Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 330

Septiembre 2005

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Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
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**Documento de Trabajo**
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# SOVEREIGN DEBT, VOLATILITY AND INSURANCE

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**Resumen**

El endeudamiento externo aumenta la vulnerabilidad de las economías emergentes frente a la volatilidad macroeconómica y las crisis financieras. Con frecuencia, las reversiones de la cuenta de capitales de los países endeudados originan crisis de pago de la deuda soberana que solo se resuelven tras largas y dificultosas reestructuraciones de pasivos. El endeudamiento externo exacerba las penurias financieras internas de una crisis, pues aumenta tanto su incidencia como su gravedad. Estos resultados contrastan con el supuesto habitual de que el tener acceso a los mercados internacionales de capitales ayuda a las economías emergentes a protegerse de los shocks sin tener que bajar demasiado el consumo o la inversión. El presente artículo utiliza modelos de deuda soberana para revisar el rol que cumplen las renegociaciones a la hora de repartir los riesgos entre entidades internacionales, y plantea un enfoque para analizar innovaciones contractuales diseñadas para el pago de deuda contingente. Las innovaciones financieras que podrían permitir flujos de capital que compartieran los riesgos en lugar de inducirlos van más allá de cambios contractuales que facilitan la renegociación de deudas separando los pagos contingentes de los bonos.

**Abstract**

External debt increases the vulnerability of indebted emerging market economies to macroeconomic volatility and financial crises. Capital account reversals often lead to sovereign debt repayment crises that are only resolved after prolonged and difficult debt restructuring. Foreign indebtedness exacerbates domestic financial distress in crisis, increasing both the incidence and severity of emerging market crises. These outcomes contrast with the presumption that access to international capital markets should help countries to smooth domestic consumption and investment against macroeconomic shocks. This paper uses models of sovereign to reconsider the role of sovereign debt renegotiation for international risk sharing and presents an approach for analyzing contractual innovations for implementing contingent debt repayments. The financial innovations that might allow risk-sharing rather than risk-inducing capital flows go beyond contractual changes that ease debt renegotiation by separating contingent payments from bonds.

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Prepared for the Eighth Annual Conference of the Central Bank of Chile: External Financial Vulnerability and Preventive Policies, August 10-11, Santiago, Chile
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## 1. Introduction

In theory, international capital inflows should enable emerging market economies to reduce the volatility of private and public consumption in the presence of income volatility in addition to allowing foreign savings to finance domestic capital accumulation. Access to international financial markets should provide opportunities for the domestic private sector and government to diversify against aggregate country-specific income risk. In practice, international capital flows to emerging markets are themselves volatile and sometimes propagate external shocks to domestic consumption and investment or exacerbate domestic shocks. Higher levels of external debt increase the exposure of developing countries to world output and interest rate fluctuations and to the possibility of sudden capital flow reversals that may be poorly explained by country fundamentals.

This comparison between theory and experience of borrowing by emerging market economies motivates the arguments made below. The comparison suggests two questions: can the volatility associated with external debt be reduced and can capital inflows be managed to reduce domestic volatility? These are a single question that is addressed directly in models of foreign borrowing with country-specific income shocks and a risk-sharing motive.

Another feature of international borrowing by emerging markets is prospect of default followed by a restructuring of public sector external liabilities, which can include guaranteed private foreign debt. Debt crises, defaults and delayed debt restructuring are all very costly and are associated with income losses for debtor countries. Debt renegotiation may be seen as a means through which international debt contracts are revealed to be an implicit state-contingent contracts allowing the sharing of country-specific risks across borders. In this sense, modeling sovereign debt renegotiation is a starting point for understanding the role of debt contracts and of debt restructurings in international risk sharing. It also raises the concern that this is a very costly way in practice to share risk and innovation in international financial contracts might be helpful.

The high costs of capital account crises, sovereign default and debt renegotiation led to renewed calls for institutional innovation or market reform in recent years. Easing debt restructuring has dominated the agenda because external debt burdens contribute to volatility and prolonged restructuring postpones recovery. Making debt restructuring easier, however, raises the possibility that debtor default will become more probable as it becomes less costly and perhaps beneficial. Although easier renegotiation may be welfare enhancing ex post, it may raise debtor moral hazard and reduce welfare ex ante by inhibiting capital flows to emerging markets. This conflict needs to be evaluated in formal models of sovereign debt.

The first part of this paper considers how debt renegotiation in equilibrium models of sovereign borrowing affects welfare and capital inflows. It discusses two major variants of equilibrium models of foreign lending subject to sovereign default and explains how renegotiation enhances welfare in these models. This discussion abstracts from the costs of renegotiation, but it does allow the costs of sovereign default to be endogenous to renegotiation.

The standard consumption-smoothing model serves as a benchmark for considering how to insure debtor economies against domestic and foreign shocks. Two versions of this model are considered, one with perfect information and one with debtor private information. The second can represent the sovereign's private information about its political will or capacity to repay foreign creditors or private information about the policies it is pursuing or expects to pursue. In the model, the debtor government simply has private information about country fundamentals. Equilibrium capital flows, implicit contracts and the interpretation in terms of debt contracts and renegotiations are summarized in both versions.

Access to international financial flows serves to smooth domestic absorption against income shocks in these models. This is achieved by state-contingent contracts, which are reinterpreted in terms of debt renegotiation, in the perfect information case. Implied renegotiation is continuous. In the private information case, conventional bond contracts implement the equilibrium with default and renegotiation occurring in equilibrium for high debt levels and poor income shocks only. In both models, implementation using GDP or commodity price indexed contracts is considered. It is argued that contractual derivatives might be combined with standard bond contracts to implement smoothing outcomes. In the case of debtor private information, the possibility that delegated monitors can observe and monitor fundamentals but dispersed bondholders will not. The paper argues that derivatives can be held by sophisticated creditors that monitor the debtor that facilitate issuing bonds that with non-contingent payments that will not need to be renegotiated. The derivative contract might be described as a combined interest and default swap.

The volatility created by foreign interest payments for emerging market governments is significant, as suggested by Borensztein and Mauro [2004] most recently. The procyclicity of capital flows and public finance in emerging markets carefully documented by Kaminsky, Reinhart and Vegh [2004] is probably not an efficient outcome. Proposals to create GDP-indexed securities are supported, naturally, by the arguments in this paper. The provisional implication of this paper, however, is that achieving the needed state-contingency can be replicated using standard bonds and derivative instruments rather than combining roles in a single financial instrument. This can allow investors of differing monitoring capacities, risk attitudes and needs to choose between low-risk bonds and risky derivatives.

The paper is organized as follows. Section 2 discusses the debt renegotiation and summarizes the perfect information consumption-smoothing model. Section 3 discusses the implementation of implicit contracts with renegotiation and using GDP-indexed and commodity-price-indexed securities. Sections 4 and 5 discuss the imperfect information model and its implications for contractual innovation, respectively. Section 6 briefly returns to the recent debate over contractual innovation to ease debt restructuring, and the last section concludes. A caveat is in order. The paper sketches properties and implications of the two models without complete analysis or formal proofs. The complete analysis of one is in the literature, but the second is wanting a full analysis.

## 2. Sovereign Debt Renegotiation and Welfare

The gains from access to international capital markets are well known. These are the traditional gains from international risk sharing and allocating savings to the most productive investment opportunities globally. Respect for the sovereign immunity of nations is one of the major impediments to international capital flows and convergence of the net returns to savings across borders. Immunity from interference with a debtor nation's sovereignty inhibits the enforcement of contracts between either sovereign or non-sovereign borrowers and foreign creditors. It rules out direct enforcement of contracts involving sovereigns, hence reducing the ability of governments to commit to fulfill the terms of contracts to which they are a party. The literature on foreign debt has long identified sovereignty as a source of market incompleteness in international financial trade. Indirect sanctions, for example, restrictions on future access to credit or interferences with commodity trade, are identified as means of enforcing debt repayment by sovereign borrowers or non-sovereign borrowers subject to foreign legal jurisdiction.

The conventional modeling framework for sovereign borrowing imposes the constraint the debtor pays only as much as is in its enlightened self interest to pay recognizing the consequences of default. The observation that willingness to pay restricts international capital flows, articulated by Wallich [1943], for example, was incorporated in formal models by Eaton and Gersovitz [1981].[1] In a riskless environment, willingness to pay leads to an upper bound on outstanding country debt. With shocks, to country resources, preferences or world markets, lending to sovereigns becomes risky for both creditors and debtors. Creditors face uncertain repayments as the debt service that borrowers are willing to repay fluctuates with shocks, sharing the adverse shocks realized by borrowers. Given external indebtedness, a borrower minimizes the cost of a drop in domestic production or a foreign price or interest rate shock by choosing between repayment and default. The risk of default is a reflection of the impact of foreign indebtedness on the cost of volatility for the debtor country.

Simple models with exogenous penalties for default are useful for fixing ideas. If the penalty for default is fixed, with a cost $P$ in terms of debtor income each period, then the borrower will service its debt if $rD$ is less than or equal to $P$. We suppose the debtor government seeks to maximize the objective

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t} u(c_s), \tag{1}$$

where aggregate consumption, $c_s$, equals an exogenous endowment, $y$, less the current repayment or the penalty. For a discount rate higher than the international interest rate, $r$, the equilibrium debt will equal the present value of the punishments, $P$. The loan is made at the outset. In this case, creditors receive nothing from any additional lending. Assuming that default results in the penalty $P$ only in the period that the payment was not received is consistent with the bargaining model of Bulow and Rogoff [1989a] which endogenizes the equilibrium cost of trade sanctions.

For volatile GDP, $y$ is stochastic and there are incentives to renegotiate debt repayments. For example, the penalty $P$ can be the gains from trade, measured in units of a perishable exportable good, which are lost if trade sanctions are imposed in a given period. With stochastic penalties, default on a standard bond contract occurs whenever $P < rD$. Both creditors and the debtor forgo sharing the gains from trade if a default is declared and punished. However, there are gains from state-contingent repayments, which might be achieved through ex post renegotiation of repayments. If the stochastic penalty $P$ equals stochastic repayments, equilibrium lending and repayment are efficient subject to the constraints imposed by the inability of debtors to commit to repay more than $P$. Suppose that $P$ is distributed uniformly over the interval, $\left[\underline{P}, \overline{P}\right]$, independently for each period. Total lending under state contingent repayment is given by

$$D = \frac{1+r}{r}\left(\frac{\underline{P}+\overline{P}}{2}\right). \tag{2}$$

Restricting contracts to standard debt contracts that are repaid with certainty restricts initial lending to equal the present value of the smallest realization of $P$, rather than the expected present value of the sequence of penalties. In the example, total lending equals $\frac{1+r}{r}\underline{P}$. Similarly, allowing no renegotiation restricts repayments to equal $rD$ when this is less than $P$ and zero otherwise. Total lending is then given by

$$D = \frac{1+r}{r}\left(\frac{\overline{P}-rD}{\overline{P}-\underline{P}}\right). \tag{3}$$

If debt repayments are renegotiable, then $rD = \overline{P}$ and renegotiation occurs with probability one, but welfare is maximized subject to the sovereign immunity constraint.

This simplest model illustrates two points. An increase in the penalty for default increases potential capital flows and gains from intertemporal trade if sovereign immunity is a binding constraint on foreign lending. The second point is that if renegotiation of repayments replicates state-contingent repayments, allowing renegotiation increases welfare. This is true in an economy with symmetric information between debtors and creditors. Renegotiation increases the probability of default under a conventional debt contract but increases lending and welfare. Below, a model in which the incentives to repay are endogenous to renegotiation opportunities is discussed at length.

If the debtor government guarantees the foreign debt of private borrowers but the sanctions for default are shared, then the government needs to restrict domestic foreign borrowing to maximize its welfare objective. At the margin, the private cost of borrowing will be less than the social cost because private borrowing increases the expected costs of default. Similarly, as demonstrated by Kletzer [1984], when foreign lenders cannot observe the total borrowing by the government or guaranteed by the government, indebtedness is higher than is optimal for the government. The sovereign needs to monitor its increase in liabilities and lenders have an incentive to coordinate lending by announcing loans and terms.

Of the several models published over the last two decades, a consumption-smoothing model with stochastic debtor resources is used for analyzing debt renegotiation further. A consumption-smoothing motive immediately leads to gains from state-contingent repayments and offers a natural way for future credit access to provide incentives for repayment. The model abstracts from capital accumulation, hence storage or borrowing for growth, but productive capital and investment can be added to such models without changing the qualitative implications for debt restructuring and renegotiation.

The objective of the sovereign is given by equation (1) where consumption can be taken as aggregate consumption of residents, government consumption or recurrent public goods spending. All external debt can be liabilities of the government, under explicit or implicit guarantees of subnational public debt and private debt, for the first interpretation. In the other interpretations, the only liabilities of the sovereign might be government debt used to finance primary deficits of the public sector. The interpretation does not matter as long as $u(c)$ is strictly concave and increasing. The consumption-smoothing model is analytically equivalent to a tax-smoothing model. Sovereign immunity is represented by the capacity of the sovereign to abandon foreign capital markets. It is not required to borrow and the national endowment cannot be seized, or otherwise impaired, by foreign creditors. Therefore, the sovereign can always choose permanent loan autarchy so that welfare in any equilibrium is bounded from below by the utility of permanent autarchy,

$$U_t = u(c_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(c_s) \geq u(y_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(y_s), \tag{4}$$

where the endowment $y_s$ is stochastic and non-storable. This constraint is a self-enforcement constraint on equilibrium, familiar from Thomas and Worrall [1988], Kocherlakota [1996], Kletzer and Wright [2000] and Kehoe and Perri [2002]. For simplicity, the endowment can be thought of as generated by an iid process, but the arguments apply when $y$ follows a Markov chain.

Following Kletzer and Wright, self-enforcement constraints are introduced for risk-neutral potential creditors as well. By assuming risk-neutral counterparties to contracts, the gains from intertemporal trade are generated in the simplest analytical way that focuses attention on the idiosyncratic risk of the sovereign borrower rather than market risk. The objective for a creditor is given by

$$U_t^c = \tau_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} \tau_s \geq 0, \tag{5a}$$

where $\tau_s$ is the net transfer received by the creditor from the debtor in date $s$. For a single creditor, $\tau_s = y_s - c_s$. Several points are made in Kletzer and Wright. The self-enforcement constraint for the creditor is important and represents the creditor's ability to simply quit dealing with the borrower. The lender does not need to provide a new net resource transfer (negative $\tau$) unless it raises its present value in expectation. This contrasts with the case of pure insurance, in which an insurer may be required to make an indemnity payment that exceeds the expected present value of insuring the insuree in the future. However, it does correspond to a bondholder or bank that chooses whether to make a net payment to a borrower in anticipation of future repayments but can always decide to buy a different asset. That is, the lender voluntarily makes new net resource transfers to the borrower, in contrast to rolling over unpaid debt service.

Punishments are demonstrated in Kletzer and Wright that satisfy an important criterion. The punishments are renegotiation-proof in a repeated game of consumption-smoothing and are not permanent exclusions from the credit market (which are not credible under renegotiation). The punishments can be interpreted as short-lived moratoria on lending which are credible in the presence of potential renegotiation and entry by new lenders, although they also lead to sudden increases in net capital outflows from the debtor country. An important result is that the constrained efficient equilibria that can be supported by the threat of permanent loan autarchy are sustainable using credible punishments. This means that the efficient outcomes of intertemporal trade can be found by maximizing

$$U_0 = u(c_0) + E_0 \sum_{t=1}^{\infty} \beta^t u(c_t) \tag{6}$$

with respect to the entire consumption plan, $\{c_t\}$, subject to

$$y_0 - c_0 + E_0 \sum_{t=1}^{\infty} \beta^t (y_t - c_t) \geq U_0^c, \tag{7a}$$

for any feasible initial creditor surplus, $U_0^c$, and the self-enforcement constraints given by equations (4) and (5a) which hold for all $t$. Thomas and Worrall [1988] solve for these equilibria and show that consumption-smoothing is incomplete in general. For a high enough discount factor, $\beta$, near unity, complete consumption smoothing in the steady state is possible, and for a low enough discount factor, but greater than zero, no credit transactions are feasible. In between, the debtor's consumption follows a Markov chain where consumption in period $t$ is an increasing function of previous consumption and current resources, $c_t\left(c_{t-1}, y_t\right)$. Consumption is non-decreasing in debtor resources, but is not iid even if resources are when consumption is incompletely smoothed in equilibrium. Also, to meet the self-enforcement constraints of each side of the market, consumption will be higher than the endowment in low resource states and below it in high states.

The self-enforcement constraints on international credit transactions in this model imply that the maximal net amount, $\overline{\tau}_t$, that the debtor will repay with the endowment, $y_t$, is given by

$$u\left(y_t\right) - u\left(y_t - \overline{\tau}_t\right) = E_t \sum_{s=t+1}^{\infty} \beta^{s-t}\left(u\left(c_s\right) - u\left(y_s\right)\right), \tag{8}$$

where the right hand side of this equality represents the equilibrium gains from access to international consumption smoothing for the sovereign. This is non-negative and provides the motivation for debtor repayment. In equilibrium, the debtor's consumption is greater than the endowment in some states so that these gains are positive. That means that $\overline{\tau}_t$ is not paid by the debtor in all states at all dates; indeed, the actual net payment, $\tau_t$, will be negative indicating a net resource inflow in many events in equilibrium. After no point can the debtor repay on net with certainty. Otherwise, the debtor would not gain by repaying and would opt for permanent autarchy.. However, risk aversion implies that the debtor can repay in expectation.

The efficient solution maximizes these gains subject to the self-enforcement constraints. Therefore, any increase in the gains from trade increase the amount that the debtor will repay. Eliminating state-contingent repayments reduces the gains from trade reducing the incentives to repay. An interpretation of debt renegotiation is that the standard debt contract is a guide for an implicit state-contingent contract. The implicit contract is the state contingent contract that supports the constrained efficient equilibrium. In this interpretation, renegotiation in a long-term debtor-creditor relationship implements the state-contingent contract. The opportunity for renegotiation in this perfect information economy increases the gains from trade and increases the incentives for debtor repayment in high endowment states.

Two complications might reverse this conclusion. One is the presence of asymmetric information between the sovereign debtor and foreign creditors. For example, if debtor resources depend on unobserved debtor policies, then creditors face debtor moral hazard. However, the general model is still informative. In models of risk sharing under repeated moral hazard, partial risk sharing is an equilibrium outcome and reported low outputs lead to both lower current consumption and lower future surplus for the debtor in constrained efficient equilibrium. This just parallels the equilibrium under perfect information with incomplete risk sharing due to self-enforcement constraints. Since an implicit state-contingent contract supports the constrained optimum, renegotiation of a simple debt contract in a long-term debtor-creditor relationship will be welfare improving. Information asymmetries matter, but debtor moral hazard may not mean that easing renegotiation reduces welfare and capital flows.

The other potential complication is that creditor rights across different creditors or classes of creditors may not be well-defined in debt renegotiations. One example is the lack of definitive seniority rights of various creditors that can make renegotiation a prolonged and costly process that reduces welfare. Problems of coordination between different creditors and between creditors and the debtor that can arise because of uncertain or ill-defined creditor rights may explain the prolonged and costly process of restructuring emerging market debt. In a second best world, the net effect of reducing these costs could be negative but it can also be positive, depending on the very details of other multiple market failures.

The consumption-smoothing model without self-enforcement constraints helps illustrate. The standard non-contingent debt contract raises welfare, smoothing consumption forward, by implementing the standard Euler condition,

$$u'(c_t) = E_t u'(c_{t+1}), \tag{9}$$

for equal discount rates for both sides of the market (as assumed here). Total wealth and the marginal utility of consumption follow Martingales. The first-best is implemented by state-contingent, pure insurance, contracts so that

$$c_t = c_{t+1} \tag{10}$$

in all events. The steady state is achieved immediately in the unconstrained first best. In the equilibrium of the permanent income model with uncontingent debt, the country's welfare will fall below its autarchy welfare (utility from consuming the stochastic endowment every period) with positive probability. Therefore, when self-enforcement constraints are imposed, there will be defaults against the standard debt contract with positive probability. For state-contingent contracts, self-enforcement constraints due to debtor sovereign immunity and limited lender liability impede full consumption smoothing, but the constrained efficient equilibrium reduces consumption volatility and reaches a stochastic steady state.

## 3. Implementing State-Contingent Repayments

The constrained efficient equilibrium for sovereign borrowing can be supported by a long-term state-contingent contract or by an implicit contract achieved through renegotiation of standard short-term debt contracts. Short-term contracts suffice because the self-enforcement constraints arise because neither lenders or borrowers can commit to make net foreign payments. New net loans or repayments are made because the lender or the borrower, respectively, gains by doing so looking forward.

The constrained efficient equilibrium is characterized with proof in Kletzer and Wright. A brief summary, with some extension, is given here. The sovereign borrower's endowment has a finite support given by $0 < y^1 < y^2 ... < y^N$. The endowment at time $t$, $y_t$, follows a stationary Markov chain over these $N$ values that displays first-order stochastic dominance. For each $y^j$, the borrower's consumption in equilibrium lies in an interval, denoted $\left[\underline{c}^j, \overline{c}^j\right]$ where $\underline{c}^j \leq y^j \leq \overline{c}^j$. The upper and lower bounds on these intervals satisfy

$$y^1 = \underline{c}^1 < \underline{c}^2 < ... < \underline{c}^N < y^N$$

and

$$y^1 < \overline{c}^1 < \overline{c}^2 < ... < \overline{c}^N = y^N$$

for a large range of discount rates. Consumption is smoothed as much as possible across states within the bounds of these intervals. That is, if $y$ rises from $y^1$ to $y^2$ in period $t + 1$ then $c_{t+1}$ will either equal $c_t$ or $\underline{c}^2$ whichever is larger. Consumption ratchets upward or downward following the endowment. Since consumption is not fully smoothed in general, consumption in any state depends on lagged consumption as well the current endowment. Therefore, consumption is smoothed against small income drops and falls with large ones. When income recovers, consumption is again smoothed for small increases and rises for large endowment increases. For a coefficient of variation in GDP growth equal to 3 to 4 percent (reasonable values for Latin America), partial smoothing in this model is possible for real discount rates on the order of 3 to 5 percent for intertemporal elasticities of substitution on the order of 0.3 to 0.5. These are reasonable ranges.

Consumption can be translated into net repayments, $\tau$, which therefore also follow a Markov chain, $\tau_t = \tau\left(\tau_{t-1}, y_t\right)$, where $\tau_t$ is increasing in both arguments. This net transfer can be written as the difference between gross capital inflows, new loans, $\ell_t$, and gross repayments, $R_t\left(\ell_{t-1}, y_t\right)$. Repayments are state-contingent, and loans are single-period contracts. Under lender free entry, expected profits for each loan satisfy

$$E_t\pi = -\ell_t + \beta E_t R_{t+1}(\ell_t, y_{t+1}) = 0. \tag{11}$$

Therefore, the present value returns to creditors can be written as

$$U_t^c = \tau_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t}\tau_s = R_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t}\left(-\ell_{s-1} + \beta R_s(\ell_{s-1}, y_s)\right), \tag{12}$$

so that creditor surplus at date $t$ is

$$U_t^c = R_t.$$

This is restricted to be greater than or equal to zero by the self-enforcement constraint.

The proper interpretation is that the constrained efficient equilibrium can be implemented by a sequence of single-period loan contracts with non-negative contingent repayments. These can be implemented by implicit contracts using standard non-contingent debt contracts with renegotiated repayment. The contract made at time $t-1$ will be the pair, $\ell_{t-1}$ and $\overline{R}_t = \max_{y_t}\{R_t(\ell_{t-1}, y_t)\}$, as suggested by Grossman and van Huyck [1989], which will be achieved for the highest state, $y^N$. Renegotiation results in repayments $0 \leq R_t(\ell_{t-1}, y_t) \leq \overline{R}_t$.

The self-enforcement constraint imposed on creditors is essential for interpreting state-contingent repayments as renegotiations. The constraint formalizes the assumption that lenders only make net resource transfers to sovereign debtors if they anticipate receiving future repayments in return that are at least as great in expected present value. That is, net real transfers from foreign lenders are loans. If the constraint, $U_t^c = R_t \geq 0$, is relaxed, then an implicit contract no longer works. Lenders must commit in period $t-1$ to make positive payments in some states in period $t$ that leave them with lower utility than if they simply stop transacting with the debtor if $R_t$ can be negative. Commitment requires exogenous enforcement and an explicit contract specifying performance.

Consumption smoothing with one-sided commitment is analyzed by Worrall [1990]. Bulow and Rogoff [1989b] also assume creditor commitment and argue that international lending cannot be supported by reputational equilibria. Kletzer and Wright [2000] explain how the assumption of creditor commitment is essential to the argument and that renegotiation-proof reputational equilibria only fail if the lenders provide pure insurance; that is, if lenders commit to make indemnity payments that they will prefer to renege on.[2] However, with international insurance enforced by creditor country governments, international capital flows are supported and begin with the accumulation of foreign assets by the emerging market economy, as implied by the equilibrium in Worrall [1990]. When only one side to an insurance or loan contract can commit, the first payment must be made by the party that cannot commit.

The equilibrium if foreign creditors can commit future payments to the sovereign borrower can be summarized using the same notation. The upper bounds, $\overline{c}^j$, are removed along with the constraint,

$$U_t^c = \tau_t + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} \tau_s \geq 0.$$

Debtor consumption is smoothed against output decreases and rises with output. This means that consumption rises monotonically over time to a completely smoothed steady state. Net payments by the debtor decrease monotonically over time.

In practice, sovereign debt renegotiation is a tedious, prolonged and costly process. External debt exposure also contributes to domestic public and private consumption volatility. This is just the opposite of what should happen in theory. Proposals for introducing GDP-indexed securities, or commodity bonds for primary commodity dependent exporters, have been revived recently. The theoretical model summarized above suggests that there should be gains from introducing bonds with GDP-contingent repayments. Implementing the implicit repayments, $R_t(\ell_{t-1}, y_t)$, as GDP-indexed repayments is straightforward in theory. As long as GDP measurement is clearly defined and not subject to moral hazard, such contracts should be feasible. The feasibility and some preliminary estimates of benefits of GDP-indexed bonds are discussed in Borensztein and Mauro [2004].[3]

Commodity bonds are proposed by Caballero [2002]. Kletzer, Newbery and Wright [1992] suggest that commodity-price linked derivatives can be combined with international bonds to eliminate sovereign default risk. They use the one-sided commitment model, so that foreign investors sell put options on export commodity prices to the debtor. The debtor exercises the put options when the commodity price falls below the strike price. This puts a floor on the value of the debtor's supply of primary exports eliminating default risk when commodity prices are low. Similar put options can be suggested for GDP.

Consider a two-state example, GDP equals $y^1$with constant probability $p$ and $y^2$ with probability $1-p$. To make the example more general, let consumption be incompletely smoothed, so that consumption equals $\overline{c}^1$ in state 1 and $\underline{c}^2$ in state 2 where $\overline{c}^1 < \underline{c}^2$. The GDP-linked bond that implements the constrained efficient equilibrium with two-sided self-enforcement satisfies

$$\ell - R\left(y^1\right) = \overline{c}^1 - y^1, \qquad R\left(y^2\right) - \ell = y^2 - \underline{c}^2 \tag{13}$$

and

$$\ell = \beta \left[ pR\left(y^1\right) + (1-p)\, R\left(y^2\right) \right]. \tag{14}$$

The solution for the loan principal, $\ell$, and the repayments, $R(y_t)$, also solves the constraint on creditor expected profits in state 1:

$$y^1 - \overline{c}^1 + \frac{\beta}{1-\beta} \left[ p\left(y^1 - \overline{c}^1\right) + (1-p)\left(y^2 - \underline{c}^2\right) \right] = 0. \tag{15}$$

The solutions for repayments are

$$R\left(y^1\right) = 0 \qquad \text{and} \qquad R\left(y^2\right) = y^2 - y^1 - \left(\underline{c}^2 - \overline{c}^1\right). \tag{16}$$

That is, for the symmetric information case, the full debt is forgiven for the lowest state.

These consumptions could also be implemented using a combination of a put and a call option that would pay off, on net, $\overline{c}^1$ when the put is exercised and $\underline{c}^2$ when the call is exercised. Another pair of contracts is to combine a GDP put option with a non-contingent foreign bond. The pair of contracts that implement the constrained efficient equilibrium in this case are a put option with strike

$$y^{strike} = y^2 - \left(\underline{c}^2 - \overline{c}^1\right) \leq y^2 \tag{17}$$

with a premium equal to

$$\rho = p\left(y^2 - y^1 - \left(\underline{c}^2 - \overline{c}^1\right)\right) \tag{18}$$

and a loan in the amount

$$\ell = \left(y^2 - \underline{c}^2\right) \frac{(1-p)}{\beta\,(1-\beta\,(1-p))} \tag{19}$$

with non-contingent repayments, $R = \ell/\beta$ . In the case of foreign creditor commitment, the steady state contracts are just these with $\underline{c}^2$ and $\overline{c}^1$ set equal because steady-state consumption is fully smoothed when foreign insurance is available.

It is clear that these contracts offer significant insurance for the sovereign debtor, but that there are gains from creating such markets subject to the caveat that asymmetries of information and moral hazard are not yet introduced. Suppose that GDP put options were used to eliminate the idiosyncratic growth risk to ensure the capacity of public and private borrowers in an emerging market to repay bonds and loans as contracted with non-contingent interest. The put premium would equal the expectation of the potential drop in GDP over the term of the option as shown by equation (18).

For a commodity-dependent exporting country, export revenue risk could be insured using put options.

Since markets for important commodity derivatives exist and are liquid, the issue for policy is whether the term of such options can match market cycles. Options with near-term expiration dates are not useful for insuring aggregate debt service requirements. Pricing sufficiently long options may not be a practical difficulty but market liquidity could be.

## 4. Debt Contracts and Infrequent Renegotiation

The market equilibrium discussed thus far is implemented by implicit contracts in which state-contingent repayment is common. This implies that renegotiation of traditional debt contracts would be frequent. The model also assumes no asymmetries of information. Moral hazard in international debt restructuring is thought to be important and motivates an incomplete information extension of the model. Asymmetric information about debtor willingness to pay can also lead to standard debt contracts with non-contingent repayment and infrequent renegotiation. Again, a model is only outlined.

Sovereign immunity is still represented by self-enforcement constraints, but the debtor's endowment is private information. A general model with hidden endowments is studied by Cole and Kocherlakota [2002] without commitment constraints. These assumptions with one-sided commitment are made by Thomas and Worrall [1990] with a finite support for the borrower's endowment. They prove that an equilibrium exists with two-sided self-enforcement constraints. Contracts are chosen so that the sovereign debtor reveals its hidden endowment in its choice of contract. Contracts are incentive compatible. They are also complicated. Using the hidden endowment model captures essentials of moral hazard in debt renegotiation.. Moral hazard in policy choices by sovereigns is modeled by Atkeson [1991], and in a simple model of debt renegotiation by Eichengreen, Kletzer and Mody [2004].

The equilibrium is found by again maximizing debtor surplus over autarchy,

$$V_t = u(c_t) - u(y_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} \left( u(c_s) - u(y_s) \right),$$

with respect to $c_t$, reported $y_t$, $\theta_t$, and promised surplus for creditors for period $t+1$, $\left\{U_{t+1}^c\right\}$, subject to the self-enforcement constraints for the debtor and creditors,

$$V_{t+1} \geq 0 \qquad \text{and} \qquad U_{t+1}^c \geq 0,$$

equation (7a) and an additional set of incentive compatibility constraints. The incentive compatibility constraints are written as

$$V_t(y_t, y_t) \geq V_t(\theta_t, y_t) \qquad \text{for} \qquad \theta_t = y^1, ..., y^N,$$

where the notation summarizes that consumption and promised creditor surplus vary depend on reported endowment, $\theta_t$.

A surprising simplification arises if the support for the endowment is a continuous closed interval. Following Townsend [1979], the incentive compatible contract will be a conventional short-term bond contract as long as the self-enforcement constraint does not bind with positive probability in the repayment period. The dynamics of the permanent income model also inform us. A low realization for output, when the sovereign immunity constraint does not bind, leads to repayment of interest and an increase in the outstanding debt. The expected marginal utility of consumption rises. A high realization leads to partial debt amortization, reducing outstanding debt, and the expected marginal utility of consumption falls.[4]

What happens when the constraint binds? The Euler condition is not satisfied since the country is at a corner, so that

$$u'(c_t) \geq E_t u'(c_{t+1}) . \tag{20}$$

Incentive compatibility allows characterization of the new implicit contract. For $u'(c_t) > E_t u'(c_{t+1})$, the debtor's utility must satisfy

$$u(c_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(c_s) = u(y_t) + E_t \sum_{s=t+1}^{\infty} \beta^{s-t} u(y_s) , \tag{21}$$

under the contract for period $t$, and the contract must repeat itself. That is, the debtor's utility will remain the same in period $t+1$ if $u'(c_t) > E_t u'(c_{t+1})$ under the implicit contract. This contract is the lower bound for the debtor. Therefore, for any state such that $u'(c_t) > E_t u'(c_{t+1})$, the debtor receives the same contract for the next period implying that the same net repayment must be made in all these states. If this were not true, the debtor would claim it was in the state with the lowest current net repayment required. Incentive compatibility rules this out. The next step is to observe that this can only be the lowest utility contract satisfying the self-enforcement constraint, equation (21), if $c_t = y_t$ when the self-enforcement constraint binds and $u'(c_t) > E_t u'(c_{t+1})$.

If, instead, $u'(c_t) < E_t u'(c_{t+1})$ and sovereign immunity binds, then the debtor makes a net repayment and is rewarded with higher utility under the contract taken in period $t+1$. Under this incentive compatible contract, the borrower's consumption is given by

$$c_t = y_t \qquad \text{for} \qquad y_t \leq \widehat{y},$$

$$c_t < y_t \qquad \text{for} \qquad y_t > \widehat{y}$$

and $c_t$ is increasing in $y_t$ for all $y$. The critical value, $\widehat{y}$, is in the interior of the support for debtor output. The debtor's surplus over autarchy in the next period contract will also be increasing in $y$. All this implies that creditor's claims remain constant in this contract for $y_t \leq \widehat{y}$ and decrease between $t$ and $t+1$ if $y_t > \widehat{y}$.

What happens in the subsequent period if $y_t > \widehat{y}$ helps us to interpret the equilibrium contracts. The borrower receives a contract that gives it surplus over autarchy.. This is the same a reduction in its debt. Since creditors do not observe $y_t$ ever but do observe the payments made to or by the sovereign debtor, their surplus, $U_t^c$, in the market is not state contingent. Conventional debt satisfies these conditions. If in period $t+1$, the self-enforcement constraint will not bind with positive probability, the new implicit contract is a conventional short-term bond contract with certain repayment. On the other hand, if the sovereign immunity constraint can bind with positive probability, the bond contract will not be fulfilled with certainty. A risk premium will be added to the riskless interest rate, $1/\beta - 1$.

When the sovereign immunity constraint binds and $y_t \leq \widehat{y}$, the contract repeats implying that creditor surplus is the same in period $t+1$ as in period $t$ but no net payments are made in period $t$. The lowest creditor surplus satisfies

$$\overline{U}^c = \beta \overline{U}^c,$$

implying that only net interest is lost in renegotiation. This is the worst that happens to creditors in equilibrium, although interest is lost when the borrower's indebtedness is greatest. The equilibrium can be implemented by a conventional bond with renegotiation in low states when the debt level is sufficiently high. Renegotiation of repayments is necessary only when the debtor's utility and endowment are both sufficiently low. There is an upper bound on the true present value of the country's debt given by $\overline{D} = \overline{U}^c$.

One more step is needed for understanding debt renegotiation.. Continuity of the support for debtor output implies continuity in the implicit contract for any debt level. For the highest debt level, a rise in $y$ leads to both net capital outflows from the debtor and a reduction in future debt. This means that any repayments, however small, include debt amortization. If this were not true, the debtor would not benefit from repaying anything since the country's welfare would not be raised in the future by doing so. There must a future benefit. That means that all the current interest is implicitly forgiven in debt renegotiation when $y_t \leq \widehat{y}$ and some interest is forgiven for higher $y$ until all the interest is paid plus additional debt amortization for the highest output level. This last part is necessary to make creditors as well off in the market as out. The net interest paid equals

$$r\left(y_t, \overline{D}\right) \overline{D} = (y_t - c_t) - \left(D_{t+1} - \overline{D}\right),$$

where $r\left(y_t, \overline{D}\right)$ indicates the dependence of the implicit contingent interest rate on the borrower's debt and current output.

## 5. Implementation with Bonds

Adding imperfect information implies that debt renegotiations do not occur continuously and only occur in low output states for high outstanding debt. These stylize the facts of debt defaults and restructurings in emerging markets. Because contracts need to reveal debtor private information, it is natural to think of the state-contingent parts of the implicit contracts as the outcome of renegotiations between creditors and sovereigns who are better informed than their creditors about their willingness to pay.

The implications for country insurance are two fold. The first is that the required insurance needs to cover at a maximum the net interest on outstanding foreign debt. This is much smaller than the coverage needed under perfect information, but it is smaller because the welfare benefits of access to foreign credit are smaller as a consequence of asymmetric information. The second is troublesome because any derivatives that are used to strip the renegotiation risk need to be incentive compatible for the debtor.

Consider a swap of the risky interest payments on the debt, $r\left(y_t, D_t\right) D_t$, for riskless interest payments made with certainty, $\left(1/\beta - 1\right) D_t$. Bondholders swap away the risky net interest payments to counterparties who hold risky, default, swaps. The contingency for the risky interest payments is the reported output for the debtor, not an independently observed signal. The renegotiable debt contracts are incentive compatible because the borrower's debt is reduced (partly amortized) at the same moment that it makes a contingent interest payment. If these are separated across foreign creditors, then the incentives for truthful reporting can fail. Debt amortization and risky interest payments need to be linked. This is a problem of market incompleteness due to moral hazard.

On the positive side, the information asymmetry might be viewed as a theoretical artifice to generate lending using conventional bond contracts with infrequent debt restructuring and ignored as a barrier to GDP or otherwise indexed derivatives. Perhaps this could be justified by assuming that the diversification needs of foreign investors and the costs of underwriting bonds and loans are such that bondholders delegate monitoring of sovereign debtors. If the monitoring costs are fixed, bond markets will be greatly disadvantaged relative to syndicated bank lending to emerging markets. Banks can internalize the costs once for all depositors as delegated monitors, while bondholders each need to be informed. Implementing the interest swap would support bond lending under these circumstances if the risky interest payments can be purchased by an informed investor. The informed investor would play the role of a delegated monitor.

Under these conditions, bonds would be issued with non-contingent interest that would be paid unless the debtor deviated from the implicit contract, effectively repudiating its obligations in part or whole. The holder of the interest swap would guarantee bondholder interest and monitor the debtor's circumstances. This could be separated further by considering a series of options based on debtor performance, say GDP. For example, a GDP put option could pay interest. In the equilibrium for the model, risky interest payments rise with GDP for high debt levels. A series of puts with different strikes covering different shares of the interest payments on country debt could be used to fine tune the derivatives that underwrite bondholder interest. Bonds may need to include covenants requiring insurance against interest defaults of this nature. Such covenants may need to bind on a domestic agent rather than the foreign debtor because bondholder monitoring of the derivative holdings of the debtor could only be more costly than enforcing GDP-indexed interest payments. Structuring such interest swaps to facilitate bond borrowing without the risk of default could also be a way to support international borrowing by non-sovereigns within the emerging markets. An emerging market government itself could implement requirements that shift the interest risk away from bondholders to other willing investors.

## 6. Contractual Innovation to Reduce Renegotiation Costs

The debate over reforming the international financial architecture focused on two alternatives in recent years, a statutory approach and a contractual approach. At this date, the statutory approach, which would introduce some form of international bankruptcy procedures for sovereigns, is on hold and all but abandoned for the time. The contractual approach is being pursued in the form of wider spread adoption of collective action clauses in sovereign bond issues, notably those issued in the United States. The collective action clauses of concern allow a qualified majority of bondholders to be decisive over restructurings of the repayment terms of bonds.[5]

There are two aspects to the debate over encouraging the adoption of collective action clauses. Enabling renegotiation can raise welfare ex post, in the event of a bond default, but it can lower it ex ante if the net effect is to reduce capital inflows to emerging markets. The second effect can arise if reducing the costs of default raises the incidence of default. As argued in Section 2, it is not easy to make renegotiation welfare reducing even under debtor moral hazard. Eichengreen, Kletzer and Mody [2004] use a reduced model of willingness to pay to allow for asymmetric information and debtor moral hazard following the renegotiation model in Kletzer [2003]. They compare unanimous action clause bonds and collective action clause bonds in this simple model. Under unanimous action clauses, some creditors will hold out in renegotiation in equilibrium leading to costly delays to agreement. Under collective action clauses, a sufficient minority of bondholders to hold up renegotiations will not do so. They are worse off delaying agreement than joining the majority in taking a negotiated settlement immediately. Eichengreen, et al show that the effects of collective action clauses on lending are ambiguous and depend upon the degree of debtor moral hazard present. Lending can contract for high risk borrowers, but this should not be interpreted as welfare reducing. The borrower can receive more insurance with lower debt and avoid debt restructuring costs under unanimous action clauses.

Eichengreen, et al estimate the impact of collective action clauses on interest rate spreads and the probability of issuance for emerging market bonds, both sovereign and non-sovereign, and proxy for moral hazard using country credit ratings. Low-rated issuers face higher spreads from collective actions clauses, while high-rated issuers face lower spreads. The second question in the debate concerns these results. The spread differences are small implying that collective action clauses do not matter much.

The main counterargument to contractual innovation is that foreign debt renegotiation may be made difficult as a market outcome enabling capital flows. The contractual innovations that the sovereign borrowing models summarized here point toward may address this issue in addition to introducing contingent contracts that reduce the need for costly debt renegotiations. Separating conventional bonds from risky GDP-indexed, commodity-price or otherwise indexed derivatives could support international markets in low-risk assets that simply are not renegotiated. This addresses the first issue. Reducing the incidence of costly renegotiations by formalizing contingencies in contracts that can be held by sophisticated investors can also raise welfare by increasing risk sharing for public and private borrowers in emerging markets.

## 7. Conclusion

External debt in emerging market economies is often a source of macroeconomic volatility, requiring increasing current account balances and fiscal contractions in the face of adverse productivity or international price shocks. Adverse macroeconomic shocks often lead to foreign debt repayment problems in heavily indebted countries, resulting in domestic financial distress. In many instances, sovereign debt restructuring has been a difficult, prolonged and costly process. These events stand in stark contrast with the presumption that access to international capital markets should help countries to smooth domestic private and public consumption and investment over macroeconomic cycles.

The theoretical analysis of debt in the presence of international risk sharing incentives suggests that debt renegotiation serves to implement an implicit contingent repayment schedule for international credit. The experience of debt crises and debt renegotiation can be interpreted as indicating a need for easing sovereign debt renegotiation. It might also be interpreted as creating a need for contractual innovation in international finance by more creative application of financial innovations in the most advanced financial markets to emerging market finance. The theoretical models described suggest that derivative contracts might be useful for sharing risk eliminating bond renegotiation as a way of trying to implement risk sharing. Such derivatives would allow debtors to insure themselves as parties to the contracts while reducing default and restructuring risk for bondholders. If markets in such securities are feasible, they could reduce macroeconomic volatility in indebted countries and increase capital flows to emerging market economies.

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# Endnotes

[1] The survey, Eaton, Gersovitz and Stiglitz [1986], gives a full overview of the modern approach to modeling country risk.

[2] The argument that reputational equilibria are not credible is addressed by Kletzer and Wright [2000] who show that renegotiation-proof equilibria with free lender entry exists with self-enforcement constraints. Mark Wright [2001] proves that this result survives creditor commitment if creditors are imperfectly competitive.

[3] Cordella and Levy Yeyati [2004] discuss the challenge of adverse policy incentives under moral hazard for country insurance.

[4] The formalization of the equilibrium in this economy awaits a forthcoming paper.

[5] A review of the policy issues is found in Bank of England [2000].

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