RESEARCH SEMINAR IN INTERNATIONAL ECONOMICS

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Ann Arbor, Michigan 48109-1220

SEMINAR DISCUSSION PAPER NO. 198

OPTIMAL ADJUSTMENT POLICY AND DEBT-RESTRUCTURING UNDER ASYMMETRIC INFORMATION

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April 1987

Abstract

With some probability a country will find it infeasible to honor its international obligations. If the probability distribution of that feasibility depends on unobservable aspects of the country's economic policy, the moral hazard present requires the imposition of an incentive-compatibility constraint on the design of debt-restructuring agreements. In this paper we discuss the implications of such a constraint for the design of a Pareto-optimal agreement.

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1. Introduction

Governments of developing countries and their foreign creditors have recently agreed, assisted by the International Monetary Fund, to several restructurings of sovereign-debt. These agreements essentially consist of two conditions: i) a repayment schedule, and ii) an adjustment policy. The repayment schedule is the intertemporal sequence of net transfers of resources between the country and its international creditors. The adjustment policy is the set of actions designed to make it feasible for the country to transfer resources to its creditors.[1]

When the scheduled net flow of foreign financing is negative, (when the foreign debt must be serviced or repaid), there is a possibility of default. This can be either formal, when the country refuses to pay, or de facto, when the country finds it infeasible to pay.

Most of the literature on international debt has dealt with the first form of default: the refusal to pay. In particular, the literature on debt repudiation has emphasized the limits imposed on a country's ability to borrow abroad by the absence of an international authority capable of enforcing payments across sovereign borders.[2] In this paper, we deal with the second type of default: when with some probability the country will find it infeasible to honor its obligations.

This paper draws from my Ph. D. dissertation at The University of Chicago. I thank the members of my dissertation committee, Michael Mussa (chairman), Jacob Frenkel, and Larry Sjaastad, for their advice and encouragement. I also thank, for their helpful comments at different stages of this work, Jorge Avila, Theodore Bergstrom, Alan Deardorff, Roger Gordon, John Laitner, Pablo Guidotti, Robert Stern, Robert Townsend, and seminar participants at the universities of Colorado-Boulder, Chicago, and Michigan, and at the VI Latin American Meeting of the Econometric Society.

[1] A payment is feasible when the debtor has an asset or a commodity acceptable to the creditor as a means of payment.

[2] See for example Eaton and Gersovitz(1981), Sachs and Cohen(1983), Sachs(1983) and Almansi(1986b).

When the feasibility of international transfers of resources is entirely random, the design of a debt-restructuring agreement is a rather simple problem. In general, however, the probability distribution of feasible transfers depends on the economic policy pursued by the country. This explains the need for stipulating an adjustment policy within a foreign debt-restructuring agreement. Moreover, if the creditors have a limited ability to monitor policy actions, the problem becomes considerably more difficult because of the moral hazard present in the choice of those actions.

There is evidence suggesting significant asymmetric information in debt-restructuring negotiations.[3] For example, the set of easily measurable economic indicators used by the International Monetary Fund in its stand-by lending, and its efforts to develop the technique of "enhanced surveillance," reveal the Fund's limited monitoring capabilities. The recent initiative by international banks of creating the Institute of International Finance Inc. is also an indication of concern about the limited information available to creditors.

Under asymmetric information, only the country's self-interest can insure the honoring of policy provisions. Therefore, to make individually rational for the country to honor the policy provisions, we must impose an incentive-compatibility constraint on the design of restructuring agreements. In this paper we discuss the implications of such a constraint for the design of a Pareto-optimal agreement.

The paper is organized as follows. Section II describes our primary assumptions. Section III presents the model we use in the subsequent analysis. Section IV characterizes the properties of an optimal agreement under moral hazard. Section V investigates the implications of the adjustment policy choice for the design of the optimal repayment schedule. Finally, Section VI discusses the policy implications of our analysis and closes the paper with some concluding remarks.

2. Primary Assumptions

We base our analysis on the following three assumptions:

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[3] See Watson et al.(1986).

Assumption 1. *The only link between the country and the international capital market is the current group of foreign creditors. To internalize the incentive-effects of their lending, the creditors negotiate with the country's authorities through a centralized agency.*

Assumption 2. *Whatever the nature of the bargaining process, its outcome is Pareto-efficient. There is no other agreement which gives the country a higher expected welfare and also repays the debt in terms consistent with the creditors's preferences.*

Assumption 3. *To highlight the implications of the incentive-compatibility constraint, we assume away the problem of enforcing commitments to execute observable actions. The country will honor both the state-contingent repayment schedule and the observable aspects of the agreed policy choice.*

3. The Model

The simplest structure we can use to discuss the design of an optimal debt-restructuring agreement is a two-period model. This setting describes the present, when the agreement is negotiated, and the future, when the country repays the debt.

Let $s_t = (y_t, \xi_t)$ be the state of nature in period t, $t = 0, 1$, where y_t is the country's aggregate income, and ξ_t the maximum feasible payment. Assume that the parties negotiate the agreement after the current state of nature realizes and everyone observes it.

Let Φ be the repayment schedule. By risk-sharing considerations, an exclusive and Pareto-efficient agreement between the country and its foreign creditors requires a state-contingent repayment schedule.[4] Since we have uncertainty only about the future realization of the state of nature, we write the repayment schedule as $\Phi = \{\phi_0, \phi_1(s)\}$.

The repayment schedule must be feasible. We represent this fact with the feasibility constraints $\phi_0 \leq \xi_0$ and $\phi_1 \leq \xi_1$.

Let $\theta \in \Theta$ be a vector contained in the finite set of available adjustment policies,Θ. There is an underlying macroeconomic model that generates a joint probability distribution

[4] A state-contingent repayment schedule implies that the creditors will write-off their loans in certain states of nature. We do not observe that kind of contingency formally included in actual debt-restructuring agreements. If these restructurings are optimal, however, the state-contingency must be part of an implicit understanding, as in the implicit contracts of Azariadis(1975).

function, $P(y, \xi \mid \theta)$, of aggregate income and the maximum feasible international payment, conditional on the vector of policy parameters θ. We denote the probability mass function as $p(y, \xi \mid \theta)$.

The discrete random variables y and ξ can take any value in the finite set $S = Y \times \Xi$. We assume that S is independent of θ.[5]

Given the agreed-upon payment schedule, Φ, present consumption is $c_0 = y_0 - \phi_0$, and future consumption, contingent on state $s \in S$, is $c_1(s) = y_1 - \phi_1(s)$. The strictly concave utility function $u(c_t)$ represents the country's preferences over different consumption levels both in the present and the future.

Conditional on a particular policy choice, θ, and repayment schedule, Φ, the country's expected utility over the entire repayment horizon is defined by the following equation:

$$U(\Phi, \theta) = u(c_0) + \beta \sum_{Y} \sum_{\Xi} u(c_1(s)) p(s \mid \theta)$$

where $\beta \in (0, 1)$ is the intertemporal-preference discount factor.

To highlight the effects of the incentive problems on the optimal repayment schedule, we assume that the creditors are risk neutral. Given the adjustment policy, θ, and the repayment schedule, Φ, the creditors's expected utility is the present value of the expected payments:

$$V(\Phi, \theta) = \phi_0 + \delta \sum_{Y} \sum_{\Xi} \phi_1(s) p(s \mid \theta)$$

where $\delta \in (0, 1)$ is the creditors's discount factor.[6]

For illustrative purposes, it is useful to discuss briefly the properties of the optimal debt-restructuring agreement under symmetric information. Since we assume that the country is risk averse and that the creditors are risk neutral, the solution is trivial. There are two possibilities:i)an interior solution, and ii)a boundary solution. In an interior solution the feasibility constraints are not binding. Hence, the creditors allow the country to enjoy a

[5] This means that the adjustment policy determines the probability assigned to each possible event, but it does not determine which events are possible.

[6] Note that in computing $U(\Phi, \theta)$ and $V(\Phi, \theta)$ we use the same joint probability distribution: we assume homogeneous beliefs about the effects of the adjustment policy on the state of the economy. The case of heterogeneous beliefs is discussed in Almansi(1986a).

state-independent consumption flow, taking for themselves the income risk.[7] In a boundary solution the optimal payment equals the maximum feasible payment in at least one state of nature. This, of course, implies a departure from the risk-sharing agreement which would be optimal considering only the assumed attitudes towards risk. It is optimal, however, given that payments must satisfy the feasibility constraints.

4. The Design Problem under Moral Hazard

There is moral hazard in a debt-restructuring agreement when a government must undertake an unobservable policy action that, given the agreed repayment schedule Φ, it does not perceive as maximizing the country's expected welfare. Since the only way to enforce an unobservable policy choice is to make it self-enforcing, we must include incentive-compatibility constraints in the description of our problem.[8]

Definition 1. *Policy $\theta_p \in \Theta$ is incentive-compatible with the repayment schedule Φ if $U(\Phi, \theta_p) \geq U(\Phi, \theta)\ \forall \theta \in \Theta$.*

We can describe the design of an optimal restructuring agreement between a country and its creditors as solving a sequence of two problems. These are Problems 1 and 2 below.

Problem 1. *For every $\theta_p \in \Theta$, maximize $U(\Phi, \theta_p)$ with respect to Φ, subject to:*

$$V(\Phi, \theta_p) \geq R \tag{1}$$

$$\phi_0 \leq \xi_0, \phi_1(s) \leq \xi_1 \forall s \in S \tag{2}$$

$$U(\Phi, \theta_p) \geq U(\Phi, \theta) \forall \theta \in \Theta \tag{3}$$

where (1) is the repayment constraint, which says that the expected payment must be greater than or equal to the debt to be repaid, R; (2) are the feasibility constraints, which say that the optimal payment in every period and in every state of nature must be smaller

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[7] Michael Mussa interpreted this result as if the creditors "buy the country." This is what would happen if the country were to offer, and the creditors to accept, titles to domestic real assets as repayment, thus transforming debt in direct investment: a debt-equity swap.

[8] We borrow heavily from the principal-agent literature. See for example Grossman and Hart(1983), Hart(1983), and Holmstrom(1979). For a survey see Arrow(1985).

than or equal to the maximum feasible payment in that period and that state; and (3) is the incentive-compatibility constraint just defined.

Let $\Phi(\theta_p)$ denote the solution to Problem 1. This solution, if it exists, gives the Pareto optimal risk-sharing rule when the country must implement policy θ_p, and that implementation is incentive-compatible. Of course, such a solution may not exist.[9] Let Θ^* be the subset of adjustment policies for which a solution to Problem 1 exists. We call the policies contained in Θ^* implementable. The final step in the optimal design problem is to choose the best among them. This is Problem 2 below.

Problem 2. *Maximize* $U(\Phi(\theta_p), \theta_p)$ *with respect to* θ_p*, subject to* $\theta_p \in \Theta^*$.

The Optimal Agreement

To simplify the characterization of the optimal agreement, we reduce the set of available adjustment policies to just two alternatives. The gains in clarity and tractability outweigh the loss of generality.

Let $\Theta = \{\theta_1, \theta_2\}$ be the set of alternative policy choices, and assume we want to implement policy θ_1. To characterize the optimal repayment schedule when the agreement requires the implementation of policy θ_1, we construct the Lagrangian for Problem 1. Let λ be the Lagrange multiplier associated with the repayment constraint, μ_0 and $\mu_1(s) \forall s \in S$ the multipliers associated with the feasibility constraints, and τ the multiplier associated with the incentive compatibility constraint. Hence, we have:

$$L(\Phi, \theta_1) = U(\Phi, \theta_1) + \lambda[V(\Phi, \theta_1) - R]$$
$$+\mu_0[\xi_0 - \phi_0] + \sum_{Y}\sum_{\Xi} \mu_1(s)[\xi_1(s) - \phi(s)]$$
$$+\tau[U(\Phi, \theta_1) - U(\Phi, \theta_2)]$$

If a solution exists, it can be characterized by the first order conditions obtained by differentiation of the Lagrangian with respect to Φ. Assuming that the incentive-compatibility constraints are binding, the first order conditions are:

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[9] For R large enough there may be no policy that can make feasible the repayment. If there are some policies that would satisfy the feasibility constraints, there may be no way of making these policies incentive-compatible.

$$u'(y_0 - \phi_0) \leq \lambda, a_0 - \phi_0 \geq 0,$$

with complementary slackness, and

$$\beta u'(y - \phi(s))[1 + \tau(1 - p(s \mid \theta_2)/p(s \mid \theta_1))] \leq \lambda\delta, \xi(s) - \phi(s) \geq 0, \forall s \in S,$$

with complementary slackness.

Proposition 1 states a fundamental property of interior solutions to Problem 1, (i.e., when the feasibility constraints are not binding).

Proposition 1. *If the incentive-compatibility constraints are binding, then a first-best Pareto optimal risk-sharing rule is unattainable.*

Whenever $p(s \mid \theta_1)$ differs from $p(s \mid \theta_2)$ the optimal risk-sharing rule will not only be affected by the risk aversion of debtors and creditors, but also by the stochastic behavior of the economy under both the adjustment policy to be implemented and its alternative. This means that the constraint imposed by the presence of moral hazard due to asymmetric information reduces the extent of risk-sharing between the country and its foreign creditors. Consequently, we obtain a second-best Pareto-optimal risk-sharing rule.

In boundary solutions, that is, when the feasibility constraints are binding, the optimal payment equals the maximum feasible payment. This obviously implies that the optimal payment does not depend on incentive considerations. Hence, the more states there are with payments at the boundary, the less ability the creditors have to affect the country's incentives.

To investigate how incentive considerations affect the design of the optimal repayment schedule, we need to describe the information provided by the realization of a particular state of nature. The following definition provides the required description.

Definition 2. *State $s' = (y', \xi') \in S$ is better news than state $s'' = (y'', \xi'') \in S$ if*

$$p(s' \mid \theta_2)/p(s' \mid \theta_1) \leq p(s'' \mid \theta_2)/p(s'' \mid \theta_1)$$

Bayes theorem provides a natural interpretation for this definition. Let $\pi(\theta_1)$ and $\pi(\theta_2)$ be arbitrary prior probability beliefs about which policy, θ_1 or θ_2, has been undertaken. By Bayes theorem $p(s \mid \theta_p)\pi(\theta_p) = \pi(\theta_p \mid s)p(s)$, where $\pi(\theta_p \mid s)$ is the posterior probability that policy $\theta_p, p = 1, 2$, has been undertaken, once state $s \in S$ has been observed, and $p(s) = \sum_{\theta_p \in \Theta} p(s \mid \theta_p)$. Then, if s' is better news than s'', we have:

$$\pi(\theta_2 \mid s')/\pi(\theta_1 \mid s') \leq \pi(\theta_2 \mid s'')/\pi(\theta_1 \mid s'')$$

This means that no matter what the original beliefs were, we will be more confident that policy θ_1 has in fact been undertaken after observing s' than after observing s''.[10]

Using the definition of better news, we can state the following proposition.

Proposition 2. *If the feasibility constraints are not binding for states $s' \in S$ and $s'' \in S$, and state s' is better news than s'', then consumption under s' will be higher than under s''.*

Proposition 2 follows immediately from the first order conditions of Problem 1. It says that the country should receive better treatment from its creditors, the better the evidence in favor of the hypothesis that the adjustment policy established by the agreement has in fact been undertaken.

5. Policy Choice and Optimal Repayment

The next step in the analysis is to use the basic information provided by Proposition 2 to predict the shape of the optimal repayment schedule, Φ, given the characteristics of the particular adjustment policy to be implemented.

Let $h(s) = p(s \mid \theta_2)/p(s \mid \theta_1)$. Since the lower the value of $h(s)$, the better the news provided by $s \in S$, it follows from Proposition 2 that consumption is decreasing in $h(s)$. Given that $\phi(s) = y - c(s)$, if we can predict consumption, $c(s)$, we can also predict the optimal payment, $\phi(s)$. Therefore, we only need to concentrate our attention on the functional relationship between the likelihood ratio $h(s)$ and the state of nature s. As we established earlier, the relationship between $h(s)$ and $s = (y, \xi)$ depends on the

[10] See Milgrom(1981).

information provided by particular realizations of s. That information depends in turn on our knowledge about the probability distribution of states of nature generated by both the policy we want to implement, θ_1, and the alternative policy, θ_2.

The following definitions provide a criterion to organize our knowledge about those probability distributions. The criterion is based on the concept of first-order stochastic dominance.[11]

Definition 3. *Adjustment policy θ_1 is more effective than θ_2, (denoted by θ_1 MET θ_2), if for any $y^* \in Y$ we have $\sum_{\xi \leq \xi_*} p(y^*, x \mid \theta_1) \leq \sum_{\xi \leq \xi_*} p(y^*, x \mid \theta_2), \forall \xi_* \in \Xi$.*

We define an adjustment policy to be more effective than another if the probability of a maximum feasible payment smaller than an arbitrary $\xi_* \in \Xi$, occurring, is smaller under the former policy than under the latter one. Similarly, we characterize the effects of different adjustment policies on the country's national income with the following definition.

Definition 4. *Adjustment policy θ_1 is more recessive than policy θ_2, (denoted by θ_1 MRT θ_2), if for any $\xi^* \in \Xi$ we have $\sum_{y \leq y_*} p(x, \xi^* \mid \theta_2) \leq \sum_{y \leq y_*} p(x, \xi^* \mid \theta_1), \forall y_* \in Y$.*

To simplify the subsequent analysis, we assume that $h(s) = h(y, \xi)$ is monotonic in y and ξ. The following Lemmas describe the relationship between $h(s)$ and the state of nature.

Lemma 1. *If $h(y, \xi)$ is monotonic in ξ, and θ_1 is more (less) effective than θ_2, then $h(y, \xi)$ is nonincreasing (nondecreasing) in $\xi \forall (y, \xi) \in S$.*

Proof. Suppose not, i.e., $\Delta h \Delta a > 0$.[12] Since θ_1 is more effective than θ_2, we have:

$$\sum_{\xi \leq \xi_*} p(y, x \mid \theta_1) \leq \sum_{\xi \leq \xi_*} p(y, x \mid \theta_2), \forall \xi_* \in \Xi, or \sum_{\xi \leq \xi_*} [h(y, x) - 1] p(y, x \mid \theta_1) \geq 0, \forall \xi_* \in \Xi.$$

Since h is monotonic in ξ, and we have assumed $\Delta h \Delta \xi > 0$, there exists a $\xi^* \in \Xi$, such that $h(y, \xi) < 1 \forall \xi < \xi^*$. Then,

$$\sum_{\xi \leq \xi^*} [h(y, x) - 1] p(y, x \mid \theta_1) \leq 0,$$

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[11] See Lippman and McCall(1981).

[12] Hereafter, the notation $\Delta y \Delta x$ represents the product of the first differences of the variables y and x, i.e., $\Delta y \Delta x = (y' - y)(x' - x)$.

a contradiction. ∎

Lemma 2. *If $h(y,\xi)$ is monotonic in y, and θ_1 is more (less) recessive than θ_2, then h is nondecreasing (nonincreasing) in y, $\forall(y,\xi) \in S$.*

Proof. By same argument that in Lemma 1. ∎

Using the results of Lemmas 1 and 2, we construct Table 1 summarizing the predicted relationship of h with y and ξ.

Table 1. Relationship of h with y and ξ under Moral Hazard

policies	θ_1 MRT θ_2	θ_2 MRT θ_1
θ_1 MET θ_2	$\Delta h \Delta y \geq 0$ $\Delta h \Delta \xi \leq 0$	$\Delta h \Delta y \leq 0$ $\Delta h \Delta \xi \leq 0$
$\theta_2\ MET\theta_1$	$\Delta h \Delta y \geq 0$ $\Delta h \Delta \xi \geq 0$	$\Delta h \Delta y \leq 0$ $\Delta h \Delta \xi \geq 0$

Recalling that $c(y,\xi) = y - \phi(y,\xi)$, and that consumption is decreasing in h, we can use the results of Table 1 to predict the relationship of Φ with y and ξ. Table 2 presents the results.

Table 2. The Optimal Payment Under Moral Hazard

policies	θ_1 MRT θ_2	θ_2 MRT θ_1
$\theta_1 MET\theta_2$	$\Delta\phi \geq \Delta y$ $\Delta\phi\Delta\xi \leq 0$	$\Delta\phi \leq \Delta y$ $\Delta\phi\Delta\xi \leq 0$
$\theta_2\ MET\theta_1$	$\Delta\phi \geq \Delta y$ $\Delta\phi\Delta\xi \geq 0$	$\Delta\phi \leq \Delta y$ $\Delta\phi\Delta\xi \geq 0$

The interpretation of Table 2 is straightforward. For example, suppose that the policy we want to implement, θ_1, is more effective and more recessive than the alternative, θ_2. Since θ_1 is more effective than θ_2, a high feasible-payment realization is better news than a low one. Then, for a given national income, a high feasible-payment realization must be rewarded by allowing greater consumption than under a low realization. This means that, for a given y, the optimal payment Φ is decreasing in ξ. Similarly, since θ_1 is more recessive than θ_2, a low national-income realization is better news than a high one. Then, for a given maximum feasible payment, a high national-income realization must be penalized by allowing lower consumption than under a low realization. This means that, for a given ξ, the optimal payment Φ is increasing in y. Moreover, to reduce aggregate consumption, the increase in the optimal payment must be greater than the increase in national income.

6. Policy implications and Concluding Remarks

Our analysis shows that asymmetric information about policy actions introduces severe constraints in the design of a Pareto-optimal debt-restructuring agreement. In particular, the repayment schedule must give the country's policymakers the right incentives for policy choice.

The results presented in Table 2 suggest how difficult it could be to find the optimal adjustment policy. For example, to implement the most effective adjustment policy the repayment must be decreasing in the magnitude of the adjustment (our variable ξ). The purpose of the adjustment policy, however, is to make it feasible the repayment. If a succesful adjustment must be rewarded by writing-off the debt, then it is unlikely that the debt can be repaid. Perhaps this explains why the International Monetary Fund has accepted relatively heterodox adjustment programs in the last few years.

The results of the analysis also offer an explanation for the typically recessive nature of standard adjustment programs. Consider the repayment schedule that would implement an expansionary policy. According to our results, all evidence against the hypothesis that the expansionary policy has been undertaken must be penalized, and all evidence in favor of it must be rewarded. Evidence against an expansionary policy, however, is a recession, and evidence in favor of it is an expansion. Thus, the repayment must be decreasing in income. An optimal agreement, however, contains an element of risk-sharing. To implement the expansionary policy the repayment schedule would have to increase the variability of consumption, thus providing no risk-sharing.

Finally, consider the implications of our analysis for the kind of relationship that sovereign states and international banks can be expected to develop. The developing countries's lack of free access to credit is currently seen as one of the main problems affecting the international financial system.[13] If asymmetric information of the sort we have considered here is indeed an important problem, then a return to free access is a hopeless

[13] See for example Watson et al. (1986).

prospect. The need to internalize the incentive effects of sovereign lending should tend to maintain the current situation. This should also consolidate the observed trend to the concentration of lending in just a few large international banks. In this context, the role of the International Monetary Fund can only be expected to evolve in the direction of becoming an information and coordination agency rather than an alternative source of funds for its members.

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