Buy-Backs and Market Valuation of External Debt

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It has been argued that “buy-backs” and “debt-equity swaps” allow developing countries to benefit from market discounts on their external debt. It is argued here, however, that if such programs are expected to be successful in increasing the market value of remaining debt, they also lead to a roughly equivalent increase in prices at which a buy-back or debt-equity swap could be carried out.

This paper develops a framework for evaluating a range of “buy-back” proposals that might reduce the market discounts currently observed for the external debts of many developing countries. The proposals considered would reduce the aggregate contractual value of a country’s debt or would alter the debt-equity mix of existing contracts. It is argued that the benefits of such proposals include capital gains and losses for debtors and creditors as well as increases in domestic investment in debtor countries that would result from a narrowing of market discounts on internal and external debt. The cost of a buy-back is measured by the current expenditure necessary to induce holders of a country’s debt to sell or exchange voluntarily the existing debt in circumstances in which they are fully informed about the new amount and form of debt that will exist following the buy-back.

Two important insights emerge from the analysis. First, proposals that are successful in increasing the market price of debt and therefore improve the climate for investment also generate roughly equal increases in the prices at which private investors will voluntarily sell or exchange these debts once the proposal is announced. If, for example, a third

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party offers to buy a part of existing debt and forgives some or all of this
debt, the price paid to purchase the debt will be the price expected to
prevail following the forgiveness. Thus, market prices prevailing be-
fore the announcement of such a program will understate the cost of
purchasing debt of a given contractual value.

The reaction of market prices to a buy-back may be a particularly
important consideration if initial market prices are very low. Although
it seems plausible that very low-price debt can be purchased and forgiven
at a low "cost," it is clear that such a proposition, if successful, would
implies a large capital gain for any individual creditor that holds his
initially low-valued investment until after the forgiveness. The analysis
below shows that in such cases the initial creditors stand to gain a large
part of the benefits of such a program, and it may be useful to consider
conditional buy-back proposals in which claims that remain outstanding
following forgiveness are in some way subordinated to new claims.

The second insight that emerges from the framework developed in this
paper is that voluntary exchanges of existing contracts for new contracts
with different attributes, such as "equity" content, will reflect the ex-
pected post-exchange values of the new contracts. For example, if a third
departies offers to exchange equity for existing debt, a voluntary exchange
will reflect the expected relative rights of debt and equity holders that
will prevail following the exchange. An important determinant of this
relative price would be the implicit or explicit subordination of the
relative rights of holders of different types of financial contracts. In
general, the increased value that might accrue to one type of contract
will be matched by the decreased value of other contracts. This change
in relative values of existing credits to a given country may have little
effect on the climate for investment in the debtor country.

In Section I it is argued that the aggregate value of external claims on
a country depends on the present value of expected resource transfers
from that country. Section II shows how the cost of forgiveness of a share
of the existing contractual claims might be calculated. The analysis uti-
\zers a hypothetical auction designed to induce private investors to reveal
the cost incurred by a third party in raising the market prices of debt
remaining after a partial forgiveness of existing debts. Section III
analyzes debt-equity swaps, and the final section discusses extensions of
this line of research.

I. The Aggregate Value of External Debt

The argument developed in this section is that the aggregate market
value of claims on a debtor country depends on the expected present
value of resource transfers from that country that will be available to
creditors. The expected resource transfer is determined by many factors, some of which are controlled by the debtor government and some of which are not. It is assumed that these factors are not affected by the proposals discussed below, but this assumption is to some extent unrealistic. For example, a buy-back that succeeds in increasing the market value of existing debt should improve the debtor's growth prospects and, in turn, the payments that the country could be expected to make to nonresident creditors. A more complete investigation of such linkage is left to future research.

In the following analysis, expected future payment streams are translated into expected present values. For the usual reasons, payoffs expected to occur far in the future are worth less today compared with equal payoffs expected earlier. Nevertheless, investors are assumed to arbitrage claims on payment streams with the same present value so that their expected yields are equalized. This assumption requires that some market participants can borrow and lend at any maturity at market interest rates. It is not necessary for the debtor to be able to borrow and lend at market interest rates.

Suppose that a country's debt is selling at 50 percent of its contractual value and that its total debt is $100 billion. What value would the remaining debt carry if some part of the existing debt were forgiven? For example, if investors now value $100 billion worth of bonds at $50 billion, what value would they place on the remaining $75 billion worth of bonds if $25 billion of the country's debt was forgiven? If one assumes that the behavior of the debtor is unaffected by a partial forgiveness of its legal obligations, the answer depends entirely on why investors valued the original bonds with a face value of $100 billion at $50 billion.

A simple way of characterizing investors' expectations is to envision a probability distribution for the present value of various possible payoffs by a country to all its creditors. In the first example developed in Section II below, it is assumed that all creditors hold identical bond contracts and that each creditor expects to receive the average payment on the country's aggregate contractual obligation. For example, if a uniform distribution for outcomes is assumed over aggregate payoffs with present values ranging from zero to the entire contractual liability of $100 billion,

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1 As argued in Dooley (1987), there is probably little useful distinction between so-called internal and external debt, at least in the context of this exercise. Thus the relevant stock of debt, $100 billion, should be thought of as the total government debt of the country concerned.

2 For convenience it is assumed that the contractual value and the face value of the debt were identical when the debt was issued. This will not in general hold but does not affect the analysis as long as changes in the market discount are interpreted relative to the "at issue" discount.

3 For convenience it is assumed that all the bonds have the same infinite maturity and are indexed to market interest rates.
each investor assumes that he will receive the same share of his contractual rights. Thus, the expected probability of receiving a payoff of $0.50 per dollar is equal to the expected probability of the country generating a payment stream to all creditors with a present value of $50 billion. The "payment stream" for external debt can be thought of as net exports of goods and services.

II. Reductions in the Contractual Value of Debt

To explore the question of how a change in the contractual rights of creditors will alter the market value of credits, an auction can be imagined in which a benefactor buys and forgives a portion of the existing debt. It is assumed that the funds made available by the benefactor would not otherwise be made available to the debtor country. The benefactor then reissues a reduced stock of claims on the debtor country with a lower contractual value. This procedure would, in most cases, generate conditions after the auction consistent with a reduced gap between the market value of the debt and its contractual value. The private sector's behavior with regard to the auction would depend on expectations about the present value of the country's aggregate payments to creditors. For simplicity it is assumed in this analysis that these expectations are not changed by the auction. Thus, the predicted changes in market prices reflect the lower value of contractual claims on the expected payments after the auction.

Pricing for a Uniform Probability Distribution

To focus on the implications of debt forgiveness, a simple probability distribution for aggregate payments is assumed. In particular, it is assumed that the present values of all payoffs between zero and $100 billion inclusive are believed to be uniformly likely to occur. Thus, the mean expected payoff is $50 billion, and each dollar's worth of contractual value sells for $0.50.

The benefactor offers to buy existing debt in a single auction and promises to forgive the difference between the auction price, $PA$, at

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4 See Rodriguez (1988) for conditions under which the growing contractual value of debt as interest payments are borrowed implies an expected fall in market prices.

5 The assumption that market prices reflect the mean of the probability distribution of the present value of expected payment streams is maintained throughout the analysis. Alternative specifications of debtors' and creditors' attitudes toward risk-taking are explored in Helpman (1988).
which he purchases bonds, and the contractual value of the bonds purchased. The effects of such an auction can be illustrated for the uniform distribution ranging from zero to one shown in Figure 1. If the benefactor purchases all of the outstanding debt, the amount forgiven per dollar would be $(1 - PA)$, the shaded area in Figure 1. The probability that new contracts would be paid off at the contractual value (that is, where $PA$ equals unity for the new contracts) is assumed to be the probability of all outcomes equal to or greater than $PA$ for the old contracts. Since the auction price $PA$ will be equal to one for the new contracts, the value of the new contracts is in part due to the probability of complete payoff, which must be $(1 - PA) \cdot 1$ or simply $(1 - PA)$.²

Some chance remains, however, that the new contracts will not be completely paid off. This is assumed to be the probability of events to the left of $PA$ for the original contracts. The mean of this probability density, the unshaded area in Figure 1, is $\frac{1}{2} PA$. The market price of the new contracts must therefore be

\[ PM = \frac{1}{2} PA + 1 - PA \]

\[ PM = 1 - \frac{1}{2} PA. \]

⁶The benefactor can either hold the new bonds or sell them in the market. As long as the rights of the benefactor and other investors are identical, this would not affect market prices. In practice, the rights of the benefactor or his preferences for enforcing those rights may be different. Thus, the “cleanest” assumption would be that the benefactor sells the new bonds back to private investors.

⁷Note that the value of this part of the new contract as a percentage of the auction price would be $(1 - PA)/PA$. This, however, is not of interest because the objective is to calculate the market discount on the new contractual value of debt.
Competitive bids at the auction will ensure that the auction price is equal to the expected market price after the auction. If, for example, the auction price was higher than the subsequent market price, successful sellers at the auction would realize an immediate capital gain. Conversely, if the auction price was lower than the subsequent market price, successful sellers at the auction would experience an immediate capital loss. If there is no collusion among bidders, any expected gain would be eliminated as bidders competed against one another. It follows that the equilibrium auction price, \( PA \), is the one that sets the auction price equal to the subsequent market price, \( PM \). For a uniform distribution where the benefactor buys and resells all the outstanding debt, this would simply be

\[
PM = PA = \$0.66.
\]

Although more realistic examples of auctions and probability distributions are considered below, all the important aspects of a forgiveness proposal are captured in this simple example. The benefactor incurs a cost of about \$22.2 billion in lowering the market discount on existing debt from 50 percent to 33\( \frac{1}{3} \) percent. The “investment” benefit of this reduction in market discounts would be the present value of future investment undertaken at this discount and not undertaken at the initial 50 percent discount. This calculation would require, of course, an empirical estimate of the investment schedule in the debtor country.

The initial creditors enjoy a rise of \$16.6 billion in the market value of their debt because the market value of their bonds rose from \$50 billion to \$66.6 billion when the auction was announced.

The debtor country gains the rights to payoffs above \$66.6 billion that without forgiveness would have been due to external creditors. In this example, the expected present value of these outcomes would be about \$5.6 billion.

Thus, the \$22.6 billion expenditure by the benefactor has three effects. First, the market discount is reduced from 50 percent to 33\( \frac{1}{3} \)

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8 This is an important assumption. In practice, creditors may try to enforce noncompetitive bids by insisting that sales be allocated according to ownership shares rather than according to amounts offered for sale. Under these conditions the auction becomes a bilateral monopoly problem. In general, the sales price will be higher in this case and need not be equal to the expected price after forgiveness.

9 Any auction rule that generates the same amount of forgiveness would generate the same price at and after the auction. The convention assumed here is therefore not crucial to the results.

10 In selling their holdings, the initial creditors would realize an accounting loss of \$33.4 billion if it is assumed that the initial accounting loss of \$50 billion had not been realized.
percent. Second, the creditors realize a capital gain of $16.6 billion. Third, the debtor realizes an expected gain with a present value of about $5.6 billion. It should be noted that the initial creditors gain even though their collective rights to some relatively good outcomes have been transferred to the debtor country. This negative "income" effect from the point of view of creditors is more than offset in this example by a "substitution" effect that results from the lower value of contractual debt following forgiveness. That is, the lower expected present value of payments by the debtor country will satisfy a larger share of credits following forgiveness.

This simple example of a buy-back proposal serves to highlight several important results that might be expected from such proposals. The relative strength of these effects, however, is not invariant to assumptions about the probability distribution for payoffs. These difficulties are explored further in the discussion that follows. In particular, it is argued that the income effect in this example that was positive for the debtor and negative for the creditors as a group may not play an important role in some cases.

Partial Buy-Backs

It may not be realistic for the benefactor to offer to purchase all outstanding debt because this implies that all bids will be accepted regardless of cost. If the benefactor offers to buy less than the total outstanding debt, the reasoning is slightly more complicated, but the basic results still hold. In this case, the securities not purchased at the auction will also increase in value after the auction, although their contractual value will remain unchanged. The benefactor would buy some share, $S$, of the existing debt, forgive $S(1 - PA)$ for each dollar purchased, and sell the new securities to the market. Returning again to Figure 1, the contractual value for each dollar of outstanding debt forgiven by the benefactor would be $S(1 - PA)$. Thus, by analogous reasoning the market value of all debt following the auction would be

$$PM = \frac{1}{2} [1 - S(1 - PA)] + S(1 - PA).$$

The equilibrium auction price is found by setting $PA = PM$, so that

$$PM = PA = \frac{1 + S}{2 + S}.$$

If, for example, the benefactor agreed to buy half of the $100 billion described in Figure 1, the equilibrium auction price would be

$$PM = PA = 0.60.$$
The cost to the benefactor of "improving" the discount on debt outstanding after the auction from 50 percent to 40 percent is $12 billion. Corresponding to this, the creditors realize a capital gain of $10 billion, and the debtor realizes an expected gain of $2 billion. Note that the capital gain to creditors accrues both to those who participate in the auction and to those who choose not to.

An accounting loss may be realized by the initial creditors participating in the auction, although the rise in the market price after the auction would provide an economic benefit to the initial creditors regardless of their participation in the auction. If the initial creditors have to be paid to realize the accounting loss, then an auction price above the expected subsequent market price should be expected as compensation. This might be important if initial investors' relationships with regulators or their own creditors depend on accounting as well as on market prices.

Pricing for a Normal Probability Distribution

If the appropriate probability distribution over payoffs on existing debt was normal rather than uniform, there would be less value associated with payoffs near the extremes of zero and unity. To illustrate this, consider a normal distribution, $F(x)$, of expected present values of resource transfers, $x$, with a mean of 0.5 and 98 percent of the probability density between zero and unity (Figure 2). As described above, the benefactor might purchase all of the outstanding debt at $PA$ and forgive $(1 - PA)$ of the debt. In this case the probability that repayment will exceed the reduced face value of the debt is not $(1 - PA)$, as in the

Figure 2. Normal Probability Distribution
uniform distribution, but $1 - F(\text{PA})$, the shaded area in Figure 2. Moreover, the mean of the probability density of the remaining contractual value is not $\frac{1}{2} \text{PA}$ but the price corresponding to the mean of the truncated probability density from zero to $\text{PA}$. If $y$ is defined as the payoff for each dollar of the new contractual value following the auction, then

$$y = \begin{cases} 1.0 & \text{if } x \geq \text{PA} \\ \frac{x}{\text{PA}} & \text{if } x < \text{PA}. \end{cases}$$

The probability that $x < \text{PA}$ is $F(\text{PA})$. The probability that $x \geq \text{PA}$ is $1 - F(\text{PA})$. Thus the expected value of $y$ will be the market price after auction: \footnote{If the benefactor offered to purchase a share, $S$, of the outstanding debt, the equilibrium auction price would be

$$\text{PA} = \text{PM} = 1 - F(1 - S(1 - \text{PA})) + \frac{1}{\text{PA}} \int_{0}^{(1 - S)(1 - \text{PA})} xf(x)dx.$$ If $S = \frac{1}{2}$, then

$$\text{PA} = \text{PM} = 0.64.$$}

$$E(y) = \text{PM} = 1 - F(\text{PA}) + \frac{1}{\text{PA}} \int_{0}^{\text{PA}} xf(x)dx,$$

where $f(x)$ is the probability density function of a truncated normal distribution and where, as before (since in equilibrium $\text{PA} = \text{PM}$), the solution can be solved numerically.

Suppose the auction price was $0.66 as the equilibrium value was for the uniform distribution. The market price following the auction would be slightly higher than $0.66, giving the sellers an expected loss from participating in the auction. Expected losses would induce sellers to drive the auction price up to about $0.69 for each dollar bid. At this auction price the market price after auction would also be about $0.69 for each dollar of contractual value.

The cost to the benefactor of raising the market price of the remaining debt from $0.50 to $0.69 would be about $21.4 billion. Creditors receive a capital gain of $19.0 billion while the debtor regains control over expected payments with a present value of about $2.4 billion. It is interesting that the results are comparable with the uniform distribution discussed above. Indeed, if one allows the variance of the truncated normal distribution to become very large, the results converge to the uniform distribution. As the variance of a normal distribution becomes very small, it approaches the point at which there is a certain return of some present value on existing debt. This case is taken up next.
Pricing for Single Value and Nonsymmetric Distribution

For simplicity it is assumed that all of the probability mass is concentrated on one payoff corresponding to $0.50 for each dollar of contractual value. An auction along the lines discussed above would result in a market price after auction that is simply $0.50 times the ratio of the contractual values at and after the auction:

\[
P_M = 0.50 \cdot \frac{100}{100 - (1 - P_A)100} = 0.50 \cdot \frac{1}{P_A}.
\]

In equilibrium, therefore,

\[
P_M = P_A = $0.706.
\]

Thus the benefactor would incur a cost of $20.6 billion in raising the market price by 20.6 percentage points. Moreover, creditors would realize a capital gain that is exactly equal to the benefactor's cost, because there is no income effect in this example. The assumption that there is no probability that payments will exceed the new contractual value of debt of $70.6 billion means that creditors as a group "lose" payoffs that have a zero chance of occurring. By the same logic, the debtor does not regain the rights to payoffs. Thus, in any circumstance where the contractual value of debt after forgiveness exceeds all probable payoffs, the creditors gain because of the substitution effect, whereas the debtor gains only to the extent that investment is higher owing to the fall in market discounts.

A purchase with forgiveness seems particularly attractive if initial market prices are relatively low. However, in such cases a large share of the benefits of forgiveness might accrue to the creditors. If, for example, the initial probability distribution over outcomes was massed at $0.10, the equilibrium auction price would be about $0.316. The benefactor would incur a cost of $22 billion in raising the market price by 22 percentage points. But there may be little or no increase in investment at a discount of 68 percent.

In this limiting case where the variance of expected returns is zero, the benefactor can obtain a percentage increase in the market price of existing debt only by incurring a cost equal to the equivalent share of the contractual value of outstanding debt. This simply reflects the fact that creditors remaining after the auction and forgiveness expect to share the same distribution of payments. It follows that if the initial price is very low, an auction scheme to reduce the market discount to a level that might encourage new investment would require the purchase of a sizable part of existing debt at a high cost.
Pricing for Bimodal Distribution

Another interesting distribution is an "all-or-nothing" possibility represented by a 0.5 probability that all creditors receive full payment and by a 0.5 probability that creditors receive nothing. Such a distribution might be relevant if a single important change in the economic environment would either render the country incapable of making any payments or make the existing debt small relative to the country's capacity to pay. The equilibrium condition for this auction would be

\[ PA = PM = 0.5 \cdot 0 + 0.5 \cdot 1.0 \]

\[ = 0.5. \]

In this case the market value of debt will always remain at $0.50 regardless of the amount purchased by the benefactor. The benefactor would incur a cost of $25 billion but would not succeed in narrowing the market discount. Therefore, the investment effect would be zero. The creditors would receive no capital gain, and the debtor would receive a capital gain of $25 billion.

Comparison of Results

The results of this section are summarized in Table 1. It is clear that the distribution of benefits of a buy-back scheme depends on the nature of the probability distribution over outcomes. In any case, the debtor stands to gain either from an improvement in the climate for investment or from an expected capital gain through reduction of debt. Creditors gain to the extent that market prices rise as a result of the buy-back.

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<td>Cost to benefactor</td>
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<td>Investment effect</td>
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<td>Realized gain for creditors</td>
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Table 1. Reductions in Contractual Value
(In U.S. dollars)
One way to alter the distribution of benefits is to break the equality between the auction price and the expected market price after auction. For example, the debtor country might specify that debt not purchased at the auction would not be fully honored. Although this might be considered a partial default on the part of the debtor country, donor countries might reduce the expected cost of such an action to the debtor by refusing to assist creditors in enforcing payments for debt not purchased at the auction.

The difficulty in analyzing such schemes is that the probability distribution over payoffs is obviously changed by default or by subordination of debt not bought at the auction. Default or subordination might succeed in reducing the market discounts with or without a buy-back. An extreme example of this case would be if the debtor defaulted completely on all debt not purchased in the buy-back. If credible, this default would allow all initial debt to be purchased at any positive price the debtor offered, since the expected price of existing debt after auction would be zero. It seems to follow that a buy-back under these conditions is analytically equivalent to a unilateral default on the part of the debtor combined with some compensation as provided by the buy-back.

III. Pricing for Different Types of Financial Contracts

In this section the assumption that all creditors receive the average payment is relaxed. As before, it is assumed that the aggregate value of financial claims on a country's resource transfers will reflect the present value of a range of possibilities for expected payment streams. Given this aggregate value, however, the value of each different type of claim on the expected resource transfers will depend on the "place in line" for payment granted to different types of creditors. For this reason individual creditors will be quite interested in their rights relative to other creditors. It follows that creditors would welcome proposals that might move them up a place or two in line. But such proposals may not affect the market valuation of a debtor's aggregate obligations.

It has been suggested, for example, that equity could be substituted for debt to improve a country's financial position. One way to analyze such an idea is to imagine that a benefactor offers to purchase debt at the market discount and then reissues equity claims on the debtor country. The cost of such an auction would be the difference between the auction price of the bonds and the after-auction market price of the equities sold.

The introduction of two types of financial claims on the debtor country requires an assumption about the relative rights of the holders of these instruments. If it is assumed that bondholders will always be first in line
for payment, then, from the bondholders' point of view, the substitution of equity for debt would be equivalent to a forgiveness of the outstanding debt purchased by the benefactor. For the normal distribution discussed above, this would mean that the value of the bonds after auction would correspond to the mean of the shaded area of Figure 3, plus the probability of a payoff of 1.0 for all outcomes to the right of 0.5:  

\[ P_h = 1 - F(S) + \frac{1}{s} \int_{s}^{1} x f(x) \, dx. \]

If half of the initial debt is purchased, the equilibrium price would be $0.84. Thus, the benefactor would purchase $50 billion in bonds at a 16 percent discount, a total expenditure of $42 billion. The benefactor would then sell equities to the market. The value of the equities would reflect the value of all outcomes that yield a payment after all bondholders are satisfied. Note that in this case the value of outcomes above unity would also go to equity holders.

If half of the outstanding bond debt is purchased by a benefactor and reissued as equity, the value of the newly issued equity would be

\[ P_E = \int_{s}^{\infty} (x - s) \tilde{f}(x) \, dx = \$8.7 \text{ billion}. \]

\(^{12}\) Note that the integral's value is indexed by \(s\), rather than \(PA\) as in the earlier examples, since it is assumed that in valuing the remaining bonds, \((1 - s)\) of the contractual value of the initial debt is forgiven.

\(^{13}\) Note that \(\tilde{f}\) is the \(f\) density defined above, not truncated at zero and unity but defined from minus infinity to plus infinity.
Note that the equity price function differs from the bond price function because outcomes from zero to $S$ imply a zero price for the equity, since for all outcomes when $x \leq S$ the payoff to equity holders would be zero. Also note that, by assumption, there is very little probability weight above unity. For this reason, the value of the equity, $8.7$ billion, plus the value of the bonds, $42$ billion, exceeds only slightly the market value of the original bond contracts. The benefactor would incur a total cost of $33$ billion in narrowing the discount on debt from $50$ percent to $16$ percent. The lesson from this auction is that a conversion of debt into equity could lead to a substantial increase in the market value of the remaining bonds but would do so at a considerable cost to the benefactor. Moreover, in this example the debtor has absorbed a loss of $0.7$ billion in expected income effect.

IV. Limitations and Extensions

In attempting to evaluate fully the proposals outlined in this paper, several issues remain. It has been shown that there is no typical distribution of benefits associated with buy-back proposals. Under plausible circumstances, both debtors and creditors could benefit substantially. It is possible, however, that almost all the benefits of a forgiveness scheme could go to the creditors in the form of a substitution effect, with little or no benefit to the debtor country in the form of investment or income effects.

Another difficult problem is to identify the relevant alternative uses of available funds. Suppose, for example, that the benefactor gave the funds to the debtor country and that the debtor used the funds for imports and real investment. Alternatively, the funds could be used to service existing debt in the usual way or to accumulate reserve assets. These alternatives or combinations of alternatives might be preferable according to individual circumstances. At this point it seems reasonable to conclude that there is no general rule on whether a buy-back with forgiveness is an optimal strategy for individual countries. Each case would have to be judged against the alternative uses of funds available.

The distribution of benefits of buy-backs can be changed fundamentally by adding elements of subordination to a buy-back proposal, since this would break the link between auction prices and expected market prices. Although it may be possible to tilt benefits toward the debtor country through conditional buy-backs, this could result in sanctions against the debtor and prejudice future access to private credit markets.

Finally, the effects of any scheme on market discounts will reflect not
only the initial offer by a benefactor but also any information that might be inferred about future schemes. If, for example, investors believe that the benefactor will do what is necessary to maintain a given discount on a country’s debt, the market discount will move to this level, and the benefactor’s actions then become endogenous to the system.

REFERENCES


