Policy, Research, and External Affairs

WORKING PAPERS

Debt and International Finance

International Economics Department
The World Bank
October 1990
WPS 441

Inefficient Private Renegotiation of Sovereign Debt

Kenneth M. Kletzer

Private renegotiation of debt repayments and new loans is inefficient because of the creditors' seniority privileges and lack of commitment and the inadequate information creditors have about debtors' policy choices.

Policy, Research, and External Affairs

WORKING PAPERS

Debt and International Finance

WPS 441

This paper — a product of the Debt and International Finance Division, International Economics Department — is part of a larger effort in PRE to determine the conditions under which debtor countries benefit from debt and debt service reduction operations. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Sheilah King-Watson, room S8-025, extension 31047 (57pages).

The negotiation of sovereign debt repayments and of new loans after default may yield inefficient outcomes that justify intervention by creditor country governments and international financial institutions. Kletzer analyzes possible distortions arising in renegotiations between private creditors and sovereign borrowers. He argues that legal privileges accorded to existing creditors in their home jurisdictions can distort the flow of resources for capital formation abroad. Seniority privileges for old lenders convey to them some of the social returns from new lending, reducing the potential rewards for those who might provide the new funds.

A simple dynamic model is presented in which the motivation for borrowing from abroad is to smooth consumption over time when national income is subject to random fluctuations. The borrower cannot commit to make future repayments to creditors due to sovereign immunity. Payments are made by the borrower to avoid credible suspensions of access to consumption-smoothing opportunities. These are imposed in the future, in contrast to a repeated static model in which sanctions are traded for payments contemporaneously.

Time inconsistency arises because lenders cannot commit to accept future net resource transfers which, in some contingencies, they will wish to renegotiate. Therefore, renegotiation of simple debt contracts *ex post* need not lead to the equilibrium path achieved using state-contingent contracts when commitment is possible. New capital inflows to heavily-indebted countries will not be forthcoming when further lending is socially efficient. The bargaining conduct in renegotiations of a long-term relationship between lenders and a borrower depends on the commitment opportunities of lenders and their legal privileges vis-a-vis other lenders. Cooperative equilibria can be unattainable for the coalition of lenders due to institutional distortions. The importance of legal institutions within and across creditor countries for efficiency of renegotiations is discussed at length.

Informational asymmetries are an additional source of distortions in the resource allocation sustained through bargaining over repayments and new loans. Because a borrower may be able to conceal that she would be willing to repay as contracted, she may be able to renegotiate debt-service obligations to her advantage. In an equilibrium with imperfect information about debtor characteristics, the loan and renegotiation offers made by lenders anticipate this possibility leading to less initial lending and a faster build-up of a debt overhang.

The paper also presents a model of strategic bargaining with asymmetric information about the debtor government's social preferences to capture the constraints that the domestic political environment imposes on debt-servicing. Creditors may delay agreement to elicit private information, and the consequent suspension of inflows leads to a socially inefficient capital accumulation path in this dynamic model.

The analysis stresses the distinction between explicit contracts with state-contingent repayment schedules and long-term relationships created by simple contracts that exchange resources for an ability to impose sanctions whose value is negotiated ex post. Because institutions created by creditor country governments convey legal privileges that distort the allocation of resources in the bargaining process, the paper urges investigation of official alienation of these privileges, regulatory reform, and introduction of alternative financial instruments that embody opportunities for creditor commitment.

Inefficient Private Renegotiation of Sovereign Debt

by
Kenneth M. Kletzer*

Table of Contents

* I wish to thank Willem Buiter, Jonathan Eaton, T. N. Srinivasan, and John Van Huyck for helpful conversations.

Nontechnical Summary

The current absence of financial assistance from the private credit markets of the developed countries for undertaking investments in the less-developed nations is widely regarded to be inefficient. The potential high productivity of investment in the capital-poor regions of the world suggests that the existence of high external debt burdens is inhibiting the efficient allocation of capital internationally. The intervention by creditor country governments and international financial institutions in private lending to less-developed countries requires justification by the presence of social inefficiencies in the private negotiation of sovereign debt repayments and new capital inflows.

While the presence of sovereign immunity restricts the amount of resources that can be transferred through private international credit transactions, the absence of commitment technologies for both creditors and debtors can create socially inefficient outcomes due to time inconsistency and incomplete coordination across market participants. Possible sources of market failure can be exacerbated by the legal and political institutions surrounding credit markets. The type of potential coordination failure that has received the most attention by writers on sovereign lending is the inability of the coalition of existing creditors to achieve a cooperative equilibrium because of the public goods nature of new funds enhancing repayment streams. Difficulties can also arise coordinating the policy choices of debtor governements with the actions of creditors because debtor policies can affect the surplus bargained over during negotiations of net resource transfers. Bilateral private renegotiation of debt claims itself can be inefficient if the commitment of the bargaining parties is incomplete or if there is asymmetric information between parties.

The legal status of existing debt claims can create a distortion in the flow of new resources of capital formation because the social returns to new investment may partly accrue to non-providers of the new capital. The privileges enjoyed by old lenders may deny new creditors their opportunity cost of capital, even though it is exceeded by the marginal productivity of investment. The frequently discussed free-ridership problem in international lending arises because of this externality. However uncertain their ultimate value, legal privileges provide reservation levels of utility for old creditors which can inhibit coordinated lending. The difficulty for assuring new cpaital flows to heavily indebted countries when further lending is socially efficient (subject to the constraint imposed by sovereign immunity) is the absence of mechanisms for credible commitment of lenders to a coordinated policy. Cooperative equilibria for the coalition of lenders may not be attainable because of the time consistency problem created by institutional distortions.

Bargaining between creditors and debtors during renegotiations of initial contractual obligations can also be subject to inefficiencies. The role of institutions which allocate legal privileges among the set of creditors for the conduct of debt renegotiations is crucial. Institutions

which create both legal privilege and provide mechanisms for credible commitment by some of the parties to a long-term relationship play a major role in the conduct of bargaining. The primary purpose of this paper is to discuss the importance of inefficiencies in debt renegotiation which arise as a consequence of seniority privileges and absence of commitment by creditors. A secondary purpose is to examine the effect of asymmetries of information about the opportunities available to debtors between lenders and borrowers on the outcomes achievable in a bargained renegotiation.

The model studied concentrates on the importance of the basic institutional and informational environment on renegotiation in a simple dynamic context. The motivation for borrowing from abroad is to smooth consumption across dates when national income is subject to random shocks. This setting contrasts with a repeated static one because the sanctions available to creditors to punish a repudiating debtor are imposed in future periods rather than the current one; an example of such penalties is the disruption of intertemporal trade, that is, access to future insurance. In a repeated static model, bargaining between debtors and creditors results in a trade of sanctions for the current period for a current payment in settlement of debt-service obligations. The outcome of a strategic non-cooperative bargaining game yields loan flows constrained only sovereign immunity, exactly as in Eaton and Gersovitz (1981) (although they do not allow renegotiation, it only introduces a quantitative difference). In the forward-looking sanctions model, the absence of commitment and seniority privilege of existing creditors render strategic bargaining equilibria inefficient relative to the international allocations of capital feasible under sovereign immunity.

Time inconsistency arises in bargaining because lenders cannot commit themselves to accept future net transfers which they will wish to renegotiate in some, if not all, contingencies. If creditors provided loans with state-contingent repayment schedules, then an equilibrium path for capital flows is attained which is efficient given the constraint that the debtor can repudiate and accept the consequent sanctions at any time. Such a plan requires that the repayment schedules be binding on the creditors, and in most cases, the lender will write a contract which requires a net transfer from it to the debtor to settle the contract. That is, ex ante state-contingent contracts provide insurance that may be incomplete due to the insuree's ability to repudiate. Ex post renegotiations of debt contracts conveying seniority privileges of some type do not lead to equivalent outcomes due to the absence of commitment mechanisms for creditors. It is important to note that this paper explores the inefficiency of renegotiation using a particular form of bargaining conduct, but the qualitative results emphasized generalize to any exogenous distribution of bargaining power in the renegotiation game.

The importance of asymmetries of information for the allocational efficiency of private bargaining over debt repayments and new inflows is also discussed. The existence of private information creates an additional distortion in the bargaining process with seniority privileges. In particular, even when the current creditors possess all the power in renegotiations, a debtor who would be willing to repay in full may be able to renegotiate debt-service obligations to its advantage. These possibilities further limit the extent of smoothing over random income

shocks which is provided by private creditors. The case of strategic bargaining with shared bargaining strength is modelled in a growing economy under asymmetric information about the government's social preferences (the domestic political environment's constraints on debt-service). In this case, delay in agreement during renegotiations is used strategically to elicit private information. The suspension of new inflows for capital formation can make these delays especially costly.

The inability of debtor countries to adopt socially efficient policies can arise for both reasons of domestic political economy and the presence of external payment obligations which are enforced by sanctions, whose value can be affected by domestic policy choice. Furthermore, the adoption of a socially beneficial plan may require coordinated action by both lenders and borrowers. When the only policy tools available for transferring resources for debt repayment from the private sector to the government are distortionary, then the post-tax rate of return on investment will be endogenous to the net external transfer anticipated. In the absence of external finance, the government must reduce the net tax burden on investment by either substituting other taxes (current or futrue) or reducing expenditures. Both measures carry social costs. Since the optimal policy choices for the government depend upon the supply of external credit, the rate of return for foreign lenders could be rising in the amount lent. With many lenders this could lead to a problem of coordination between creditors. However, the debtor's ex ante optimal policy choices may not be time consistent; that is, commitment by both parties may be required to attain an efficient flow of resources.

The bargaining problem discussed in this paper does not address the issue of coordination within the coalition of current creditors. Nor does it address the problems of coordination and time inconsistency for simultaneous policy choices for debtors and creditors. The emphasis is on the distinction between contracts which are written ex ante as state contingent in an uncertain world and those that exchange resources for some ability to impose sanctions, the value of which are negotiated ex post. The argument that the latter can merely comprise an implicit contract which duplicates a formal state-contingent contract has appeared in the literature. The point of this paper is that these are fundamentally not equivalent. The importance of legal privileges, however uncertain, for the efficiency of capital mobility under renegotiation should not be understated. Perhaps, the main policy implications to be drawn from this tentative analysis is that the possibilities of official alienation of these privileges, increased regulation of private capital flows, and the introduction of alternative instruments for providing capital flows to developing regions should be explored.

Inefficient Private Renegotiation of Sovereign Debt

The current absence of financial assistance from the private credit markets of the developed countries for undertaking investments in the less-developed nations is widely regarded to be inefficient. The potential high productivity of investment in the capital-poor regions of the world suggests that the existence of high external debt burdens is inhibiting the efficient allocation of capital internationally. The intervention by creditor country governments and international financial institutions in private lending to less-developed countries requires justification by the presence of social inefficiencies in the private negotiation of sovereign debt repayments and new capital inflows. While the presence of sovereign immunity restricts the amount of resources that can be transferred through private international credit transactions, the absence of commitment technologies for both creditors and debtors can create socially inefficient outcomes due to time inconsistency and incomplete coordination across market participants. In a second-best world, the legal and political institutions surrounding international credit markets can exacerbate the effects of incomplete commitment by the negotiating parties. Coordination failures can arise within the group of creditors in their lending practices or between creditors and debtors in the choice of their respective policies. Time inconsistency of constrained optimal resource allocations (by sovereign immunity) can appear in both debtor actions and in the lending behavior of creditors.

The type of potential coordination failure that has received the most attention by writers on sovereign lending is the inability of the coalition of existing creditors to achieve a cooperative equilibrium because of the

public goods nature of new funds enhancing repayment streams. The legal status of existing debt claims can create a distortion in the flow of new resources of capital formation because the social returns to new investment may partly accrue to non-providers of the new capital. The privileges enjoyed by old lenders may deny new creditors their opportunity cost of capital, even though it is exceeded by the marginal productivity of investment. The frequently discussed free-ridership problem in international lending arises because of this externality. However uncertain their ultimate value, legal privileges provide reservation levels of utility for old creditors which can inhibit coordinated lending. The difficulty for assuring new cpaital flows to heavily indebted countries when further lending is socially efficient (subject to the constraint imposed by sovereign immunity) is the absence of mechanisms for credible commitment of lenders to a coordinated policy. Cooperative equilibria for the coalition of lenders may not be attainable because of the time consistency problem created by institutional distortions.

Bilateral private renegotiation of debt claims itself can be inefficient if the commitment of the bargaining parties is incomplete or if there is asymmetric information between parties. The role of institutions which allocate legal privileges among the set of creditors for the conduct of debt renegotiations is crucial. Institutions which create both legal privilege and provide mechanisms for credible commitment by some of the parties to a long-term relationship play a major role in the conduct of bargaining. The primary purpose of this paper is to discuss the importance of inefficiencies in debt renegotiation which arise as a consequence of seniority privileges and absence of commitment by creditors. A secondary purpose is to examine the effect of asymmetries of information about the

opportunities available to debtors between lenders and borrowers on the outcomes achievable in a bargained renegotiation.

Credit market equilibria are studied when debt contracts can be subsequently renegotiated in a simple model of borrowing from abroad to smooth consumption when national income subject to stochastic shocks. Borrowers have the ability to repudiate their obligations, but face sanctions for doing so. Lenders are assumed to be risk neutral and there is free entry in loan contracts, so that new creditors will provide any debt contract which assures them non-negative expected profits given existing debt service obligations. When a debtor suffers a low income state, repudiation with consequent penalization can be superior to meeting debt service obligations as originally contracted and choosing a new debt contract that provides zero expected profits to lenders. In this case, existing creditors have an incentive to reduce the repayment obligations and refrain from declaring a default. A breach of contract does not automatically lead to declaration of default, because this is a subsequent option available to creditors and need not be exercised.

The primary purpose of the analysis of this paper is to investigate market imperfections which arise in the renegotiation of sovereign debt in a fairly general bargaining framework. The institutional environment in which debt contract renegotiation takes place is a crucial determinant of the welfare economics of sovereign lending. In particular, the privileges which existing creditors possess with respect to other creditors and potential lenders as well as their debtors are important both for supporting lending and for the conduct of renegotiations. The role of seniority rights for existing creditors in the presence of potential free entry by new lenders is investigated at length in this paper.

Contract renegotiations are first studied in the consumption smoothing model for the case in which all characteristics of the debtor are common knowledge. Equilibrium renegotiations of payments and new loan contracts are characterized in a bargaining environment in which the existing creditors offer settlements to debtors which are accepted or rejected, subject to the discipline of potential entry in new loans. Under seniority privileges, the negotiated settlements are shown to be equivalent to the provision of a new debt contract which any potential entrant would offer along with a possible reduction in the current debt-service due. This follows from the intertemporal optimization problem for the creditors. While unmet current debt-service obligations may be rolled forward in a renegotiation, in the general case creditor optimal renegotiations will be a hybrid of debt-service reduction, new loans, and increased future debt burden. The simple relending of old debt-service obligations has an opportunity cost as well as a non-negative option value.

When the seniority privileges of existing creditors preclude entry by other potential lenders, current creditors may provide net transfers to a debtor as part of a renegotiation offer. Because renegotiations occur when a debtor would choose outright repudiation to full repayment of the existing obligations and the selection of a new debt contract under free entry, existing creditors are able to extract all of the debtor's surplus over the utility he obtains in repudiation. The lenders will increase their profit, in general, by offering funds when the debtor experiences a low income realization providing the debtor with strictly greater utility than the repudiation level. The increase in repayments received in the high income states naturally makes up for the cost of the transfer in low states; a recalcitrant debtor will be held to his repudiation level of

utility in at least the highest state in this model.

However, there are gains from trade available despite the presence of sovereign immunity which are not attained in the bargaining model. In the lowest income state, creditors will maximize their profit in a renegotiation by assuring a lower consumption level for the debtor than he attains in higher states even if full consumption smoothing is possible under the potential of repudiation. This inefficient exploitation of opportunities for restricted risk sharing is consequent to the ex post renegotiation of contracts which convey seniority rights and are not a priori binding state contingent commitments for the creditors. Further, it is argued that the inefficient pattern of international transfers this infers is not a result restricted to the one-sided bargaining conduct in which the creditors make all renegotiation offers. Loans are not written with state contingent repayment schedules which can bind them to provide net transfers in some states the next period without any further obligation on the part of the borrower. The surplus negotiated over ex post in the model of the paper is created by the seniority privileges of existing creditors. Both the privileges conveyed by contracts and the conduct of bargaining are part of an exogenous institutional environment which can be varied in this approach. That is, bargaining power can be given a different distribution across parties.

The approach of this paper contrasts somewhat with that taken elsewhere in the anlysis of sovereign debt negotiations as a bargaining problem and as a problem of implicit contracting. Bulow and Rogoff (1989), for example, model debt repayment negotiations as a noncooperative bargaining game.[1] In their paper, the bargaining game is repeated indefinitely, but repetition plays no role. The equilibrium bargaining

outcome for each period is the same whether there is only one period or many. In this paper, the cost of repudiation is paid in the future, and negotiations in any period can depend upon the full history of borrowing and repayment. However, in keeping with other bargaining approaches, the manner in which bargaining is conducted is taken exogenously in a noncooperative game.

In the model of Bulow and Kogoff, the lender possesses an endowment of one unit of a good each period which can be traded with the debtor. This good is simply the right to disrupt intratemporal trade for that one period; supplying the good, that is, suspending the imposition of sanctions, is assumed to be costly to the lender. This cost is the benefit the creditor derives from disrupting the debtor's trade for one period. There are gains from trading the one unit of sanctions between the two parties. In their model, these are divided using an alternating offers bargaining game in which the equilibrium share of the gains from trade obtained by the creditor exceed the benefit he would derive by imposing the sanctions instead. Each period, the price paid for the sanctions (that is, not to be imposed) by the debtor is simply the price paid for one unit of a diminishing cake derived by Rubinstein (1982). Current negotiations are over the gains from trade only in the current period and not over future gains. There is a implicit institution which conveys the right of the creditor to impose sanctions on the debtor; presumably, the endowment of one unit of sanctions for each period must be purchased with the payment of its present value. Alternatively, this might be viewed as a model of extortion: the only difference is in the social and legal view of how the ability to impose sanctions is acquired.

Grossman and Van Huyck (1988) propose a model of the view that debt

renegotiations are part of an implicit contract governing a repeated consumption smoothing relationship when a risk-averse debtor has random income and lenders are risk-neutral. While they do not explicitly solve for the equilibrium pattern of capital flows, they argue that because there are gains from trade in an insurance relationship, debt contracts which are not written ex ante as state contingent can yield state contingent trading as part of the implicit contractual relationship. The sanctions available for supporting trade are an interruption of intertemporal rather than intratemporal trade. The same framework is used in this paper; however, the bargaining equilibria do not duplicate the outcome of state-contingent claims which observe sovereign immunity. While the full dynamics of equibrium paths of lending and repayment are not solved in the analysis below, several qualitative characteristics of equilibria are derived.

The next section of the paper examines debt renegotiations when the debtor possesses private information. In this extension of the simple model of sovereign borrowing debt, reschedulings and new capital inflows may replace simple debt write-downs in equilibrium renegotiations in order to satisfy a set of incentive compatibility constraints. Alternatives to debt write-downs separate borrowers according to their current state, which is not observable directly by creditors. By inducing self-selection by borrowers, equilibrium debt renegotiation offers induce revelation of the debtor's private information. Therefore, the offers made by existing creditors are not necessarily equivalent to a new contract which any entrant would provide plus a possible current debt-service reduction. Debt-renegotiation in this model leads to a dynamic behavior of net capital flows and debt-service obligations that may be of some interest. When initial indebtedness is low, poor states of the world for debtors lead to

large increases in debt burdens although the net inflow of capital is negative or small. The marginal rate of interest for rescheduled debt can become very large as a consequence of the asymmetry in information.

A natural extension of the analysis of these two sections is the introduction of bilateral bargaining ex post, to give debtors more market power than simply access to new lenders. The adoption of the noncooperative strategic approach to the Nash bargaining problem in the complete and perfect information model will not affect qualitatively the outcomes of debt renegotiation. Under incomplete information about debtor characteristics, separation of different types of borrowers occurs through strategic delay rather than choice over a number of simultaneous offers made by creditors. The third section presents an approach to extending the analysis under asymmetric information to a strategic Nash bargaining framework. Both separating and pooling equilibria are possible outcomes. The model outlined includes capital accumulation, so that depreciation of the per capita physical capital stock is part of the social cost of delaying agreement in debt renegotiations.

The fourth section briefly summarizes a multi-period contracting approach when the debtor has sovereign immunity and lenders can credibly enter into contractual obligations binding on them which are enforceable in creditor nation courts. An application of such contracts, which incorporate, explicitly or implicitly, the possibility of revision, is the self-enforcement of restrictions on debt-dilution and provisions for debt-seniority. Contracts providing access to future loans on favorable terms provide an incentive for performance contingent on future events; repayment terms for early periods compensate lenders for the expected loss on these future contract options. An alternative to the two extreme

information assumptions is also discussed. A more realistic assumption may be that the debtor's current state is observable by creditors, but that policies (for example, those affecting investment levels) chosen by debtors are unobserved by lenders. In this case, inefficient policy choices for the debtor will be induced in equilibrium by the pattern of capital flows over time because contracts cannot be written or renegotiated contingent upon the choice of policy. The adaption of a socially efficient plan may require coordinated action by both lenders and borrowers. When the only policy instruments available for transferring resources for debt repayment from the private sector to the government are distortionary taxes, the post-tax rate of return to investment will be endogenous to the net transfer anticipated. Equilibria can exist that involve periods of large capital outflows requiring policies creating significant deadweight losses. Since the optimal policy choices for the government depend upon the supply of external credit, the rate of return to foreign lenders could be rising in the amount lent. A large reduction in the current trade surplus may lead to an adequate shift in the marginal productivity of new loans to support the lower current debt service requirement. However, the debtor's optimal policy choices may not be time consistent, so that commitment by both parties may be required to attain an efficient flow of resources.

The last section offers concluding remarks.

I. Debt Renegotiation with Seniority Privileges

This section discusses the renegotiation of debt service obligations in a version of the familiar Eaton-Gersovitz (1981) model. The sovereign debtor always has the option to repudiate her obligations outright and suffer consequent sanctions. The reduction in social welfare for the debtor country that sanctions can cause is limited, so that the borrower has limited liability for debt obligations. I assume that the threat of penalization for repudiation is credible and that creditors receive nothing by imposing sanctions. The behavior of the borrower is derived by maximizing a discounted stream of felicity of current consumption subject to a set of constraints. This represents a decision maker's social welfare function. A single good is produced and consumed. For simplicity, investment is ignored, so that output is an exogenous random variable. Under the informational assumptions of this section and the next, investment plays no essential qualitative role.

If the debtor chooses to repudiate, she receives a level of utility, $\tilde{V}$, which depends on the current realization of output, y, and possibly on the value of the outstanding debt service obligations, R. That is, the repudiation level of utility depends on the debtor's current state, (y,R). The borrower's felicity function, $U(c)$, is concave, displays positive marginal felicity of current consumption, c, and is continuous. In equilibrium, the borrower will face a set of debt-contract offers in the event she chooses to pay current debt service and another set of offers if she seeks to renegotiate current contractual obligations. Because I assume a stationary environment (output is identically and independently distributed each period), the borrower can always select the same debt contract each period by paying the interest obligation on the constant

principal every period. Since the realized level of output is observed before current consumption and the new loan is chosen, the borrower will select different contracts (or repudiation), including a possible request to renegotiate, depending upon the current state, (y,R).

An important assumption is that there is free entry in debt contracts -- any expected profitable contract will be offered by a pool of potential lenders. If a loan providing non-negative expected profits will be accepted by a borrower, then it will be offered by some creditor. When a debtor prefers repudiation to repayment and selection of a new debt contract from this pool of potential lenders, existing creditors have an incentive to offer combinations of net current payments and new debt service obligations that cannot be obtained from the market. Such renegotiations are modelled in a setting in which current creditors make offers to their debtors who choose to accept or reject these offers, but do not make counteroffers. The market power of existing creditors is limited by the potential entry of new creditors.

The utility maximization problem for debtors is first described. This provides constraints for the creditor's maximization problem. A debt contract is a pair (ℓ_t, R_{t+1}), where ℓ_t is the principal provided at time t and R_{t+1} is the total debt service obligation due at time $t+1$, or, equivalently, the time $t+1$ present value of the contracted repayment obligations.

In the event of full repayment, the borrower's value is given by:

$$V^r(y_t,R_t) = \max\ [U(y_t + \ell_t - R_t) + \beta EV(y_{t+1},R_{t+1})], \tag{1}$$

with respect to ℓ_t and R_{t+1}

subject to $(\ell_t, R_{t+1}) \in S$,

where the set S is independent of (y_t, R_t). The expectation is taken with respect to y_{t+1}; $V(\cdot,\cdot)$ will be defined below. The set S is the equilibrium set of debt contracts providing non-negative expected profits. The difference, $(\ell_t - R_t)$, is the net inflow of funds at time t. The discount factor, β, is between 0 and 1.

Let the debtor's repudiation value under limited liability be given by $\tilde{V}(y_t, R_t)$ which is increasing in y_t and non-increasing in R_t.[2] In the event of renegotiation, the debtor will choose a contract from a set of debt contracts that depend on the information available to creditors. This is assumed to always include R_t and the realization of y_t is assumed to be common knowledge in this section. In the next section, it is debtor private information. Throughout, the debtor's utility function is assumed to be common knowledge.

Define:

$$V^{re}(y_t, R_t) = \max [U(y_t + \ell_t - R_t) + \beta EV(y_{t+1}, R_{t+1})], \tag{2}$$

subject to $(\ell_t, R_{t+1}) \in S(y_t, R_t)$.

This latter set contains S and will include additional contracts if $V^r(y_t, R_t)$ is less than $\tilde{V}(y_t, R_t)$. The value of the debtor's optimal program is just

$$V(y_t, R_t) = \max \{V^{re}(y_t, R_t), \tilde{V}(y_t, R_t)\}, \tag{3}$$

since $V^{re}(y_t, R_t)$ is at least as great as $V^r(y_t, R_t)$.

The distribution for output is assumed to have compact support. The expectation of V is taken with respect to y_t. I use the shorter notation $EV(R)$ for the remainder.

Creditors are assumed to be risk neutral (therefore, expected profit

maximizers) and face an opportunity cost of loans given by a discount factor, ρ. A one-period debt contract provides expected profits given by

$$E\pi(\ell_t, R_{t+1}) = -\ell_t + \rho E(R|R_{t+1}),$$

(4)

where the expectation, taken with respect to the distribution of output, is of the actual period $t+1$ present value of debt service payments conditional on the contractual obligation, R_{t+1}

The legal status of existing debt service obligations within or between creditor nations will be crucial for determining the set of offered contracts. For example, while loan covenants binding on debtor behavior may not be credibly enforceable, seniority provisions binding on subsequent lenders may be enforceable in creditor nation courts. A senior creditor may be able to recover fully any payments made to successor lenders in its home country up to its contractual claim. On the other hand, if all claims have equal priority, creditors will share according to some proportions in actual settlements.

Suppose that the variable x denotes the surplus available for meeting debt service in an equilibrium settlement of obligations and that x is distributed according to the cumulative distribution function F(x). This distribution depends upon the distribution of y and is conditional on R, in the general case. With strict seniority, the senior creditor obtains expected profits

$$E\pi(\ell,R) = -\ell + \rho \left[\int_0^R x dF(x) + R \int_R^M dF(x) \right],$$

(5)

where M is the maximum total settlement possible.

A second creditor will obtain

$$E\pi(\tilde{\ell}, \tilde{R}; R) = -\tilde{\ell} + \rho \left[\int_R^{\tilde{R}} (x-R)dF(x) + \tilde{R} \int_{\tilde{R}}^{M} dF \right]$$

with contract $(\tilde{\ell}, \tilde{R})$ given prior commitments R. In such an instance, the set of new debt contracts available to a borrower will be identical for any number of concurrent loans taken. The debtor can do no better than to accept a zero expected profit contract from a single source.

If lenders share in payments according to the portion of their claims in total claims, then each lender attains expected profits

$$E\pi(\ell_i, R_i; R) = -\ell + \rho \left[(R_i/R) \int_0^R x \, dF(x) + R_i \int_R^M dF(x) \right],$$

where $R = \sum_i R_i$.

In this case, in an equilibrium debt contract, each lender correctly anticipates subsequent contract offers so that expected profits for every creditor are non-negative. The set of total debt contracts that attain non-negative expected profits is the same whenever obligations to new lenders do not take precedence over existing debt, since the conditional distribution of x is unaffected. However, the equilibrium debt contract will not be the same. Under strict seniority, the choice of contract made in equation (1) will be the best zero-expected profit contract for the debtor (equivalent to the Nash equilibrium contract under observability defined in Kletzer (1984)). In the absence of seniority provisions (for example, the neutral case above), the equilibrium contract will be an interest-rate taking zero-profit contract, as defined in Kletzer (1984) (equivalently, in Gale and Hellwig (1985)). This type of contract is socially inefficient, in that it is dominated for the debtor by the strict seniority outcome. For now, we assume that seniority provisions enforceable between creditors in their home courts are credible.

The initial description of equilibrium debt renegotiations in this

standard approach will be made assuming that the debtor always has the option to pay contractual debt service and select a new debt contract that will realize a non-negative expected profit. However, a new debt contract may not be offered if existing obligations are not met, because new creditors' claims are junior to existing claims. If new funds are offered when old debts are not being serviced, in the absence of a negotiated settlement, the debt service obligations on these new funds are at least as great as they would be for incremental funds taken in addition to the original contract (that is, the additional debt service that would be incurred to obtain a larger original contract). The additional debt service obligations will be even greater if the old creditors can claim additional interest from payments made to the new suppliers.

Free entry in debt contracts and the limited liability of debtors impose limitations on the outcomes attainable by creditors in debt service renegotiations. Constrained contract renegotiations for the lender can be described using a simple bargaining model in which the creditor offers contract revisions to the debtor. In this setting, I argue that a first-best contract will not be a standard debt contract with ex post renegotiation of debt service because additional risk sharing may be provided by state-contingent contracts.

Because the equilibrium set of debt contracts offered will be bounded from above in ℓ, there exist states such that the borrower prefers repudiation to full repayment. These states can be shown to occur with positive probability. Because creditors lose the entire opportunity cost of their loans in a repudiation, any settlement that provides some current repayment or net expected future payment will be preferred by the creditor. The borrower's alternative of choosing a zero-expected profit contract (but

junior claim) from another lender without repaying will, at the worst, result in a loss to the current creditors of the opportunity interest on the maximum settlement they would obtain in the current state. Assume, for simplicity, that no additional interest is attainable, then the debtor prefers to repudiate if

$$\tilde{V}(y,R) > \max\{\max_{(\tilde{\ell},\tilde{R}+R)\in S} (U(y+\tilde{\ell}) + \beta EV(R+\tilde{R})),\ V^{r}(y,R)\}, \tag{6}$$

Modification for imperfectly enforceable seniority clauses or enforceable contracts specifying overdue interest charges is straightforward.

Whenever (6) obtains, creditors will select contracts that provide the debtor with utility at least equal to the repudiation level. These offers will depend only on the debtor's current state. If we make the simplification that $\tilde{V}(y,R) = \tilde{V}(y)$, then the equilibrium expected profits for debt contracts is given by (5), where F(x) depends on the level of debt service obligations and the distribution of y. The set S is given by

$$S = \{ (\ell,R) \mid E\pi(\ell,R) \geq 0 \}$$

When only the lender makes offers that the debtor accepts or rejects (in the presense of free entry of new creditors under our seniority assumption), the equilibrium renegotiated offers satisfy

$$\max\ [\ R - \ell(y_t) + \rho \int_0^{R(y_t)} x dF(x) + \rho\, R(y_t) \int_{R(y_t)}^{M} dF(x)\ ] \tag{7}$$

with respect to $\ell(y_t)$, $R(y_t)$

s.t. $\tilde{V}(y_t) \leq U(y_t + \ell(y_t) - R) + \beta EV(R(y_t))$.

Note that any solution cannot be contained in S since (6) holds. The solution to this problem is identical to the solution to the problem:

$$\max R$$

$$\text{s.t. } \tilde{V}(y_t) \leq \max \left[U(y_t + \ell' - R) + \beta EV(R') \right], \quad \text{with respect to } (\ell', R') \in S$$

The profit-maximizing lender will never choose to make an offer of a net flow of funds to or from a debtor that involves an incremental loan providing negative expected profits. Any creditor-optimal renegotiation is equivalent to a simple reduction in current debt service (in expected present value terms) plus a new loan attainable from any potential entrant. The creditor should be indifferent between offering a current net payment with a new debt service obligation and offering a reduction in the current debt service just enough that a new creditor will take over the debt and the borrower will not choose to repudiate. Because the debtor always has the option to repudiate, the expected value of continuation in (1)-(3) must be at least as great as the expected value under repudiation. Because the debtor has limited liability for debt obligations in this framework, the utility attained with a current zero net flow of resources is always at least as great as the level of utility received by repudiating. Therefore, no new flows from lenders are required to avoid repudiation.

The seniority privilege implies that debt obligations serve the purpose of detering current and future entry by other lenders, so that an increase in the debt burden for the next period can lead to a rise in the present value of net payments received by current creditors. This suggests that relending unmet debt service provides old creditors with a larger claim on future payments than a new lender could obtain for the same price. If the debtor prefers repudiating to meeting her current obligation in full and choosing a new contract from any potential lender, then senior creditors can hold the debtor to attaining only her repudiation level of

utility. However, they cannot improve upon offering the debtor a new debt contract which any new entrant would provide along with a gross repayment not exceeding their present claim. The marginal amount an existing creditor would be willing to pay for a future debt claim is the same as what a new creditor would pay for the same right. That is, the benefit that seniority provides the existing creditor is the present value of present gross repayments only; relending unmet debt service obligations does not have a special option value to old creditors.

In equilibrium, the lender maximizes its present value by offering a reduction in current payments along with a new loan that any new entrant would have offered. The carried over debt obligation is just the sum of the new debt burden for the free entry contract plus any additional debt obligation that provides positive 'option' value. This latter addition is constrained by my institutional setting to be the old debt obligation minus the net repayment made plus accrued interest. This entire contract can be reinterpreted as a simple combination of a gross repayment today plus a new zero expected profit one-period debt contract. That is, in equilibrium the existing creditor will gain nothing by relending existing debt obligations on any terms other than those that a new risk-neutral lender would. If any debt-service obligation has positive value, then there is a price greater than zero at which another lender would have purchased it. This price is just the extra amount of new loan principal that an entrant would provide to obtain the additional debt-service. The set of zero expected profit debt contracts provides the equilibrium value of future debt service claims to any creditor, including existing ones. The existing debt service obligation is simply the upper bound on the ex post return achieved by the old creditors.

If the debtor is held to her repudiation level of utility, then the best action for the existing creditor is to reduce the payment this period and provide a new zero expected profit contract. However, the set of contracts which might be offered depend upon the equilibrium behavior of creditors when full repayment and selection of a new zero expected profit contract is not optimal for the debtor.

Even when senior creditors are able to hold the debtor to her repudiation level of utility in every state of nature, they may gain from allowing the debtor to attain higher utility in some income states. If the creditors choose to extract all the debtor's surplus in any outcome, then the equilibrium payments they must receive in any state cannot exceed zero when loan autarky is the available sanction. In general, profit maximization implies that in some states even when full repayment is inferior to repudiation, the lender will provide positive flows, so that in those states the debtor achieves positive surplus over repudiation without the discipline of potential entry. This just follows from the gains available from trade in insurance.

However, a consequence of the bargaining conduct assumed in the presence of potential entry and seniority privileges is that any debt renegotiation by current creditors is equivalent to offering a debt contract which any potential entrant would offer and possibly a reduction in current debt service payments. If the debtor just attains his repudiation level of utility, then no current inflow of resources occurs in the consumption smoothing model adopted, as one would expect.

Given the seniority privilege of the existing creditors, denial of all future inflows to a recalcitrant debtor could be a credible threat. In this model, there are gains from trade due to the difference in attitudes

towards risk which can be attained because future access to credit is always possible (and valuable to the debtor). Reversion to autarky by creditors or debtors suggests by the Folk Theorem for repeated games that if the common rate of discount is below some threshold exceeding zero, then a Pareto efficient outcome can be attained in a subgame perfect equilibrium. With the bargaining possibilities assumed in this model, complete smoothing of the risk averse debtor's consumption (as required in a Pareto optimum) will not occur in equilibrium for any positive discount rate. This follows because the lender will always benefit from reducing the amount provided in low income states of nature cognizant of the reduction in the net transfer it can command in high output states as a consequence when consumption is smoothed fully across states.

Suppose that consumption is fully smoothed across states and that the sanction provided by creditor seniority rights is an embargo on access to future consumption smoothing possibilities. If all bargaining power ex post is held by the creditor, then the debtor achieves exactly the repudiation level of utility in the highest income state. The creditor provides an inflow in the lowest state. If this is reduced, then less will be repaid in some other state to assure that repudiation does not occur in the highest state. For example, if there are two income states then a reduction in the transfer to the debtor in the low state leads to a reduction in the net repyament made in the high state. However, the creditor will always gain ex post in the lowest state by reducing the consumption of the debtor fully aware of the consequences for repayments in other states. This follows because the debtor discounts the reduction in inflows in low states when choosing between repudiation and acceptance of a renegotiation in the highest state. Likewise, the creditor discounts the

reduction in receipts in the highest state when offering less in the low state. Therefore, full smoothing of the debtor's consumption is not an equilibrium outcome for any value of the discount rate greater than zero.

In terms of the model, let y_2 be output in the highest state and y_1 be the lowest output level. Assume that the debtor's surplus is zero in the highest state in equilibrium:

$$\bar{V}(y_2) = U(y_2 - R + \ell_2) + \beta EV(R_2).$$

If the debtor's consumption is fully smoothed, then

$$\bar{V}(y_1) < U(y_1 - R' + \ell_1) + \beta EV(R_1),$$

where R and R' are the renegotiated repayments and (ℓ_2, R_2), (ℓ_1, R_1) are zero expected profit loans, and

$$c_1 = y_1 - R' + \ell_1 = y_2 - R + \ell_2 = c_2.$$

Suppose that the lender raises R' and lowers R so that the debtor will not repudiate in the highest state. Note that the change in the debtor's utility in this state is given by

$$-U'(c_2) \cdot (dc_2/dc_1) - \beta\,(d/dc_1)EV(R_2).$$

This must exceed zero and is larger than

$$-U'(c_2) \cdot (dc_2/dc_1) - \beta U'(c_1),$$

where $-dc_2/dc_1$ is the increase in c_2 consequent to a decrease in c_1.

The change in the creditor's profit in the lowest state is given by

$$-\frac{d\pi(y_1)}{dc_1} = 1 - \beta \frac{dE\pi(R_1)}{dc_1}$$

$$\geq 1 + \beta \frac{dc_2}{dc_1}$$

Let $-U'(c_2)\,(dc_2/dc_1) - \beta U'(c_1) = 0$, so that

$$-\frac{d\pi(y_1)}{dc_1} \geq 1 - \beta^2\,(U'(c_1)/U'(c_2)),$$

which exceeds zero if $c_1 = c_2$. Therefore, the lender's profits are maximized

in the lowest output state in a subgame perfect equilibrium of this model by offering less than full smoothing of the debtor's consumption stream. No assumptions have been made here about the distributions of the equilibrium consumption or net transfers (even though output is identically and independently distributed between periods).

These implications should not be restricted to the special case that the creditor proposes renegotiation offers which are either accepted or rejected by the debtor. If the debtor instead makes all of the renegotiation offers, then a deviation from full smoothing will also occur because it would raise the debtor's equilibrium utility in the highest state to reduce the amount repaid. For any fixed distribution of bargaining power in this institutional environment, complete smoothing of the debtor's consumption appears to be incompatible with equilibrium. If bargaining power is shared between lenders and borrowers, then the outcome of alternative distributions of bargaining strength will be different divisions of the present value of the surplus available to the existing creditors. The renegotiation of contracts which are not ex ante contingent and convey seniority privileges to old creditors which restrict new entrants using exogenous bargaining conduct creates an inefficiency for risk sharing beyond that created by sovereignty alone. It should be noted that the seniority rights assumed refer to the rights of all existing creditors vis-a-vis entrants who lend before a settlement of the existing claims.

A common argument (for example,Krugman (1985)) is that the relending of contractual debt service obligations when a debtor is unwilling to meet them currently is a preferred action for lenders because the option on higher future payments is obtained at no cost in new capital. The general

optimization problem for creditors examined here implies that unmet debt-service may be rolled forward until additional increments to the debt burden are valueless to creditors. Current creditors will not choose to offer any renegotiation that is not equivalent to a new loan contract any entrant would offer and a permanent write-off of part of the debt-service obligation. However, until the maximum debt burden that could ever be paid is reached, the latter part of this package will be trivial in general (that is, no debt reduction is offered). Relending unmet debt-service is valuable only as long as it precludes possible future entry by other creditors. Several authors (for example, Cline (1983), Krugman (1987), and Sachs (1984)) have argued that lending to a recalcitrant debtor is defensive for creditors collectively because it raises the present value of their claims. In the model above, creditors can increase their expected profits by providing insurance to the debtor. New inflows to the country will not be as large in low income states as dictated by either expected profit maximization conditional on being in a high income state or unconditional (ex ante) expected profit maximization. However, creditors are unable to bind themselves not to maximize the present value of their program after low income states have been realized. In this noncooperative bargaining model, optimal behavior by creditors is time inconsistent. The welfare gains from insurance transactions (defensive lending) cannot be fully realized in the renegotiation of short-term obligations for the creditor, as well as for the debtor, however bargaining power is exogenously distributed.

Figure 1 depicts the set of new debt contracts, S, and indifference curves for the debtor for the more general case of the repudiation utility depending on both y and R. The horizontal axis measures the net inflow of

resources to the debtor. The set S is not bounded from above in contractual obligations in the presence of equilibrium renegotiations. The maximum expected present value of a renegotiation attainable by creditors can be seen to be the greatest value of $-R$ such that the set S intersects the repudiation indifference curve.

The presence of debt service obligations as a state variable introduces a simple history dependence in the expected utility of debtors and the renegotiation offers made available. Past realizations of income affect current choices of debtors and, in the event of renegotiation, existing creditors. In this simple Markov model, however, the set of new debt contracts, S, is unaffected. In equilibrium, only partial risk sharing between risk-neutral lenders and risk-averse borrowers is achieved through debt contracts with renegotiation. This occurs because creditors are limited in their abilities to obtain large payments in the best income states of nature.

The result that smoothing of the debtor's consumption is incomplete in equilibrium for all positive discount factors contrasts with the result of Grossman and Van Huyck that complete smoothing arises if the discount rate is low enough (but positive) when the implicit state contingent contract is supported by trigger strategies. The important distinction between the two approaches is that when no ex ante state contingent agreement is made and bargaining power is fixed the ex post agreement is not equivalent to what would occur in an equilibrium with state contingent contracting subject to potential repudiation. In this model, lenders are not bound to accept obligations to provide new inflows ex post in low income states, although it is in their best interest to provide negotiated (ex post) new funds.

Worrall (1989) derives the dynamics of lending under potential

repudiation when one-period state contingent contracts are feasible. In his model, debtors are constrained from lending to third parties without fear of expropriation in the event of repudiation of their (state contingent) debt obligations. Debtor savings, however, plays a crucial role for the nature of the equilibrium path. Unlike the approach taken above, state contingent obligations are binding on the creditor, who can be obligated to provide a net transfer to the debtor in poor states of nature. With state contingent claims, the debtor's consumption in an equilibrium path will not change between periods if the realization of income does not rise above its historical maximum. Each period for which the maximum realized level of income rises, the consumption level also rises. With a finite number of states of nature which occur with positive probability, complete smoothing of debtor consumption is eventually attained.

Because creditors have available debt instruments with seniority privileges vis-a-vis other creditors and payments are negotiated ex post in my approach, full smoothing of the debtor's consumption does not arise in an equilibrium. That is, these institutions are assumed in place of state contingent contracts which might bind the creditor to a commitment to provide future transfers with no claim to a repayment. In Worrall, the equilibrium allocation is constrained efficient (constrained by the possibility of repudation by the debtor), while in this section the sharing of risk between lenders and borrowers is inefficient in the same sense. The source of this inadequacy of sequential negotiations is the absence of opportunities for the lender to credibly commit itself to forgive debt and provide new loans at the same time. A constrained efficient equilibrium path fails to be time consistent in this model of renegotiation.

II. Private Information and Separating Equilibria

In this section, debtors are assumed to possess private information about the utility they receive by accepting various debt contracts. Therefore, they have an incentive to report incorrectly their willingness to repudiate to obtain a reduction in debt service payments. Whenever lenders perceive a positive probability, given current debt obligations, that a borrower would prefer repudiation to the selection of a new debt contract with repayment, the borrower may be able to misrepresent its private information. If creditors are unable to observe the realized value of output, under the equilibrium renegotiation scheme of the previous section in every output state the debtor will claim willingness to repudiate. Some contract with debt service reduction chosen in a low output state will be preferred in a high output state to repayment. Creditors will seek to design the offers they make in debt renegotiations to induce correct revelation of the private information. Lenders will want to offer debt renegotiation packages which will be chosen over repudiation in poor events but which are inferior to repayment in favorable outcomes.

The private information possessed by debtors can be anything that affects the social welfare attained by choosing different debt contracts. For example, national leadership may be better informed about factors determining the social costs of achieving given levels of trade surplus than are foreign creditors. For expositional simplicity, let the realized value of output be unobservable by creditors, although we intend it to be a proxy for some measure of debtor country surplus. The distribution of output is assumed to be common knowledge, as are all other characteristics of the borrower. Also, suppose that output, y, can only take a finite number of values with positive probability. These are given by y_1, y_2, . . .

$., y_n$ in increasing order. The random variable, y, can be thought of as parameterizing a class of utility functions for the national leadership. Creditors do not know what type of decision-maker they face at each date. Each period a new type is drawn from the common distribution. In this interpretation, the period length is the time a particular type is in power. Again, the identification of y with output is not intended to be literal[3].

The creditors' problem is to choose a set of contracts to offer in the event of renegotiation requests such that their ex ante expected profit is maximized, when debtors ex post maximize utility over the set of contracts (including renegotiation packages) available. A contract renegotiation will be chosen only if it is the maximal contract in the realized state over the set of contracts offered for all states. The creditor's inability to observe output implies that debtor self-selection alone must be relied upon to assure the anticipated behavior in each output state. The creditor's problem is to design a contract set that induces truthful revelation. The equilibrium set of renegotiations offered will separate different output realizations through contract choice, so that ex post the private information is revealed.

The set of equilibrium offers under free entry in ex ante contracts, debtor-creditor relationships) and debtor limited liability is characterized again using a principal-agent framework. Because simple reductions in debt service will be chosen by the borrower in either low or high output states, offered revisions of debt repayments under asymmetric information about output realizations must observe a self-selection constraint. The contracts offered to assure non-repudiation in low output states must be inferior to other contracts available when the debtor

realizes high output value. The addition of constraints assuring correct contract selection leads to a separating equilibrium. There will be n contracts available, with a different contract selected in each output realization. The contract intended to be selected in a particular state will provide the maximum utility to the debtor in that state over the set of offers. Some of these contracts will simply be the best choices over the set of new debt contracts available from any potential creditor. That is, the set of ex ante debt contracts will always be available with repayment of contractual debt service.

The set of ex ante debt contracts (those available from any new entrant creditor following repayment) will be found by first characterizing the set of ex post repayment revisions offered in equilibrium for a given current debt service obligation, R. Each member of the set of debt contracts offered by the current creditor will consist of a current net payment and a debt service obligation for the next period. These contracts will not be equivalent to the debt reductions derived in the previous section. Imposition of the self-selection contraints is found to result in lower ex post profit in each state than could be attained if the value of output were observed directly by the creditor. The equilibrium set of contracts involve higher levels of debt service for the next period for low output realizations than would arise with symmetric information.

The set of ex ante offers is derived using the solution to the creditor's ex post problem, as a perfect equilibrium. The set of initial non-negative expected profit contracts offered is a subset of what it would be without private information. Lenders are assured non-negative expected profits ex ante, so that ex ante debtor utility is lower than under symmetric information. In most states, however, debtors are better off ex

post than if they could then report their output state before revised repayment offers are made. In states for which repudiation provides higher utility than full repayment, the debtor can receive higher utility under debt renegotiation than the repudiation level. Since under symmetric information, the debtor is always forced to either its repudiation utility level or its maximal utility over the set of new contracts with repayment (whichever is larger), direct reporting of the value of output before the choice of a contract ex post is incredible. Direct revelation only occurs with the selection of a separating equilibrium contract revision.

Given a level of existing debt service obligations, R, the existing creditor's problem is to find contracts, (ℓ_i, R_i), for each i, to maximize expected profits. The set of zero expected profit debt contracts, S, will be found implicitly; however, we assume that it is non-empty and define a loan offer, ℓ', for each next period debt service obligation, R_i. That is, $\ell'(R_i)$ is the size loan which repayment obligation R_i equals in expected present value for creditors. The present value loss to a creditor from offering the contract

(ℓ_i, R_i), is $(\ell_i - \ell'(R_i))$.

The existing creditor's problem is given by

$$\max \sum_{i=1}^{n} p_i(\ell'_i(R_i) - \ell_i) \tag{8}$$

with respect to $\{(\ell_i, R_i)\}$ for $i=1,\ldots,n$, subject to, for all i,

(a) $U(y_i + \ell_i - R) + \beta EV(R_i) \geq \hat{V}(y_i, R)$

(b) $U(y_i + \ell_i - R) + \beta EV(R_i) \geq V^r(y_i, R)$

(c) $U(y_i + \ell_i - R) + \beta EV(R_i) \geq U(y_i + \ell_j - R) + \beta EV(R_j)$,

for all $j \neq i$.

The probability of output y_i being realized is p_i. Constraint (a) is the restriction that repudiation is inferior to the debt contract offered for each value y_i, and (b) is the restriction on offers created by free entry in new contracts. The third is the self-selection constraint. The contract (ℓ_i, R_i) is at least as good for the debtor in state i as every other offer. I assume that indifference for the debtor is resolved in the lender's favor to assure a solution.

The solution to this problem yields a set of n offers ex post such that debt repudiation never occurs. The contracts offered to the debtor which are taken in some states for which repudiation is superior to repayment on contracted terms can provide greater utility than outright repudiation. Likewise, in some states for which selection of a new ex ante debt contract (with full repayment) is preferred to repudiation, the debtor will attain even higher utility by taking a contract offered by the current creditor but not by new entrants. The self-selection constraints produce these possibilities by creating trade-offs between expected profit in different states. The equilibrium contracts are interrelated.

The Appendix provides a proposition which summarizes the properties of the equilibrium set of debt renegotiations. In equilibrium, utility is nondecreasing and the net payment by the debtor is nondecreasing in output, while the next period debt service obligation is nonincreasing in output. The set of debt renegotiations offered may force the debtor in the lowest output state, if repudiation is ever preferred to repayment, to its repudiation level of utility. This may also be true for higher states.

The debtor may choose contracts from the ex ante zero expected profit set (contracts new entrants offer) in some high output states. The equilibrium ex post contract in these states may provide even higher

utility. If the debtor attains just $V^r(y_i,R)$ in state y_i, then the existing creditor just offers the same set of debt contracts which any new entrant will offer, S. If the solution to the creditor's problem has the debtor choose repayment and a new zero expected profit contract in a state j, then the equilibrium choice in all higher states is also repayment as contracted. An important result is that the debtor may be better off renegotiating with existing creditors even if she is willing to repay. In this case, the equilibrium contract set offered by the existing creditors is such that the debtor is indifferent between the equilibrium debt contract intended by creditors for the realized state under renegotiation and the contract intended for the next lowest state, except, possibly, in two situations. The first occurs when the current state renegotiated debt contract provides just the repudiation level of utility for that state. The second occurs when the contract chosen in equilibrium involves full repayment for the present realization of output.

This latter property, called continuous-state indifference, and the above exceptions deserve explanation. If the debtor is offered a contract, (x_{i-1}, R_{i-1}), the expected present value for the creditor in the next highest state can always be increased if the debtor's utility can be reduced in this next highest state. Therefore, unless utility cannot be reduced further in state i, the debtor is indifferent between the debt renegotiations for that state and for the next lower state. When the debtor achieves exactly the repudiation level of utility or the level assured by free entry in new debt contracts, this indifference may or may not hold. If the debtor chooses a new debt contract with full repayment in both the present state and next lower state, under concavity of felicity, this property does not hold.

Figure 2 shows a separating equilibrium set of debt renegotiations. The intertemporal marginal rate of substitution portrayed decreases with y for a given contract because $U(c)$ is strictly concave. Concavity is important for demonstrating the proposition; however, concavity of $U(c)$ does not imply that the derived indifference curves are convex everywhere. The relationship between expected value and contractual debt service obligations depends on the entire set of equilibrium debt contracts. The indifference curves are drawn smooth in Figure 2 for simplicity; with a finite number of states, they will each contain kinks.

The equilibrium ex post contracts display a simple relationship between the intertemporal rate of substitution in contract terms along the boundary of S (zero expected profit contracts) and the intertemporal marginal rate of substitution. These are equal if full repayment occurs in equilibrium. If the debtor in state i is assigned contract (x_i, R_i), then the slope of the boundary of S at the contract $(\ell'(R_i), R_i)$ equals the intertemporal rate of substitution if the debtor is not indifferent in state $i+1$ between this contract and (x_{i+1}, R_{i+1}). In the case of continuous state indifference, the rate of contract substitution equals a weighted sum of the marginal rate of substitution in state i and in state $i+1$. The weight on the state $i+1$ marginal rate of substitution is negative, but smaller in absolute value than the weight on the state i rate of substitution. This reflects the trade-off to ex post expected profit between lowering state i profit by revising R_i and x_i and increasing state $i+1$ profit by reducing utility in state $i+1$ (lowering x_{i+1}). The marginal rate of substitution of R_i for x_i in state i is less than the intertemporal rate of contract substitution. Therefore, state i profit alone is not maximized. The weights are implicitly given in the proof of the

proposition; they depend upon the probability distribution of output and the marginal felicity of consumption in the two states.

Derivation of the set of initial loan contracts, S, remains. The ex ante expected profit is given by

$$E\pi = -\ell + \rho[R + \sum_{i=1}^{n} p_i(\ell'(R_i) - \ell_i)],$$

where (ℓ_i, R_i) are solutions to the creditor's ex post optimization problem. The last term (summand) is the expected present value of the reduction in debt service received. Even if ℓ_i exceeds $\ell'(R_i)$, the lender's return may exceed opportunity cost in some states. Maximization of expected profit will lead to a non-zero probability that the debtor is willing to repudiate. Risk neutrality of creditors allows risk-averse debtors to achieve some degree of insurance. As in the well-known principal-agent literature (for example, Holmstrom (1979), Harris and Raviv (1979)), risk sharing is incomplete due to the need for equilibrium debt renegotiation to observe the self-selection constraints. Maximization of ex ante expected profit gives the set of non-negative expected profit contracts offered by new entrants. I assume that the utility function for the debtor, possible output states, and lender's discount factor are adequate to assure that the set is non-empty and potential debtors choose to borrow initially.

It should be noted that the maximal ex ante contractual debt service obligation is at least as great as the resulting ex post debt service for the succeeding period in the lowest output state. Any increase in debt obligations beyond this level will never be met. This debt obligation is the maximum amount such that ex post, the debtor repays in full and selects a new zero expected profit contract in the highest output state. Figure 3 portrays this equilibrium. The indifference curves are vertical beyond R_1,

as increases in R_i have no effect on the debtor because such incremental repayment obligations are never repaid.

In a separating equilibrium, the net capital outflow from the debtor can be either positive or negative in a state for which repudiation dominates full repayment of existing debt service and choice of a new ex ante debt contract. This contrasts with the equilibrium outcome under symmetric information. The possibility that the lender provides additional inflows to a recalcitrant debtor arises when the repudiation level of utility depends upon the debt service obligations that are repudiated. Contracts that satisfy the necessary conditions for expected profit maximization in low states may involve positive values of x, because the intertemporal marginal rate of substitution is finite for the repudiation level of utility at contracts with zero net outflows (x equal to zero). This possibility does not arise if the cost of repudiation depends only on the current value of output. In this case, the debtor will always prefer a contract with zero net outflow to repudiation, regardless of the next-period repayment obligation. Therefore, in the binding state, a net payment to the existing creditor is made under debt renegotiation.

It should be noted that the creditors' two-stage optimization problem can have many equilibria; nothing in this framework rules them out. Multiple equilibria are likely to occur when repudiation costs depend upon current debt service obligations.

In the presence of debtor private information, the equilibrium pattern of debt renegotiation reduces the extent to which existing creditors can extract surplus from a borrower. This implies that the social cost of the informational asymmetry is a reduction in the flow of capital to the debtor countries. Also, because the debt contracts offered in a renegotiation

serve the additional purpose of signalling debtor characteristics, (therefore, willingness to fulfill contractual obligations), the borrower can become locked into a permanent relationship with senior creditors more quickly for a given event than under symmetric information. The dynamics for this model are not fully derived, however.

III. Separation through Costly Delay in Bargaining

In the preceding two sections borrowers have no more bargaining power than just the options to return to the loan market or repudiate. The equilibria discussed in both the perfect and imperfect information cases are equilibria for a strategic bargaining game in which the creditor makes all offers when output in any given period to be storable for some positive length of time (see Sobel and Takahashi (1983)). For a strategic bargaining game, with alternating offers, debtors will achieve better outcomes ex post than were attained in the preceding solutions. Nevertheless, the ex ante contract offers will adjust to account for the ex post divisions of surplus in any subgame perfect equilibrium.

Bulow and Rogoff (1989) adopt the strategic approach to Nash bargaining games under complete information, due to Rubinstein (1982), to sovereign debt negotiations. The creditor who acquires the right to impose sanctions by making an initial loan sells a promise not to impose sanctions each period to the debtor. The amount paid in the subgame perfect equilibrium each period for this property right is just the debt service payment. The discounted stream of these prices is equal to the amount initially lent under perfect competition among lenders. The perfect equilibrium is unique if penalization benefits creditors an arbitrarily small amount. The complete information model presented earlier in this

paper needs minor additional assumptions to fit the Rubinstein (1982) framework: let output be storable and let the debtor be risk neutral. In this setting, renegotiations will never result in new inflows unless a new creditor will also supply them. Under risk aversion, access to new credit in the presence of seniority provisions can become the object bargained over, but the characterization of renegotiations will not be affected. In the complete information bargaining approach, there is no particular reason why the initial contract does not simply specify the perfect equilibrium debt service payments. If it does, then no bargaining actually takes place.

The asymmetric information model can also be extended to a bargaining framework. Delays to agreement can lead to separation of debtors by type in an alternating offers bargaining game. Simultaneously offered contracts by the creditor no longer serve the purpose of inducing truthful revelation. Incomplete information can be introduced, as before, through asymmetric observability of output, or through private information about rates of time preference. Delaying agreement can arise strategically to separate borrowers with different realizations of privately observed random variables, or of different social preferences, which are unobserved by creditors. Delay can also arise because one or both parties find that waiting for publicly observed information to arrive is individually rational. This case may be important when creditors, as well as debtors, have limited liability and are therefore risk loving.

This section outlines an approach to modeling socially costly delays to a resolution of debt repayment problems. The impasse in the current repayments crisis and the consequent lack of funds to finance capital formation have been discussed widely. In noncooperative Nash bargaining

models, equilibrium delay to agreement has been shown to arise in the presence of incomplete information by a large number of authors. I discuss one source of delay: strategic delay necessary to convey the debtor's private information.

The approach is to adopt the bargaining model with one-sided incomplete information of Admati and Perry (1987), in which has equilibrium paths displaying strategic delay to external borrowing by a growing economy. Following Bulow and Rogoff, we assume that by lending the creditor purchases a right to impose sanctions; the promise not to exercise this right is then sold to the debtor at the subgame-perfect price and time. Unlike their model, agreement need not occur immediately here. A major cost of delay to agreement will be the absence of new credit. New creditors may not provide additional funds to a growing debtor in the presence of unresolved existing claims. The reason is that the net inflow of resources will affect the bargaining game between old creditors and the debtor and therefore the investment undertaken by the borrower. The future flow of output following a given loan will, in general, be less if existing claims need to be resolved.

Several possible approaches can motivate the adoption of the strategic delay model. The debtor is assumed to have private information about the value it places on avoiding sanctions. Sanctions are assumed to lead to lower levels of per capita consumption than are attainable along an equilibrium path for the bargaining game, so that debt repudiation will never occur in equilibrium. Capital accumulation is possible, and either the labor force grows at a constant proportional rate or physical capital depreciates. Foreign borrowing can be motivated by assuming that either the planner's discount rate or the marginal productivity of capital exceed

the world rate of interest. A simple model is one in which output, which depreciates in storage, is traded for capital goods which are noncompetitive imports. During an impasse, the per capita capital stock declines.

The private information of the debtor is about the surplus available to pay creditors. This can be the current realized value of output in a stochastic model, as in previous sections, or it can be the minimum level of per capita consumption politically acceptable in a renegotiation, or other debtor characteristics. Suppose that whenever per capita consumption falls below some level, $\bar{c}$, political leadership is replaced immediately (through either parliamentary or nondemocratic means). Then the surplus available to service debt obligations, that is, the value placed on purchasing the promise not to impose sanctions, is the amount of current resources exceeding those needed to sustain $\bar{c}$ along a perfect equilibrium path. The country's policymakers are likely to be more informed about $\bar{c}$, or, more generally, the social cost of generating given levels of trade surpluses (for example, the excess burden of indirect taxes).

Suppose that output is produced using capital and labor according to a constant returns-to-scale technology. Output is storable (depreciation can occur, but need not) and is consumed or traded for investment goods, which are not produced at home. Let output be given by

$$y_t = f(k_t)$$

and let

$$\Delta k_t = k_{t+1} - k_t = i_t - nk_t$$

Storage is given by s_t, so that

$$y_t = c_t + (\gamma s_{t-1} - s_t) - R_t,$$

where γ is the rate of depreciation of stored output and R_t is output exported.

The trade surplus is just

$$R_t - i_t,$$

Repudiations lead to consumption equal to or less than the minimum politically acceptable in a negotiated settlement. If lenders benefit from imposing sanctions, by any arbitrarily small positive amount, then no subgame-perfect equilibrium involves repudiation without consequent penalization (see Bulow and Rogoff). I simply assume that penalization for repudiation is a credible threat.

The policymaker's social welfare function is just

$$U = \sum_{t=0}^{\infty} \beta^t c_t.$$

The value of the optimal capital accumulation program along a subgame-perfect equilibrium path can be defined directly. Note that once the debtor's private information is revealed, a complete information bargaining subgame follows for the model described here. The creditor's lack of information about the value of sanctions to the debtor derives from potential differences in the type of debtor, rather than imperfect information about its current state. With this assumption, examination of a single episode is adequate, but the generalization is a formal exercise.

The debtor's type is characterized by the maximum surplus she can transfer to creditors in exchange for suspension of the threat of sanctions at a given time. Time matters both because the social discount rate is positive and the per capita capital stock declines during delays to agreement.

Suppose that the low $\bar{c}$ type repays at time 0. Then the surplus

(denoted h_0) in a given state, k_0, is defined by the problem

$$V(k_0 \mid h) = \max_{k_1} \{ c_0 + \beta V(k_1) \}$$

subject to

$$k_1 = k_0 + i - nk_0,$$

$$c_0 = f(k_0) - (h + i),$$

where $V(k_1)$ is the value of the debtor's utility along a subsequent equilibrium path. Let h_0 be the maximum value of h such that $c_0 \geq \bar{c}$.

The debtor's value can be derived in terms of the amount paid the creditor and the time at which settlement takes place by noting that if her type is revealed, then subsequent negotiations have the unique complete information bargaining solution, so that the value function is well defined. If a pooling equilibrium results (which is a possible outcome), then the game repeats. If the state variable, k_t, is observed by the creditor, however, the type can be inferred after one round with a pooling equilibrium outcome.

For given k_0, define the debtor's value of an agreement as

$S(h_t - R, t)$, for the low $\bar{c}$ type, and

$S(\ell_t - R, t)$, for the high $\bar{c}$ type,

where $\ell_t < h_t$ for an agreement which transfers an amount R at time t to creditors. $S(\cdot,\cdot)$ is increasing in the first argument and decreasing in the second. The approach of Admati and Perry (1987) can now be applied.

Suppose at time 0, the lender can make an offer to which the debtor replies at time 1. The debtor will never accept an offer that provides less value than the value of an offer it can make at time 1 that would be accepted by the lender. The discount factor for the lender is determined

by the opportunity interest rate. The results of Admati and Perry can be directly applied to this model with algebraic modification. The high surplus type can refuse a current high offer and wait to receive an offer that the low surplus type would accept. In equilibrium, the low surplus debtor cannot offer at time 1 an amount which the high surplus type would prefer to wait and offer to taking the time 0 offer. The low surplus debtor must wait long enough to make a counteroffer to separate itself from the high surplus type when the creditor's first (time 0) offer is the equilibrium offer for the high type in the complete-information bargaining game.

Multiple equilibria emerge from this approach. Unique separating equilibria exist for large enough creditors' priors that the debtor is of the high surplus type. These involve offering the complete information game division for the high type at time 0. The low type offers its complete- information game equilibrium division after a time delay adequate to signal its type. Separation becomes costly by reducing the surplus obtained by the low value debtor and reducing through delay the available output that may be divided.

If the creditor's prior belief is that there is a low probability that the debtor is the high surplus type, both multiple separating and pooling equilibria are possible. For low priors, there exists only a unique pooling equilibrium in which no delay occurs. This latter equilibrium involves lenders offering the complete information equilibrium repayment for the low surplus type in time 0. Either type accepts this offer.

One consequence of introducing capital stock depreciation as a cost of delay is to increase the possibilities for pooling equilibria to arise. Another is that the cost of delay to the high surplus type can, in general,

be lower than the cost for the low surplus type. Of course, the depreciation of the capital stock also increases the effective discount factor for the lenders. Resulting separating equilbria may entail even longer delays with capital decumulation when the cost of delay is lower for high surplus types. If there are many possible types of debtors (as noted above), a separating equilibrium (or mixed pooling and separating equilibrium) must entail a delay between counteroffers made by each possible type of debtor, in declining order of surplus. Because this type of delay does not disappear as the length of time between possible offers shrinks to zero, significant costly delays to agreement can arise.

IV. Possible Extensions

Multi-Period Contracting

In the simple stationary consumption-smoothing model with potential repudiation, multi-period debt contracts serve no additional purpose if seniority provisions are enforceable. If every creditor claims on an equal footing renegotiation proceeds, then multi-period contracts with renegotiation may arise in equilibrium. Creditors offering zero-expected profit loans recognize that an entrant will offer an additional loan on terms preferred by the debtor to those that would not reduce the value of earlier creditors' claims. A two-period contract may be profitable that reduces the debtor's incentive to borrow additional amounts. Such contracts can increase the ex ante utility of the debtor in equilibrium by moving the chosen contract away from the interest-rate-taking one toward the constrained first-best one (Kletzer (1984)). Because renegotiation is possible, such a contract offers the debtor an option to choose a particular second-period loan that, in events in which it would be taken,

new lenders would not offer.

An example of such contracts is one offering a loan that, taken by itself, is expected to be profitable for the first period. A clause is included which obligates the lender to provide a new loan during the second period, which entrants would not offer if performance criteria are met by the debtor. If these covenants are not fulfilled, the lender can choose to declare a default and not provide the second loan. A restriction on debt dilution in the first period is a potential covenant; this type of contract can be self-enforcing for the sovereign debtor. In the case of sovereign loans, creditors may be subject to third-party enforcement of their obligation if the debtor does not breach the contract, which can specify that disputes be brought to the home court of the creditor. The debtor will generally choose not to breach the contract through first-period debt dilution. Because the debtor can choose to exercise the second-period option or select another debt contract in the absence of renegotiation, the debtor's expected utility the second period is increased, inducing first-period performance (if output in the first-period is private information, then contract breach may occur in equilibrium). These two-period loans may provide access to debt contracts in the second period that the debtor desires in poor output states over market contracts and chooses not to accept in high output states. Because of the debtor's limited liability (and consequent market imperfection), these loans offer insurance possibilities that a sequence of one-period loans with renegotiation do not. In the event of a demanded second-period revision of debt service obligations (which may become less probable), the obligations of the creditor to supply a second loan can be voided by a contract clause. Therefore, in the event of a renegotiation of debt service, the

multi-period contracts have no effects.

The creditor's two-period lending problem is to maximize the expected two-period profit with respect to the choice of contract terms while deciding whether or not to declare a subsequent default in the event of contract breach subject to a series of constraints. These constraints include the debtor's choice of accepting the contract over other contracts available and the equilibrium choices in each output state at each of the two future dates of the debtor. That is, the creditor correctly values the repayment streams along each equilibrium path for the subsequent subgames. In the absence of creditor observability of the debtor's output, the incentive compatibility constraints employed in the previous section are imposed at each date.

If the opportunity cost to creditors is a random variable, then an additional motive arises for multi-period contracts. Since the set of offered contracts shrinks with an increase in the world rate of interest, the second- period loan option will provide desirable insurance opportunities to the debtor; if the lenders' opportunity cost of funds falls, then the second- period (or later) debt contract can be revised. In equilibrium, in these events the resulting debt contract will be the debtor's best contract from among those offered by other lenders. While risk-neutral lenders will offer multi-period contracts providing higher utility to borrowers than equilibrium single-period loans, interest rate increases benefit borrowers ex post and interest rate declines lead to contract revision ex post. Therefore, the length of multi-period contracts in equilibrium is limited by the ex ante expected profitability of debtor welfare-improving contracts. Such contracts exist at all because the limited liability of debtors leads to equilibrium contractual marginal

rates of interest exceeding average rates of interest on their debts.

Unobservable Debtor Policy Choices

The supposition that debtor income is unobservable by creditors may strike readers as peculiarly unrealistic. The natural alternative is to suppose that income is publicly observable while policy choices by the debtor affecting the distribution of income are unobserved by creditors. In a stochastic environment, moral hazard in policy selection arises if policies enhancing the probability of favorable outcomes for creditors (that is, if they raise anticipated debt repayments) are costly to debtors. The choice between investment and current consumption is a standard example.

The first-best contracts for simple principal-agent problems have been characterized when output is publicly observable, while the agent's choice of an action affecting the distribtuion of output is known only to the agent (Holmstrom (1979) and Rogerson (1985)). These contracts specify divisions of output as functions of the observable quantity, output alone. In the repeated principal-agent problem, the first-best contract depends upon the entire past history of output, as well as current output. The extent of risk sharing between a risk-neutral principal and risk-averse agent is limited by the necessity that the output-contingent contract provide incentives for the agent to choose output-increasing actions.

In the model used in this paper, assume that debtor income is observed by lenders, but that the distribution of income realizations depends upon a set of current policies selected by the debtor, which cannot be observed directly by creditors. Let the distribution of income conditional on policy choice be stationary, and assume that current-period felicity depends positively on current consumption and negatively on some measure of

policy choice (for example, investment).

Constrained first-best capital flows have been characterized under a number of special assumptions for the problem of maximizing debtor utility subject to the constraints that repudiation is never chosen in equilibrium, expected profits are zero in every period, and the contract is incentive compatible in the choice of policy. A recent paper by Atkeson (1988) incorporates debtor private information about the investment undertaken in a repeated moral hazard model. In his approach, state-contingent repayment schedules are binding on the lenders in one-period contracts. This allows commitment by the creditors which is precluded in the model presented above. The analysis of ex post renegotiation with limited commitment by the creditors under given bargaining conduct may differ significantly from that of first-best solutions for the repeated moral hazard problem. Although it awaits investigation, the absence of creditor commitment is likely to increase the severity of the problem of coordination between lenders and borrowers.

Suppose that the only policy instruments available to the debtor government for transferring resources from the private sector to service debt create distortions in the domestic economy (for example, commodity taxes). In this case, the contracts that satisfy the first-order incentive compatibility condition (that is, are locally maximal for lenders) will tend not to lead to the optimal pattern of capital flows (constrained by the asymmetry of information). In such a model, a serious coordination problem can arise between creditors and debtors because there can be complementarities between policy choices and external capital flows. Large net capital outflows may be compatible with distortionary policies that reduce the expected return to new loans. The possibility that

unsatisfactory equilibria arise when the policies required to meet large debt service obligations are distortionary can create a significant international public policy problem.

V. Conclusions

The analysis of bargaining between current creditors and a recalcitrant debtor in the consumption smoothing model has led to the identification of potential sources of inefficiency in the intertemporal allocation of resources beyond that created by sovereign immunity alone. The sanctions available to creditors to use in the event of repudiation result in future losses of utility for the debtor; the seniority privileges of creditor both help insure the credibility of such sanctions in this model and lead to an inefficient outcome of exogenous bargaining conduct of borrowers and lenders in renegotiations. A main point of the major part of the analysis in this paper has been the potential for bargaining to lead to inefficient outcomes in renegotiations because of this privilege.

In the presence of informational asymmetries, equilibrium for the creditor-debtor renegotiation problem is a separating type. In lower output states, smaller current payments are made with larger debt service obligations carried forward. A debtor unwilling to meet current debt service may obtain new net inflows in a constrained optimal response by creditors only in the version of the model in which the penalties for repudiation increase with the debt service repudiated. This follows because a debtor may prefer to repudiate now with R relatively low to simply consuming current output while incurring larger future debt service obligations with the consequent reduction in expected utility.

The separating nature of equilibria derived in the imperfect

information case may have implications for the evaluation of the (stochastic) debt service burden. Subsequent poor output realizations may lead in only a few steps to the maximal level of debt service obligations possible with net outflows or only minor net inflows of capital along the way. This might be the most significant cost of the informational imperfection.

Our model stands in contrast to an important paper on indeterminacy in lending under possible bankruptcy by Hellwig (1977). In that paper, the creditor sets a credit limit, which is optimal ex post to relax when it is reached by the debtor. If it is not relaxed, bankruptcy occurs automatically and the lender receives nothing. Additional loans are expected to be profitable because they raise the value of existing loans; no new creditor will provide them, but an existing creditor should. Time inconsistency arises because the interest schedule is given to the creditor, and the creditors' policies are restricted to setting limits on the stock of debt. We have relaxed two constraints imposed by Hellwig: default need not be declared following a breach of contract, and the interest charged in a renegotiation of debt is a choice variable for the existing creditors. Current lenders have access to a richer set of policies. Time inconsistency arises in this model instead through the existing creditors' seniority privileges in debt relationships.

Appendix

Define $V(x_i, R_i) = U(y_i + \ell_i - R) + \beta EV(R_i)$, where $x_i = \ell_i - R$. The following proposition characterizes equilibrium debt renegotiations. For simplicity, the continuation value is held constant; this will be calculated recursively, maximizing lender profits to derive the sequential equilibrium. Therefore, in general, part(c) does not hold in a sequential equilibrium.

Proposition: Given current debt service obligations, the lender's most preferred debt renegotiations satisfy:

a) x_i and R_i are both non-increasing in i.

b) $V_i(x_i,R_i)$ is non-decreasing in i.

c) If $\tilde{V}(y_1,R) < V^r(y_1,R)$, then $V_1(x_1,R_1) = \tilde{V}(y_1,R)$.

(An analogous condition may hold for additional i)

d) Whenever $V_i(x_i,R_i) > max\{\tilde{V}(y_i,R),\ V^r(y_i,R)\}$,

$V_i(x_i,R_i) = V_i(x_{i-1},R_{i-1})$ holds.

e) If $V_i(x_i,R_i) = V^r(y_i,R)$, then $(\ell_i,R_i) \in S$, $\ell_i = x_i + R$, and $(\ell_j,R_j) \in S$, for all $j > i$, so that $V_j(x_j,R_j) = V^r(y_j, R)$, also.

Sappington (1983) presents similar results to part of the above for a simpler limited liability principal-agent problem.

Outline of proof of proposition:

To show that x_i is non-increasing in i, we use the self-selection constraint

$$U(y_i + x_i) + \beta EV(R_i) \geq U(y_i + x_j) + \beta EV(R_j).$$

Let $i>j$, then $U(y_j + x_i)+\beta EV(R_i) > U(y_i+x_j) + \beta EV(R_j)$. if $x_i > x_j$, because $U(c)$ is strictly concave. This violates the self-selection constraint for

state j. Therefore, $x_i \leq x_j$. Monotonicity of $EV(R)$ in R implies that $R_i \leq R_j$, again using the state i self-selection constraint.

$V_i(x_i,R_i) \equiv U(y_i + x_i) + \beta EV(R_i)$ is non-decreasing in i by

$$U(y_i + x_i) + \beta EV(R_i) \geq U(y_i + x_j) + \beta EV(R_j)$$
$$> U(y_j + x_j) + \beta EV(R_j),$$

since $y_i > y_j$.

The Lagrangian for the creditor's optimization problem is

$$L = \sum_{i=1}^{n} p_i (\ell'(R_i) - \ell_i) + \sum_{i=1}^{n} \sum_{j \neq i} \alpha_{ij}(V_i(x_i,R_i) - V_i(x_j,R_j))$$
$$+ \sum_{i=1}^{n} \delta_i(V_i(x_i,R_i) - V^r(y_i,R))$$
$$+ \sum_{i=1}^{n} \gamma_i(V_i(x_i,R_i) - \bar{V}(y_i,R)).$$

Necessary conditions for a maximum are

$$p_i = ((\delta_i + \gamma_i) + \sum_{j \neq i} \alpha_{ij}) U'(y_i + x_i) - \sum_{j \neq i} \alpha_{ji} U'(y_j + x_i)$$

$$p_i \cdot (d\ell'/dR_i) = ((\delta_i + \gamma_i) + \sum_{j \neq i} (\alpha_{ij} - \alpha_{ji}))(-\beta EV'(R_i)).$$

Because the derivative of ℓ_i with respect to R_i may not be well defined for discrete values of y, (2) should be interpreted as the appropriate weak inequalities for right and left derivatives. The function $\ell'_i(R_i)$ can be shown to be continuous.

Following Sappington (1983), $\alpha_{ij} = 0$ for $j>i+1$ and for $j<i-1$. Using the fact that $x_j < x_{i+1}$ if $j>i+1$, suppose the converse. Then, the i self-selection constraint implies

$$U(y_i + x_j) + \beta EV(R_j) \geq U(y_i + x_{i+1}) + \beta EV(R_{i+1}).$$

Concavity of $U(c)$ implies

$$U(y_{i+1} + x_j) + \beta EV(R_j) > U(y_{i+1} + x_{i+1}) + \beta EV(R_{i+1}),$$

which contradicts the $(i+1)$ self-selection constraint. A similar argument holds for $j<i-1$. Therefore, only $\alpha_{i\ i+1}$, $\alpha_{i\ i-1}$ can be non-zero for any i.

Further, note that if $\alpha_{i\ i-1} > 0$, then

$$U(y_i + x_i) + \beta EV(R_i) = U(y_i + x_{i-1}) + \beta EV(R_{i-1}) \text{ and}$$

strict concavity of $U(c)$ and $x_i < x_{i-1}$ imply that

$$U(y_{i-1} + x_i) + \beta EV(R_i) < U(y_{i-1} + x_{i-1}) + \beta EV(R_{i-1}).$$

Therefore, if $\alpha_{i\ i-1} > 0$, $\alpha_{i-1\ i} = 0$, and conversely.

Similarly, for $\alpha_{i\ i+1}$ and $\alpha_{i+1\ i}$.

S is convex, since $R + \sum_{i=1}^{n} p_i(\ell'(R_i) - \ell_i)$ is non-decreasing in R. The following arguments assume that $d\ell'/dR_i$ is continuous in R_i.

Rewriting (1):

$$p_n = (\delta_n + \alpha_{n\ n-1})\ U'(y_n + x_n) - \alpha_{n-1\ n}\ U'(y_{n-1} + x_n)$$

If $\delta_n > 0$, then $\alpha_{n-1\ n}$ must be zero. Otherwise, either

$V_n(x_n, R_n) < V^r(y_n, R)$, or

$V_{n-1}(x_n, R_n) < V^r(y_{n-1}, R)$.

This follows by simply increasing x_n by ϵ and R_n by δ such that expected profit remains zero. If $\delta_{n-1} > 0$, then $\alpha_{n\ n-1} = 0$ by the same argument.

Let k be the minimum value for i such that $\delta_k > 0$. Note that $\delta_k > 0$ implies that $\delta_{k+1} > 0$, because $\alpha_{k+1\ k}$ and $\alpha_{k\ k+1}$ are both zero. Also, whenever $\gamma_j > 0$, $V_j(x_j, R_j) = \tilde{V}(y_j, R)$ which implies that $\tilde{V}(y_j, R) \geq V^r(y_j, R)$. In case of equality, $\gamma_j + \delta_j > 0$, and with inequality, $\delta_j = 0$. We can let $\delta_j = 0$ whenever $\gamma_j > 0$. Let ℓ be the maximum value of i such that $\gamma_i > 0$.

(1) implies:

$$p_n = \delta_n U'(y_n + x_n)$$

$$\vdots$$

$$p_{k+1} = \delta_{k+1} U'(y_{k+1} + x_{k+1})$$

$$p_k = (\delta_k + \alpha_{k\ k-1})\ U'(y_k + x_k)$$

$$p_j = (\gamma_j + \alpha_{j\ j-1} + \alpha_{j\ j+1})\ U'(y_j + x_j)$$

$$- \alpha_{j-1\ j}\, U'(y_{j-1} + x_j)$$
$$- \alpha_{j+1\ j}\, U'(y_{j+1} + x_j),$$

for all j < k, and

$$p_1 = (\gamma_1 + \alpha_{1\ 2})\, U'(y_1 + x_1) - \alpha_{2\ 1}\, U'(y_2 + x_1)$$

Suppose γ_1 is zero, then $\alpha_{1\ 2} > 0$; using both (1) and (2), this implies that $(\ell'(R_i) - \ell_i)$ must increase if (x_1, R_1) is changed so that $V_1(x_1,R_1)$ falls until $\gamma_1>0$. If $\alpha_{1\ 2} > 0$, then the quotient of (1) and (2) for $i=2$ implies that reduction of (x_2,R_2) along V_2 constant increases expected profit. Therefore, $\alpha_{1\ 2} = 0$ and $\gamma_1 > 0$. Note, if $\ell'(R_i)$ has unequal right and left derivatives, then $\alpha_{k-1\ k}=0$ because S is convex, but $\alpha_{j\ j+1}$ need not be zero for $j \geq k$.

Summing (1) over all i gives

$$\sum_{i=1}^{n} p_i = 1 - \sum_{i=k}^{n} \delta_i U'(y_i + x_i) + \sum_{i=2}^{k} \alpha_{i\ i-1}(U'(y_i+x_i) - U'(y_i+x_{i-1}))$$
$$- \sum_{i=2}^{k} \alpha_{i-1\ i}(U'(y_{i-1}+x_i) - U'(y_{i-1}+x_{i-1})) + \sum_{i=1}^{\ell} \gamma_i\, U'(y_i + x_i).$$

The arguments above can be used to imply that $\alpha_{i-1\ i} = 0$. Whenever $(\delta_{i-1} + \gamma_{i-1}) > 0$, $\alpha_{i\ i-1} = 0$ is possible, but not necessary. If $(\delta_{i-1} + \gamma_{i-1}) = 0$, then $\alpha_{i\ i-1} > 0$.

The above properties can be used recursively to derive values for each multiplier. The quotient of (1) and (2) when $\alpha_{i\ i-1} = 0$ yields

$$d\ell'(R_i)/dR_i = (-\beta EV'(R_i))/(U'(y_i + x_i)),$$

and if $\alpha_{i\ i-1} > 0$,

$$d\ell'(R_i)/dR_i = \frac{-\beta EV'(R_i)\ (\delta_i + \gamma_i + \alpha_{i\ i-1} - \alpha_{i+1\ i})}{(\delta_i+\gamma_i+\alpha_{i\ i-1})U'(y_i+x_i) - (\alpha_{i+1\ i})U'(y_{i+1}+x_i)}$$
$$< \frac{-\beta EV'(R_i)}{U'(y_i+x_i)}.$$

References

Acharya, S. and I. Diwan, "Debt Buybacks Can Signal Sovereign Countries' Willingness to Raise Investment and Repay Debt when Partial Debt Relief is Offered: Theory and Evidence," mimeo, June 1987.

Admati, A. and M. Perry (1987) "Strategic Delay in Bargaining," Review of Economic Studies, Vol. 54, July, pp. 345-364.

Atkeson, A. (1988), "International Lending with Moral Hazard and Risk of Repudiation," University of Chicago, Department of Economics, mimeo, May.

Bulow J. and K. Rogoff (1989) "A Constant Recontracting Model Of Sovereign Debt," Journal of Political Economy, Vol. 97, February.

Cline, W. (1983) International Debt and the Stability of the World Economy. Washington, D.C.: Institute for International Economics.

Eaton, J., "Debt Relief and the International Enforcement of Loan Contracts," University of Virginia, mimeo, September 1989.

Eaton, J. and M. Gersovitz (1981) "Debt with Potential Repudiation," Review of Economic Studies, Vol. 48, pp. 289-309.

Fernandez, R. and R. Rosenthal, "Sovereign Debt Renegotiation: A Strategic Analysis," Boston University, mimeo, 1988.

Froot, K. D. Sharfstein, and J. Stein, "LDC Debt: Forgiveness, Indexation and Investment Incentives," mimeo, January 1988.

Gale, D. and M. Hellwig (1985) "Incentive-Compatible Debt Contracts: The One-Period Problem," Review of Economic Studies, Vol. 52, pp. 647-663.

Gersovitz, M., "Trade, Capital Mobility and Sovereign Immunity," Research Program in Development Studies Paper No. 108, Princeton University, 1983.

Grossman, H. and J. Van Huyck (1988), "Sovereign Debt as a Contingent Claim: Excusable Default, Repudiation, and Reputation," American Economic Review, Vol. 78, December.

Harris, M. and A. Raviv (1979) "Optimal Incentive Contracts with Imperfect Information," Journal of Economic Theory, Vol. 20, pp. 231-259.

Hellwig, M. (1979) "A Model of Borrowing and Lending with Bankruptcy," Econometrica, Vol. 45, pp. 1879-1906.

Holmstrom, B. (1979) "Moral Hazard and Observability," Bell Journal of Economics, Vol. 10, pp. 74-91.

Kletzer, K. (1984) "Asymmetries of Information and LDC Borrowing with Sovereign Risk," Economic Journal, Vol. 94, pp. 287-307.

Kletzer, K. (1988) "Sovereign Debt Renegotiation Under Asymmetric Information," Economic Growth Center Discussion No.555, June 1988.

Krugman, P. (1985) "International Debt Strategies in An Uncertain World," in G. Smith and J. Cuddington, eds., International Debt and the Developing Countries. Washington, D.C. : World Bank.

Krugman, P. (1987) "Private Capital Flows to Problem Debtors," manuscript.

O'Connell, S., "A Bargaining Theory of International Reserves," University of Pennsylvania, mimeo, 1988.

Ozler, S. (1988), "On the Relation Between Reschedulings and Bank Value," University of California, Los Angeles, Department of Economics, mimeo.

Rogerson, W., (1985) "Repeated Moral Hazard," Econometrica, Vol. 53, pp. 69-76.

Rubinstein, A. (1982) "Perfect equilibrium in a Bargaining Model," Econometrica, Vol. 50, pp. 97-109.

Sachs, J. (1984) Theoretical Issues in International Borrowing. International Finance Section, Princeton University, No. 54.

Sappington, D. (1983) "Limited Liability Contracts Between Principal and Agent," Journal of Economic Theory, Vol. 29, pp. 1-21.

Sobel, J. and I. Takahashi (1983) "A Multi-Stage Model of Bargaining," Review of Economic Studies, Vol. 50, pp. 411-426.

Worrall, T., (1989) "Debt with Potential Repudiation: Short-Run and Long-Run Contracts," European Economic Review, forthcoming.

Notes

* This paper is based on an earlier paper, Kletzer (1988), entitled, "Sovereign Debt Renegotiation Under Asymmetric Information." Sections I and II are significantly different and section III has been shortened while section IV is nearly identical.

[1]Several authors have also considered noncooperative bargaining models of debt renegotiation. These include Ozler (1988), Fernandez and Rosenthal (1988), and O'Connell (1988).

[2]Implicitly, an assumption is made about the debtor's access to insurance from other sources which he would retain in the event of repudiation. It is assumed that no such possibilities exist (see Eaton (1989), Gersovitz (1983), and Eaton and Gersovitz (1981).

[3]Other analysis of asymmetric information about debtor characteristics include Acharya and Diwan (1987) and Froot, Sharfstein and Stein (1988). Both of these papers introduce private information about debtor's time preference and investigate the effect of debt reduction schemes on investment. The issues studied here are not discussed in the context of asymmetric information about the discount rate.

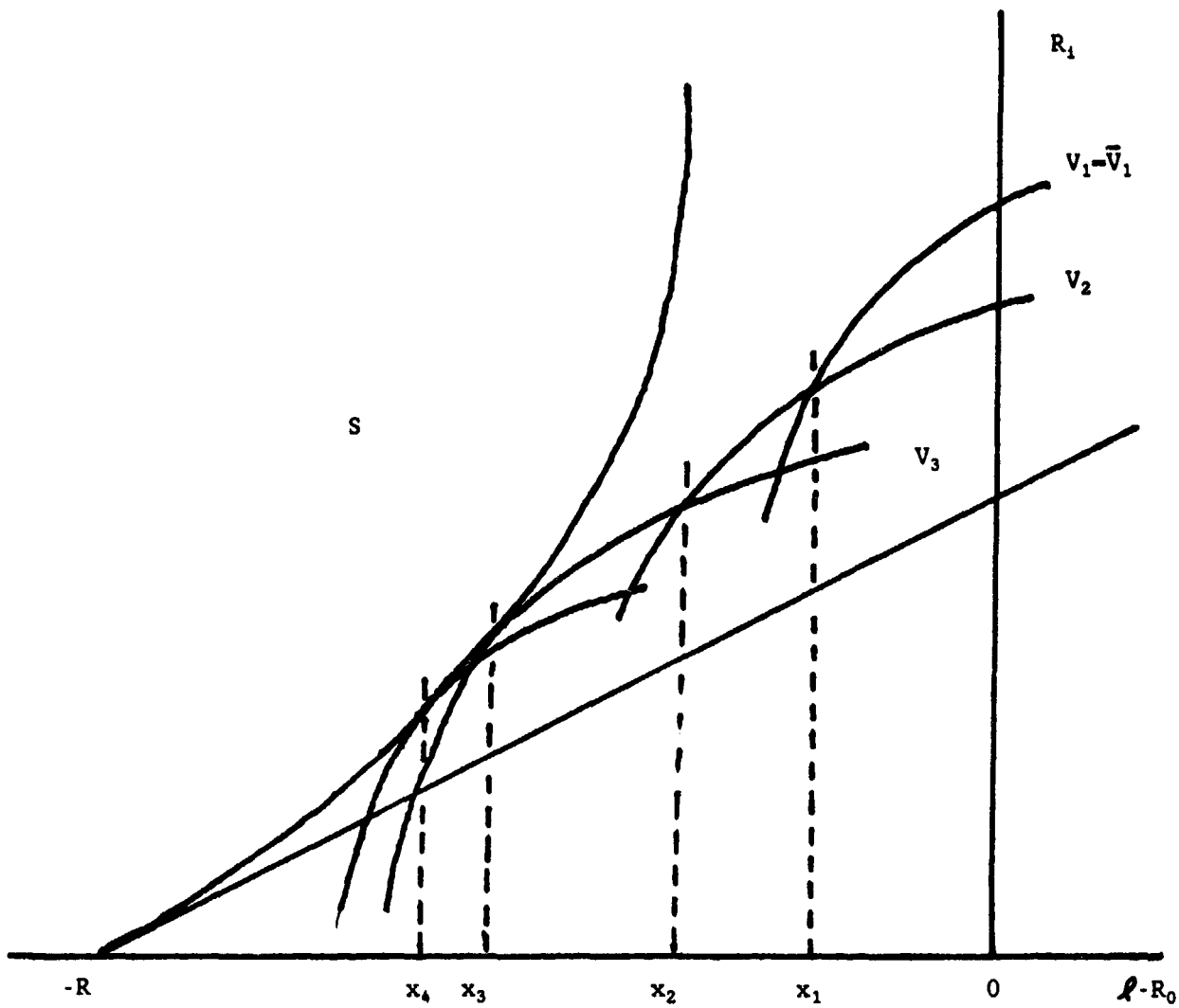

Figure 2

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS416	Improving Data on Poverty in the Third World: The World Bank's Living Standards Measurement Study	Paul Glewwe	May 1990	A. Murphy 33750
WPS417	Modeling the Macroeconomic Requirements of Policy Reform	William Easterly E. C. Hwa Piyabha Kongsamut Jan Zizek	May 1990	R. Luz 34303
WPS418	Does Devaluation Hurt Private Investment? The Indonesian Case	Ajay Chhibber Nemat Shafik	May 1990	M. Colinet 33490
WPS419	The Design and Sequencing of Trade and Investment Policy Reform: An Institutional Analysis	Brian Levy	May 1990 37488	B. Levy
WPS420	Making Bank Irrigation Investments More Sustainable	Gerald T. O'Mara	May 1990	C. Spooner 30464
WPS421	Taxation of Financial Intermediation: Measurement Principles and Application to Five African Countries	Christophe Chamley Patrick Honohan	May 1990	W. Pitayato-nakarn 37666
WPS422	Civil Service Reform and the World Bank	Barbara Nunberg John Nellis	May 1990	R. Malcolm 37495
WPS423	Relative Price Changes and the Growth of the Public Sector	M. Shahbaz Khan	May 1990	WDR Office 31393
WPS424	Mexico's External Debt Restructuring in 1989-90	Sweder van Wijnbergen	June 1990	M. Stroude 38831
WPS425	Earmarking Government Revenues in Colombia	William A. McCleary Evamaria Uribe Tobon	September 1990	A. Bhalla 37699
WPS426	Growth-Oriented Adjustment Programs: A Statistical Analysis	Riccardo Faini Jaime de Melo Abdel Senhadji-Semlali Julie Stanton	June 1990	M. Ameal 37947
WPS427	Exchange Reform, Parallel Markets and Inflation in Africa: The Case of Ghana	Ajay Chhibber Nemat Shafik	May 1990	M. Colinet 33490
WPS428	Perestroyka and Its Implications for European Socialist Countries	Bela Balassa	May 1990	N. Campbell 33769

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS429	Ghana's Cocoa Pricing Policy	Merrill J. Bateman Alexander Meeraus David M. Newbery William Asenso Okyere Gerald T. O'Mara	June 1990	C. Spooner 30464
WPS430	Rural-Urban Growth Linkages in India	Peter B. Hazell Steven Haggblade	May 1990	C. Spooner 30464
WPS431	Recent Developments in Marketing and Pricing Systems for Agricultural Export Commodities in Sub-Saharan Africa	Panos Varangis Takamasa Akiyama Elton Thigpen	May 1990	D. Gustafson 33714
WPS432	Policy Choices in the Newly Industrializing Countries	Bela Balassa	May 1990	N. Campbell 33769
WPS433	The Pervasive Effects of High Taxation of Capital Goods in India: Findings and Conclusions from a Sample of Projects	Francois Ettori	August 1990	F. Ettori 80324
WPS434	Tax Sensitivity of Foreign Direct Investment: An Empirical Assessment	Anwar Shah Joel Slemrod	June 1990	A. Bhalla 37699
WPS435	Rational Expectations and Commodity Price Forecasts	Boum-Jong Choe	June 1990	S. Lipscomb 33718
WPS436	Commodity Price Forecasts and Futures Prices	Boum-Jong Choe	June 1990	S. Lipscomb 33718
WPS437	Institutional Development Work in the Bank: A Review of 84 Bank Projects	Cheryl W. Gray Lynn S. Khadiagala Richard J. Moore	June 1990	L. Lockyer 36969
WPS438	How Redistribution Hurts Productivity in a Socialist Economy (Yugoslavia)	Milan Vodopivec	June 1990	J. Lutz 36970
WPS439	Indicative Planning in Developing Countries	Bela Balassa	May 1990	N. Campbell 33769
WPS440	Financial Sector Policy in Thailand: A Macroeconomic Perspective	William Easterly Patrick Honohan	June 1990	R. Luz 34303
WPS441	Inefficient Private Renegotiation of Sovereign Debt	Kenneth M. Kletzer	October 1990	S. King-Watson 31047
WPS442	Indian Women, Health, and Productivity	Meera Chatterjee	October 1990	Rose Vo 35108