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Sovereign Debt Buybacks as a Signal of Creditworthiness

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and
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In a signaling equilibrium, countries that buy debt back get debt relief. Those that do not buy debt back do not get debt relief.

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Why don't all indebted countries promote buybacks (including debt exchanges and debt-to-equity swaps)? Why do some countries promote buybacks only part of the time? And why are debt buybacks the mechanism for debt reduction favored by international public policy?

To solve the puzzle of attitudes toward debt buybacks, Acharya and Diwan use a model that combines considerations of debt overhang with the possibility of asymmetrical information between debtor countries and their creditors.

In this environment, a debt overhang may create disincentives for a country to undertake a worthwhile investment, and debt relief may induce the country to invest and to increase its output, raising future debt repayments.

But creditors cannot directly observe the variables that determine this choice, and in particular, the "impatience rate" of the debtor's government.

Acharya and Diwan show that debt buybacks can credibly reveal a debtor country's willingness to invest and to repay in the future when offered relief today. In equilibrium, countries that buy back debt get debt relief and those that do not buy back debt do not get debt relief.

Acharya and Diwan tested and failed to reject two implications of their model:

- That banks systematically grant debt relief to countries that have a swap program in place.
- That the secondary market price of country debt, conditional on a swap, is higher than the debt price, conditional on no swap.

This paper is a product of the Debt and International Finance Division, International Economics Department. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Sheilah King-Watson, room S8-025, extension 33730 (24 pages with tables).

Sovereign Debt Buybacks as a Signal of Creditworthiness

by
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*The first author is at the Stern School of Business of New York University and the second author is at the World Bank. We thank Stijn Claessens, Stanley Fischer, Ken Froot, Homi Kharas, and Ken Rogoff for helpful comments. While we address the same issue we had in an earlier paper (June 1987), "Debt Conversion Schemes of Debtor Countries as a Signal for Creditworthiness: Theory and Evidence," the current paper is substantially different in the theory and tests.

1. Introduction:

The commercial bank debt burden faced by many developing countries has created a global crisis. To mitigate this crisis, recent agreements between commercial banks and their debtor countries have encouraged various forms of voluntary debt prepayments, such as, buybacks, debt exchanges and debt to equity swaps.[1] These agreements have raised the amount of debt conversions from a mere $1 billion in 1984 to $21 billion in 1988.[2] Several creditor nations have recently extended official support to include voluntary debt conversion more formally in the debt reduction strategy.[3] The International Monetary Fund, the World Bank, and the Japanese government have, as a result, agreed to fund ($34 billions committed as of June 1989) market based debt reduction schemes within "menu" driven rescheduling agreements.

The main argument in favor of debt buybacks and other voluntary debt reduction plans has been that debtors can improve their welfare by capturing a part of the discount at which their debt trades in the secondary market. [See, e.g., Sachs and Huizinga (1987)]. This argument does not consider, however, the implicit nature of the international debt contracts. These contracts specify repayment schedules that sovereign countries might not be willing (or able) to honor in toto. Indeed, Bulow and Rogoff (1989a) have recently shown in a dynamic model of international lending that "debtors can sometimes successfully negotiate partial defaults or 'rescheduling agreements.'" [See also Fernandez and Rosenthal (1989).] If the discount in the secondary market debt price *fully* reflects the expected partial default in the future repayments by the debtor country, the debtors gain less in spending a dollar for buybacks than in using the same dollar for domestic investment or consumption. [See, e.g., Bulow and Rogoff (1989b) and Claessens and Diwan (1989).][4] Thus, when lenders and borrowers are symmetrically informed, buybacks seem to be mere concessions to the creditors. Why then some indebted developing countries promote market based buybacks (including debt exchanges and debt to equity swaps), and why is such a promotion the official goal of international public policy?

In this paper, we attempt to explain this puzzle in a model that combines debt overhang considerations with the possibility of asymmetry of information between debtor countries and their creditors. The debt overhang (high enough debt) may distort a country's incentives to invest, as it imposes an implicit tax on investment returns. By providing debt relief (debt forgiveness or rescheduling at concessional

interest rates) in a situation of debt overhang, creditors may increase their net payoffs if the country can be induced to raise investment and repayments. [See Sachs (1989), Krugman (1989), Corden (1988), and Helpman (1988).] But since retaining the option to collect the whole debt is also valuable, creditors would like to provide debt relief only when the debtor country is truly willing to respond with large enough investment, leading to debt repayments in future. This raises a problem of screening in the absence of binding mechanisms, since every indebted nation would attempt to receive debt relief by promising to undertake adjustment policies of increasing investment and improving repayment capacity. We model a country's true willingness to adjust by the subjective discount rate which is used by its decision makers to evaluate intertemporal tradeoffs between the current and the future consumption. We analyze equilibria in two cases: (1) when the debtors' discount rates are observable (the case of symmetric information), and (2) when the discount rates are unobservable by the banks (the case of asymmetric information). We show that when the banks observe the discount rates, they can benefit by offering debt relief only when the discount rate is low enough, in comparison with the rate of return on domestic investment. In the symmetric informational equilibrium, there are no buybacks, and debt relief is offered to patient countries (with low discount rates) but not to impatient ones. In the case of asymmetric information, however, we show the existence of an informational equilibrium, as defined in Spence (1973) and Riely (1979). In this equilibrium, banks offering debt relief only to countries that engage in buybacks screen countries that are truly willing to increase investment and improve debt repayments from those that are unwilling. Intuitively, debt reliefs increase the future consumption of a country as they lower future debt repayments, whereas debt buybacks involve an immediate cost, lowering the current consumption. If a country's discount rate is sufficiently low, the present value of debt relief may exceed the immediate cost of buybacks, and this country will *self-select* to promote a buyback program when banks offer debt relief. On the other hand, rational banks will offer debt relief only when their net receipts are expected to increase. As banks can extract up to a maximum possible fraction of a sovereign country's output, given the implicit nature of the debt contract, debt relief may increase the net debt repayments when relief can induce the country to undertake sufficient number of positive net present value projects. Countries with lower

discount rates are more likely (than others) to undertake sufficiently higher number of positive net present value projects. It is thus in the interest of the banks to offer debt reliefs to a country which *self-selects* a buyback program, as it reveals a lower discount rate indicating that the country will undertake more positive net present value investments leading to higher debt repayments to banks. We formally show the existence of this informational equilibrium and derive testable implications in Section 3. In this equilibrium, some debtor countries and their creditors exchange concessions, with the countries buying back some of their debt and their creditors offering them debt relief. Debt relief is not offered to the countries that do not engage in debt buybacks. In Section 4, we construct an econometric model to test and fail to reject these implications: (1) banks systematically grant debt relief to countries when an operational debt-equity program is in place; and (2) the secondary market debt price, conditional on existence of a swap program, is higher than the debt price, conditional on no such program. In Section 5, we conclude by discussing the recent global initiatives for easing the debt burden.

2. A Model of Debt Buyback, Debt Relief, and Investment

We consider the operation of a country over two dates, denoted by t=0,1. The country has an outstanding commercial bank debt of D dollars, and is contractually required to pay the bank at t=1 the sum D less any amount of debt bought back and any amount of debt relief granted by the bank. Whether or not the country buys back some of its debt (assumed to take place only at t=0), is denoted by strategy, $\sigma \in$ {B (buyback), and N (no-buyback)}. Given σ=B, the country is assumed to buyback a fixed amount of debt, denoted by $\bar{d} \in (0,D)$, where $\bar{d}$ is endogenously determined in equilibrium. We denote the amount of debt buyback by a variable d, where d=0 iff σ=N and d=$\bar{d}$ iff σ=N.[5] Given σ=B, the country buys its debt at t=0 at the prevailing market price p (per $1 of face value of debt), which is endogenously determined in equilibrium. While the buyback operation reduces the country's bank-debt to D-d, it involves a transfer of dp dollars worth of domestic assets from the country at t=0. We assume that, conditional on the country's action, the bank may offer the country a debt relief of ρ (D-d$\geq\rho\geq$0) dollars at t=0, if doing so is profitable. This debt relief (reduced interest rates, new money, or out-right write-off) is assumed to decrease the country's contractual repayment to D-d-ρ dollars at t=1 after the

voluntary buyback of d dollars.

The country is assumed to have a known endowment of Q_0 dollars at t=0. We assume that soon after date 0 (denoted by $t=0^+$), the country undergoes an uncertain state of its economy, denoted by ω, which results in an endowment of $Q_{1\omega}$ at t=1. For simplicity, ω is assumed to take one of two possible values at 0^+: g (good), and b (bad), such that $Q_{1g} > Q_{1b} > 0$. While state $\omega \in \{g,b\}$ is unknown at t=0, the probability of its occurrence, π_ω, is assumed to be common knowledge at t=0. The country is assumed to have an investment opportunity (e.g., a trade or a fiscal reform) with an investment outlay of $\bar{I}$ dollars at $t=0^+$. The country's investment strategy at $t=0^+$, denoted by I, can thus take one of two possible values, 0 and $\bar{I}$. The investment strategy at $t=0^+$ is assumed to produce μI at t=1, where μ is equal to 1 plus the rate of return per dollar on the investment. The gross output of the country at t=1 is thus equal to the sum of the realized endowment and the production achieved by the investment policy, $Q_{1\omega}+\mu I$. We assume that the bank can extract a maximum repayment equal to a fraction, α ($\alpha \leq 1$), of the sovereign country's gross output at t=1.[6] By this implicit nature of the external debt contract, the country repays the bank at t=1 an amount:

$$(1) \qquad R_1(\sigma,\rho,I,\omega) = \text{Min}[D-d-\rho,\ \alpha(Q_{1\omega}+\mu I)], \qquad \omega=g,b.$$

The country is assumed to consume the remaining part of its endowment after investment and payment toward the retired debt at $t=0^+$,

$$(2) \qquad C_0 = Q_0 - I - pd,$$

[7]and the remaining part of its output after repayments at t=1,

$$(3) \qquad C_1(\sigma,\rho,I,\omega) = Q_{1\omega}+\mu I - R_1(\sigma,\rho,I,\omega).$$

We specify that the objective of the country's decision-maker at $t=0^+$ is to choose an investment level that maximizes the following utility function over available consumptions at $t=0^+,1$:

(4) $\quad U(\sigma,\rho,I,\beta,\omega) = C_0 + \beta C_1(\sigma,\rho,I,\omega),$

where β, the decision maker's discount factor over one period, is assumed to take one of two possible values: β_H and β_L, with $\frac{1}{r_f} > \beta_H > \beta_L$, where r_f is 1 plus the risk-free rate of interest in the global economy and the country is assumed to be too small to impact r_f.[8] The β represents the country's degree of willingness to adjust its policies of consumption and investment. The country in our model is either type H (patient) or type L (impatient) with a positive probability of becoming either type. We have assumed the subjective discount factors β_H and β_L to be lower than the global discount factor $[\frac{1}{r_f}]$ so that the country has an incentive to hold foreign debt. We shall analyze two cases involving the state of information about β: the case of symmetric information where β is common knowledge, and the case of asymmetric information where banks and other investors do not observe the β, known to the country's decision maker. [For simplicity, we do not distinguish the country (its citizens) from its decision maker.] In any case, we assume that $\mu \geq \frac{1}{\beta}$, $\beta=\beta_H,\beta_L$, so that the incentive to undertake the project purely as an investment is non negative. This allows us to isolate conditions under which debt overhang may create disincentives for undertaking the (worthwhile) investment, and when debt relief measures by the bank may induce the country to undertake the investment. The country's problem at $t=0^+$ [$\forall\ \omega\in\{g,b\}$, $\sigma\in\{B,N\}$, $\beta\in\{\beta_L,\beta_H\}$] is thus:

(5) $\quad \underset{I\in(0,\bar{I})}{\text{Max}} \quad U(\sigma,\rho,I,\beta,\omega) = (Q_0 - I - pd) + \beta\left[Q_{1\omega} + \mu I - \text{Min}[D-d-\rho, \alpha Q_{1\omega} + \alpha\mu I]\right].$

Given the solution of (5), a set of investment strategies I^*, the objective of the country at t=0 is to maximize its expected utility to choose $\sigma\in\{B,N\}$:

(6) $\quad \underset{\sigma\in\{B,N\}}{\text{Maximize}}\ U(\sigma,\rho,I^*,\beta,g)\pi_g + U(\sigma,\rho,I^*,\beta,b)\pi_b.$

Given the observed action σ of the country, the bank makes an inference at t=0 that the country's true β is $\hat{\beta}$, and then derives an inferred optimal investment strategy for the country, $\hat{I}$. [In the case of symmetric information $\hat{\beta}=\beta$, and $\hat{I}=I^*$.] Given the inferred $(\hat{\beta},\hat{I})$, the bank is assumed to maximize its expected receipts from the

country to choose debt relief ρ:

(7) $\quad \text{Maximize}_{\rho}\ R_1(\sigma,\rho,\hat{I},g)\pi_g + R_1(\sigma,\rho,\hat{I},b)\pi_b.$

We then define Nash equilibria in the model as follows:

Definition of Equilibrium: The equilibrium in the game among the players (the bank and the country) comprises of: (i) an investment strategy I^* which solves (5), a buyback strategy σ which solves (6), inference rules $(\hat{\beta},\hat{I})$ and an amount of debt relief ρ (given $\hat{\beta}$, $\hat{I}$) which solve (7), such that σ is optimal given ρ, ρ is optimal given σ, the inferences are rational [e.g., in fully revealing informational equilibrium, $\hat{\beta}=\beta$, and $\hat{I}=I^*$], and (ii) the price of debt at t=0 is given by [for D-d-ρ>0]:

(8) $\quad p(\sigma) = \frac{1}{r\cdot(D-d-\rho)}\left[R_1(\sigma,\rho,\hat{I},g)\pi_g + R_1(\sigma,\rho,\hat{I},b)\pi_b\right].$

The secondary market price of country debt, given by (8), is indeed the conditional expectation of the expected receipts per dollar of debt outstanding, given the country's buyback strategy and the bank's relief strategy; where the expectation is evaluated by the risk-adjusted probability (equivalent martingale) measure, as in Harrison and Kreps (1979). [Under this measure the price of an asset at t=0 is simply equal to the expected future payoffs to the asset at t=1, discounted to time 0 by the economy's risk-free rate.]

We show the existence of two equilibria of interest, one in the case of symmetric information and the other in the case of asymmetric information about β. The asymmetric informational equilibrium we consider is fully revealing so that $\hat{\beta}(\sigma(\beta))=\beta$, and $\hat{I}(\hat{\beta},\omega)=I^*(\beta,\omega)$. In either case, the investment strategy at $t=0^+$ which solves (5) is stated in Lemma 1.

Lemma 1: Optimal Investment Strategy: Given $d\in(0,D)$, and $\rho\in(0,D-d)$, the country's optimal investment strategy for $\omega\in\{g,b\}$ is given by:

(9) $\quad I^* = \bar{I}$ iff $\bar{I}(\mu-\frac{1}{\beta}) \geq \text{Min}[D-d-\rho,\alpha Q_{1\omega}+\alpha\mu\bar{I}] - \text{Min}[D-d-\rho,\alpha Q_{1\omega}] = X;$

$I^* = 0$ otherwise,

where:

(10) $X = 0$ for $D\text{-}d\text{-}\rho \leq \alpha Q_{1\omega}$,

(11) $X = D\text{-}d\text{-}\rho\text{-}\alpha Q_{1\omega}$ for $\alpha Q_{1\omega} < D\text{-}d\text{-}\rho \leq \alpha Q_{1\omega}+\alpha\mu\bar{I}$,

(12) $X = \alpha\mu\bar{I}$ for $D\text{-}d\text{-}\rho > \alpha Q_{1\omega}+\alpha\mu\bar{I}$.

Proof: It follows by solving (5) for $d\in(0,D)$ and $\rho\in(0,D\text{-}d)$.

Since $\mu\geq\frac{1}{\beta}$, the country will optimally invest in both states at $t=0^+$ if its remaining debt (after buyback and debt relief), $D\text{-}d\text{-}\rho$, is small enough such that the inequality in (10) holds. If the outstanding debt is large (such that (12) holds), the country will optimally invest at $t=0^+$ only if $(1\text{-}\alpha)\mu\geq\frac{1}{\beta}$, and forgo the investment otherwise. The country's investment strategy thus depends on the amount of buyback d and debt relief ρ, the original amount of debt D, and on the other parameters according to (9)-(12). In this paper, we focus on a scenario (a set of parameter values) in which:

(A) the country voluntarily undertakes the investment in at least one state;

(B) the country voluntarily forgoes the investment in some state, if the debt relief is zero, but can be induced by a positive debt relief to undertake the investment; and

(C) the bank finds it profitable to offer debt relief to at least one type of country and no relief to another type.

We ensure (A) by assuming $D<\alpha Q_{1g}$. [Then $D\text{-}d\text{-}\rho < \alpha Q_{1g}$ for $D\geq d\geq 0$ and $D\text{-}d \geq\rho\geq 0$, implying that $X=0$ if $\omega=g$, and by (9)-(10), $I^*=\bar{I}$ since $\mu>\frac{1}{\beta}$]. To ensure (B), we note that since there are two states, the country can forgo the investment only in state $\omega=b$. Further, if $(1\text{-}\alpha)\mu < \frac{1}{\beta}$ and $\alpha Q_{1b}+\alpha\mu\bar{I} < D$, then it can be seen from (9) and (12) that with no debt relief and no buyback the country will forgo the investment in the bad state, but by a sufficient amount of debt relief it can be induced to buyback and undertake the investment by (9) and (11). We therefore specify the following:

(13) $\alpha Q_{1b}+\alpha\mu\bar{I} < D < \alpha Q_{1g}$,

(14) $(1\text{-}\alpha)\mu < \frac{1}{\beta}$, $\beta = \beta_H, \beta_L$.

Condition (14) suggests that the part of the return on investment, remaining after payment toward the bank loan (for ω=b), is less than the subjective discount rate of the country. Undertaking the investment is therefore not attractive when the level of debt is D and the uncertain state turns out to be bad. Given (9)-(14) and a level of debt D, the country will thus invest in the good state and not invest in the bad state, and pay the bank αQ_{1b} at t=1 if the bad state occurs at t=0$^+$ and pay the full amount D at t=1 if the good state occurs at t=0$^+$. Given a voluntary buyback of $\bar{d}$, the minimum amount of positive debt relief that can induce the country to undertake the investment if state is bad at t=0$^+$ is shown in Lemma 2.

Lemma 2: (a) The minimum debt relief that can induce the country to undertake the investment is given by:

$$\rho_{min} = 0 \qquad \text{if } D-\bar{d} < \alpha Q_{1b}+\bar{I}(\mu-\tfrac{1}{\beta}), \tag{15}$$

$$\rho_{min} = D-d-\alpha Q_{1b}-\bar{I}(\mu-\tfrac{1}{\beta}) \qquad \text{if } D-\bar{d} \geq \alpha Q_{1b}+\bar{I}(\mu-\tfrac{1}{\beta}).$$

(b) The maximum amount of relief that the bank can profitably offer the country is given by:

$$\rho_{max} = \pi_b[D-d-\alpha Q_{1b}]. \tag{16}$$

(c) The optimal debt relief, ρ^*, is given by: $\rho^*=\rho_{min}$ if $\bar{I}(\mu-\frac{1}{\beta}) \geq \pi_g[D-d-\alpha Q_{1b}]$, and $\rho^*=0$ otherwise.

Proof: See the Appendix.

Note that there exists a positive debt buyback $\bar{d}$ which the country can choose even when ρ_{min} in (15) is positive since $(D-\alpha Q_{1b}) \geq \bar{I}(\mu-\frac{1}{\beta})$, by (13)-(14) as $\alpha\mu\bar{I}>\bar{I}(\mu-\frac{1}{\beta})$. Although ρ_{min} may be positive, the maximum amount of relief that the bank can profitably offer the country is given by (16); this solution means that a reduced debt repayment in the good state is offset by an increase in debt repayment in the bad state. Thus an optimal ρ^* is given by ρ_{min} whenever $\rho_{max} \geq \rho_{min}$. Although this analysis in Lemma 2 is similar to the analysis by Froot et.al. (1988),[9] Krugman (1987), and Sachs (1988), we focus on equilibria with buyback programs under

symmetric and asymmetric information, which are not considered in these papers. Since there are two possible types of countries in the economy, we ensure (C) by specifying β_H and β_L as:

$$(17) \qquad \bar{I}(\mu-\tfrac{1}{\beta_H}) > \pi_g[D-\alpha Q_{1b}] > \bar{I}(\mu-\tfrac{1}{\beta_L}).$$

The rational bank's debt relief would clearly not exceed $[D-\alpha Q_{1b}]$, implying that $\pi_g[D-\alpha Q_{1b}]$ in (17) is the maximum expected cost of relief. Thus, (17) means that [before a buyback] the *investment surplus* $[\bar{I}(\mu-\frac{1}{\beta_H})]$ when the country is type H is greater than the maximum expected cost of relief, and conversely when the country is type L. It is thus potentially profitable for the bank to sacrifice a part of its debt in the good state in exchange for an increased repayment (greater than αQ_{1b}) in the bad state if the country is H type since this country can be induced to increase its output from Q_{1b} to $Q_{1b}+\mu\bar{I}$, by undertaking the investment; this tradeoff is not possible for the L type country. In other words, given a debt buyback d, Lemma 2 and (17) would imply that $\rho^*(\beta_H)=\rho_{min}>0$ and $\rho^*(\beta_L)=0$.

3. Symmetric and Asymmetric Informational Equilibria:

The first inequality in (17) suggests that if the bank observes the type of the country, it would then be better off offering a positive debt relief to type H country, who would be better off undertaking the investment. The bank would be better off not offering debt relief to the L type country, who would then find it optimal to not undertake the investment. In this symmetric information case, a buyback of debt at its market price is costly to either type of country. This result follows since the market price of a dollar of debt yields the global rate of interest r_f-1, whereas the benefits (measured in terms of expected utility) of debt relief yield a lower rate given by $\frac{1}{\beta}$-1, $\beta=\beta_H,\beta_L$. We state and formally show the existence of this equilibrium (under symmetric information) in the following proposition.

Proposition 1 (Symmetric Information Equilibrium): Given that β is common knowledge: (a) the optimal investment strategies are: $I^*(\beta_H,\omega) = \bar{I}$, for ω=g,b; $I^*(\beta_L,g) = \bar{I}$ and $I^*(\beta_L,b) = 0$; (b) the bank offers a positive debt relief, equal to

$\rho(\beta_H)=D-\alpha Q_{1b}-\bar{I}(\mu-\frac{1}{\beta_H})$, to the H type country and a relief $\rho(\beta_L)=0$ to the country L type country; (c) neither type country engages in buyback program: $\sigma(\beta_H)=N=\sigma(\beta_L)$, i.e., $d=0$.

Proof: See the Appendix.

Proposition 1, similar to Bulow and Rogoff (1988), does not explain why buybacks take place. More importantly, this proposition does not shed any light on why some countries engage in buyback programs, whereas others do not. This proposition also cannot indicate how the secondary market debt price should behave in equilibrium with respect to the buyback by a country, to explain our empirical results later. Indeed, if β is unobservable, the equilibrium in Proposition 1 no longer holds since every country (H or L type) may desire to get the debt relief by mis-representing itself. In the next proposition, we consider the case of asymmetric information about β to show the existence an equilibrium where the H type finds it optimal to buyback, the type L does not find it optimal to buyback, the bank profitably offers a positive debt relief if the country engages in buyback and no relief if the country does not. We also show that in this equilibrium the secondary market debt price of the country's debt is higher, conditional on a buyback than on a no-buyback.

Proposition 2 (Asymmetric Informational Equilibrium): When β is not observed by the bank and by the investors, then there exists an equilibrium in which (a) for $\beta=\beta_H,\beta_L$: $I^*(\beta,B,g)=\bar{I}=I^*(\beta,B,b)$; $I^*(\beta,N,g)=\bar{I}$ and $I^*(\beta,N,b)=0$; (b) $\exists\ \bar{d}\in(0,D)$ such that $\rho(B)=D-\alpha Q_{1b}-\bar{d}-\bar{I}(\mu-\frac{1}{\beta_H}) > 0$, $\rho(N)=0$, $\sigma(\beta_H)=B$, $\sigma(\beta_L)=N$; (c) $\hat{\beta}(\sigma(\beta))=\beta$, and $\hat{I}(\hat{\beta},\sigma,\omega) = I^*(\beta,\sigma,\omega)$; and (d) $p(B) > p(N)$.

Proof: See the Appendix.

The basic intuition behind the informational equilibrium can be easily described by the two necessary conditions for existence, derived in the Appendix:

(A1) $$\bar{d}/r_f \le [(D-\alpha Q_{1b}) - \bar{I}(\mu-\frac{1}{\beta_H})]\pi_g\beta_H,$$

(A2) $$\bar{d}/r_f \ge [(D-\alpha Q_{1b}) - \bar{I}(\mu-\frac{1}{\beta_H})]\pi_g\beta_L,$$

where (A1) guarantees that the H-type engages in buyback and (A2) guarantees that the L-type does not. Under these conditions, $\bar{d}p(B)=\bar{d}/r_t$ is the *current* (t=0) cost of buying back $\bar{d}$ dollars of face value of bank debt, $(D-\alpha Q_{1b})-\bar{I}(\mu-\frac{1}{\beta_H})=\bar{d}+\rho(B)$ is the corresponding reduction in the face value of debt outstanding (by the buyback $\bar{d}$, and debt relief $\rho(B)$). After such debt reductions, the country will be required to pay $\bar{d}+\rho(B)$ dollars less in the *future* (t=1), if $d=\bar{d}$. Thus, $(\bar{d}+\rho(B))\pi_g\beta$ is the country's current evaluation of the future cut in the debt repayment, for $\beta=\beta_H,\beta_L$. By (A1) the H type would thus find it beneficial to buyback, and given (A2), the L-type would find it beneficial to not buyback. There exists $\bar{d}\in(0,D)$ which satisfies (A1)-(A2) such that a separating equilibrium obtains [since $\beta_H>\beta_L$], and a positive cut in the nominal debt by relief and debt buyback is mutually optimal, when feasible $[\bar{d}+\rho(B) = (D-\alpha Q_{1b})-\bar{I}(\mu-\frac{1}{\beta_H})>0]$.[10] In this equilibrium, the unobserved β of a country is fully revealed by the buyback/no-buyback action. Since the L-country does not buyback and therefore does not get debt relief, it lands up defaulting at t=1 if the state at $t=0^+$ turns out to be bad. On the contrary, the H-type country repays at t=1 the rescheduled amount of debt $[D-\bar{d}-\rho(B)]$ fully whether the state at $t=0^+$ is $\omega=g$ or $\omega=b$. It should then be clear that the secondary market debt price of the country that engages in buybacks should be more than the price of debt of the country that does not. In the next section, we test and fail to reject this implication of the informational equilibrium.

4. Tests of the Model:

Using the monthly data obtained for 17 highly indebted countries that have not received voluntary new loans since 1982,[11] over March 1985 through December 1987 [from World Debt Tables and the World Development Report (World Bank), the International Financial Statistics (International Monetary Fund)], we test the following two implications of our model:

(A) Countries promoting swap programs receive higher debt reliefs,

and (B) the secondary market debt price of the country debt is higher, conditional on swap, than the debt price, conditional on no-swap.

Our data for testing (A) consists of: (1) the spread between the interest rates charged by the banks on new loans to the countries and the London Interbank Offer Rate (LIBOR), and (2) the amount of new money (at below market interest rate) received by a country as a percent of the debt service. If (A) is true, then the spread over LIBOR should be lower and the amount of new money loaned should be higher on average for countries that swap than for countries that do not swap. To test (B), we used monthly data on the secondary market debt price for these 17 countries.

Table 1 presents results of simple F-tests for comparing the means of these three variables across swap and no-swap actions of these countries. The group of countries that swapped received on average significantly more new money (50%) from their lenders than the group of countries that did not swap. Lenders charged significantly lower interest rates (15% more) on new loans to the group of countries that swapped than on the new loans to the group of countries that did not swap. The price of secondary market country debt has been significantly higher for the group of countries that swapped than for countries that did not swap (16.5%). These test results are consistent with our predictions [Proposition 2], although they are not exact tests. We hence carry out more formal tests of prediction of Proposition 2, based on an econometric formulation of endogenously chosen swap/no-swap actions of countries and on measurement of the conditional means of the three dependent variables that are realized contingent on the actions chosen by the countries.

4.1 Formulation of Tests of the model:

In this section, we specify that the unobservable subjective discount factor, β, of a country is a continuous random variable, which for simplicity is assumed to be normal.[12] The country's decision maker first observes β (which may be different over time) and then announces its swap/no-swap action. Based on the model in Section 3, it can be shown that the swap action is announced if $\beta > \bar{\beta}$, where $\bar{\beta}$ is the threshold of β implied in equilibrium by the parameters in the global economy. If a country undertakes a swap program whenever $\beta > \bar{\beta}$, then the market can rationally infer this decision rule, although it does not observe β. Thus the expected value of the dependent variables, as a function of other observable attributes of a

country, should be measured contingent on the inferred rational rule: the country swaps whenever $\beta>\bar{\beta}$, and does not swap otherwise. Let y be one of the three dependent variables: ratio of new money to the total debt service due in the year, spread of interest rate charged in excess of LIBOR, and the log of secondary market debt price. Let $y=\theta'z+\varepsilon$, where z is a vector observables, specified later, and θ is the conforming vector of coefficients. We need to estimate the expected value of the dependent variable contingent on swap and no-swap actions: $E(y|z,\beta>\bar{\beta})$ and $E(y|z,\beta\leq\bar{\beta})$. Clearly then the expected payoff of the country, y, contingent on its chosen action σ, can be written as: $E(y|z,\sigma) = E(y|z,\beta>\bar{\beta})J+E(y|z,\beta\leq\bar{\beta})(1-J)$, where J=1 if and only if the country swaps and J=0 otherwise. We also specify: $\beta-\bar{\beta}=\gamma'z+\xi$, where ξ is assumed to be normally distributed, and both sides of this equation is divided by the standard deviation of ξ so that the resulting ξ is unit normal, γ is a vector of coefficients. It then follows that $E(y|z,\beta>\bar{\beta}) = \theta'z+q\phi(\gamma'z)/\Phi(\gamma'z)$ and $E(y|z,\beta\leq\bar{\beta}) = \theta'z-q\phi(\gamma'z)/[1-\Phi(\gamma'z)]$, where $\phi(\cdot)$ is the density and $\Phi(\cdot)$ is the cdf of a standard normal distribution, and $q=Cov(\xi,\varepsilon)$. We can then estimate q as well as θ and γ in the following model:

$$(18) \qquad y = \theta'z + q\left[\frac{\phi(\gamma'z)}{\Phi(\gamma'z)}J\right] - q\left[\frac{\phi(\gamma'z)}{1-\Phi(\gamma'z)}(1-J)\right] + \nu,$$

where $E(\nu|z,J)=0$. We can test whether $E(y|z,\beta>\bar{\beta}) > E(y|z,\beta\leq\bar{\beta})$, by testing whether $q>0$ in (18). The econometric model (18) is a special case of the action-contingent payoff model of Acharya (1989), or of the signalling model of Acharya (1988). Although (18) can be estimated by non-linear least squares, we use simpler two stage procedures, as in Acharya (1988,1989). In the first stage, we estimate θ in a probit model in which J is the discrete dependent variable and z is the vector of the right hand side variables. In the second stage, we estimate (18) by OLS, and derive the correct asymptotic covariance matrix of the coefficient estimator.[13] Note that in Heckman's (1976) two-stage procedure, terms like $\phi(\cdot)/\Phi(\cdot)$ are used to correct for bias, arising from sample selection, truncation, or censoring. We have, however, the complete sample of data on the dependent variables over the two possible actions of the countries in our sample. [It is unnecessary for us to group the data according to whether a country has or has not swapped.]

We specify z as the following pre-determined variables: (a) LIBOR, (b) ratio of

total external debt outstanding to the gross domestic product (GDP), (c) ratio of total exchange reserve to GDP, (d) ratio of investment to GDP, (e) ratio of total debt service to exchange reserves, and (f) ratio of trade deficit to GDP of a country. We collected data on these variables from various publications: the World Debt Tables and the World Development Report (World Bank), and the International Financial Statistics (International Monetary Fund).

4.2 Test Results:

The results of estimation are presented in Panels A, B and C in Table 2. First, we fail to reject the hypotheses that the spread over LIBOR is less (and the log of debt price is more), conditional on swap action, than conditional on no-swap action of a country: q is significantly negative in Panel A, and significantly positive in Panel C. Although statistically insignificant, q is positive in Panel B, indicating that the new money (as a fraction of total debt service) is also more, conditional on swap, than on no-swap action of a country. These results are consistent with the predictions of our model.[14]

About signs of the other coefficients, θ, note that LIBOR is negatively related to spread of the interest rate over LIBOR since the interest rate charged by banks is much less variable than the LIBOR. When the LIBOR goes up, the spread thus goes down. The amount of new money granted by banks do not depend significantly on the LIBOR, but the secondary market debt price goes up when the LIBOR goes down, as expected. The ratio of total debt to GDP is found to be positively related to the spread, negatively related to the debt price, as expected since the level of debt is inversely related to the probability of default. [See Edwards (1985) who obtains similar results.] Interestingly, the ratio of debt to GDP is not significantly related to the amount of new money granted. The ratio of exchange reserves to GDP is found to be negatively related, although insignificantly, to the spread [Edwards (1983)], and positively related to new money and debt price. The investment-GDP ratio is positively related to new money and to the secondary market debt price, as higher investment-GDP ratios enhance the credit-worthiness. The spread is found to be negatively related to the investment-GDP ratio. The debt service to GDP ratio is negatively related to the spread, positively related to the new money, and positively related to the secondary market debt price, as expected [Feder and Just

(1977)]. The trade balance to GDP ratio is positively related to the amount of new money, positively related to the secondary market debt price, and negatively related to spread, as expected under the willingness-to-pay approach.

5. Concluding Remarks

We showed that debt buybacks can be useful in resolving the debt crisis by acting as credible indicators for a country's willingness to respond to debt relief by increasing investment and debt repayment. In our informational equilibrium, some debtor countries and their creditors exchange concessions and share the burden of debt reduction: the debtor country by using its current resources to pre-pay a part of its debt, and the creditors by offering debt relief in the form of new money, reduced interest rate in the rescheduled loans, or outright debt write-offs. On the other hand, countries that experience a debt overhang but do not buyback some of their debt reveal that they are unwilling to sacrifice current consumption for the sake of future consumption. These countries in turn are unwilling to undertake sufficiently high level of investment.

It is tempting to interpret the recent initiative by the United States Treasury Secretary Brady [endorsed by the international financial institutions (IFIs)] as an attempt to devise a self selection mechanism, offering debt relief only to the *deserving countries*. In the recent Mexican deal, $7 billion of credit enhancements were made (including $1.3 billion from Mexico's own funds) with a view to reducing Mexico's debt considerably. The deal offered the banks a menu of options (including new money instruments and debt exchanges) to choose from. Concessions were exchanged as Mexico used its scarce foreign exchange for buybacks while banks offered new money at below the market rate. While the IFIs have committed to fund a part of the debt enhancement bill over a period of 2 years in order to help Mexico smooth the expense through time, there has been an insistence for Mexico to adjust its policies for promoting investment as a pre-condition for such supports in future.

Table 1: F-tests for comparing the means across swap/no-swap actions

Panel A: Spread of interest rate charged over LIBOR

Given action → Variable ↓	Swap	No-swap
Mean Spread of interest rate over LIBOR (%)	1.195	1.378
Standard error	.021	.017
F-test for equality of means across swap and no-swap actions:		
F(1,468), significance	46.02, .0000	

Panel B: New Money as a Percent of Total Debt Serviced

Given action → Variable ↓	Swap	No-swap
Mean of ratio of new money to total debt service (%)	7.340	4.894
Standard error	.877	.611
F-test for equality of means across swap and no-swap actions:		
F(1,576), significance	5.24, .0224	

Panel C: Natural Log of Secondary Market Debt Price

Given action → Variable ↓	Swap	No-swap
Mean of log of secondary market country debt price	3.848	3.695
Standard error	.047	.033
F-test for equality of means across swap and no-swap actions:		
F(1,576), significance	6.99, .0084	

Table 2: Tests of the Model (whether q=0), based on:

$$(18) \qquad y = \theta'z + q\left[\frac{\phi(\gamma'z)}{\Phi(\gamma'z)}J\right] - q\left[\frac{\phi(\gamma'z)}{1-\Phi(\gamma'z)}(1-J)\right] + \nu,$$

where the dependent variable y is: spread of interest rate charged over LIBOR in Panel A, the new money as a percent of total debt service in Panel B, and natural logarithm of the secondary market debt price in Panel C, z is the vector explanatory variables, and J=1 iff the country swaps and J=0 otherwise.

Panel A: Dependent Variable is Spread of Interest Rate over LIBOR*

Variables (z)	Coefficient	Standard Error	t-stat.	Signif.
Constant	1.658	.125	13.28	.000
Swap (q)	-.095	.015	-6.30	.000
LIBOR	-.092	.012	-7.57	.000
External debt	.322	.039	8.35	.000
Reserves	-.169	.261	-.65	.258
Investment	.007	.003	2.14	.016
Debt service	-.001	.001	-1.06	.145
Trade	-.003	.002	-1.98	.024

*Adjusted R^2 = .375.

Panel B: Dependent Variable is New Money as a Percent of Total Debt Serviced*

Variable (z)	Coefficient	Standard Error	t-stat.	Signif.
Constant	-1.799	4.850	-.37	.365
Swap (q)	.673	.661	1.02	.154
LIBOR	-.952	.510	-1.87	.031
External debt	.972	1.635	.59	.278
Reserves	39.952	11.152	3.58	.000
Investment	.145	.010	1.46	.072
Debt service	.250	.041	6.10	.000
Trade	.339	.071	5.47	.000

*Adjusted R^2 = .164.

Panel C: Dependent Variable is Natural Log of Secondary Market Debt Price*

Variable (z)	Coefficient	Standard Error	t-stat.	Signif.
Constant	4.267	.246	17.33	.000
Swap (q)	.109	.034	3.26	.000
LIBOR	-.191	.026	-7.37	.000
External debt	-.292	.083	-3.52	.000
Reserves	1.932	.566	3.41	.000
Investment	.036	.005	7.08	.000
Debt service	.013	.002	6.46	.000
Trade	.003	.004	.93	.276

*Adjusted R^2 = .265.

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The Appendix

Proof of Lemma 2: (a) When $\rho=0$, $\bar{d}=0$, and $\omega=b$, the inequality in (12) holds, given (13). If $d > D-\alpha Q_{1b}-\bar{I}(\mu-\frac{1}{\beta})$ such that $X<\bar{I}(\mu-\frac{1}{\beta})$, the investment is undertaken even in state $\omega=b$ and the minimum debt relief that the bank should optimally offer in this case is zero. If $d \leq D-\alpha Q_{1b}-\bar{I}(\mu-\frac{1}{\beta})$, a debt relief ρ can lead to $X\leq\bar{I}(\mu-\frac{1}{\beta})$, so that: $I=\bar{I}$ if $\rho>D-d-\alpha Q_{1b}-\alpha\mu\bar{I}$ and $\rho > D-d-\alpha Q_{1b}-\bar{I}(\mu-\frac{1}{\beta})$. Since $\alpha\mu\bar{I} > \bar{I}(\mu-\frac{1}{\beta})$ by (14), the minimum debt relief that can induce the country to undertake the investment is given by (15).

(b) Suppose that a debt relief, $\rho>0$, can induce the country to invest also in state $\omega=b$ at $t=0^+$ such that it can pay $D-d-\rho$ at $t=1$ if the state turns out to be either $\omega=g$ or $\omega=b$ at $t=0^+$. Since the country pays αQ_{1b} as it forgoes the investment if $\omega=b$ and pays $D-d$ if $\omega=g$, the bank finds it profitable to offer a positive relief if $D-d-\rho > \alpha Q_{1b}\pi_b+(D-d)\pi_g$. The maximum debt relief that the bank profitably offers (if undertaking the investment can be induced) is thus given by (16).

(c) Thus, a positive debt relief is feasible if $\rho_{max} \geq \rho_{min}$, i.e., if $\bar{I}(\mu-\frac{1}{\beta}) \geq \pi_g[D-d-\alpha Q_{1b}]$. This condition implies an optimal debt relief, given by $\rho^*=\rho_{min}$. Otherwise $\rho^*=0$.

Q.E.D.

Proof of Proposition 1: (a) Given the debt relief and buyback strategies stated in (b)-(c) and given (13)-(14), the stated investment strategies can be seen to satisfy (9)-(12). (b) Given any debt buyback $d\in(0,D)$, a positive debt relief is feasible and optimal by the first inequality in (17) since $\rho_{max} \geq \rho_{min}$ if the country is type H; this relief is given by ρ_{min} in (15). Given that the L type country does not engage in buyback, the optimal debt relief is zero by the second inequality in (17).

(c) If the country is type H, its expected utility by (5)-(6) is:

$$Q_0-\bar{I}-dp(\beta_H,B) + \beta_H[Q_{1g}\pi_g+Q_{1b}\pi_b+\mu\bar{I} - (\alpha Q_{1b}+\bar{I}(\mu-\tfrac{1}{\beta_H}))],$$

where the equilibrium price of debt $p(\beta_H,B)$ [by (8)] is equal to $\frac{1}{r_f}$. Since over all $\bar{d}$ this expected utility is maximized for $d=0$, the type H country will not buyback its debt. If the country is type L, its expected utility by (5)-(6) is given by:

$$Q_0-\bar{I}\pi_g-dp(\beta_L,B) + \beta_L[Q_{1g}\pi_g+Q_{1b}\pi_b+\mu\bar{I}\pi_g - ((D-d)\pi_g+\alpha Q_{1b}\pi_b)],$$

where by (8) $p(\beta_L,B) = [(D-\bar{d})\pi_g+\alpha Q_{1b}\pi_b]/[r_g(D-\bar{d})]$. The type L will not engage in buyback if $p(\beta_L,B) \geq \beta_L\pi_g$, i.e., if $\alpha Q_{1b}\pi_b/(D-\bar{d}) \geq \pi_g[r_g\beta_L-1]$ which holds when $\beta_L \leq \frac{1}{r_g}$. Q.E.D.

Proof of Proposition 2: (a) Given $\bar{d}\in(0,D)$, $\rho(B)=D-\alpha Q_{1b}-\bar{d}-\bar{I}(\mu-\frac{1}{\beta_H})$, we have $X=\bar{I}(\mu-\frac{1}{\beta})$ for $\omega=b$ in (11), which along with (9) implies that $I^*(\beta,B,g)=\bar{I}$, $\beta=\beta_H,\beta_L$. Given $\rho(N)=0$, $\sigma=N$ implies that X=0 in (9) if $\omega=g$ since $D\leq\alpha Q_{1g}$, which implies that $I^*(\beta,N,g)=\bar{I}$, $\beta=\beta_H,\beta_L$. If $\rho(N)=0$, $\sigma=N$ and $\omega=b$, then using (13) in (9) and (12) implies that $I^*(\beta,N,b)=0$.

(b) Given the inference rules in (c), and given $\sigma(\beta_H)=B$, it follows from (12) that $\rho(B)=\rho_{min}(B)=D-\alpha Q_{1b}-\bar{d}-\bar{I}(\mu-\frac{1}{\beta_H})$ [cf. arguments leading to (15)]. Given $\sigma(\beta_L)=N$, $\rho_{min}(N)=D-\alpha Q_{1b}-\bar{I}(\mu-\frac{1}{\beta_H})$, $\rho_{max}(N)=\pi_b[D-\bar{d}-\alpha Q_{1b}]$ and $\rho_{max}(N)<\rho_{min}(N)$ by the second inequality in (17), implying that $\rho(N)=0$.

Now, we have to show that $\sigma(\beta_H) = B$ and $\sigma(\beta_L)=N$ and the implied $\bar{d}\in(0,D)$ is such that $\rho_{min}(B)>0$ in (15) First, $\sigma(\beta_H)=N$ iff $E[U|B,\rho(B)] \geq E[U|N,\rho(N)]$. That is, using (5)-(6), $\rho(B)=\rho_{min}(B)$, $\rho(N)=0$, $p(B)=\frac{1}{r_g}$, and (13)-(14), we must show:

$$\begin{aligned}
&\pi_g[Q_0-\bar{I}-p(B)\bar{d} + \beta_H(Q_{1g}+\mu\bar{I} - (\alpha Q_{1b}+\bar{I}(\mu-\tfrac{1}{\beta_H})))] + \\
&\pi_b[Q_0-\bar{I}-p(B)\bar{d} + \beta_H(Q_{1b}+\mu\bar{I} - (\alpha Q_{1b}+\bar{I}(\mu-\tfrac{1}{\beta_H})))] \geq \\
&\pi_g[Q_0-\bar{I} + \beta_H(Q_{1g}+\mu\bar{I} - D)] + \pi_b[Q_0 + \beta_H(Q_{1b} - \alpha Q_{1b})],
\end{aligned}$$

i.e.,

(A1) $$\bar{d} \leq [(D-\alpha Q_{1b}) - \bar{I}(\mu-\tfrac{1}{\beta_H})]\pi_g r_g/\pi_l = \bar{d}_{max}.$$

Similarly, $\sigma(\beta_L) = N$ iff $E[U|N,\rho(N)] \geq E[U|B,\rho(B)]$. That is, using (5)-(6), $\rho(B)=\rho_{min}$, $\rho(N)=0$, $p(B)=\frac{1}{r_g}$, and (12)-(13), we must show:

$$\begin{aligned}
&\pi_g[Q_0-\bar{I} + \beta_L(Q_{1g}+\mu\bar{I} - D)] + \pi_b[Q_0 + \beta_L(Q_{1b} - \alpha Q_{1b})] \geq \\
&\pi_g[Q_0-\bar{I}-p(B)\bar{d} + \beta_L(Q_{1g}+\mu\bar{I} - (\alpha Q_{1b}+\bar{I}(\mu-\tfrac{1}{\beta_H})))] + \\
&\pi_b[Q_0-\bar{I}-p(B)\bar{d} + \beta_L(Q_{1b}+\mu\bar{I} - (\alpha Q_{1b}+\bar{I}(\mu-\tfrac{1}{\beta_H})))],
\end{aligned}$$

i.e.,

(A2) $$\bar{d} \geq [(D-\alpha Q_{1b}) - \bar{I}(\mu-\tfrac{1}{\beta_H})]\pi_g r_g \beta_L = \bar{d}_{min}.$$

Since $D-\alpha Q_{1b}) \geq \bar{I}(\mu-\frac{1}{\beta_H})$ and $\beta_H \geq \beta_L$, $\exists \bar{d} \in (0,D)$ since $\bar{d}_{min}>0$ and $\bar{d}_{max}<D$ as $\pi_g \beta_H r_g<1$. This $\bar{d}$ must, however, ensure that $\rho(B)=\rho_{min}(B)$ in (15) is positive, i.e., $\bar{d}<D-\alpha Q_{1b}-\bar{I}(\mu-\frac{1}{\beta})$. It is sufficient to show that $\bar{d}_{max}<D-\alpha Q_{1b}-\bar{I}(\mu-\frac{1}{\beta})$, which holds since $\pi_g r_g \beta_H<1$.

(d) Using (8), $p(B) = \frac{1}{r_g}$, and $p(N) = \frac{1}{r_g}[\pi_g+\alpha Q_{1b}\pi_b/D]$. Since $D>\alpha Q_{1b}$, $p(B)>p(N)$.

Q.E.D.

End Notes

1.By a debt buyback, we mean all debt conversions that involve a current expense. Debt exchanges that are collaterized by foreign exchange, and debt to equity swaps that require current public financing in the domestic country also fall in this category.

2.See Claessens and Diwan (1989,p.271), Table 15A-1 (source: the International Economics Department, World Bank).

3.See, for example, the recent plans of the Finance Minister Miyazawa of Japan, President Mitterand of France, and Treasury Secretary Brady of the United States of America.

4.Buybacks can be Pareto improving, however, when they lead to a larger economic pie (when the domestic investment yields a very low rate of return) and when the proportion of debtor's assets that can be seized by the creditors in case of a default is large, as in case of a domestic corporation.

5.Our model easily extends to a case where d is a continuous variable. Since, we do not gain further economic insights from this generalization, we focus on countries' simple buyback and no-buyback actions.

6.Since imposing default penalties on the debtor, through sanctions by the government of the country in which the banks are located, may not benefit the banks fully, there must exist some level of repayment that the debtor is willing to make and the banks are ready to accept in order to prevent an outright default. Indeed, Bulow and Rogoff (1989) show that the extractable repayment is the outcome of a bargaining between the debtor and its banks. To focus on the swap programs, we abstract away from the bargaining problem and treat α as given.

7.In our model buyback is thus funded by a reduction in the current consumption.

8.Our analysis easily extends to a continuum of possible values of β, as we investigate within our econometric model in Section 4.

9.Froot, et. al. (1988), consider only cases in which ρ^* is decreasing in β.

10.The minimum $\bar{d}$ which will solve the problem of type H country is equal to $[(D-\alpha Q_{1b}) - \bar{I}(\mu-\frac{1}{\beta_H})]\pi_g\beta_L r_f$. This will imply a $\rho(B) = [(D-\alpha Q_{1b}) - \bar{I}(\mu-\frac{1}{\beta_H})](1-\pi_g\beta_L r_f)$.

11.These 17 countries are: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Cote D'Ivoire, Jamaica, Mexico, Morocco, Nigeria, Peru, Philippines, Uruguay, Venezuela, and Yugoslavia.

12.We can alternatively specify that $\log(\frac{1}{\beta})$ is normally distributed.

13.A simpler way to derive the asymptotic co-variance matrix of the second stage estimators is to rewrite (18) as a standard non-linear regression model:

$$y_{jt} = g(\theta' z_{jt}) + \nu_{jt},$$

where z_{jt} is the vector of all regressors on the right side of (18), and θ is the conforming vector of all coefficients being estimated in the first and the second stage. Using the standard results from non-linear least squares, it follows that:

$$\mathrm{Cov}(\hat{\theta}) = A^{-1}CA^{-1},$$

where $A = \Sigma_{jt}[g'(\theta' z_{jt})]^2 z'_{jt} z_{jt}$, $C = \Sigma_{jt}[g'(\theta' z_{jt})]^2 u^2_{jt} z'_{jt} z_{jt}$, and $g'(\cdot)$ is the derivative of $g(\cdot)$. To obtain a consistent estimate of $\mathrm{Cov}(\hat{\theta})$, we substitute the maximum likelihood estimate of θ in the expressions for A and C.

14.The coefficient vector γ, whose estimates are not reported here, is found to be highly significant, with level of significance of almost 0 for a test that $\gamma=0$.

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