SOVEREIGN DEBT REPURCHASES: NO CURE FOR OVERHANG*

JEREMY BULOW AND KENNETH ROGOFF

Troubled debtor countries do not gain by repurchasing external bank debt at market discount, even if a buyback would stimulate investment by relieving debt overhang. The reason is that buybacks allow creditors to reap more than 100 percent of any efficiency gains that might result from increased investment. We show that open-market buybacks provide a benchmark for evaluating more complex negotiated buyback deals. By comparing any given deal with a hypothetical market buyback of the same size, one can derive upper and lower bounds on the gain to the country. We apply our model to the 1990 Mexican debt deal.

Over the past several years many troubled debtor countries have repurchased part of their foreign bank debt at secondary market prices. Examples of such open-market buybacks include the debt-equity swaps used extensively by Brazil and Chile, the straight repurchases by government-controlled domestic banks in Mexico, and the Bolivian tender offer of 1988. Unfortunately, a strong case can be made that buybacks are a giveaway to creditors. The problem is that if a country already owes ten times as much as it is likely to repay in full, then it is unlikely to benefit from a buyback that marginally reduces the face value of its debt.

The main argument in favor of buybacks is that they indirectly benefit debtors by stimulating domestic investment.[1] A large overhang of foreign debt can dampen a country's investment incentives, because higher growth generally means higher payments to foreign creditors.[2] Buybacks alleviate this problem by reducing the face value of the debt.

We demonstrate that even if buybacks do stimulate investment significantly, they still are not likely to benefit debtors. The

*The authors are grateful to the Bradley Foundation, the National Science Foundation, and the Sloan Foundation for supporting this research.

1. See Dornbusch [1988] and the Brookings panel discussion on Bulow and Rogoff [1988]. In the early buyback literature a number of authors argued that debtor countries can benefit from debt repurchases even in the absence of efficiency considerations; see the references in Bulow and Rogoff [1988]. However, many of these authors have subsequently revised their views.

2. However, see Bulow and Rogoff [1990] for a skeptical discussion of the view that debt overhang was the major reason for Latin America's investment slump in the 1980s. The empirical work of Warner [1990] also casts doubt on the quantitative significance of debt overhang.

The Quarterly Journal of Economics, November 1991

central problem is that if creditors believe that the buyback will stimulate growth, then they will demand a higher price in order to sell. Under empirically plausible conditions, creditor gains will exceed 100 percent of the efficiency benefits of the buyback.

Our analysis also provides quantitative bounds on the gain or loss to a country from negotiated buybacks, such as those recently completed under the Brady initiative for Mexico, Costa Rica, the Philippines, and Venezuela. In a negotiated buyback lenders agree to concessions so that a country can effectively repurchase its debt at below-market prices. One can evaluate any given negotiated buyback by comparing its cost with that of a hypothetical open-market buyback of the same size. We illustrate this method by assessing Mexico's 1990 debt restructuring.

I. A Model of the Open Market Buyback Problem

A. Timing

We model the buyback problem as part of a five-stage, complete-information process. In the first stage the country "inherits" a stock of external debt, D^0. In the second stage it chooses X, the amount of its initial resources W^0 to devote to an open-market debt buyback. After the buyback, the country will be left with a debt of D^x, where D^x is a function of buyback expenditures X and investor expectations about future repayments.

In stage 3 the country decides how to allocate its remaining resources, $W^0 - X$ $(\equiv W^x)$, between investment I and direct consumption C. In stage 4 the production shock θ is realized, determining gross income Y. Finally, in stage 5 the country makes repayment R to foreign creditors and then consumes the remainder of its gross income, $Y - R$. Figure I outlines the timing of events.

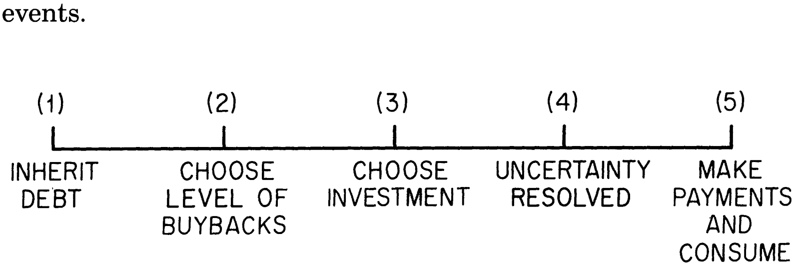

FIGURE I
Sequence of events

B. Production Technology

All borrowers and lenders are risk neutral, and the riskless interest rate is zero.[3] The country's gross income Y is given by

$$Y = C + \theta g(I), \tag{1}$$

where $g' > 0, g'' < 0, g'(0) = \infty$, and $\theta \in [0,\theta^{\max}]$. For convenience, the expected value of θ is normalized to one ($\bar{\theta} = 1$) so that $\bar{Y}$ is given by

$$\bar{Y} = C + g(I). \tag{2}$$

(Bars over variables denote expected values; e.g., $\bar{Y} \equiv E(Y)$.) We shall assume that $g'(W^0) > 1$, which implies that shifts from C to I always increase $\bar{Y}$, even as $I \to W^0$. Thus, if not for the perverse incentives created by external debt, the country would always set $I = W^0$ and $C = 0$.

C. Enforcement Technology

Once investment returns are realized (i.e., after stage 4), foreign creditors are able to extract repayments R equal to the minimum of the face value of the remaining debt D^x and an amount $\sigma[C,g(I),\theta]$:

$$R = \min\{\sigma[C,g(I),\theta],D^x\}, \tag{3}$$

where $1 > \partial\sigma/\partial C \geq 0$, $\theta > \partial\sigma/\partial g \geq 0$, and $g > \partial\sigma/\partial\theta \geq 0$. Thus, greater income from any source—C, $g(I)$, or θ—raises creditors' ability to extract repayments, but less than dollar for dollar. We further assume that

$$\sigma[\lambda C,\lambda g(I),\theta] \leq \lambda\sigma[C,g(I),\theta], \qquad \text{for } \lambda \geq 1. \tag{4}$$

That is, when a country doubles its output by raising C and $g(I)$ in equal proportions, its creditors are able to extract at most twice as much in repayments. The rationale for the inequality is that creditors' leverage might not increase proportionately with country size if larger, more diversified economies are less dependent on international trade. Note that (4) implies

$$\bar{R}[\lambda C,\lambda g(I),\lambda D] \leq \lambda\bar{R}[c,g(I),D] \qquad \text{for } \lambda \geq 1. \tag{5}$$

3. This assumption is completely innocuous: in the analysis below, one could alternatively consider all financial variables to be written as present discounted values.

D. Market Price of Debt

When a country spends X on a debt repurchase, the post-buyback price P^x equals investors' expectations of future repayments, $\overline{R}^x$, divided by the amount of debt that remains after the repurchase, D^x:

$$P^x = \overline{R}^x / D^x. \tag{6}$$

Of course, when a country purchases debt via an open-market buyback, investors who sell must receive the same value as those who do not. Therefore, P^x must also be the price the country pays in the repurchase, so that the amount of debt it retires is given by

$$D^0 - D^x = X / P^x. \tag{7}$$

For later purposes, it is convenient to combine (6) and (7) to obtain

$$D^x = D^0 (\overline{R}^x / (X + \overline{R}^x)). \tag{8}$$

E. Investor Expectations of C and I

Investors' expectations of future repayments $\overline{R}^x$, and therefore P^x and D^x, depend critically on how they believe the buyback will affect the country's incentives to invest. Consider then the country's decision problem in stage 3, after the buyback has taken place. At this point W^x and D^x have been determined, and the country will allocate its remaining resources between C and I to maximize $\overline{Y} - \overline{R}$.[4] Thus, investor beliefs C^x and I^x solve

$$\max_{C,I} \overline{Y}(C,I) - \overline{R}(C,I,D^x) \tag{9}$$

subject to

$$C + I = W^x \equiv W^0 - X \tag{10}$$

and $C, I \geq 0$. Substituting out for $\overline{Y}$ and $\overline{R}$ using (2) and (3), C^x, I^x, and D^x are then determined by solving (8), (9), and (10).

II. Proof That Open-Market Buybacks Hurt Debtors

Summarizing the debtor's problem, the country wishes to solve

$$\max_{C,I,X} \overline{Y}(C,I) - \overline{R}(C,I,D^x) \tag{11}$$

4. The solution to the country's stage-three maximization problem may not be unique. However, our proof of Theorem 1 below still goes through in this case.

subject to (2), (3), and

$$C + I + X = W^0 \tag{12}$$

$$C, I, X \geq 0 \tag{13}$$

$$D^x = D^0(\overline{R}^x/(X + \overline{R}^x)), \tag{14}$$

where $\overline{R}^x$ is determined by investor expectations as in subsection I.E above. In equilibrium, of course, the country will voluntarily choose $C = C^x$ and $I = I^x$, and investors' beliefs will be ratified.

We are now ready to prove that the country's welfare is maximized when it sets the level of buybacks, X, at zero. Define a solution to the country's problem (11)–(14) as (C^*, I^*, X^*).

THEOREM 1. $X^* = 0$.

Proof of Theorem 1. Compare any allocation (C^x, I^x, X), where $X > 0$, with an alternative allocation z in which $x = 0$ and

$$C^z/C^x = g(I^z)/g(I^x) = z > 1. \tag{15}$$

Define $\overline{Y}^x \equiv \overline{Y}(C^x, I^x)$; $\overline{Y}^z \equiv \overline{Y}(C^z, I^z)$; and $\overline{R}^z \equiv \overline{R}(C^z, I^z, D^0)$.

Case A. Suppose that $D^0 \leq zD^x$. Then by (5), $\overline{R}^z \leq z\overline{R}^x$. Since $\overline{Y}^z = z\overline{Y}^x$ by construction, we must have $\overline{Y}^z - \overline{R}^z \geq z(\overline{Y}^x - \overline{R}^x)$.

Case B. Suppose that $D^0 > zD^x$. Then by (5),

$$\frac{\overline{R}^x}{D^x} \geq \frac{\overline{R}[(D^0/D^x) \cdot C^x, (D^0/D^x)g(I^x), D^0]}{D^0} > \frac{\overline{R}^z}{D^0}. \tag{16}$$

Combining (16) with (8) implies that $X + \overline{R}^x > \overline{R}^z$. Since $g'(I) > 1$, we also have $\overline{Y}^z > \overline{Y}^x + X$. Therefore, $\overline{Y}^z - \overline{R}^z > \overline{Y}^x - \overline{R}^x$.

Q.E.D.

Theorem 1 states that in the presence of debt overhang, countries should not engage in open-market buybacks. As the proof illustrates, a debtor country can always do better by taking any resources earmarked for a buyback and using them to increase $g(I)$ and C proportionately, relative to what they would have been had the country gone through with the buyback. This is true even in the main case (B), where the alternative strategy leaves the country with a higher percentage increase in debt than in output.[5]

5. In the alternative case (A) the buyback brings only a relatively small reduction in debt. While this case may be unlikely, it is a theoretical possibility if $g(I)/(I)$ is sufficiently large.

Note that in this case, creditors would definitely prefer to see the buyback. Creditors who do not sell must gain, since the country's debt-income ratio would be lower. And creditors who do sell must also gain; market equilibrium requires that they receive the same value as nonsellers. Moreover, the buyback is less efficient from a social perspective, since our proposed alternative channels more funds into high-yielding investment projects. Since the buyback yields a lower social product and yet gives creditors more, it cannot be as good for the country as just proportionately increasing C and $g(I)$.

It is important to emphasize that the alternative strategy we consider is merely an *option* for the country and not necessarily the one it would actually choose after forgoing the buyback. Indeed, one can easily show that in this model the net effect of buybacks on investment is generally *positive*.[6] Although a buyback reduces the total resources available for investment and consumption, it also ameliorates perverse debt overhang incentives. The implication of our theorem, then, is that even though open market buybacks may lead to increased efficiency-enhancing investment, creditors always reap more than 100 percent of the efficiency gains.

III. Alternative Production and Enforcement Technologies

Under more general assumptions, it is possible to rationalize small buybacks. To do so, however, one must rig the model to make the price of debt (and therefore of debt repurchase) very low, and at the same time make the debt overhang disincentive very large.

First, instead of assuming that production is given by $Y = C + \theta g(I)$ as in equation (1), we assume that

$$Y = C + f(I,\theta), \tag{17}$$

where $f_1,f_2 > 0$, $f_{12} \geq 0$, and $\partial \overline{Y}/\partial I > 1$ for $I \leq W^0$ (so that, as before, shifts from C to I always increase $\overline{Y}$). Second, we shall eliminate the weak homogeneity assumption on the enforcement technology embodied in equation (4). Thus, the analysis of this section allows for the possibility that when a country's output doubles, creditors' ability to extract resources may more than double.[7]

6. The level of investment rises with the level of buybacks until the point where consumption is crowded out entirely.

7. We are grateful to Zhu [1990] for pointing out an error in our analysis of the general case in an earlier draft of this paper.

With these modifications to the model, one can show (see Appendix) that the efficacy of buybacks depends on three variables. Define m as the probability the country will fully repay its debts, P as the market price of debt (see equation (6)), and q as the average marginal "tax" rate on investment in defaulting states:

$$q \equiv \frac{E(\partial\sigma/\partial I)|_{\sigma} < D^0}{E(\partial Y/\partial I)|_{\sigma} < D^0}. \tag{18}$$

The necessary condition for a buyback to be profitable is then given by

$$q > \frac{1 - m/[P(\partial \overline{Y}/\partial I)]}{1 - m}. \tag{19}$$

A striking feature of (19) is that all of the key parameters are independent of the responsiveness of investment to debt reduction. The reason is that marginal changes in investment affect only creditors. Absent the buyback, the debtor allocates resources so that it is indifferent between C and I on the margin. Therefore, the envelope theorem tells us that shifts from C to I have only a second-order effect on the country, and the efficiency gains go solely to the creditors.[8]

In practice, it seems unlikely that condition (19) would hold empirically for very many highly indebted countries: m/P must be close to 1, and q must be relatively large.[9] A high value of m/P implies that the price of debt is not much higher that the probability of full repayment, so that creditors must be expecting an all-or-nothing payout. This implication seems at odds with the observation that historically, most countries that have defaulted on their external debts have ultimately made partial repayments. Moreover, a high value of q seems inconsistent with the observa-

8. One can also define a variable analogous to q, q_c, as

$$q_c \equiv \frac{E(\partial\sigma/\partial C)|_{\sigma}<D^0}{E(\partial Y/\partial C)|_{\sigma}<D^0} = E\left(\frac{\partial\sigma}{\partial C}\right)\bigg|\sigma < D^0 = \frac{\partial \overline{R}/\partial C}{1 - m}$$

and derive the result,

$$q_c > \frac{1 - m/P}{1 - m},$$

which is the same as condition (6) in Bulow and Rogoff [1988, p. 686], for a model in which investment is fixed.

9. Indeed, if $P \cdot (\partial \overline{Y}/\partial I) > 1$, then it is impossible for (19) to hold.

TABLE I
EXPECTED REPAYMENTS ON DEBT TO FOREIGN PRIVATE CREDITORS RELATIVE TO MONTHLY INCOME

Country	Debt-GNP (1988) (1)	Percent private (1989) (2)	Debt price 1/18/90 (3)	Expected repayments (months of income) (4)
Argentina	0.605	74.3	12.25	0.7
Bolivia	1.355	12.2	11.00	0.2
Brazil	0.307	75.2	27.50	0.8
Chile	0.966	68.8	64.25	5.1
Costa Rica	1.000	47.4	19.00	1.1
Ecuador	1.133	51.1	14.50	1.0
Honduras	0.819	22.3	21.00	0.5
Ivory Coast	1.618	61.6	6.00	0.7
Mexico	0.580	76.0	38.00	2.0
Morocco	1.059	26.2	37.00	1.2
Peru	0.473	43.0	5.50	0.1
Philippines	0.729	56.1	47.75	2.3
Poland	0.639	31.2	16.50	0.4
Senegal	0.766	15.5	39.00	0.6
Uruguay	0.501	79.1	50.00	2.4
Venezuela	0.577	94.7	35.25	2.3

Data Sources. Columns (1) and (2): World Bank, *World Debt Tables, 1989–1990,* Vol. 1, p. 30. Column (3): Salomon Brothers, *Indicative Prices for Less Developed Country Bank Loans.* Column (4) equals the product of columns (1), (2), and (3), divided by 1,000, and multiplied by 12. The table includes all the World Bank's severely indebted middle-income countries for which data were available.

tion that few countries have made net repayments of more than 5 percent of GNP or 25 percent of exports over any extended period.[10] Indeed, as Table I shows, the market expects that the present value of *total* future payments to private creditors will amount to no more than a couple of months income, for the most problem debtors. Finally, note that it is difficult to have both m/P and q be high at the same time. A high value of q means that creditors get significant payments in defaulting states, while a high value of m/P implies that payments in defaulting states are worth relatively little.

It is important to emphasize that our analysis of open-market buybacks applies to any voluntary participation scheme where the country buys out creditors one at a time. Debt-equity swaps, for

10. See Bulow and Rogoff [1988].

TABLE II
OPEN-MARKET DEBT BUYBACKS, 1984–1988
(MILLIONS OF DOLLARS)

	1984	1985	1986	1987	1988
Debt-equity swaps	773	1,843	1,522	3,335	9,205
Buybacks	0	0	0	0	648
Informal	0	0	0	3,500	5,414
Other	0	245	714	1,337	2,366

Source. World Bank, *World Debt Tables,* 1989–1990, Vol. 1. Amounts represent the face value of debt retired. Informal debt conversions represent transactions by private citizens and companies taking place outside official programs. Table II does not, however, include repurchases by government-controlled domestic banks that, as our later analysis of Mexico's 1990 deal indicates, can have the same implications for foreign creditor/country debtor bargaining as a straight government repurchase. Preliminary estimates for 1989 indicate a 40 percent decline in overall activity, largely because of the elimination of debt-equity programs in Argentina, Brazil, and Mexico.

example, may be thought of as combining a debt repurchase with conventional direct foreign investment. As Table II documents, open-market buybacks (broadly defined) have been quite significant in recent years. However, a growing alternative is the negotiated buyback, where a debtor country trades cash for debt reduction as part of a broader renegotiation package. We turn to evaluating such deals next.

IV. NEGOTIATED BUYBACKS

While open-market repurchases may be ill-advised, obviously a country may gain if it repurchases debt at an effective price that is sufficiently below market.[11] Here we show that our analysis of open-market buybacks applies directly to small-scale negotiated buybacks, and provides a valuable benchmark for empirically evaluating larger ones.

For negotiated buybacks where only a small fraction of the country's debt is retired, condition (19) applies with only slight modification: one must use the negotiated price actually paid in place of the market price P. As a simple example, consider the February 1988 Mexican repurchase. At the time, Mexican debt was selling on the secondary market at 52 percent of face value.

11. Suppose, for example, that a country's debt is selling at 40 cents on the dollar. Theorem 1 shows that the country will lose if it spends $40 to buy back $100 worth of debt. However, if in return for making the repurchase creditors lend the country an extra $40, then the country is effectively reducing its debt by $60 at no cost.

However, by negotiating jointly with its creditors, Mexico succeeded in retiring \$1.38 billion worth of debt at a cost of \$480 million;[12] thus, the actual buyback cost was 35 cents on the dollar. Observe that condition (19) can be rearranged to yield $m > (1 - q)/\{[1/P(\partial\overline{Y}/\partial I)] - q\}$. Assuming that q was no higher than 0.2 and that $\partial\overline{Y}/\partial I \geq 1$, then the buyback could only have benefited Mexico if the probability of full payment

$$m > (1 - 0.2)/\{[1/0.35] - 0.2\} \simeq 0.301.$$

For a larger buyback, such as Mexico's 1990 Brady plan operation, debt overhang relief can have first-order effects on the country; and if so, then (19) no longer applies. One can, however, still use the rougher approximations afforded by Theorem 1. By using the price of the country's debt before and after the repurchase, and the amount of debt reduction achieved, one can place bounds on the country's gain or loss from the repurchase.

Suppose that by a negotiated buyback, a country reduces the face value of its debt from D^0 to D', and the market value from P^0D^0 to $P'D'$, where D' is post-buyback debt and P' is the post-buyback price. Theorem 1 states that the gross benefit of this negotiated debt reduction cannot exceed the cost of reducing debt by the same amount through an open market repurchase. $P'(D^0 - D')$ provides an upper bound on the cost of an open-market repurchase, since the price that would prevail after an open-market repurchase would be no more than the price after the negotiated repurchase.[13] Therefore, the maximum net benefit to the country of the negotiated buyback is given by

$$P'(D^0 - D') - N, \tag{20}$$

where N is the total amount paid in the negotiated buyback.

The minimum net benefit is found by assuming that the buyback yields no efficiency gains. In this case, the country's gain is just equal to the reduction in creditor wealth, or

$$P^0D^0 - P'D' - N. \tag{21}$$

In the next section we apply our analysis to Mexico's 1990 Brady Plan debt reduction.

12. For details see Bulow and Rogoff [1988].

13. Because the open-market buyback would cost more than the negotiated buyback (by assumption), the debtor country would be left with fewer resources with which to pay off its remaining creditors.

V. Example of a Negotiated Buyback: Mexico Under the Brady Plan

Following the initiative of U. S. Treasury Secretary Nicholas Brady, Mexico in early 1990 became the first major debtor country to negotiate a large-scale buyback. In this section we apply equations (20) and (21) to place upper and lower bounds on Mexico's benefit from its Brady-plan buyback. We shall first present the basic elements of the deal, and then describe our procedure for calculating the parameters P^0, P', N, D^0, and D'.

A. The Basic Elements of the Mexican Deal

Restructuring negotiations covered \$45.8 billion, or about half of Mexico's debt. The negotiations covered only half the debt because some private debt was treated as immune—trade creditors, PeMex debt, and bond debt—and because some debt was owed to "official creditors," who generally were not interested in pressing Mexico for net repayments; see Table III.

Creditors were given three options under the restructuring (though some pressure was put on banks to make sure their

TABLE III
COMPOSITION OF MEXICO'S EXTERNAL DEBT
(END OF 1988, BILLIONS OF DOLLARS)

Total external debt		100.4
Less: Private sector debt	6.5	
Equals: Public sector debt		93.9
Less: Debt to official creditors	25.1	
Less: Bond debt	3.7	
Equals: Public sector debt to commercial banks		65.1
Less: Interbank loans	7.3	
Less: Other nonrescheduled	5.1	
Equals: Debt eligible for rescheduling		52.7
Less: Reductions from exchange rate changes, debt-equity swaps, etc.	3.8	
Equals: Rescheduled debt		48.9
Less: Debt held by Mexican banks (ineligible for enhancements)	3.1	
Equals: Restructured foreign bank debt		45.8
Of Which: Par bonds 22.846		
Discount bonds 18.672		
New money 4.325		

Data Sources. Van Wijnbergen [1990] and the World Bank *Quarterly Review*, March 1990.

aggregate choices were in line with Mexico's targets). Eventually, banks chose to trade \$22.846 billion of bank debt for an equal amount of 30-year "par bonds" and \$18.672 billion of bank debt for \$12.137 billion of 30-year "discount bonds." The discount bonds pay full interest but the par bonds offer a reduced rate of 6.5 percent. Finally, a few banks holding \$4.325 billion in loans agreed to a "new money" option that required them to give Mexico an immediate loan equal to 10 percent of the original amount owed. In addition, the new money banks agreed to relend roughly half their semiannual interest payments for the next two and a half years, an amount equal to \$130 million per six months. In return, these banks would face a reduction neither in interest nor in principal.

Mexico, for its part, was required to collateralize eighteen months of interest payments on the new bonds, plus the principal payments rescheduled for the year 2019. The total cost of this collateral was \$7 billion, though the immediate infusion from banks offering "new money" reduced the net cost to \$6.6 billion.[14]

B. Calculating an Upper Bound on Mexico's Potential Benefit

It is useful to rewrite expression (20) as

$$P'D^0 - (P'D' + N),$$

where $P'D^0$ is the value of pre-buyback debt calculated at post-buyback prices, and $P'D' + N$ is the market value of the debt remaining after the buyback, including both the Mexican-guaranteed component, worth $P'D'$, and the collateralized component, worth N.

To calculate $P'D' + N$, we must sum the post-buyback market values of the par bonds, the discount bonds, and the claims of the new money banks. Immediately after the buyback, the par bonds were selling for 41.25 percent of face value, and the discount bonds were selling at 62.75 percent.[15] Thus, together, they were worth

14. The sources for this \$7 billion were as follows: International Monetary Fund, \$1.7 billion; World Bank, \$2.0 billion; Japanese government, \$2.05 billion; Mexico, \$1.25 billion; see World Bank, *Quarterly Review,* March 1990. One can argue that the next cost to Mexico was relatively small and therefore that the buyback was almost pure benefit. However, we shall analyze the deal from the combined perspective of Mexico and its donors rather than Mexico individually. This is most appropriate if the funds employed were already earmarked for aid to Mexico. A further cost to Mexico was that during the period the restructuring was being negotiated, it religiously met all its interest payments.

15. Debt prices are from Salomon Brothers, *Indicative Prices for Developing Country Credits,* April 16, 1990.

$[(0.4125 \times 22.846) + (0.6275 \times 12.137)] = 17.040$ (billion dollars). Calculating the value of the claims of the new money banks is more difficult because their market is very thin. Furthermore, one cannot impute the value of the new money claims by directly using the discount rates implied by the par and discount bonds. Because those bonds include $7 billion of U. S. Treasury bills, they are really a hybrid of U. S. and Mexican-government guaranteed debt.

To calculate the appropriate discount rate for evaluating the claims of new money banks, one must first "strip out" the U. S.-guaranteed component from the par and discount bonds. Since the total market value of these bonds was $17.04 billion, out of which $7 billion is collateralized, the Mexican-guaranteed component is clearly $10.04 billion. Our computations are then based on the assumption that the discount bonds will pay 10 percent annual interest and the par bonds 6.5 percent, in semiannual installments beginning two years after the debt renegotiation package goes into effect and ending 30 years after, for a total of 57 payments of $1.349 billion each. We further assume that Mexico's first eighteen months of interest payments and its final principal payment are met by collateral, though in fact Mexico may choose to wait to call in its interest guarantees. We also ignore the value to banks of supplementary provisions that provide for higher payments if the price of oil is high. Accounting for oil price indexation and postponed use of interest collateral would slightly raise our estimate of the implied rate of return on Mexican debt, and give us a lower estimate of Mexico's benefit from the buyback.

The implicit rate of return on the par and discount bonds can be found by solving

$$10.04 = \sum_{t=4}^{60} \frac{1.349}{(1 + r)^{t/2}}, \tag{22}$$

where r is the required yield on Mexican debt, per six months. It is straightforward to solve (22) for $r = 0.10$, or 21 percent per annum. Finally, we apply this rate to evaluate the stream of claims owed to new money banks. These banks have an immediate claim of $-\$432$ million and then receive a stream of interest payments that begins roughly at $108 million after six months, rises linearly to $134 million after 30 months, and then rises again to $270 million every six months thereafter. Discounting this stream at the risky Mexican debt rate of 0.10 (per six months) yields $1.70 billion as the value of the claim of the new money banks. Thus, $P'D' + N = 17.04 + 1.70 = 18.74$ (billion dollars).[16]

Last, we need to calculate $P'D^0$, the value of the pre-buyback level of debt at post-buyback prices. Under the assumption that the pre-buyback debt of \$45.83 million carried an interest rate of 5 percent per six months, the semiannual payment would be \$2.292 billion. Discounting this stream by the risky Mexican interest rate of 10 percent per six months, yields $P'D^0 = \$22.92$ billion dollars.

Thus, an upper bound on Mexico's gain from the buyback is given by

$$22.92 - (17.04 + 1.70) = 4.18 \text{ (billion dollars).}$$

To put this potential gain of \$4.2 billion in perspective, note that it is equal to roughly 2 percent of Mexican GNP, and that Mexico reaps a comparable windfall when oil prices temporarily rise by \$9 a barrel for one year.

C. Calculating the Lower Bound on Mexico's Gain

To use expression (21) to calculate a lower bound on Mexico's benefit from the repurchase, we must estimate P^0, which conceptually is the price Mexican debt would have sold at if there had never been any talk of a buyback. The actual price at the conclusion of the negotiations on March 15, 1990, was approximately 40 cents. There is, of course, the possibility that this price may have been buoyed by the success of the debt negotiations. However, the price of Mexican debt was essentially unchanged from the previous year (39 cents on March 16, 1989). To obtain a benchmark value for P^0, we shall assume that investors expected the Mexican restructuring to be a break-even deal for the banks. This assumption implies that $P^0 = 0.40$ so that banks' claims would have had the same value with or without the negotiations.

Applying $P^0 = 0.40$ to expression (21), and noting that $D^0 = 45.83$ and $P'D' + N = 18.74$ (calculated above) yields a lower bound on Mexico's benefit of $0.40(45.83) - 18.74 = -0.41$ (billion dollars). So at worst, Mexico had only a small loss from the buyback.[17] Of course, this estimate is sensitive to P^0. Using $P^0 =$

16. We assume that Mexico is allowed to perpetually refinance the principal on this debt at 10 percent.

17. This estimated lower bound does not, however, take into account that Mexico made very high net repayments to its creditors (roughly the full interest due) over the year prior to the repurchase. One might argue that a portion of these repayments should be added to the up-front cost of the deal, N, thereby decreasing our estimates of both the upper and lower bounds to Mexico's gain.

0.35 (the minimum price in 1989) would yield a maximum net loss of \$3.3 billion; whereas $P^0 \geq 0.41$ would imply that Mexico unambiguously gained from the Brady plan.

VI. Conclusions

If a country has high-yielding investment projects available to it, then under reasonable assumptions, the option of increasing consumption and investment proportionately is always preferable to an open-market buyback. It is true that buybacks can stimulate domestic investment, but when they do it is creditors who reap the efficiency gains.

The elasticity of investment with respect to debt reduction is shown to be completely irrelevant for evaluating small buybacks. Since the country is already allocating resources between consumption and investment to maximize its income net of debt repayments, the envelope theorem implies that any reallocation induced by a small buyback affects only creditors. A general analysis of small buybacks therefore yields exactly the same conditions as in the fixed investment model of Bulow and Rogoff [1988].

Though an open-market buyback represents only one type of debt reduction operation, it is especially important because it provides a benchmark by which any negotiated debt deal can be evaluated. In particular, one can calculate the maximum and minimum benefits to a country from a debt reduction deal. Using the 1990 Mexican debt deal as an example, we find that Mexico may have gained as much as \$4.2 billion. While this amount is large relative to the total resources expended on the buyback, it is equivalent to only 2 percent of Mexico's GNP.

Appendix

This Appendix derives condition (19) in Section III of the text. Assuming the more general production function (17) and totally differentiating the country's objective function (11) with respect to X yields

$$\left(\frac{\partial \overline{Y}}{\partial C} - \frac{\partial \overline{R}}{\partial C}\right)\frac{dC}{dX} + \left(\frac{\partial \overline{Y}}{\partial I} - \frac{\partial \overline{R}}{\partial I}\right)\frac{dI}{dX} - \left(\frac{\partial \overline{R}}{\partial D^x}\right)\frac{dD^x}{dX}. \tag{A.1}$$

If a small buyback benefits the country, then expression (A.1) must be positive when evaluated at $X = 0$.

Expression (A.1) can be simplified by noting that $dC/dX + dI/dX = -1$ by the budget constraint (12), and that

$$\text{(A.2)} \qquad \left(\frac{\partial \overline{Y}}{\partial C} - \frac{\partial \overline{R}}{\partial C}\right) \leq \left(\frac{\partial \overline{Y}}{\partial I} - \frac{\partial \overline{R}}{\partial I}\right) \qquad (= \text{if } C > 0)$$

by the first-order conditions for the country's maximization problem. Substituting into (A.1), one finds that small buybacks benefit a country if and only if

$$\text{(A.3)} \qquad \frac{-\partial \overline{R}}{\partial D^x} \cdot \frac{dD^x}{dX} > \left(\frac{\partial \overline{Y}}{\partial I}\right)\left[1 - \frac{\partial \overline{R}/\partial I}{\partial \overline{Y}/\partial I}\right].$$

Using (8) to substitute for dD^x/dX, (A.3) can be rewritten as

$$\text{(A.4)} \qquad -\left(\frac{\partial \overline{R}}{\partial D^x}\right) \cdot D^0 \left(\frac{d\overline{R}/dX}{X + \overline{R}} - \frac{\overline{R}[1 + d\overline{R}/dX]}{(X + \overline{R})^2}\right) > \left(\frac{\partial \overline{Y}}{\partial I}\right)\left[1 - \frac{\partial \overline{R}/\partial I}{\partial \overline{Y}/\partial I}\right].$$

Evaluating (A.4) at $X = 0$ yields

$$\text{(A.5)} \qquad \frac{\partial \overline{R}}{\partial D^0} \cdot \frac{D^0}{\overline{R}} \equiv \frac{m}{P} > \left(\frac{\partial \overline{Y}}{\partial I}\right)\left[1 - \frac{\partial \overline{R}/\partial I}{\partial \overline{Y}/\partial I}\right].$$

On the left-hand side of (A.5), $\partial \overline{R}/\partial D^0 \equiv m$ is the expected marginal cost to the country of having an extra dollar of debt, and $\overline{R}/D^0 = P$ is the market price of debt; see equation (6). Note that m is simply equal to the probability that the debt will be fully repaid, since $\partial R/\partial D^0 = 0$ in defaulting states (when $\sigma < D^0$), and $\partial R/\partial D^0 = 1$ in full repayment states.

On the right-hand side of (A.5), $(\partial \overline{R}/\partial I)/(\partial \overline{Y}/\partial I)$ is the fraction of marginal investment income that is expected to go to debt repayment. Of course, marginal investment is only taxed in states of nature where the country defaults. In nondefaulting states, the country gets to keep the entire return on marginal investment. Define

$$\text{(A.6)} \qquad q \equiv \frac{E(\partial \sigma/\partial I)\,|\,\sigma < D^0}{E(\partial Y/\partial I)\,|\,\sigma < D^0}$$

as the average marginal tax rate on investment in states of nature where the country defaults. Noting that $(\partial \overline{R}/\partial I) = (1 - m)\{E(\partial \sigma/\partial I)\,|\,\sigma < D^0\}$ and that $f_{12} = \partial^2 Y/\partial I \partial \theta \geq 0$, we have

$$\text{(A.7)} \qquad q = \frac{(\partial \overline{R}/\partial I)/(1 - m)}{E(\partial Y/\partial I)\,|\,\sigma < D^0} \geq \frac{\partial \overline{R}/\partial I}{(\partial \overline{Y}/\partial I)\,(1 - m)}.$$

Substituting into (A.5) yields

$$q > \frac{1 - (m/P)/(\partial \overline{Y}/\partial I)}{1 - m}, \tag{A.8}$$

which is equation (19) of the text.

STANFORD UNIVERSITY
UNIVERSITY OF CALIFORNIA, BERKELEY

REFERENCES

Bulow, Jeremy, and Kenneth Rogoff, "The Buyback Boondoggle," *Brookings Papers On Economic Activity,* 2 (1988), 675–98.

——, and ——, "Cleaning Up the Debt Crisis Without Getting Taken to Cleaners," *Journal of Economic Perspectives,* IV (1990), 31–42.

Dornbusch, Rudiger, "Developing Country Debt Conversions: Comment," *Brookings Papers On Economic Activity,* (1988), 699–703.

Van Wijnbergen Sweder, "Mexico's External Debt Restructuring in 1989/1990: An Economic Analysis," mimeo, The World Bank, March 1990.

Warner, Andrew, "Testing the Debt-Overhang Hypothesis," mimeo, Harvard University, January 1990.

World Bank, *World Debt Tables: External Debt of Developing Countries,* Volumes 1 and 2 (Washington, DC: World Bank, 1988–1990).

Zhu Ning N., "The Calculus of Debt Repurchase: A Note on the Bulow–Rogoff Sovereign Debt Buyback Model," mimeo, Georgetown University, March 1990.