POLICY RESEARCH WORKING PAPER 1317

Estimating the Efficiency Gains of Debt Restructuring

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The debt-overhang disincentive may not be as important as the broader problem of debtors' credit constraints in international capital markets. For severely indebted low-income countries, the best strategy is probably to replace nonconcessional debt with new concessional loans.

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Summary findings

One rationale for debt reduction operations under the Brady Plan has been, by alleviating the debt overhang, to improve investment efficiency. Brady-type debt and debt-service reduction (within a strong policy framework, where there is a track record of economic adjustment) has been shown to affect development significantly.

The principle benefit of eliminating the debt overhang is to improve investment incentives for private investors — direct liquidity relief is secondary. So, evaluating a debt and debt-service reduction operation should involve estimating efficiency gains as well as direct financial savings.

Bulow, Rogoff, and Zhu present a method (requiring only weak assumptions) for establishing an upper bound on the efficiency impact of debt reductions. The key reference framework for evaluating much more complex Brady-type debt deals is open-market debt buybacks.

Their approach to determining this upper bound hinges on the assumption that efficiency gains on a straight open-market repurchase of debt never exceed the gains to creditors. If an open-market buyback indeed reduces the debt overhang and moves a country toward more (and more efficient) investment, creditors will anticipate this in setting a price for remitting their claims. So, at least part of the efficiency gains are dissipated in additional capital gains to creditors.

To give point estimates to efficiency gains, they develop a simple two-period model of debt overhang and investment and discuss assumptions under which it is possible to obtain a closed-form solution to the model. Their empirical estimates indicate that the general bounds derived in the first step tend to overstate substantially the efficiency gains of debt reduction operations. In Mexico's case, for example, the upper-bound estimate of efficiency gains is US$15 billion, but the point estimate is only about US$1 billion.

What are the policy implications of their low point estimates? The debt-overhang disincentive may not be as important as the broader problem of debtors' credit constraints in international capital markets.

How can new loan packages to developing countries be structured to maximize investment incentives? By using loans rather than outright grants, donors can give a country more funds for current investment at lower present discounted expense. But grants, unlike loans, do not distort investment incentives.

In short, if a credit-constrained country starts with no debt overhang, the first tranche of aid should probably be in hard loans. As total transfers increase, if the borrowing country has not gained access to private capital markets, marginal transfers should be grants. The optimal strategy for new flows can involve both increasing grants and decreasing loans. When transfers are expected to be heavy, a case can be made for using grants exclusively.

This paper — a product of the International Finance Unit, International Economics Department — is part of a larger effort in the department to understand the costs and benefits to countries of debt and debt service reduction arrangements. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Rose Vo, room S8-136, extension 33722 (30 pages). July 1994.

Estimating the Efficiency Gains of Debt Restructuring

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* The usual disclaimer applies. We thank Eduardo Fernandez-Arias, Ronald Johannes, Homi Kharas, Miguel Kiguel, and colleagues in the Bank for the useful comments on an earlier version of the paper.

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Summary

One of the main rationales for debt reduction operations under the Brady Plan has been to alleviate the debt overhang in order to enhance investment efficiency. Earlier research has pointed out that Brady-type debt and debt service reduction has a significant development impact when it is implemented in the context of a strong policy framework and a track record of economic adjustment reform. The principal benefit of eliminating a debt overhang is the improvement of investment incentives for private investors, while the direct liquidity relief is only of secondary importance.

Thus the evaluation of a debt and debt service reduction operation should include estimates of efficiency gains as well as the usual calculation of direct financial savings achieved. This paper first considers a method for establishing an upper bound on the efficiency impact of debt reductions, a method that requires only relatively weak assumptions. The key reference framework for evaluating much more complex Brady-type debt deals is open-market debt buybacks.

Our approach of bounding the efficiency gains hinges on the proposition that the efficiency gains to a straight open-market repurchase of debt never exceed the gains to creditors. If an open-market buyback indeed ameliorates debt overhang and induces a country to move to a higher and more efficient level of investment, creditors will anticipate this in deciding what price they require to remit their claims. So at least part of the efficiency gains will necessarily be dissipated in additional capital gains to creditors.

To go further -- to give point estimates to efficiency gains -- we develop a simple two-period model of debt overhang and investment, and discuss assumptions under which it is possible to obtain a closed-form solution to the model. Our empirical estimates indicate that the general bounds derived earlier tend to substantially overstate the efficiency gains of debt reduction operations. In the case of Mexican debt reduction, for example, the upper bound efficiency gains estimate is US$15 billion, but our point estimate is only about US$1 billion.

The policy implication of our low point estimates is that the debt overhang

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disincentive itself may not be as important as the broader problem that debtors are credit constrained in international capital markets. This raises the interesting question of how new loan packages to developing countries might be structured so as to maximize investment incentives. By using loans rather than outright grants, donors can provide a country with more funds for current investment at lower present discounted expense. But grants, unlike loans, have the advantage of not distorting investment incentives.

The analysis can be extended to assess the efficiency implications of this tradeoff. It appears to confirm the conventional financial wisdom regarding a credit-constrained country. For such a country, if it starts from a position of no debt overhang, the first tranche of aid should be most probably in the form of hard loans. As total transfers increase, if the borrowing country has not gained access to the private capital markets, marginal transfers should be grants. Indeed, the optimal strategy for new flows can involve both increasing grants and decreasing loans. At very high levels of expected transfers, there is a case for using grants exclusively.

This research is part of a larger effort in the International Economics Department to understand the costs and benefits to countries of debt and debt service reduction arrangements. The analysis on structuring new loan packages also sheds some light on the pressing issue of resolving debt problems for severely indebted low-income countries. Given the large debt overhang these countries face, a strategy of replacing existing nonconcessional debt by new concessional loans seems to be an appropriate policy response.

1 Introduction

One of the main rationales for debt reduction operations under the Brady Plan has been to alleviate debt overhang and enhance efficiency. But while many Brady Plan deals have been considered quite successful, there does not exist any generally accepted methodology for empirically measuring their efficiency impact.[1] One can, in principle, estimate a large structural model and quantitatively simulate debt reduction, but such an exercise involves a plethora of theoretical assumptions and empirical estimates.

Section 2 of this paper considers a method for establishing bounds on the efficiency impact of debt reductions that are extremely simple to calculate and require only relatively weak assumptions. The central proposition underlying our approach is that although a country may benefit from large Brady Plan type negotiated deals, it never benefits from straight open-market buybacks of debt. It is straightforward to extend this proposition to the case of lending packages to a country that has not previously received assistance. We use this result to provide efficiency bounds on new loans as well as on Brady Plan debt reduction deals.

While the *ex post* efficiency bounds derived in section 2 appear to be quite informative, it is not possible to go further without assuming more structure. In section 3, we summarize a version of the standard two-period model of debt overhang and investment developed by Bulow, Rogoff and Zhu (1994). As is well known, empirically assessing the value of risky debt requires modern option pricing techniques which have, of course, become routine in the investment world. Standard option pricing formulas, however, do not allow for moral hazard problems, which are especially important in the case of developing country debt. Specifically, a country's incentive to invest can be very sensitive to its debt levels.

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[1] Claessens, Diwan and Fernandez-Arias (1992) provide estimates on how much countries gain by using menu-driven Brady Plan deals rather than open-market buybacks. However, they do not derive the efficiency gain for negotiated debt restructuring deals.

This paper offers a new approach that deals with this issue. We show that for certain probability distributions for the underlying productivity disturbance, it is possible to obtain closed-form option pricing solutions for investment and the price of debt. Based on these closed-form solutions, we derive point estimates of debt overhang effects and show that the general bounds derived in section 2 often tend to substantially overstate the negative efficiency effects of debt overhang. In the case of Mexico, for example, the upper bound efficiency estimate is US$15 billion but our point estimate is only US$1 billion.

The model also yields a number of interesting comparative statics results. For example, in the standard exogenous investment model, a rise in the variability of the underlying productivity shock would unambiguously lower the value of a country's debt to creditors. As the variance of the shock rises, the value of the country's option to default rises; therefore the creditors must lose. However, with moral hazard, a rise in the variability of disturbances can easily induce an improvement in investment incentives sufficient to raise the value of creditors' claims. In addition, a strengthening of creditors' ability to enforce repayments will not necessarily exacerbate debt overhang and lower investment. On the contrary, countries facing tough creditors may invest more rather than less.

This interesting result points to the potential application of our model to issues of structuring new loan packages to countries that have not previously received assistance. By using loans rather than outright grants, donors can provide a country with more funds for current investment at lower present discounted expense. But grants, unlike loans, have the advantage of not distorting investment incentives. The model can be used to assess the efficiency implications of this tradeoff and it appears to confirm the conventional financial wisdom. The first tranche of aid should be most probably in the form of hard loans. As total transfers increase, marginal transfers should be grants; indeed, the optimal strategy can involve both increasing grants and decreasing loans. At very high levels of expected transfers, there is a case for using grants exclusively.

2 Bounding the Ex-Post Efficiency Gains from Debt Restructurings

Before turning to more complex restructurings, it is helpful to first review the basic economics of straight open-market buybacks, which form a key reference point for evaluating larger deals. Sovereign debt restructurings such as those conducted under the Brady Plan are generally far more complex than a simple open-market buyback of debt. Negotiated deals generally provide creditors with a broad menu of asset options. They often involve infusions of new official lending and occasionally private lending. And perhaps most important, negotiated deals generally involve mechanisms to mitigate the free rider problem that plagues straight market buybacks. Nevertheless, despite these sharp differences between buybacks and negotiated deals, we will show that straight open-market buybacks (and "reverse buybacks") provide a valuable frame of reference for measuring the efficiency and distribution effects of much more complex transactions.

Our results in this section hinge on the following proposition: <u>The efficiency gains to a straight open-market repurchase of debt never exceed the gains to creditors</u>.[2] That is, even if an open-market repurchase of debt enhances efficiency by ameliorating debt overhang, the benefits are never enough to compensate for the leakage to creditors. The reader should note that this proposition refers only to open-market buybacks in which each individual creditor resells his claim to the debtor on an individual and strictly voluntary basis. It does not refer to large negotiated buybacks such as Brady Plan deals in which the debtor can (and often does) succeed in repurchasing debt at a lower price than would be possible in a buyback. Moreover, the proposition that a country does not benefit from open-market buybacks hinges on some (we argue quite

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[2] The proposition that the efficiency gains to any voluntary participation open-market buyback never exceed the gains reaped by creditors was first demonstrated in Bulow and Rogoff (1991). One can easily extend the proposition, via continuity, to prove that a highly indebted country always benefits (up to a point) from "reverse buybacks", that is, new loans at default risk adjusted market interest rates.

plausible) assumptions that will be clarified shortly.[3]

2.1 Open-Market Buybacks in the Absence of Efficiency Effects

The simplest case is one in which a buyback has no adverse incentive effects on the debtor's investment decisions. In this case, whatever the creditors gain from a buyback, the debtor must lose (and vice-versa). If we denote the average secondary market price of a country's debt as P_0,[4] the price that prevails after an open-market buyback of debt as P_1^M, and D_0 as the initial level of indebtedness, then

$$\textit{Creditors' Gain (Loss)} = (P_1^M - P_0)D_0, \tag{1}$$

where the right-hand side is the capital gain on debt outstanding before the buyback. To derive this relationship, note that creditors who do not sell gain $(P_1^M - P_0)D_1$, where D_1 is the post-buyback level of debt. But if debt is tendered voluntarily -- the central characteristic of the open-market buyback -- then creditors who sell must be exactly as well off as creditors who do not sell. If V(D) denotes the market value of a debt of total value D, and X the amount the debtor spends on the buyback, then the condition for market equilibrium is: $X = (D_0 - D_1)P_1^M$, and $P_1^M = V(D_1)/D_1$, the average value of debt after the buyback. Combining this cash outlay of the buyback with the gain to creditors who do not sell and after netting out the previous value of debt tendered: $P_0(D_0 - D_1)$ yields expression (1). Since there is no efficiency gain, the country's loss in the buyback is the negative of (1). For later discussion, one can alternatively

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[3] In an interesting paper, Diwan and Spiegel (1992) argue that menu-driven buybacks may benefit a country by taking advantage of an illiquid secondary market for sovereign debt. The consequence of an illiquid market may be to increase or reduce the differential between the pre- and post-buyback price of debt, and therefore their effect on the bounds derived in this section is ambiguous.

[4] It is helpful for now to think of there as being just one class of creditors; if there is more than one class of creditors then P denotes the average secondary market price, weighted by debt outstanding.

express this loss as:

$$\textit{Debtor's Loss from Buyback in the Absence of Efficiency Gains} = V(D_1) + X - V(D_0) = (P_1^M - P_0)D_0 = \textit{Gain to Creditors}, \tag{2}$$

by making use of the market equilibrium condition and the definition of debt price.

Must it be that the price of debt rises after the buyback: $P_1^M > P_0$ so debtors always lose? Consider a simple model in which creditors are able to bargain for up to q percent of the country's random output Y. The value of a country's debt is then the minimum of qY and the face value of debt D in expected value terms: V(D) = min (qY,D). It is the expected value of repayments in states of nature where the country defaults, and the repayments in states where the country repays in full. Consider the costs and benefits of a small buyback: The cost is the average value of debt: V(D)/D, since creditors will only tender their debt if they are paid as much as they expect to get if they do not sell. But the benefit in terms of lower expected future repayments (remember we are not yet allowing for efficiency effects) is given by the marginal value of debt: V'(D) which is defined by the probability of the good states of nature in which the country makes payments to its external creditors.

Thus the cost of a dollar of debt reduction, the average value of debt P, is greater than the benefit, the marginal value of debt V'(D). The intuition for this result,[5] which is easily shown to hold in this example for large buybacks as well, is as follows: in the absence of efficiency gains, a country only benefits from a lower face value of its debt in states of nature where it would otherwise have paid in full. But to induce an individual creditor to tender his debt, the country must also compensate the creditor for payments he would have received in the event of partial default.

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[5] This result was first derived in Bulow and Rogoff (1988); for the related result in a more complex bargaining theoretic model of debt, see Bulow and Rogoff (1989a, 1989b and 1990).

If there were no efficiency benefits to debt restructuring, it would be also a relatively simple matter to calculate the gain or loss to country from a much more complex deal. Essentially, all one would have to do is to calculate the total value of creditors claims before the buyback, and compare it with the total value of creditors claims after the buyback, inclusive of any cash the country pays out for the repurchase. That is,

$$\textit{In the Absence of Efficiency Effects, Cost (Benefit) to a Debtor from a Debt Restructuring} = V(D_1) + N - V(D_0) = P_1D_1 - P_0D_0 + N, \quad (3)$$

where N is the country's cash outlay (which may be negative if the debt restructuring provides for new loans or aid). The above equation embodies the assumption that from the country's point of view, the burden of debt depends on the total amount of money owed, and not on how the debt is divided up into seniority classes; this assumption is not crucial for our later calculations as long as there are no efficiency gains from any source. The main practical complication posed by the existence of different classes of debt is that the calculation of V(D) becomes more involved, but as we shall later demonstrate, these complications can be surmounted.[6]

Thus far, we have assumed that a buyback does not have any efficiency consequences. If there are efficiency benefits to a debt restructuring, then the loss given by equation (3) represents a lower bound on the gain to a country of the restructuring. With efficiency effects, it is possible for both the debtor and the creditor to gain from the restructuring. To calculate exact estimates of the efficiency benefits from restructuring, it is necessary to develop and parameterize a model of the investment, output and repayments. We will tackle this task later, though clearly it will be necessary to make a number of assumptions to parameterize a model of debt overhang. But even absent a structural model, it turns out to be possible to bound the efficiency effects *ex*

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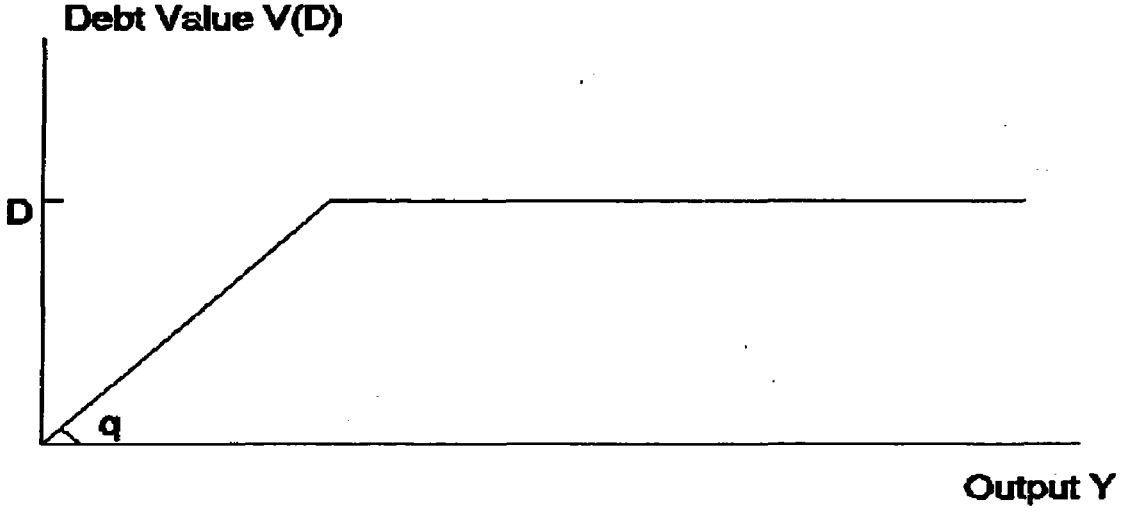
[6] Official debt, if it is senior or equal priority, does present some problems because there is no meaningful market price; we consider this issue later.

post.

Before leaving the case where output is exogenous, it is useful to note one very important feature of the debt value function given by min(qY,D). It is concave in Y, so a rise in the variance of Y (more precisely an increase in mean-preserving spread), necessarily lowers the value of debt. Note that in Figure 1, with Y on the horizontal axis and the debt value function on the vertical axis, the function rises with slope q until Y = D/q and then becomes a horizontal line at D.

Figure 1. Concavity of the Debt Value Function



This is the standard result in option pricing: debt offers the country the option of partially defaulting. A rise in the variance of the underlying asset (the country's output) raises the value of this option and therefore lowers the value of the debt to creditors. As we shall see later, this standard option pricing intuition does not necessarily follow once one allows for moral hazard in investment.

2.2 Open-Market Buybacks in the Presence of Debt Overhang

The foregoing analysis ignores any efficiency gains a country might enjoy as a result of debt reduction. Isn't it possible that these efficiency effects may be so large as to cancel out the losses from a buyback given by equation (2)? As we have already indicated, the answer to this question turns out to be no under a fairly broad range of assumptions. If this seems surprising, the following intuition may be helpful: If an open-market buyback indeed ameliorates debt overhang and induces a country to move to a higher and more efficient level of investment, creditors will anticipate this in deciding what price they require to remit their claims. So at least part of the efficiency gains will necessarily be dissipated in additional capital gains to creditors.

The basic assumptions necessary to prove that buybacks do not benefit creditors are derived in Bulow and Rogoff (1991). Sufficient conditions are that new investment must increase output proportionately across states of nature, and that as a country's consumption, investment and debt double, the ability of creditors to extract repayments no more than doubles. That is, large countries do not pay relatively more than smaller countries. These are sufficient conditions, but they are not necessary. In general, a buyback cannot benefit a debtor unless the marginal value of debt is quite close to the price, and the marginal tax rate on new investment is very high.[7]

If one accepts the proposition that a country does not benefit from a

[7] For a more complete discussion, see Bulow and Rogoff (1991).

straight open-market repurchase of debt, then it is possible to use the *ex post* average price of debt to place an upper bound on the benefit to the country and, in conjunction with (3), on the potential efficiency gain. The key to constructing the bound on efficiency gains is to note a straight open-market buyback operation is at best a break-even deal for a debtor country, then

$$\textit{Efficiency Gain to an Open-Market Buyback} \leq \textit{Gain to Creditors} = (P_1^M - P_0)D_0. \tag{4}$$

Of course, P_1^M is a hypothetical price corresponding to what the average secondary market price of debt would have been had the country conducted a buyback instead of a negotiated deal. Note that the actual price that prevails after a negotiated debt deal, P_1^N, will in general be at least as great as the price that would have prevailed after a straight market repurchase that reduces the face value of debt by the same amount: $P_1^N > P_1^M$. The reason this must hold is that a negotiated repurchase allows a country to reduce debt at lower cost than in a buyback. Because the debtor retains more assets (it spends less), creditors can in general expect higher expected future repayments after a negotiated deal.[8] As a corollary of this, we have:[9]

$$\textit{Efficiency Gain to a Negotiated Buyback} \leq (P_1^N - P_0)D_0. \tag{5}$$

Note that $(P_1^N - P_0)D_0$ is not the gain to creditors in a large negotiated buyback. In general, they receive less than P_1^N per dollar of debt repurchased -- the essence of a negotiated deal is that the debtor pays something closer to marginal value of debt.

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[8] O'Connell (1988) argues that higher reserves may improve a country's bargaining position and thereby actually lower repayments. If this were the case, then our bounds would tend to somewhat overstate the efficiency gains.

[9] Note that it is not necessarily easy to calculate P_0 due to expectations of buyback.

As a first pass, we apply the bounds derived in (5) to actual Brady Plan deals of five countries: Mexico, the Philippines, Costa Rica, Venezuela and Uruguay. The bound derived in (5) is an upper bound to the total efficiency gain (i.e. aggregating creditors and the country). Bulow and Rogoff (1991) give a tighter bound to the country's gain in the presence of debt overhang effect. Claessens, Diwan and Fernandez-Arias (1993) derived an alternative measure of creditor banks' gain based on implied secondary market prices of structural models. We report their estimates in column (h) of Table 1.

We have already argued that a lower bound on the gain a country enjoys from a large negotiated deal is given by creditors' gain; the lower bound is derived under the assumption that there are no efficiency benefits to debt reduction. Since the gain to creditors in a market buyback of comparable size is the upper bound on the total efficiency gain in any debt reduction deal, the net gain to a country from a negotiated restructuring deal is simply equal to the upper bound on the efficiency gain (5) minus creditors' capital gain (3):[10]

$$\textit{Net Gain to Debtor from a Large Negotiated Buyback} \leq (P_1^N - P_0)D_0 - (P_1^N D_1 - P_0 D_0 + N) = P_1^N(D_0 - D_1) - N. \quad (6)$$

A key issue in empirical implementation is how to take account of official debt, for which there are no secondary market prices. Temporarily, we will simplify matters by treating official debt as implicitly junior to private debt. It is not our intention to take a strong stand on this issue here; the evidence is mixed.[11] We take up this case first simply because it is the easiest; later we will investigate how altering the assumed seniority structure may increase or decrease the estimated efficiency bounds. Column

[10] If the value of total stock of debt rises after the buyback: $V(D_1) > V(D_0)$, then there must be an efficiency gain of at least the increase in debt value: $V(D_1) - V(D_0)$.

[11] For discussions of the relative seniority of official debt, see Bulow and Rogoff (1988), (1990), and Bulow, Rogoff and Bevilaqua (1992).

(e) of Table 1 gives upper bounds to efficiency gains from the combined perspective of the country and its official creditors, i.e., under the assumption that official debt is aid. The estimates given in columns (f) and (g) correspond to alternative seniority assumptions on official debt.

Table 1. Upper Bounds on the Total Efficiency Gains

	(a) P_0	(b) P_1	(c) D_0	(d) CB_0	(e)	(f)	(g)	(h)
Mexico	0.36	0.52	95.40	47.20	7.60	15.30	61.10	2.36
Philippines	0.40	0.52	28.50	6.60	0.80	3.40	17.10	0.40
Costa Rica	0.12	0.39	4.60	1.60	0.40	1.20	4.00	0.19
Venezuela	0.37	0.61	33.30	19.00	4.60	8.00	21.00	2.47
Uruguay	0.56	0.74	4.30	1.60	0.30	0.30	1.90	0.06

Sources: World Debt Tables and Claessens, Diwan and Fernandez-Arias (1992).
Definition of columns:
(a) Debt price before the deal;
(b) Debt price after the deal;
(c) Total debt outstanding in US$ billions before the deal;
(d) Commercial bank debt in US$ billions;
(e) Upper bound on the gain when official debt is junior to commercial debt;
(f) Upper bound on the gain when official debt is equal priority debt;
(g) Maximum efficiency gain, i.e., when price of debt rises to par;
(h) Commercial banks' gain.

2.3 Modifying the Bounds For the Case Where Official Debt Is Equal Priority or Senior to Private Debt

Using secondary market prices for seventeen heavily indebted countries for the years 1986-1991, Bulow, Rogoff and Bevilaqua (1992) find that one cannot reject the hypothesis that official debt and private debt are equal priority; that is, that the expected rate of repayment is the same for both. Suppose we adopt this assumption instead of treating official debt as junior. How would this modify the bounds derived in the preceding subsection? Let d_0 denote the initial level of official debt, so that a country's total initial debt is D_0+d_0. If official and private debt are equal priority, then both private and official creditors enjoy the same capital gain from a straight open-market buyback. Thus, the total gain to creditors of a straight open-market buyback is now given by:

Total Gain to Private and Official Creditors from an Open-market Buyback when Debt is Equal Priority (7)

$$= (P_1^M - P_0)(D_0 + d_0).$$

Our theorem that open-market buybacks do not benefit a debtor still goes through in the case where official creditors have equal priority. Thus the right-hand side of (7) provides an upper bound to the efficiency gains from a buyback, and an upper bound to the efficiency gains in a negotiated buyback is given by:

Efficiency Gains to a Negotiated Buyback (8)

$$\leq (P_1^M - P_0)(D_0 + d_0) \leq (P_1^N - P_0)(D_0 + d_0).$$

Comparing (8) and (5), we see that allowing for the possibility that official debt is equal priority considerably raises the upper bound on the efficiency gain. If a country is to break even on a buyback, the efficiency gain must now compensate it both for the capital gains to private creditors and for the capital gains to official creditors. Columns (f) and (g) of Table 1 provide alternative estimates of the aggregate gains and losses to participants from Brady Plan deals. Note that the gain to banks is the same, and the gain to official creditors is similarly straightforward to calculate. The upper bound to the country's gain is simply the difference between the maximum efficiency gain (8) minus the gain realized by creditors.

What if instead of being equal priority, official creditors are in fact senior? The formula for determining the net benefits to creditors still applies, but now P must be replaced by a weighted average of the price of official debt and private debt. We denote the average market price of a country's debt as Q, which is an average of the price of official debt P^d and the price of commercial debt P: $Q = zP^d + (1-z)P$, weighted by the fraction of

official debt in total debt: z.[12] Of course, in order to calculate the average price Q, it is necessary to have an estimate of the price of official debt, P^d. For simplicity, we will assume that the total quantity of official loans is small enough so that $P^d = 1$. In this case, the upper bound on the efficiency gain to a debt restructuring is given by:[13]

$$\textit{Upper Bound on Efficiency Gain from a Debt Buyback When Official Debt is Strict Senior} = (Q_1 - Q_0)(D_0 + d_0). \tag{9}$$

It is easy to show that for any given debt reduction deal, the bound given by (9) may be greater than or less than the efficiency bound given by (8) for the case where official debt is equal priority. Consider, for example, the case where a debt restructuring leads to an increase in official debt and a decrease in privately-held debt, and where the initial level of official debt is zero. Note from the definition of debt prices that $dQ = z\,dP^d + (1-z)\,dP + (P^d - P)\,dz$. By assumption, $d\,P^d = 0$ if the official debt is always small enough so that it is valued at par. If the initial share of official debt z is zero, then clearly $dQ > dP$ if $dz > 0$. This clearly implies $Q_1 - Q_0 > P_1 - P_0$. On the other hand, if the share of private debt is sufficiently small, then the upper bound given by (9) will be lower than that given by (8).

Note that our formula for the upper bound on the efficiency gains tells us that no type of debt restructuring deal -- even one where all creditors walk away from their claims voluntarily -- can yield an efficiency gain greater than the maximum possible capital gain to creditors, or Maximum Attainable Efficiency Gain = $(1 - P_0)\,(D_0 + d_0)$. For most countries, this upper bound can be quite large; Column (g) of Table 1 lists the upper bound on

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[12] Formally, $Q = V(D+d)/(D+d) = z[V(d)/d] + (1-z)[V(D+d)-V(d)]/D$, where V(d) here equals the value of the d dollars of senior official debt holding the level of investment constant or equivalently given total debt of (D+d).

[13] The change in the price of total debt can also be expressed as $Q_1 - Q_0 = (P_1D_1+d_1)/(D_1+d_1) - (P_0D_0+d_0)/(D_0+d_0)$.

attainable efficiency gains for some major Brady Plan countries under the equal priority assumption.

2.4 Applying the Efficiency Bounds to Analyze New Loan Packages

The same logic that suggests that open-market buybacks do not benefit a country can be reversed to show that a highly indebted country gains from new borrowing even if it is forced to pay the market default risk premium.[14] In most cases, of course, equal sharing clauses make reverse buybacks impossible since a country cannot pay a new lender a much larger interest rate. But even though reverse buybacks may appear to have limited practical relevance,[15] this conceptual construct will help place bounds on the efficiency effects of more complex lending packages.

The derivation of the bounds for reverse buybacks is quite similar to the case of buybacks but there are slight differences and it will be helpful to briefly discuss them. In our fictitious reverse buyback operation, a country receives X dollars from new lenders in return for $D_1 - D_0$ worth of face value debt. In order for new lenders to be willing to participate in the loan package, it is necessary that: $X = (D_1 - D_0)P_1$, where $P_1 = V(D_1)/D_1$ is the average price of debt. Note that for every dollar they are asked to contribute, new lenders are given $1/P_1 > 1$ in face value debt. Thus new lenders break even. Assuming that the price of the debt falls, however, existing lenders suffer a capital loss of $(P_1 - P_0)D_0$, which is the same as in expression (1) except here the sign of $(P_1 - P_0)$ is reversed. Thus the country gains because the new loan inflicts capital losses on existing creditors. Because debt overhang efficiency effects are exacerbated rather than alleviated in a reverse buyback, condition (1) now represents an upper

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[14] The result only holds for sufficiently small reverse buybacks; the country does not necessarily benefit if the new loan is so large that country cannot profitably invest the funds.

[15] Some equity swaps might be construed as reverse buybacks.

bound on the gains to the country, rather than a lower bound.[16] It also gives the upper bound on debt overhang efficiency losses.

As an illustration, we consider the case of a debt restructuring plan that involves significant new loans for a stylized country that has not previously received much Western assistance (Table 2). In our calculations we assume that official debt is equal priority, and we consider three alternative *ex post* prices and compare the possible benefits and efficiency losses.

Table 2. The Capital Gain of Alternative Loan Packages

	(a) P_0	(b) D_0	(c)	(d)
P1 = 0.35	0.42	67.2	4.7	28.2
P1 = 0.30	0.42	67.2	8.1	28.2
P1 = 0.25	0.42	67.2	11.4	28.2

Sources: Stylized numbers for a large middle-income country.
Definition of columns:
(a) Debt price before the deal;
(b) Total debt outstanding in US$ billions before the deal;
(c) Upper bound on the gain when official debt is equal priority debt;
(d) Maximum efficiency gain, i.e., when price of debt falls to zero.

3 Obtaining Point Estimates of Efficiency Gains, Ex-Post and Ex-Ante

We have been able to say quite a bit about a broad range of debt reduction operations, and even new lending initiatives, using only the simple proposition that a debtor country would not benefit from trying to reduce debt through straight open-market buybacks alone. To go further -- to give point estimates to efficiency gains, to make *ex ante* predictions, and to develop the comparative static results needed to evaluate alternative loan packages -- it is necessary to develop a more fully articulated model.

In a companion paper (Bulow, Rogoff and Zhu (1994)), we employ a fairly

[16] A reverse buyback can make a country worse off if it is sufficiently large that there is no productive use for the new funds.

standard model of debt overhang and investment and show that in certain cases, it is possible to derive a closed-form solution, which is tantamount to solving a problem involving option pricing with moral hazard.[17] Implementing the model does, of course, require obtaining estimates of the key parameters; we offer some sample calculations for five debt reduction deals, both *ex ante* and *ex post*. But perhaps the main interest of our approach is that it enables one to tackle a number of issues concerning the structuring of loan packages in a relatively simple and transparent way.

3.1 A Simple Model of Debt Overhang and Investment

The model is a simple version of the standard two-period model of debt overhang.[18] The five-stage timing of events is as follows: In the first stage, a small country inherits a debt D_0, and an initial level of resources W_0. In the second stage, it negotiates a debt deal with its public and private creditors; it may also receive aid at this stage. In the third stage it chooses how to allocate its resources between current consumption and investment. In the fourth stage, exogenous shocks to the country's production are revealed, and in the fifth and final stage the country produces, consumes and makes (possibly partial) repayments to creditors.

All lenders are able to diversify risks in the international capital market and thus are taken as being risk neutral for simplicity. The country's gross income is then given by the sum of its first-period consumption and the second-period output. A central assumption in this debt overhang model is that the country's own resources are insufficient to achieve the globally

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[17] It is well known that sovereign debt can be thought of in an option pricing framework; see Saunders (1986), Genotte, Kharas and Sadeq (1987) and more recently Claessens and van Wijnbergen (1993a, 1993b). These earlier analyses, however, do not take into account the moral hazard in investment problem, as is also universally the case in the domestic debt option literature. Allowing for moral hazard turns out to have important qualitative implications for the effects of increase in risk on the value of debt V(D).

[18] See Bulow, Rogoff and Zhu (1994).

efficient level of investment, i.e., the marginal product of investing all resources is greater than 1 if both the riskless interest rate and the country's internal rate of time preference are assumed to be zero. Nothing important hinges on these assumptions. Given that the riskless interest rate is zero, the country would invest up to the point where investment returns equal to 1 in the absence of default risk.

Lenders cannot necessarily force the country to repay its debts in full in states of nature where its output turns out to be too low. Once investment returns are realized in stage 4, creditors are able to extract repayments equal to a fraction: q percent of the country's future uncertain output Y up to the limit of the contractual value of debt service payments. Under this expropriation technology by creditors, the "tax" on current consumption is zero, and the returns from future investment are taxed at a constant rate q; these assumptions capture the key point that creditors generally gain more when the country invests in growth than when it consumes. Froot (1989) and Krugman (1989) assume a "gunboat" technology which expropriate all of the country's future output in case of default, i.e., q = 1. Here, however, we allow for the more general and realistic case of partial expropriation. As Bulow and Rogoff (1988) argue, the empirical evidence strongly suggests that creditors can generally bargain for only a fraction of any gains from higher outcomes. Given this partial expropriation assumption, the country's expected future payments to creditors V(D;I) can be expressed as the minimum of qY and D.

This is, of course, analogous to our earlier definition of the debt value function for the case where there was no investment decision. The essential difference here is that investment is a choice variable for the country that will depend on debt D, the marginal tax rate on investment q, and the total resources available for investment and consumption.

The country's objective is to maximize the present value of two-period consumption, net of repayments to creditors: maximize $W = C + E(Y) - V$. Recall that we have assumed that the country's internal rate of time preference is zero, and we have assumed that the debtor is also risk neutral;

allowing for risk aversion would complicate the analysis without adding any important new insights.[19]

The key step in solving the model is to formulate the country's investment decision given the stock of external debt D and the initial resources W_0. Once we have the investment function I, it is straightforward to work backwards to solve for the value of debt $V(D;I)$, and for the price a country would have to pay in a buyback. Once D and W_0 are set, the debtor's budget constraint is given simply by $W_0 = C + I$. The critical first-order condition that governs the country's choice of investment is characterized by the fact that the debtor invests up to the point where the marginal expected return on investment, net of the expected tax paid to foreign creditors, must equal the return on current consumption.

3.2 Comparative Statics of Debt Overhang and Investment

It is helpful to study some general characteristics of the country's first-order condition before looking at closed-form solutions to the model. First, the expected tax paid to creditors is captured by the tax rate q and a threshold value of shocks which uniquely defines the bad states of nature: the higher is the threshold value of shocks, the more likely the country will not be able to make payments to creditors. In what follows, we refer to this factor as the debt overhang effect. At the first sight, the effect of higher debt on investment decision is seemingly ambiguous. As debt rises, the marginal tax on investment rises. A rise in investment lowers the marginal product of investment, but also lowers the critical value of shocks which has an offsetting effect. However, it is straightforward to see that the second-order condition requires that the debt overhang effect to be negative. That is, the marginal value of debt is less in the case with moral hazard of

[19] The most important qualification is that when the debtor's utility function is concave in second-period income, then having a higher debt may cause it to invest more rather than less (the income effect of the "tax" on marginal investment exceeds the substitution effect; see Helpman (1991)). We assume that the debt overhang effect works in the normal way; otherwise there would be no efficiency rationale for debt reduction.

investment than without. Otherwise, we would obtain the perverse case of a severely indebted country investing all the way to a corner solution.

Some sharper results can be derived from closed-form solutions of the first-order condition. The first major result Bulow, Rogoff and Zhu (1994) obtained is: A mean-preserving increase in the variance of productivity shocks may lead to an increase rather than decrease in the value of debt to creditors.

Recall that in Figure 1 of the fixed investment model in section 2, a mean-preserving spread increase in the volatility of shocks unambiguously lowered the value of debt because it raised the value to the country of the option to default. Here, however, a rise in the volatility of shocks may increase the country's incentives to invest and thereby lead to an efficiency gain. Why might an increase in the variance of shocks lead to an increase in investment? Because very good realizations of the uncertainty are not taxed; once the country has paid its debt in full, there is no debt overhang. Bad realizations of the uncertainty are taxed, but the average tax rate on investment may easily fall. For given investment, greater variance reduces the average tax rate on investment and therefore the value of debt, which hurts creditors. But the greater variance may also reduce the marginal tax rate on investment. If the marginal product of investment is sufficiently flat so that the lower marginal rate generates enough extra investment, the extra variance can raise the value of debt.

With the aid of a closed-form solution, it is fairly straightforward to confirm our earlier discussion that increases in debt damp investment and, similarly, increases in expected productivity raise investment. An interesting question is whether investment in highly indebted countries is more or less elastic with respect to changes in productivity than investment in countries that are not in debt difficulties. Some intuition can be gained by examining the first-order condition of the country's problem, which maintains that a debtor country allocates resources by trading off the expected return on investment, net of "tax" paid to external creditors (i.e., the debt overhang effect), with current consumption.

An increase in productivity raises returns on investment, and the subsequent rise in investment causes the threshold value of shocks to fall. Therefore the elasticity of investment with respect to productivity changes hinges on how "elastic" the debt overhang factor is with respect to the threshold value of shocks. Unless the probability density function falls rapidly, the elasticity is higher when the threshold value of shocks is higher. This is simply to say that the debt overhang problem is most pronounced for a country that is so far in debt that the probability of full repayment is almost zero. Thus for extremely highly indebted countries, one should expect that not only will the mean level of investment be lower than it would be otherwise, but the volatility of investment must also be higher. On the other hand, for countries that have a very high probability of repayment, the effective tax on investment is relatively low and the elasticities are lower. Investment in "rich" debtor countries is likely to exhibit lower rather than higher variance.[20]

This analytical result has interesting implications for empirical research on debt and investment. Most recent empirical studies have looked at time series data and tried to explain the sharp decline in the level of developing country investment in the early 1980s. It would be interesting to test the hypothesis that investment volatility falls as the price of debt rises in cross-section data. A related prediction is that as former Soviet Bloc countries become more heavily indebted, the volatility of their investment will rise.

Interestingly, one can also intuit from the first-order condition that the effect of a toughening of debt enforcement on investment is also ambiguous. It might seem obvious that as creditors' ability to bargain for a larger share of output increases, the tax on investment will rise and

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[20] We focus on the first-order effect of higher debt on the likelihood of default. As our mode endogenizes investment decision, one should also take into account the moral hazard aspect of investment in determining the elasticity. However, the second-order condition predicts that this effect is reinforcing as a higher debt depresses investment thus increases the default probability even higher.

investment will fall, at least in defaulting states of nature. But again reference to the first-order condition shows that this is not necessarily the case. Because a higher marginal tax rate lowers the threshold level of shocks, it makes default less likely, and thus implies a higher probability of full repayment. This effect tends to lower the expected tax on investment by raising the probability of full repayment. Which factor dominates:[21] the debt overhang effect in the bad states of nature, or the fact that increases in the marginal tax rate lower the expected tax by raising the probability of full repayment? The overall effect on investment is not determinate, as it turns out that the second order conditions do not rule out the possibility that a higher marginal tax rate increases investment. This is largely an empirical question, and the model studied here sheds some light on the issue.

If the realizations of the productivity shock are uniformly distributed, more stringent enforcement by creditors actually lowers the marginal tax rate paid by the debtor and raises investment. However, if the probability mass for the productivity shock is heavily weighted towards the bad states of nature, then it is likely that a rise in the marginal tax rate will lower investment. It is also the case that the more likely the full repayment, the more likely that a rise in the marginal tax rate will raise investment. This harkens back to our earlier discussion of productivity changes: For very heavily indebted countries, harsher enforcement of debt repayments will clearly raise the tax on investment and exacerbate debt overhang inefficiency. For countries that are doing sufficiently well, however, a strengthening of legal systems governing bankruptcy will generally raise investment. We shall return to this issue in thinking about the implications of the model for how to structure Brady Plan deals and new lending packages to countries that have not previously received western financial assistance.

3.3 Point Estimates of Debt Reduction Deals

[21] If the greater enforcement is not accompanied by aid, then, of course, the country's welfare falls.

How can one make use of the closed-form solutions of the model to improve upon the results from section 2? One key result there was that the upper bound on the efficiency gain from any debt reduction deal is given by the capital gain on the stock of debt before the buyback: $(P_1^M - P_0)(D_0 + d_0)$, where P_1^M is the price of debt that would have prevailed if debt reduction had been achieved via an open-market operation rather than a negotiated debt reduction. We are taking as our baseline the case where official debt is equal priority which we showed generally leads to the highest efficiency gain estimates.

But this is an upper bound. With our closed-form solutions, we can give more precise estimates. First, in Table 3, we revisit the Brady Plan deals we looked at earlier by providing point estimates based on the Pareto distribution of the productivity shock. The five economies are simulated by a simple Cobb-Douglas type of "production function" and calibrated by the latest macroeconomic data for the countries.

Table 3 presents both the upper bound efficiency estimate and the point estimate derived from our model -- In the case of Mexico, for example, the upper bound efficiency estimate to the Brady Plan deal is US$15 billion but our point estimate is only US$1 billion. It is important to note the qualification that no new loans are permitted. Allowing for new loans would raise the efficiency estimates provided sufficient positive present value projects were available. But Table 3 illustrates that the debt overhang tax itself may not be as important as the broader problem that debtors are credit constrained in international capital market. The implication that our point estimates for the efficiency gains are far below our upper bound estimates is that the upper bounds considerably overstate the debt overhang problem. Why should this be the case? In parameterizing the model, it is necessary to choose a value of the marginal tax rate low enough to explain actual secondary market prices. But with the marginal tax rate being relatively small, the tax on average and therefore marginal investment cannot be that large either. In Table 3, we also calculate the efficiency gains that would be achieved if both official and private creditors were to write off half of their debts,

contingent on no further borrowing.[22]

Table 3. Point Estimates of the Total Efficiency Gain

	Brady Plan Deals		Upper Bound on Gains if All Creditors Would Write off half of Debt
	Estimate	Upper Bound	
Mexico	934	15,300	8,675
Philippines	59	3,400	929
Costa Rica	27	1,200	77
Venezuela	130	8,000	1,592
Uruguay	56	800	267

Sources: World Debt Tables and authors' calculation.
All numbers are in US$ millions.

3.4 The Induced Efficiency Effects of Alternative Loan/Aid Packages

The possibility that harsher enforcement might actually lead to lower rather than higher marginal taxes on repayment discussed in section 3.1 raises the interesting question of how new loan packages to some developing countries might be structured so as to maximize investment incentives. One potential extension of our model is to study such issues in a simple and transparent way. Let us assume that the donor countries aim to provide a fixed resource transfer T. For simplicity, we will assume that there is no pre-existing debt although the analysis is easily modified to take account of this possibility. This is also a relatively realistic assumption about countries that have not previously received western financial assistance, e.g. former Soviet Bloc countries.

In this case, if D is the quantity of new loans to be provided, then the implied transfer associated with any given aid/loan package is: $G + D - V(D;I)$

[22] Of course, it would be inefficient for a country facing debt overhang to borrow more money.

$\leq T$, where G denotes grants.[23] Suppose that the goal of donors is to induce the most efficient level of investment subject to this constraint. Is it better to give grants or loans, or what mix? Initially, we will treat the enforcement parameter q as given, so that the lenders' and donors' only choice is between grants and loans. Later, we will admit the possibility that by mixing different types of loans in the aid package, the donors can effectively control q.

Taking grants and new loans into account, the country's budget constraint becomes: $W_0 + D + G = C + I$. As the model suggests, higher debt reduces investment; so in any region the interior first-order condition holds, it pays to raise grants and lower debt. However, in any region where the debt overhang tax is more than offset by the high return on investment, donors want to raise debt and lower grants.

Why should this be the case? Because grants cost more per dollar than loans. If all the resources being given to the country are being invested despite debt overhang, the optimal strategy is clearly to maximize total resources transferred. This implies substituting loans for grants.[24] Combining this observation with the fact that the first-order condition holds for any interior solution, we see that the optimal policy can be characterized as follows: The donors should use loans up to the point where debt overhang begins to divert resources away from investment (say, into capital flight). Beyond this point, efficiency is best served by adding grants and reducing loans. If the marginal return to the country from investment is less than 1 when donors' budget constraint is binding, it is best to replace enough loans with grants, with loans disappearing and only grants being left when the

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[23] We do not distinguish yet between private and official sources and assume that all loans are made at approximately the riskless interest rate so that the maximum present value of repayments equals the amount borrowed.

[24] In this capital constrained region, any policy which can increase current gross transfers to the country, holding net transfers T constant will raise investment. So, for example, if T and q are taken as given, it will make sense to lend at rates above the riskless rate so that D will exceed the amount borrowed.

marginal return of investment approaches the discount rate.

One extension of the preceding analysis is to allow the donor the possibility of choosing the level of enforcement parameter corresponding to the loan component of the aid package. This is obviously more difficult, as the resulting marginal rate of tax might depend on the mix of the lending package. IMF credits are generally thought to be senior loans that have to be repaid,[25] for example, while AID loans are generally made on much less tough terms and IDA flows contain a large grant element. Trade credits are generally thought to be more difficult to default on than other types of privately-held debt (and sell at a higher price). In this case, the donor now has two policy instruments: the concessionality mix between debt and grants, and the level of conditionality on the loans. Given the continuity assumption of relevant variables in the model, the choice of the enforcement parameter is a bang-bang control problem, so creditors will either set it close to 1 or close to 0.

Thus the same general logic applies; it is desirable to use loans up to the point where the debt overhang problem begins to bite. Beyond that, it pays to use grants. The only difference is that in this case, by using highly concessional loans, the lender can provide a higher level of total resources before needing to resort to grants. The upshot of the analysis is that for a country that has a large number of high return projects, and little capital flight, large quantities of hard loans maximize investment. For countries that have debt overhang problems, however, aid leads to more efficient investment than would new loans.

4 Concluding Remarks

This paper uses modern finance technique to evaluate the costs and

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[25] Bulow, Rogoff and Bevilaqua (1992) emphasize that IMF seniority can only properly be evaluated in a broader bargaining context that takes into account that the creditor country governments that fund the IMF also fund other aid and loan agencies.

benefits of debt restructuring packages. The insight that option pricing techniques are useful in evaluating debt is not new; indeed these techniques are already widely employed: recent examples include Claessens and van Wijnbergen (1993a and 1993b).

Our contribution here is to show how to extend this widely-used approach to allow for the moral hazard problems central to sovereign lending. We have shown that one can obtain efficiency bounds to the gains on debt restructuring under fairly weak assumptions on the production structure and the debt enforcement process. Our upper bound estimates are, however, sensitive to what one assumes about the seniority of official debt relative to private debt; they are generally higher when official debt loans are perceived as equal priority than when they are perceived as aid. Also, although the upper bound estimates suggest very high efficiency returns to Brady Plan deals, our point estimates -- which admittedly require much stronger assumptions than do the bounds -- suggest a more modest result; on the order of a couple billion dollars in efficiency gains for the largest deals. The basic reason for these more modest numbers is that a large debt overhang effect requires a high tax on marginal investment, which is difficult to reconcile with the observed secondary market discount. Our low point estimates indicate that the debt overhang tax itself may not be as important as the broader problem that debtors are credit constrained in international capital markets.

The framework here is certainly a very simple one but appears to produce a number of useful insights on debt overhang and investment. In addition, our analysis potentially can be extended to analyze issues in structuring aid packages to countries that have not previously received Western financial assistance. The model presented here confirms the conventional wisdom that the first tranche of aid should be in the form of hard loans, but if achieving high investment is the objective, later tranches should involve grants and some substitution of grants for loans. Clearly, our analysis can only be regarded as a first pass at the important problem of how to structure aid packages between grants and loans. One direction for further work could be in the form of extending the two-period analysis here to a multi-period framework.

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