^* - \pi\overline{\phi}(n)$, where y_u^* is the expected unconstrained level of consumption.

Clearly, expected consumption is the same across countries and across states, and is decreasing in the average verification cost, suggesting that a country's consumption is decreasing in the verification costs of other countries. Let $\Psi^* = n(y_u^* - y_c^*)$ and $\Delta W = (W_u^* - W_c^*)$, where W_c^* and W_u^* are the constrained and unconstrained expected welfare. Then $\Psi^* = n\pi\overline{\phi}(n)$ and ΔW are the expected deadweight-loss in consumption and welfare, respectively, generated as a result of the verification costs.

The coalition size that maximizes $W(n) = nu(y_c^*)$, which we denote by $\hat{n}$, satisfies $u = \pi[\phi_n - \bar{\phi}(n)]u'$. Appendix B shows that $W(n)$ is concave in n and $\hat{n}$ is decreasing in ϕ_i. When the enforcement constraint does not bind the multilateral agency limits the coalition size to $\hat{n}$ and insurance rationing occurs[14] – countries whose costs exceed the threshold, $\phi_{\hat{n}}$, are excluded from the coalition although they prefer to join.

We next consider the case where the enforcement constraint binds.[15] Recall that the operative enforcement constraint for the coalition is that of the lowest member, and is given by

$$y_0 \geqslant \frac{n-1}{n}(\overline{y} - \underline{y}) + \frac{1}{n}\int \phi_{j-\{0\}}\mathrm{d}j. \tag{8}$$

[14] We again assume that the participation constraint does not bind, $y_a \leqslant y_u^* - \pi\overline{\phi}(n) \forall i$.

[15] Note that countries are not guaranteed the payments stipulated in the contract. The actual transfers and consumption levels depend on the number and type of countries that are verified. For example if all countries get the bad realization, they are all verified, and they share the total output $n(\underline{y} + y_0)$ and the total cost of verification, $n\overline{\phi}(n)$. Thus each country's consumption allocation is given by $y_c^* = [\underline{y} + y_0 - \bar{\phi}(n)]$. Joining the coalition may not provide complete risk diversification ex post, but countries will join as long as coalition membership provides a higher expected utility than autarky.

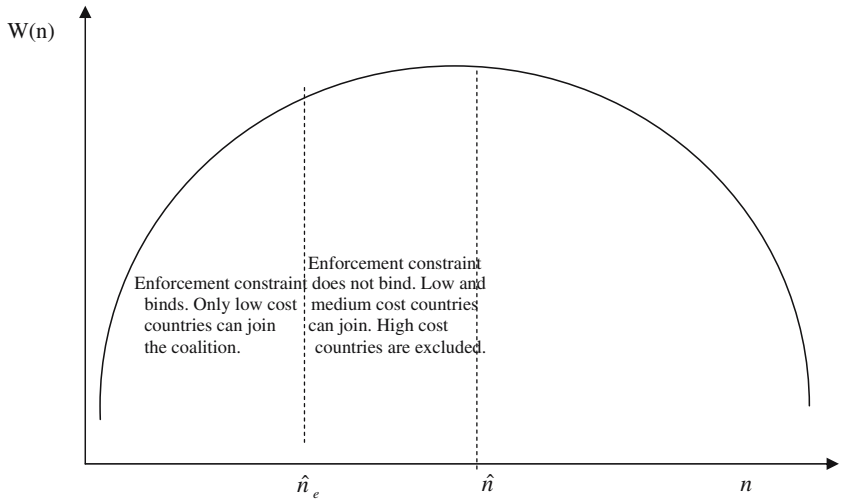

Fig. 1 Coalition size and social welfare, $W(n)$

Let $\hat{n}_e$ be the coalition size for which (8) holds with equality. Clearly, $\hat{n}_e$ is decreasing in $\phi(i)$ and the incentive constrained optimal coalition size is given by $n^* = \min\{\hat{n}, \hat{n}_e\}$. When (8) binds, $n^* = \hat{n}_e < \hat{n}$. Increasing the coalition size beyond $\hat{n}_e$ (up to $\hat{n}$) increases the expected welfare of the coalition. However, adding more (high ϕ_i) countries increases the likelihood that members will renege on the contract. This result is similar to that derived in financial contracts where loans are rationed as interest rates rise [e.g., Williamson (1986) shows that higher borrowing rates have two effects: loan revenue increases but so does the default probability, leading to a concave return function].

We illustrate the rationing result in Figure 1. Define countries i such that $\phi_i \leqslant \phi_{\hat{n}_e}$ are low cost countries, countries i such that $\phi_{\hat{n}_e} < \phi_i \leqslant \phi_{\hat{n}}$ are medium cost countries, and countries i such that $\phi_i > \phi_{\hat{n}}$ are high cost countries. The insurance rationing result can be summarized as follows: a lack of transparency (i.e., imperfect information) leads to insurance rationing that excludes high cost countries from the risk sharing arrangement. Furthermore, imperfect enforcement exacerbates the rationing problem: only low cost countries can join – medium and high cost countries are excluded although they prefer to join.

We now summarize the main results for the benchmark case.

Result 1 The optimal multilateral contract has the following features:

(i) $\alpha^* > 0$ and $t_i^* < 0$: Members with high realizations make payments to the coalition and those with low realizations receive transfers.
(ii) There is complete expected risk sharing across members and across states. Information asymmetry (verification costs) generates a deadweight loss and decreases consumption; consumption is decreasing in the monitoring cost of other countries – generating an externality.
(iii) When information and enforcement are perfect, no rationing occurs.
(iv) Imperfect enforcement reduces welfare and leads to rationing, even when information is symmetric.

(v) Information asymmetry reduces welfare and limits the number of countries that can participate in risk sharing arrangements. A lack of enforcement exacerbates the problem.

3.2.1 Discussion

The coalition permits members to share risk. High realization members make transfers while low realization members receive transfers. In our model countries receive transfers because they have experienced an exogenous adverse shock (i.e., $y = \underline{y}$) and not because they are poor. For instance, the top three borrowers from the IMF in 1998 were South Korea, Indonesia and Thailand (cf., IMF 1998a). The GDP per capita of these countries during that period was much higher than that of some members that did not draw from the fund. Also, developed countries sometimes draw from the Fund. For example, Canada drew from the Fund in 1962; Italy in 1964, 1977; UK in 1964, 1965, 1966, 1967, 1977, France in 1968 and the US in 1978 (Bordo and Schwartz 1998; Masson 1995). South Korea was on the IMF's creditor list until just before its financial crisis in 1997. Thus, membership allows all countries, both rich and poor, to diversify idiosyncratic consumption risk.

A second implication of Result 1 is that the optimal multilateral contract is *interdependent*: the "fundamental characteristics" of a country (the verification cost) affect the welfare of other countries because a country's welfare is decreasing in the monitoring cost of other countries. This introduces an *externality* into the problem. The cost incurred by the coalition from verifying members' reports is borne equally by all the countries. The cost-sharing feature of the optimal contract implies that low cost countries bear a relatively higher cost burden, and therefore subsidize high cost countries. This implication of our model is interesting because it suggests that the coalition "rewards" instead of "punishes" countries with weak institutions. This is a major criticism of the IMF. However, note that higher transfers do not translate into higher consumption: consumption is equal across countries.

Finally, Result 1 indicates that when there are no information or enforcement problems, welfare increases with coalition size, and therefore the multilateral agency should have an open door policy. However, when these frictions exist the optimal coalition size is limited to n^*. This result has implications for IMF membership. Specifically, the IMF has almost universal membership (184 members) and an open door policy. Our model characterizes conditions under which the open door policy is optimal, and hence when the Fund should bar high cost countries from membership. However, we note that some Fund programs are available only to countries with transparent institutions, which gives countries an incentive to lower costs. For example, the IMF's contingent credit line (CCL) provides funds for countries to assist with crisis prevention. To qualify for the CCL, countries must "meet high data quality standards." Clearly, one policy option is for the multilateral agency to mandate that countries improve their institutions, but the sovereignty status of countries makes this option infeasible. For this reason in section 4, we consider a tax/subsidy policy which can induce a sovereign country to improve its institutions *voluntarily*, thereby ameliorating the social inefficiency.

4 Endogenous verification costs

Our analysis so far suggests that low transparency (i.e., high verification costs) creates inefficiencies, but the benchmark model did not permit countries to alter the exogenous costs. This is problematic because countries can, and sometimes do, take actions to influence their institutions. We now augment the model to allow countries to reduce their costs if they choose to expend effort. Define $\Phi_i = \Phi(e_i, \phi_i)$, where ϕ_i is the status quo verification cost, and e_i is the level of effort expended. Assume $\Phi(\cdot)$ is increasing in ϕ and decreasing in e, $\frac{\partial \Phi}{\partial e}$ is increasing in e and $\Phi_i = \phi_i$ when $e_i = 0$. Following Mookherjee and Png (1989), assume that effort generates disutility, $v(e_i)$, and that utility is additively separable in consumption and effort, $U(\cdot) = u(y_i) - v(e_i)$, where $v(\cdot)$ is increasing, differentiable, strictly convex and $v(0) = 0$.[16]

Consider two cases:

Case 1 (Centralized) The coalition chooses the effort levels for the countries in the coalition.

Case 2 (Decentralized equilibrium) Each country chooses its level of effort, taking as given the effort of all other countries.

We now summarize the main results for the case when verification costs are endogenous.

Result 2 (i) When the marginal benefit of reducing cost, $\frac{\partial \Phi}{\partial e}$, is increasing (decreasing) in ϕ, higher cost countries make more (less) effort.

(ii) When e_i is endogenous, the coalition size may be smaller than the case when it is exogenous. Furthermore, when the participation constraint does not bind, insurance rationing occurs.

(iii) When the multilateral agency chooses e_i, effort levels are higher, verification costs are lower, and consumption is higher for a given n.

Problem 3 Choose t_i, α and possibly e_i to maximize:[17]

$$W = \pi \int_0^n u[(y_0 + \underline{y}) - t_i - \Phi(e_i, \phi_i)]\mathrm{d}i + n(1-\pi)u(y_0 + \bar{y} - \alpha) - v(e_i).$$

Subject to the aggregate feasibility constraint: $\pi \int_0^n t_i \mathrm{d}i + n(1-\pi)\alpha \leqslant 0$

Note that the transfer functions that solve Problem 3 are similar to that of the benchmark case.

Case 1. The Multilateral Agency Influences Institutions: coalition chooses e_i

The multilateral agency chooses e_i, t_i and α to maximize $W(\cdot)$, subject to the feasibility constraint. The optimal level of effort, e_i^{**} satisfies

$$v'(e_i) + \pi u'[y_u^* - \pi \bar{\Phi}(n)]\frac{\partial \Phi}{\partial e_i} = 0, \tag{9}$$

[16] Note that the exogenous case is a special case of the endogenous case, where effort is zero.

[17] We consider the participation and enforcement constraints separately.

where $\bar{\Phi}(n) = \frac{1}{n}\int \Phi_i \mathrm{d}i$. The expected constrained consumption, y_c^{**}, is given by: $y_c^{**} = y_u^* - \pi\bar{\Phi}(n)$. The coalition size that maximizes $W(\cdot)$, $\hat{\hat{n}}$, satisfies $u = \pi[\Phi_n - \bar{\Phi}(n)]u\prime + v(e_n)$.

To prove Result (i) note that (9) implies:

$$v'(e_j^{**})\frac{\partial\Phi(e_k^{**},\phi_k)}{\partial e_k^{**}} = v'(e_k^{**})\frac{\partial\Phi(e_j^{**},\phi_j)}{\partial e_j^{**}}. \tag{10}$$

Suppose $\phi_j < \phi_k$ and $\frac{\partial\Phi}{\partial e}$ is increasing in ϕ. Then $\frac{\partial\Phi(e_j^{**},\phi_j)}{\partial e_j^{**}} < \frac{\partial\Phi(e_k^{**},\phi_k)}{\partial e_k^{**}}$. It follows from (10) that $v'(e_j^{**}) < v'(e_k^{**})$, and therefore $e_j^{**} < e_k^{**}$.

Finally, the optimal coalition size is now affected by the participation constraint, which differs for each country and is given by

$$u(y_a^*) \leqslant u[y_u^* - \pi\bar{\Phi}(n)] - v(e_i^*). \tag{11}$$

To prove Result (ii), let $\hat{\hat{n}}_p$ be the coalition size for which (11) holds with equality. When the marginal benefit of reducing cost, $\frac{\partial\Phi}{\partial e}$, is increasing in ϕ, higher cost countries make more effort and therefore incur a higher disutility, $v(\cdot)$. Here, higher Φ_i countries will opt not to join the coalition – countries i such that $i \leqslant \hat{\hat{n}}_p$ (countries for which $\Phi_i \leqslant \Phi_{\hat{\hat{n}}_p}$) are willing to join the coalition. The opposite holds if $\frac{\partial\Phi}{\partial e}$ is decreasing in ϕ: lower cost countries will not join the coalition since they expend more effort.

Similar to the exogenous case, the enforcement constraint satisfies

$$y_0 \geqslant \frac{n-1}{n}(\overline{y} - \underline{y}) + \frac{1}{n}\int \Phi_{j-\{0\}}\mathrm{d}j. \tag{12}$$

Let $\hat{\hat{n}}_e$ be the coalition size for which (12) holds with equality. Then the incentive compatible optimal coalition size, n^{**}, is given by $n^{**} = \min\{\hat{\hat{n}}_p, \hat{\hat{n}}_e, \hat{\hat{n}}\}$. When $\hat{\hat{n}}_p > \min\{\hat{\hat{n}}_e, \hat{\hat{n}}\}$, the participation constraint does not bind and insurance rationing occurs.

Case 2. The Multilateral Agency does not Influence Institutions: country chooses e_i

Each country anticipates the multilateral contract and then chooses its level of effort, e_i, to maximize the country's utility, $U(\cdot)$. The optimal level of effort, e_i^{***} satisfies

$$v'(e_i) + \frac{\pi}{n}u'[y_u^* - \pi\bar{\Phi}(n)]\frac{\partial\Phi}{\partial e_i} = 0. \tag{13}$$

To prove Result (iii), define $g(e_i) = v'(e_i) + \frac{\pi}{n}u'[y_u - \pi\bar{\Phi}(n)]\frac{\partial\Phi}{\partial e_i}$. Then from (9), $g(e_i^{**}) > 0 = g(e_i^{***})$. Since $g(\cdot)$ is increasing in e_i, it implies that $e_i^{**} > e_i^{***}$. The result follows.

4.1 Discussion

The intuition behind Result (i) is clear. High ϕ countries expend more effort because the benefit that accrues to the coalition (and also to the country) is larger when a high ϕ country makes an effort to reduce its costs than when a low ϕ country makes a similar effort. Result (ii) shows that unlike the exogenous cost case, asymmetric information now limits the number of countries *willing* to join the coalition. Thus, the size of the coalition can be reduced both by countries' inability and unwillingness to join. Furthermore, insurance rationing occurs.

The intuition behind (iii) is that e_i generates a positive multilateral externality and moral hazard: an increase in effort by one country reduces the average verification cost, and therefore increases the consumption of all countries in the coalition. However, the country incurs a disutility, $v(e_i)$, from taking such an action. The individually optimal, but socially sub-optimal, choice of e_i by an individual country can be rectified by a social contract. This aspect of our analysis provides a rationale for the existence of multilateral organizations and formalizes a claim by Krueger (1997, p. 21) who notes that "if one can demonstrate that there are Pareto-superior outcomes or sufficiently large externalities, a clear rationale for (multilateral) institutions could result." Result (iii) also shows that a better outcome is achieved when the agency chooses e_i, which is consistent with Nsouli et al. (2004).

By choosing e_i, the multilateral agency is implicitly choosing the cost structure for the countries in the coalition. This is synonymous to the agency taking a "brute force" approach and mandating countries to improve their institutions. However, the sovereignty status of countries limits the extent to which the agency can compel countries to take certain actions.[18] Thus, agencies often create incentives for countries to voluntarily reduce their cost. For example, according to the IMF, the reason for creating the CCL was "to provide *incentives* for members to adopt strong policies and adhere to internationally accepted standards" (cf., IMF 1999, p. 1). In this spirit we now construct an example to illustrate a tax/subsidy policy to give countries the incentive to choose the Pareto optimal effort.

Example Suppose that a country reduces its cost by a fraction $\eta(e_i)$ if it expends effort, e_i, and that the cost function takes the form

$\Phi_i = \Phi(e_i, \phi_i) = [1 - \eta(e_i)]\phi_i = \left(1 - \frac{e_i}{1+e_i}\right)\phi_i$. Then there exists a tax/subsidy scheme that induces countries to choose the Pareto optimal level of effort. Furthermore, the subsidy is increasing in effort, e_i, and verification costs, ϕ_i.[19]

Proof Suppose country i gets a subsidy of $s_i\eta(e_i)\phi_i$ from the multilateral agency if it reduces its verification cost by a fraction $\eta(e_i)$. Also assume that each country

[18] Developing country governments often complain that the policies of the IMF and World Bank are too intrusive and undermine their sovereignty status. For example, since July 2000, the central banks of countries that draw from the Fund are required to publish annual financial statements audited to *international standards* by outside experts. In April 2001, Russia's representative at the IMF announced that Russia would not draw from the Fund because it considered the IMF's demands as "intrusive and irritating" and preferred not to subject itself to such inquiry. See "Kohler attempts to focus IMF," 4/24/2001, *Financial Times*.

[19] The result holds provided $\Phi(\cdot)$ is increasing in ϕ and decreasing in e.

pays a lump-sum tax T. Then country i chooses its level of effort, e_i, to maximize

$$U(\cdot) = u[y_u^* - \pi\bar{\phi}(n) + \frac{\pi}{n}\int\{(1+s_j)\eta(e_j)\phi_j - T\}\mathrm{d}j] - v(e_i).$$

Subject to the feasibility constraint $nT = \int s_j\eta(e_j)\phi_j\mathrm{d}j$.

The optimal effort level, $\bar{e}_i$, satisfies

$$v'(e_i) + \frac{\pi}{n}(1+s_i)u'[y_u^* - \pi\bar{\Phi}(n)]\frac{\partial\Phi}{\partial e_i} = 0. \tag{14}$$

To achieve the outcome in Case 1, we compare equations (9) and (14). Clearly, $\bar{e}_i = e_i^{**}$ when $s_i = n-1$. The total subsidy to country i, S_i, is therefore given by $S_i = (n-1)\phi_i\frac{e_i}{1+e_i}$, which is increasing in e_i and ϕ_i. □

5 Extension of the benchmark model

In this section we discuss two possible extensions of the benchmark model when verification costs are exogenous: we examine how income affects welfare gains from risk sharing and the implications of risk-sharing in a dynamic model.

Extension 1: How does income affect the gains from welfare?

The benchmark model assumes that countries differ in only one respect – cost of verification. However, multilateral agencies such as the IMF consist of rich and poor countries. Furthermore, poor countries tend to have a less diversified economy, and therefore tend to experience more fluctuations in output and consumption, suggesting that poorer countries may benefit more from international risk sharing.[20] For example, see Head (1995) and Rogoff (1999).

We extend our model to capture this stylized fact by introducing a second consumption good, X. We assume that each country has access to a production technology that is used to produce good X. Let x_i be the quantity of good X produced by country i using technology θ_i [i.e., $x_i = x_i(\theta_i)$]. The production technology embodies country specific assets such as capital, labor and infrastructure that affect productivity and growth. We assume that rich countries adopt better technologies and therefore have a higher x_i.[21] There is no uncertainty about good X. The form of each country's preferences is identical, represented by the additively separable utility function, $U(x(\theta_i), y_i) = h(x_i) + u(y_i)$, where, $h(\cdot)$ and $u(\cdot)$ are strictly increasing, continuous, twice differentiable, strictly concave and normal in consumption. Thus countries now differ in two respects: adoption of production technology, θ_i, and verification costs, ϕ_i. For simplicity we assume that the participation and enforcement constraint do not bind. Result 4 follows:

Result 4 Risk sharing is more beneficial to "poor" countries than "rich" countries.

Proof Define $f(\cdot) = U_c^* - \bar{U}$, where U_c^* and $\bar{U}$ are the expected utilities under coalition membership and autarky respectively and $U(x(\theta_i), y_c^*) = h(x_i) + u(y_c^*)$. Then, $f(\cdot) = u(y_c^*) - u(y_a)$. The result follows from the fact that the gain in utility from coalition membership is given by $\frac{u(y_c^*)-u(y_a)}{h(x_i)+u(y_a)}$, and is decreasing in x_i. □

[20] We thank an anonymous referee for raising this issue.

[21] See Parente and Prescott (2000) for documentation and an explanation of this fact.

Extension 2: How does a multi-period horizon affect risk-sharing?

To answer this question, we extend the benchmark model from a two-period to an infinite horizon model. For simplicity we assume that the discount factor is one. Assume that in even periods, each country receives a non-random endowment amount, y_0, of good Y. In odd periods, the endowment is random with realization of Y equaling $\underline{y}$ or $\bar{y}$. Consumption occurs in odd periods.

Result 5 Prolonged loss of access to social insurance reduces rationing and increases welfare.

Proof Suppose a country obtains the high realization, $\overline{y}$, in period $(2t+1)$. The only operative constraint is the enforcement constraint. Then the country has the option to renege on the agreement. If it reneges, it keeps $\overline{y}$, losses its deposit and remains in autarky in subsequent periods, with utility $u(y_a)$. Then the enforcement constraint is

$$u(\overline{y}) + \sum_{k=t+1}^{\infty} u(y_a)_{2k+1} \leqslant \sum_{k=t}^{\infty} u\left(y_0 + \frac{1}{n}[\overline{y} + (n-1)\underline{y}] - \frac{1}{n}\int \phi_{j-\{0\}}\mathrm{d}j\right)_{2k+1}. \tag{15}$$

The left hand side is the present value of utility from reneging and the right hand side is the present value of utility from not reneging in period $(2t+1)$, thereby maintaining membership in the coalition.

Recall that the enforcement constraint in the two-period model is given by

$$\overline{y} \leqslant y_0 + \frac{1}{n}[\overline{y} + (n-1)\underline{y}] - \frac{1}{n}\int \phi_{j-\{0\}}\mathrm{d}j. \tag{16}$$

Let $\hat{n}_e$ be the coalition size when (16) binds and define

$H(n) = y_0 + \frac{1}{n}[\overline{y} + (n-1)\underline{y}] - \frac{1}{n}\int \phi_{j-\{0\}}\mathrm{d}j$. Then $H(n)$ is decreasing in n and

$$H(\hat{n}_e) = \overline{y}. \tag{17}$$

Let $\hat{n}_e^{'}$ be the coalition size when (15) binds, then we have

$$\sum_{k=t}^{\infty} u\left(H(\hat{n}_e^{'})\right)_{2k+1} = u(\overline{y}) + \sum_{k=t+1}^{\infty} u(y_a)_{2k+1}.$$

Note that $y_a < \overline{y}$, and therefore $\sum_{k=t}^{\infty} u\left(H(\hat{n}_e^{'})\right)_{2k+1} < u(\overline{y}) + \sum_{k=t+1}^{\infty} u(\overline{y})_{2k+1}$.

This implies

$$H(\hat{n}_e^{'}) < \overline{y}. \tag{18}$$

Equations (17) and (18) and the fact that $H(n)$ is decreasing in n imply that $\hat{n}_e^{'} > \hat{n}_e$. The results follow. □

The intuition behind the result is clear. Increasing the penalty for default relaxes the enforcement constraint and therefore increases the coalition size and welfare. Note that the opposite would be true if capital accumulation were possible because this provides an opportunity to self-insure. Specifically, the expected consumption in autarky would increase. This tightens the constraint and causes the optimal coalition size and welfare to decrease.

6 Conclusion

This paper analyzes risk-sharing arrangements in a coalition of 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. The cost of verification reflects the "transparency" of a country's institutions. Lack of transparency, imperfect enforcement and voluntary participation can compromise risk sharing – reducing consumption and welfare and causing insurance rationing. Countries can ameliorate these problems by forming a multilateral agency, which resembles the IMF in key ways.

The importance of transparency to the operations of multilateral agencies has generated a discussion as to whether these organizations should influence the institutions in their member countries.[22] Some have argued that the IMF should limit the scope of its operations and return to its original purpose: short-term emergency lending (cf., IFIAC Report 2000).[23] Others argue that the lack of transparency among member countries undermines the operations of the IMF, and therefore the Fund's mandate should be expanded to cover issues relating to governance, accountability and quality of institutions (cf., Frankel 2003; Nsouli et al. 2004). We present an analytical framework to study the extent to which lack of transparency can compromise risk-sharing, when participation by sovereign countries cannot be compelled and they can renege on ex ante agreements (i.e., the problem is constrained by voluntary participation and limited enforcement). We show how a social contract (multilateral agency) can improve outcomes.

Finally, our results provide a plausible explanation for the international risk sharing puzzle: why is there little international risk sharing despite apparently large potential welfare gains from international diversification?[24] In the absence of information and enforcement problems, all countries would participate in risk sharing and attain the *potential* (unconstrained) welfare benefits of risk sharing. However, these frictions, when they exist, have two effects. First, they reduce the welfare gains from risk-sharing.[25] As a consequence, some countries willingly refrain from participating in risk sharing arrangements because they are better off in autarky. Second, they can cause insurance rationing: only countries with transparent institutions are permitted to participate in risk sharing arrangements. Constructive policies such as the CCL can induce countries to increase transparency, thus altering their willingness and ability to participate in voluntary risk-sharing arrangements. Further, such policies, which reward countries for good institutions, are likely to have lower political costs of implementation (cf., Parente and Prescott 2000).

[22] For example, the panel session of the IMF's annual conference in 2002 was titled "Promoting Better National Institutions: The Role of the IMF". See http://www.imf.org/external/pubs/ft/staffp/2002/00-00/arc.htm.

[23] The US Congress created the International Financial Institutions Advisory Committee (IFIAC) in 1998 to review the operations of the IMF and the World Bank. See Masson (1995), Krueger (1997), and Rogoff (1999) for an analysis of the functions of the IMF.

[24] There is extensive empirical evidence suggesting that risk sharing across countries is quite limited (e.g., French and Porterba 1991; Backus et al. 1992).

[25] Wagner (2002) finds that the welfare loss due to lack of enforcement and moral hazard is quite substantial. For example, for a country that insures about 50% of its income, the loss can be about 25% of income.

Appendix A: The Ukraine

This appendix summarizes the facts of a recent example of information misreporting to the IMF by a member country, the Ukraine. As indicated in the quote below by an IMF official, inaccurate reports from countries impede the agency's operations.

> "In the late 1990s, we discovered that two large borrowers (Russsia and Ukraine) had *misreported* information to us (the IMF) and *gained access to our resources under false pretenses*. This is very serious. *Incomplete* or *misleading* information compromises our ability to judge policy aspects correctly, and *undermines the very integrity of our operations*." Eduard Brau, Head of IMF's Treasury Department, May 13, 2002.

In January 2000 *The Financial Times* reported that Ukraine's central bank had misreported financial information in order to obtain IMF loans. They also alleged that some of the funds were misappropriated to private foreign accounts. The National Bank of Ukraine engaged the international auditing firm Price Waterhouse Coopers to perform an audit.[26] The firm reviewed 21 National Bank of Ukraine transactions from December 1996 to January 1998, totaling about $1.28 billion, to determine whether the central bank had followed standard procedures required by the IMF to calculate financial information (i.e., net international reserves and net domestic assets).

The audit found that Ukraine's reserves were "potentially overstated by an amount that varied from $391 million in September 1997 to $713 million in December 1997." In addition, the audit found that the central bank double counted deposits made by Ukrainian commercial banks in December 1996 and November–December 1997 as both deposits into the central bank's international reserve fund and its commercial banks' assets account. Finally, the report found that by misreporting the size of its reserves, Ukraine received three loan disbursements that it might not otherwise have been able to obtain. The three disbursements totaled SDR145 million (about $200million).

Based on the audit and its own investigation, The IMF Directors found that Ukraine breached its obligations under Article VIII, section 5 of the IMF's Articles of Agreement to report accurate information to the Fund. In addition, the Directors found that Ukraine had made two non-complying disbursements totaling approximately SDR 72.5 million based on its false reserves statement. They found that the third disbursement would have been non-complying were it not for a 2-year limitation period under the IMF's Guidelines on Misreporting.

The IMF Director's response to this incident was fivefold:

1. The IMF pledged to continue quarterly audits of the central bank's reserve position.
2. The IMF required the central bank to hold all reserves in first-rank international banks, and refrain from any transactions that would impair reserve liquidity.
3. The Directors noted their intention to issue a complaint for a declaration of ineligibility of Ukraine to use the IMF's general resources if it failed to adhere to these understandings.

[26] The results of the audit are on the IMF website http://www.imf.org/external/np/sec/nb/2000/nb0026.htm.

4. The Directors committed to keep the proceeds of any purchases made under an Extended Arrangement in Ukraine's SDR account held with the IMF.
5. The Directors "welcomed the voluntary repurchase of SDR 72.5 million made by Ukraine against the two purchases that it would not have been entitled to make had the level of net international reserves not been overstated."

The Directors noted that the voluntary loan repayment of SDR 72.5 million (about $100 million) by Ukraine "was a tangible demonstration of a commitment by the authorities to break with the past and ensure accurate reporting in the future." They further noted that no evidence had been presented of misappropriation of Ukraine's reserves, although the auditor's examinations were incomplete because of the non-response of some third-party banks to the audit confirmation requests.

Appendix B

Proposition *There exists a coalition size $\hat{n}$ that maximizes the coalition's welfare, is unique, and satisfies the following equation:* $\frac{1}{n}\frac{u(y_c^*)}{u'(y_c^*)} = \pi\frac{\partial\overline{\phi}(n)}{\partial n}$, *where* $\overline{\phi}(n) = \frac{1}{n}\int \phi_i \mathrm{d}i$. *Furthermore, $\hat{n}$ is decreasing in verification cost, ϕ_i.*

Proof

$$W(y_c^*) = nu(y_c^*) = nu[y_u^* - \pi\overline{\phi}(n)].$$

Then

$$\frac{\partial W}{\partial n} = u(y_c^*) - nu'(y_c^*)\pi\frac{\partial\overline{\phi}(n)}{\partial n},$$

$$\frac{\partial^2 W}{\partial n^2} = nu''(y_c^*)\left(\frac{\partial y_c^*}{\partial n}\right)^2 + 2u'(y_c^*)\frac{\partial y_c^*}{\partial n} + nu'(y_c^*)\frac{\partial^2 y_c^*}{\partial n^2}.$$

Substituting $\frac{\partial y_c^*}{\partial n} = -\pi\frac{\partial\overline{\phi}(n)}{\partial n}$ and $\frac{\partial^2 y_c^*}{\partial n^2} = -\frac{2\pi}{n}\frac{\partial\overline{\phi}(n)}{\partial n} - \frac{\pi}{n}\frac{\partial\phi_n}{\partial n}$

$$\frac{1}{\pi}\frac{\partial^2 W}{\partial n^2} = n\pi u''(y_c^*)\left(\frac{\partial\bar{\phi}(n)}{\partial n}\right)^2 - u'(y_c^*)\frac{\partial\phi(n)}{\partial n},$$

where $\frac{\partial\overline{\phi}_n}{\partial n} = \frac{\phi_n - \overline{\phi}(n)}{n}$. The second order condition for maximization is satisfied since $u'' < 0$ and $\frac{\partial\phi_n}{\partial n} > 0$. □

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