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A Dynamic Model of Buy-Backs

Prepared by Michael P. Dooley, Steven Symansky, and Ralph W. Tryon

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Abstract

A dynamic framework is utilized to evaluate buy-backs of a country's external debt. The model solves for the price of debt on the basis of expectations concerning the debtor's ability to pay, and upon a variety of assumptions concerning changes in property rights consistent with various debt reduction programs. The importance of these assumptions is illustrated in simulations that relate debt reduction to a conventional balance of payments projection.

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Summary

In some cases debt reduction programs are likely to be spread over a considerable time period as debtor countries acquire the resources needed to support such programs. This raises a number of interesting questions about the growth of debt, and the behavior of market prices for debt, over time. In this paper a simple framework is developed for evaluating some of these questions.

A basic model develops the idea that when the price of debt is below par, market participants expect less than full payment, not only in the near term, but also in the long run. In such an environment, new debt obligations that are added to meet full interest payments will cause market prices to fall over time.

The terms on which interest payments are financed by existing creditors is an important determinant of the rate of growth of total debt. Although these terms are conventionally set at LIBOR plus a small spread, they can be viewed as the result of a bargaining process between the debtor and its creditors.

The outcome of this bargaining process is very difficult to evaluate in any simple framework. Nevertheless, it seems promising to view a debt reduction program as an extension of this bargaining process. A simulation model shows that the ground rules established for the debt reduction can have an important impact on the growth of debt and upon the path for prices. The reasoning is straightforward. First, the sale of assets or the acquisition of new liabilities to finance debt reduction might alter expected payments to existing creditors. Second, the "property rights" to resources for debt reduction are transferred from the debtor to its creditors at the moment the debtor is obliged to use the resources for debt reduction, not when an actual transaction occurs. It follows that the path for debt and prices of debt can be quite different if the debtor retains some discretion in entering into debt reduction transactions.

This analysis helps explain creditor's preference for limiting debt reduction to that which can be financed at highly concessional rates. Moreover, creditors typically want to know the size of the debt reduction and the terms acceptable to the debtor well in advance of the transaction. The analysis developed in this paper suggests that these rules of the game are not necessarily in the interests of debtors.

I. Introduction

This paper provides a framework for evaluating debt reduction techniques that involve buy-backs of a country's external debt over time. In order to relate a debt reduction program to a conventional balance of payments projection, a simulation model is developed. This model solves for the price of debt on the basis of expectations concerning the debtors' ability to pay, and upon a variety of assumptions concerning expectations about debt reduction programs themselves. Section 1 of the paper presents the underpinnings of the continuous time model. In Section 2, the discrete time analog of the model is developed and a variety of simulations are examined.

II. Theoretical Dynamic Model

The work here builds primarily on a dynamic analytical model developed by Carlos Rodriguez (1988). It is worthwhile to briefly review the framework developed by Rodriguez. A debtor is assumed to have some fixed nominal amount of resources, T, available to make interest payments on a stock of perpetual bonds, B, that carry a contractual interest rate, i. Each bond is paid a proportional amount of T so that each receives an actual interest payment at a rate T/B. The "unpaid" contractual interest, if any, is financed by a new bond that is identical to existing bonds and carries a contractual rate of interest, i. Thus, the increase in debt in any time period is iB - T, and the increase per unit of B is (i-T/B).

It is worth noting at the outset that this set up is descriptive of the experience of debtor countries in recent years. In behavioral terms, however, it is not clear why competitive creditors would accept new bonds <u>at face value</u> as full payment of interest in cases where the market price of debt is less than unity. If the assumption was that the creditors would only accept bonds with <u>market</u> value equal to iB - T, then in cases where the price was less than unity, stock of debt would grow without limit immediately and the price approach zero immediately.

The convention of accepting new debt at par might be seen as a negotiated way to avoid explosive growth of debt. A negotiated equilibrium is possible because the debtor is a monopolist in issuing its own debt and creditors are bound together through complex "cross default" and "sharing clauses" in syndicated loan contracts. Moreover, creditor banks have strong incentives to act collectively because they must consider how their regulators would react to alternative ways of settling "unpaid" interest. Thus, models that assume that creditors accept new debt at par to settle interest can be interpreted as relevant to negotiated settlements between debtor countries and their creditors in recent years. The "negotiated", monopolistic, nature of the model is important in interpreting the extension of the model to debt reduction techniques.

Once the rules of the game allowing buy-backs are established, investors can be assumed to evaluate investment opportunities in the usual manner. Since we are interested in the terms on which an investor would want to hold the country's debt, it is useful to consider the alternatives faced by a typical investor. First, he could sell his bond at the current market price for the debt and invest the proceeds in a safe asset that yields a risk-free market interest rate, i. The rate of return from this alternative per dollar of contractual value of debt is $i \cdot p$, where p is the market price of debt.

Second, he can hold the bond, B, for one more time period and receive: (a) the actual rate of interest payments, T/B, (b) a new bond that accrues because of unpaid interest at the rate i - T/B evaluated at the market price p, and (c) a capital gain or loss on the bond at a rate of $\dot{p}$.

This model can be summarized in a pair of differential equations that are derived from an arbitrage condition and an assumption concerning the growth of the contractual value of debt over time. 1/ The variables that can equalize the expected yield on holding or selling debt are the price of debt and the expected rate of change in the price of debt. Thus, the arbitrage condition determines an equilibrium expected rate of change that is consistent with the price of debt at any one point in time. The expected yields from holding and selling debt are equal when:

$$i \cdot p = T/B + p(i - T/B) + d\dot{p} \quad \text{or} \quad dp = (T/B) \cdot (p-1) \tag{1}$$

One aspect of this arbitrage condition on yields is that it depends at each point in time on the level of B. Since B will generally be changing, because of unpaid interest, another condition is necessary to define the level of B at each point in time. By assumption

$$\dot{B} = i - T/B \tag{2}$$

Except at an instant of time when B is altered by a buy-back, the model implicitly assumes that the level of B is an accident of history. This is true because B is a contractual amount agreed to sometime in the past. Once that original contractual value is identified, we assume that there is no further voluntary lending so that the level of B now is simply what it was when the country last had access to voluntary new lending, plus the accumulated unpaid interest between then and now.

1/ A more complete elaboration of this framework is provided in Rodriguez (1988).

While these differential equations determine the paths of price and debt, it is necessary to determine the initial price level. The transversality condition used in the model is derived as follows. Defining the present value of interest payments, PVIP, as:

$$PVIP_t = \int_{t=0}^{\infty} \frac{T_t}{(e^{-rt})} dt. \tag{3}$$

The "unpaid" interest in this model is of no apparent value since we have assumed that the actual payments are known with certainty. Nevertheless, each investor will be anxious to get these new bonds because this will allow him to keep his initial "share" of actual interest payments: Thus, although the new money bonds are of no value in themselves, they are important since they determine the growth in the contractual value of debt. Two interesting conclusions follow. First, the current price of debt will be equal to the present value of future actual interest payments divided by the contractual value of existing debt. This is true because if the investor holds some shares of B_t equal to $S \cdot B_t$, he receives in each time period $S \cdot T$, with a present value of

$$S \cdot PVIP_t = S \int_{0}^{\infty} \frac{T_t}{e^{-rt}} dt$$

If $S \cdot B_t$ is sold and reinvested at i_t, the present value of selling is simply the cash value:

$$S \cdot PVS_t = P_t \cdot S \cdot B_t \tag{4}$$

If the bond is held <u>and</u> if the share S in the outstanding contractual value of bonds is maintained, the investors receives S.PVIP. The equilibrium condition is that both alternatives have the same present value. Thus:

$$S \cdot PVS_t = S \cdot PVIP_t$$

$$P_t \cdot S \cdot B_t = S \cdot PVIP_t \tag{5}$$

$$P_t = \frac{PVIP_t}{B_t}$$

The equilibrium <u>level</u> of the prices for all investors is determined by the present value of interest payments expected in the future and by B_t, which is an accident of history. In the next time period B_t will have grown because unpaid interest is added to B_t. If the price of debt did not change the holder would realize a capital gain. Thus, the price of debt must be expected to fall by the same percentage amount that B_t rises.

The properties of the system are illustrated in Figure 1. This diagram shows the relationship between changes in market prices and debt stocks as described by equations (1) and (2) and the levels of prices and debt stocks. From (1) it is clear that $\dot{p}$ is zero when P=1.0 and that if prices are below 1.0 they will fall and if above 1.0 will rise. Since these are bond contracts and market interest rates are assumed unchanged, there is no economic meaning to a price above 1.0. If payment T exceeds contractual interest, we assume that debt is retired. Thus, the time when P = 1.0 shows when $\dot{p}$ = 0 and in general at this boundary, the stock of debt will be unchanged or falling.

From (2) it is clear that the stock of debt does not change if B•i, the contractual interest payment, is just equal to T or, equivalently, if B = T/i. If B < T/i debt will falling since a part of the payment T will be used to amortize principal. Thus in the diagram the relevant equilibrium path to the left of the $\dot{B}$ = 0 line is along the p = 1 line. Amortization implies that B will move toward zero.

The more interesting situation, of course, is where B is large enough so that B > T/i, to the right of the B = 0 line. Since the price is less than 1.0, we see as argued above that in the southeast quadrant prices are falling and debt is growing. In the simple model discussed thus far, prices will fall and debt will grow and at each point, the equilibrium condition defined by (5) will hold.

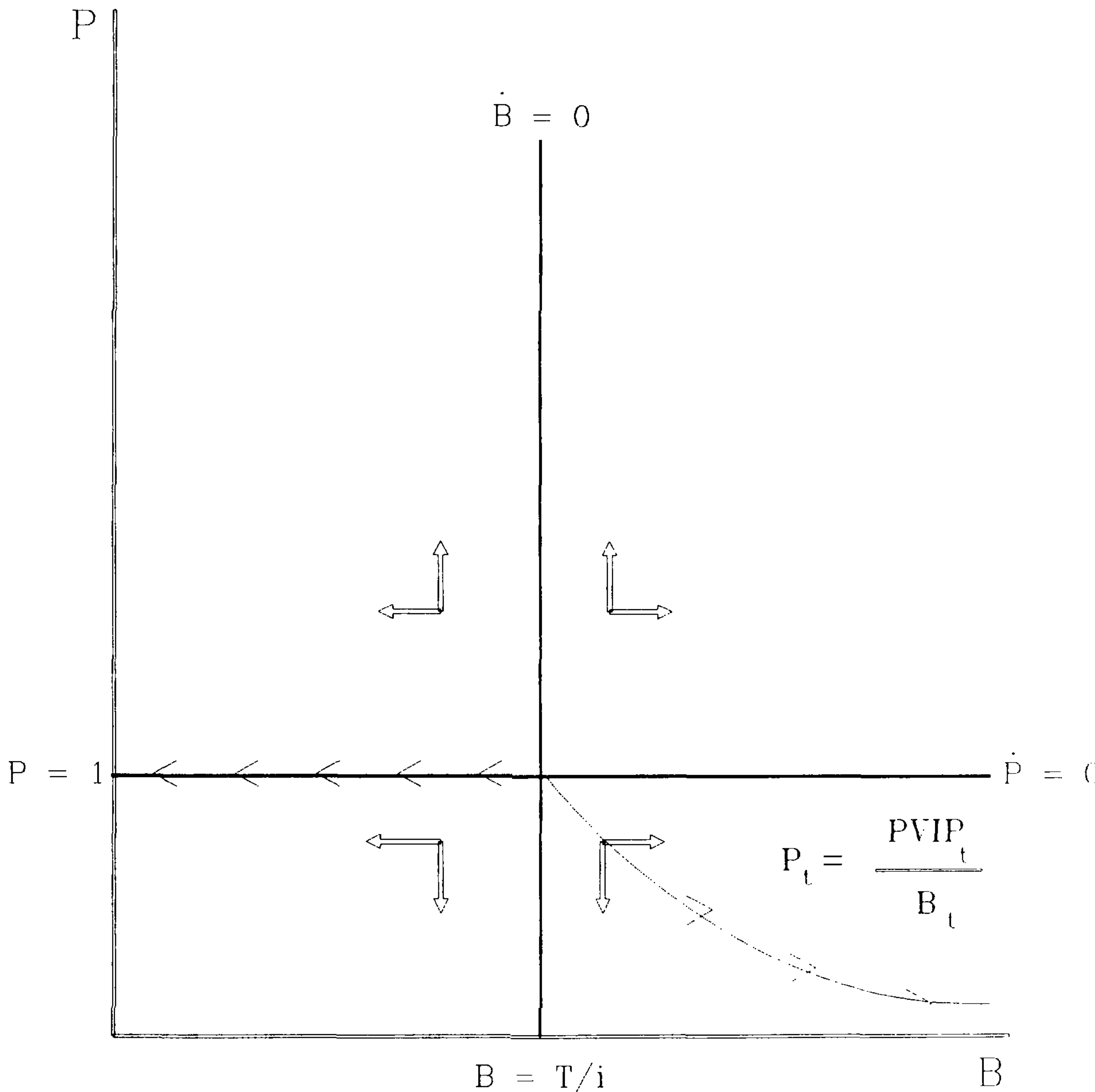
1. <u>Buy-backs</u>

It was argued above that the model developed can best be viewed as a description of a negotiated settlement between a debtor and its creditors. It follows that in order to evaluate the effects of a buy-back, it is necessary to describe more completely the nature of these negotiations.

Two questions appear to be crucial in evaluating the effects of buy-backs on market prices of debt and in turn on the amount of debt retired. The first, which has been developed elsewhere in static models, is that it is necessary to identify the source of funds used in the buy-back. Several alternatives can be considered. 1/ The debtor could use the funds that would have been available to make contractual interest or amortization payments to finance a buy-back. The debtor could utilize funds donated by a third party or perhaps funds that would have been used to support imports. Each of these will have different implications.

1/ See Dooley (1988b).

Figure 1



The second important factor which arises in the context of dynamic models, is that it is necessary to determine whether the debtor is obligated to announce that a buy-back will take place or, once announced, to carry through the buy-back at whatever price offered by creditors. It was argued above that the assumption that new bonds are accepted at face value for payment of interest makes economic sense only in a bargaining context. The terms under which a buy-back will be carried out can be considered an extension of the bargaining outcome. In most cases, debtor countries' rights to repurchase debt from individual creditors are constrained by the terms of their existing debt. Sharing and prepayment clauses in syndicated credits specify that any offer from the debtor to retire debt on terms other than specified in the contract must be approved by a certain percentage of creditors, typically a high percentage, and that an offer must be made to all creditors simultaneously. These provisions imply that creditors must act collectively to authorize a buy-back and that the debtor may be required to provide a considerable amount of information about the buy-back. As shown in the next section, it is in creditors' collective interest that buy-backs be announced, and that once announced, that the debtor be obliged to carry through the buy-back. This last point is particularly important in cases where future buy-backs are contemplated. The reason for this is intuitively obvious. If the debtor is obliged to carry out a buy-back in the future, the value of the debt today will incorporate this information and the market price is likely to rise. Thus, an <u>anticipated</u> buy-back in which the debtor has no discretion gives existing holders an immediate capital gain and limits the amount of debt retired. In contrast, if the debtor is not obliged to carry through the buy-back, there is always the option of utilizing the resources for alternative expenditures. If the debtor refuses to buy-back debt at prices above that prevailing before the buy-back was announced, the market price may not rise at all. Yet sales at that price still satisfy the arbitrage condition for creditors. Thus, buy-backs in which the debtor reserves the right to buy may not generate capital gains for creditors.

In general, buy-backs of any size would require a new set of ground rules for the debtor and its creditors. The rights and obligations set out in these ground rules will determine whether the resources used in the buy-back become the "property" of creditors--and thus raise the value of creditors claims--or remain the "property" of the debtor to be used to retire debt only on terms acceptable to the debtor. For want of a better term we will call the former case nondiscretionary buy-back and the latter a discretionary buy-back.

A buy-back of debt occurs at a point in time and affects both differential equations and causes P to jump to a new level. Equation (2), the time path of B can be rewritten as:

$$(2') \qquad \dot{B} = i - T/B - BB/P$$

where BB is the buy-back. Moreover, in cases where the debtor uses expected interest payment contained in T, either directly for a buy-back or indirectly to service a buy-back loan, the expected path for T will also adjust cause P to "jump", and also affect the time path in B. The interplay of anticipated and unanticipated changes in the expected future values of B and T provide the interesting dynamics for the simulation model developed in the next section. Both the time path of P described by (1) and the initial level of P described by (5) will be altered depending upon the assumption regarding the financing of the buy-back.

III. Simulation Model and Results

The previous section laid out a continuous time model of buy-backs. In this section, we present the discrete time analog to this model, but generalize it in order to analyze a variety of buy-back schemes. As indicated in the previous section, the effects of any buyback are critically dependent upon the source and cost of funds and whether future buy-backs are anticipated (nondiscretionary) or unanticipated (discretionary).

While the buy-backs could have been implemented in a variety of ways and the model has been designed to handle a wide variety of debt questions, we will focus on some simple, but nevertheless relevant scenarios in order to demonstrate the importance of the ground rules under which transactions are carried out. In the model and the simulations discussed below we make the following three critical assumptions: (1) There is no uncertainty about outcomes in the minds of market participants; rather expectations of future outcomes are held with certainty. As shown in Dooley (1988a), this is a special case. Because of the non-linearity of the model it is not easy to anticipate the implications of uncertainty for the results. This is a topic for future research. (2) A change in the price of debt owed to private creditors has no effect on any other variable in the model, most importantly, funds available for interest payments; and (3) The amount of interest payments to private creditors is treated as the residual item in the balance of payments. The latter assumption implies that the interest owed on money borrowed for the purpose of buy-backs will be superior to interest owed to private creditors. Secondly, buy-backs that are financed from existing funds will reduce the amount of interest payments to private creditors dollar for dollar. 1/

1/ In another version of the model that we do not use in this paper, we assume that official and private creditors are paid back at the same rate and that unpaid official interest payments are forgiven. The results from this version of the model are virtually identical to a buy back loan at concessional rates.

The equations that follow capture a simplified version of the simulation model used to produce the various scenarios described in the paper. The complete, more general model has additional features to account for the official sector, debt forgiveness, new loans, etc. However, the five equations presented here capture the essential features of the basic model.

Equation (6) describes the dynamics of debt; debt grows by the amount of unpaid interest less the impact of a buyback on the quantity of debt; debt is reduced by the amount of the buy-back purchased at the current debt price. The seventh equation keeps track of the outstanding stock of official loans made for buy-backs in order to calculate interest owed on buy-backs. Equation (8) simply states that interest payments made on private debt are determined by an exogenously specified amount of funds, $T\phi$, less the interest payments made on the superior debt (i.e., loans used for buy-backs). Of course the amount of interest payments made to private creditors are assumed not to exceed the contractual amount of interest payments. Note that i_{BB} defines the cost of the loans used for the buy-backs. If a buy-back is in the form of an interest free grant then i_{BB} is set equal to zero.

The most critical equations in the model are given by (9) and (10) and define the present value of payments and determine the price level. The discrete time analog of equation (1), the arbitrage condition, could have been used in the simulations to describe the change in the price level over time. However, an equation such as (5) in the theoretical section or (10) in the simulation model, which can be thought of as the transversality condition, is still needed to define the price level at a point in time. In solving the model for the price level we opted to use equations (9) and (10) for every time period because the model solves considerably faster than if the arbitrage condition is used. Note that anticipated future buy-backs are included in the present value calculation. If a buy-back that occurs in a future year is assumed to be nondiscretionary (i.e., known to occur with probability one by all market participants), then the buy-back can be thought of as a future payment to individuals who hold today's debt stock and is included with future interest payments. On the other hand, if future buy-backs are treated as surprises (discretionary), then the model is simulated without including the future buy-backs in the present value calculation.

$$B_t = B_{t-1} + i \cdot B_{t-1} - T_t - BB_t/P_t \tag{6}$$

$$BS_t = BS_{t-1} + BB_t \tag{7}$$

$$T_t = \text{minimum } (T\phi - i_{BB} \cdot BS_{t-1},\ i \cdot B_{t-1}) \tag{8}$$

$$PVP_t = \sum_{j=0}^{\infty} \frac{(T_j + BB_{j+1})}{(1+i)^{j+1}} \tag{9}$$

$$P_t = \frac{PVP_t}{B_t} \tag{10}$$

Variable definitions:

B	-	debt
T	-	interest payments to private creditors
PVP	-	present value of payments to private creditors (includes future buy-backs if non discretionary)
i_{BB}	-	interest rate on buy-back
i	-	interest rate on private debt
BB	-	buy-back
BS	-	stock of outstanding loans that financed buy-backs
P	-	price of private debt
$T\phi$	-	fund available for interest payment on private debt

In order to examine the effects of buy-backs, it is necessary to determine a solution to the model without buy-backs. While the choice of the baseline case is arbitrary, it does have implications for the results presented due to the nonlinear properties of the model. In a world where countries are paying most of their contractual interest obligations, the relevance of buy-backs will be very small since the price will already be in the neighborhood of par. In our simulations the baseline level of current and future interest payments are chosen to produce a debt price of 47 cents in 1989 which falls monotonically about 1.5 cents a year to 30 cents by the year 2000. As discussed earlier, the price either must jump to par instantaneously or must fall toward zero. Our baseline captures the second alternative and is therefore inconsistent with a viable debt outlook. The baseline was constructed by assuming that the country pays 15 percent of its interest obligation in 1989 with payments growing at 3 percent per year. With a contractual interest rate at 9 percent, the growth rate of debt outstrips the present value of interest payments.

The simulations below are illustrative of the model's properties and are designed to illustrate how various buy-back schemes affect the price and stock of debt. In the first set of simulations 1/ we simulate the effects of buy-backs financed by grants and by loans that are assumed to be superior to existing debt. In the case of loans, the future interest obligations on these loans will reduce the amount of interest paid to private creditors. These simulations have two competing effects. While the buy-back lowers the existing amount of debt tending to raise the price of debt, the increased interest obligations on these buy-backs reduce the amount of interest payments made to the remaining creditors. As long as the interest rate of this superior debt is below the market rate, it has a positive impact on the debt price. In simulations 1 through 3 we examine a one-time buy-back equal to 5 percent of the existing debt at: (1) 0 percent rate of interest (an outright grant) (2) 5 percent below market rate, and (3) 1 percent below market rate.

There are several important results to note from these simulations. As can be seen in Table 1 and Chart 1, the buy-back raises the price of debt and lowers the outstanding debt stock. In the first simulation, there is no impact on the present value of interest payments and the price rise captures the complete value of the gift. However, this simulation can still be thought of as a special case of a loan-financed buy-back; the concessional rate is zero. For these simulations, the lower the interest rate charged on the loan for the buy-back, the larger the price impact of the buy-back. Analogously, the higher the rate of interest charged on the loans, the greater the amount of debt reduction produced by the buy-back on impact. However, with larger amounts of interest payments made to official sources, reduced interest payments made on the private debt increases the interest arrears and therefore the debt accumulation. Thus, the debt reduction is greater in the short run with the higher borrowing cost, but the reverse is true in the longer run.

In simulations 4-6 we consider the impact of three successive buy-backs, each approximately equal to 10 percent of the debt stock, spread out over three years. The results are given in Table 1 and Chart 2. The difference in the simulations hinges on the assumption regarding the market perception of future buy-backs. In simulation 4, we assume that the buy-backs represent a binding agreement between creditor and debtor. Future buy-backs and interest payments are nondiscretionary. In simulation 5, the same buy-back is assumed to be discretionary. This can be thought of as either new unexpected loans made to the debtor for the purpose of a buy-back or a line of credit that is extended to the debtor, which market participants do not anticipate will be used by the debtor for buy-backs. In the simulation 6, it is assumed that market participants anticipate the future loans and interest obligations, but the buy-back decision is discretionary and the probability is one that the country will

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1/ The discussion of the solution algorithm and the complete details of the assumptions underlying each scenario are discussed in the appendix.

Table 1

Alternate Buy Back Scenarios

Debt Owed to Private Creditors

	1989	1990	1991	1993	1995	2000	2010	2020
Baseline Scenario............................	58.0	61.9	66.1	75.6	87.0	125.3	277.8	657.2
Sim1 - 5% BB at 0% rate of interest (grant)...	52.8	56.2	59.8	68.1	77.8	110.5	239.5	557.6
Sim2 - 5% BB at 4% rate of interest...........	52.6	56.1	59.8	68.3	78.3	112.0	244.9	573.5
Sim3 - 5% BB at 8% rate of interest...........	52.4	55.9	59.8	68.5	78.7	113.4	250.2	589.0
Sim4 - 10% BB for 3 years; BB & IP nondisc....	48.8	42.6	35.7	40.4	45.8	63.3	128.2	280.4
Sim5 - 10% BB for 3 years; BB & IP disc.......	46.9	39.9	33.4	37.6	42.4	57.9	114.2	244.1
Sim6 - 10% BB for 3 years; BB disc. IP nondisc	45.2	37.7	31.5	35.3	39.6	53.3	102.3	213.2
Sim7 - 20% BB for 3 years; BB & IP disc.......	38.1	24.6	13.7	15.3	17.0	21.5	31.5	41.2
Sim8 - No IP for 5 years; BB disc.............	54.1	55.4	56.8	59.7	62.5	89.3	184.4	414.9
Sim9 - No IP for 5 years; BB nondisc..........	52.2	52.0	52.1	53.3	55.5	78.1	155.3	339.3

Price of Debt

	1989	1990	1991	1993	1995	2000	2010	2020
Baseline Scenario............................	0.47	0.45	0.44	0.41	0.37	0.3	0.18	0.1
Sim1 - 5% BB at 0% rate of interest (grant)...	0.52	0.5	0.48	0.45	0.42	0.34	0.21	0.12
Sim2 - 5% BB at 4% rate of interest...........	0.5	0.48	0.47	0.43	0.4	0.33	0.2	0.12
Sim3 - 5% BB at 8% rate of interest...........	0.48	0.46	0.45	0.42	0.39	0.31	0.19	0.11
Sim4 - 10% BB for 3 years; BB & IP nondisc....	0.64	0.63	0.61	0.59	0.56	0.49	0.34	0.22
Sim5 - 10% BB for 3 years; BB & IP disc.......	0.53	0.59	0.66	0.63	0.6	0.53	0.38	0.25
Sim6 - 10% BB for 3 years; BB disc. IP nondisc	0.46	0.56	0.7	0.67	0.65	0.58	0.43	0.29
Sim7 - 20% BB for 3 years; BB & IP disc.......	0.59	0.76	1.0	1.0	1.0	1.0	1.0	1.0
Sim8 - No IP for 5 years; BB disc.............	0.49	0.49	0.49	0.49	0.49	0.42	0.28	0.16
Sim9 - No IP for 5 years; BB nondisc..........	0.33	0.36	0.4	0.47	0.55	0.48	0.33	0.2

Interest Payment to Private Creditors

	1989	1990	1991	1993	1995	2000	2010	2020
Baseline Scenario............................	1.91	1.97	2.03	2.15	2.28	2.65	3.55	4.78
Sim1 - 5% BB at 0% rate of interest (grant)...	1.91	1.97	2.03	2.15	2.28	2.65	3.55	4.78
Sim2 - 5% BB at 4% rate of interest...........	1.8	1.86	1.92	2.04	2.17	2.54	3.45	4.67
Sim3 - 5% BB at 8% rate of interest...........	1.7	1.75	1.81	1.94	2.07	2.43	3.34	4.56
Sim4 - 10% BB for 3 years; BB & IP nondisc....	1.68	1.5	1.32	1.45	1.58	1.94	2.85	4.07
Sim5 - 10% BB for 3 years; BB & IP disc.......	1.68	1.5	1.32	1.45	1.58	1.94	2.85	4.07
Sim6 - 10% BB for 3 years; BB disc. IP nondisc	1.68	1.5	1.32	1.45	1.58	1.94	2.85	4.07
Sim7 - 20% BB for 3 years; BB & IP disc.......	1.44	1.02	0.58	0.71	0.84	1.2	2.11	3.33
Sim8 - No IP for 5 years; BB disc.............	0.0	0.0	0.0	0.0	0.0	2.65	3.55	4.78
Sim9 - No IP for 5 years; BB nondisc..........	0.0	0.0	0.0	0.0	0.0	2.65	3.55	4.78

Capitalized Value of Private Debt

	1989	1990	1991	1993	1995	2000	2010	2020
Baseline Scenario............................	3.9	4.2	4.6	5.4	6.4	9.9	24.2	60.9
Sim1 - 5% BB at 0% rate of interest (grant)...	3.4	3.6	4.0	4.7	5.5	8.4	20.4	51.0
Sim2 - 5% BB at 4% rate of interest...........	3.5	3.7	4.1	4.8	5.7	8.7	21.0	52.7
Sim3 - 5% BB at 8% rate of interest...........	3.5	3.8	4.2	4.9	5.8	8.9	21.7	54.3
Sim4 - 10% BB for 3 years; BB & IP nondisc....	3.2	2.8	2.3	2.6	3.0	4.4	10.0	24.0
Sim5 - 10% BB for 3 years; BB & IP disc.......	3.0	2.5	2.0	2.3	2.7	3.9	8.6	20.3
Sim6 - 10% BB for 3 years; BB disc. IP nondisc	2.8	2.3	1.8	2.1	2.4	3.4	7.4	17.2
Sim7 - 20% BB for 3 years; BB & IP disc.......	2.4	1.4	0.8	0.8	0.9	0.9	1.0	0.8
Sim8 - No IP for 5 years; BB disc.............	5.4	5.5	5.7	6.0	6.3	6.3	14.9	36.7
Sim9 - No IP for 5 years; BB nondisc..........	5.2	5.2	5.2	5.3	5.6	5.2	12.0	29.2

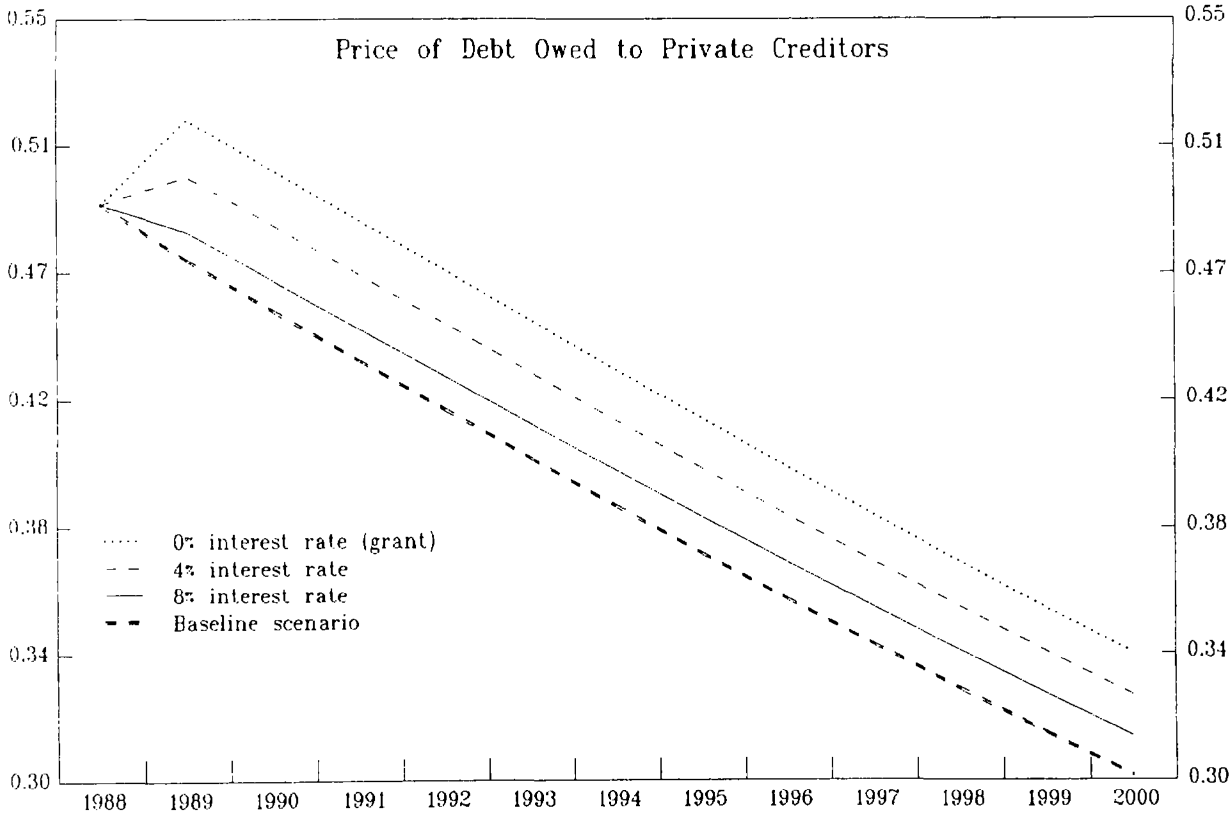
Buy-backs

	1989	1990	1991	1993	1995	2000	2010	2020
Baseline Scenario............................	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sim1 - 5% BB at 0% rate of interest (grant)...	2.68	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sim2 - 5% BB at 4% rate of interest...........	2.68	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sim3 - 5% BB at 8% rate of interest...........	2.68	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sim4 - 10% BB for 3 years; BB & IP nondisc....	5.88	5.88	5.88	0.0	0.0	0.0	0.0	0.0
Sim5 - 10% BB for 3 years; BB & IP disc.......	5.88	5.88	5.88	0.0	0.0	0.0	0.0	0.0
Sim6 - 10% BB for 3 years; BB disc. IP nondisc	5.88	5.88	5.88	0.0	0.0	0.0	0.0	0.0
Sim7 - 20% BB for 3 years; BB & IP disc.......	11.79	12.03	12.27	0.0	0.0	0.0	0.0	0.0
Sim8 - No IP for 5 years; BB disc.............	1.91	1.97	2.03	2.15	2.28	0.0	0.0	0.0
Sim9 - No IP for 5 years; BB nondisc..........	1.91	1.97	2.03	2.15	2.28	0.0	0.0	0.0

IP - interest payments to private creditors.
BB - buy backs.

Chart 1

One-time Buy Backs Equal to 5% of Existing Debt at Various Interest Rates
1988 to 2000



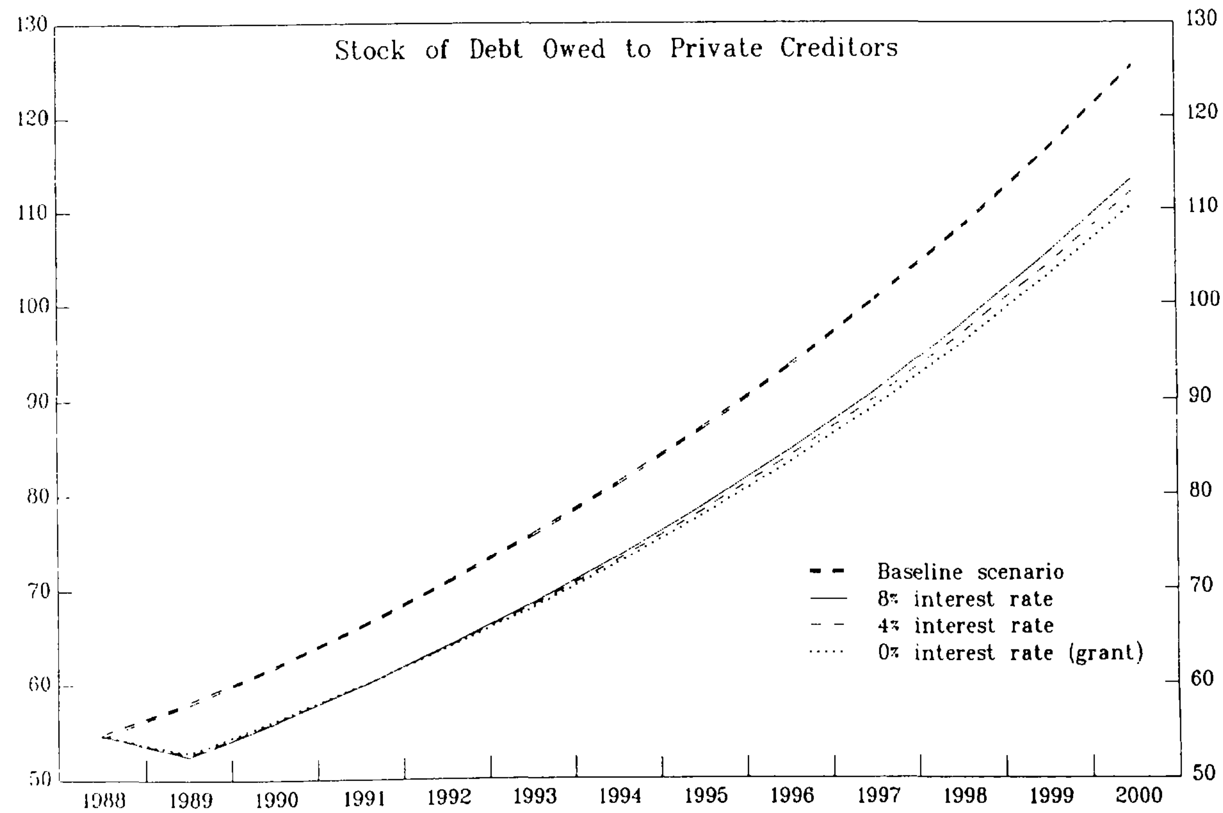
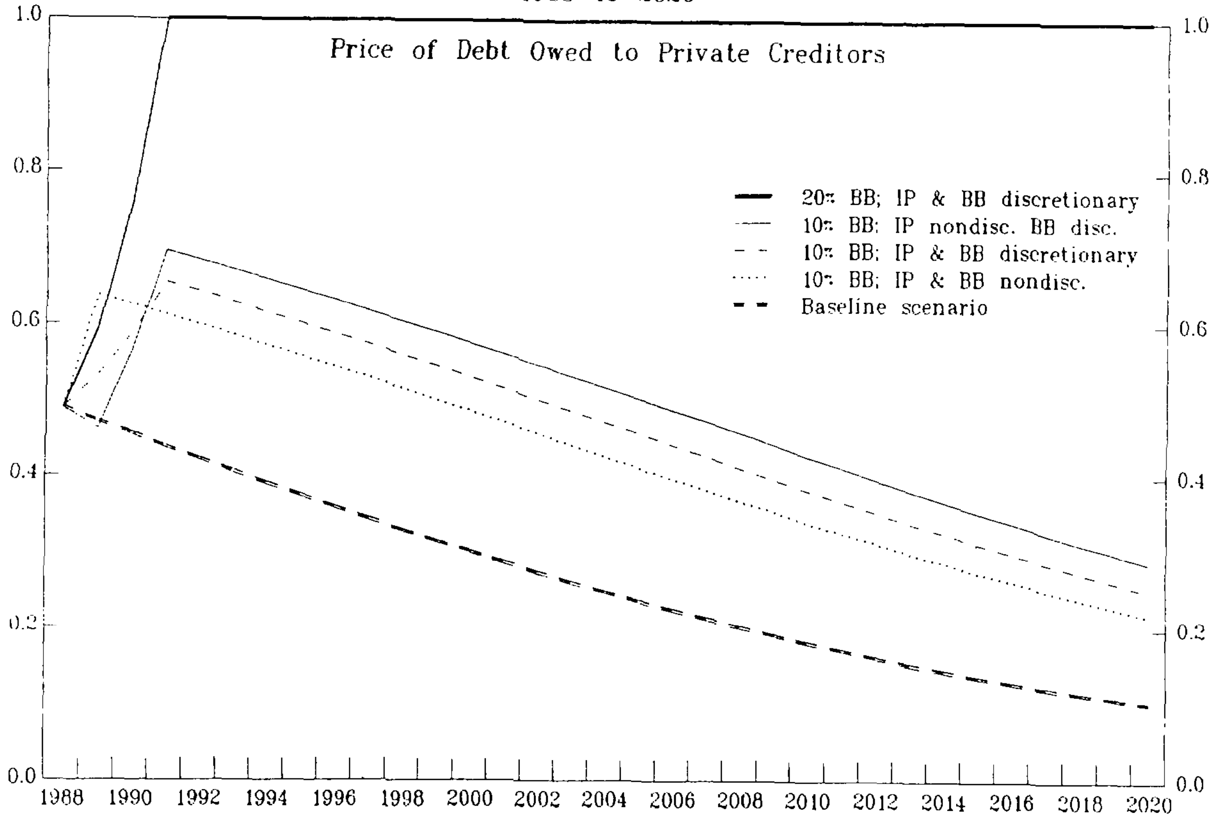
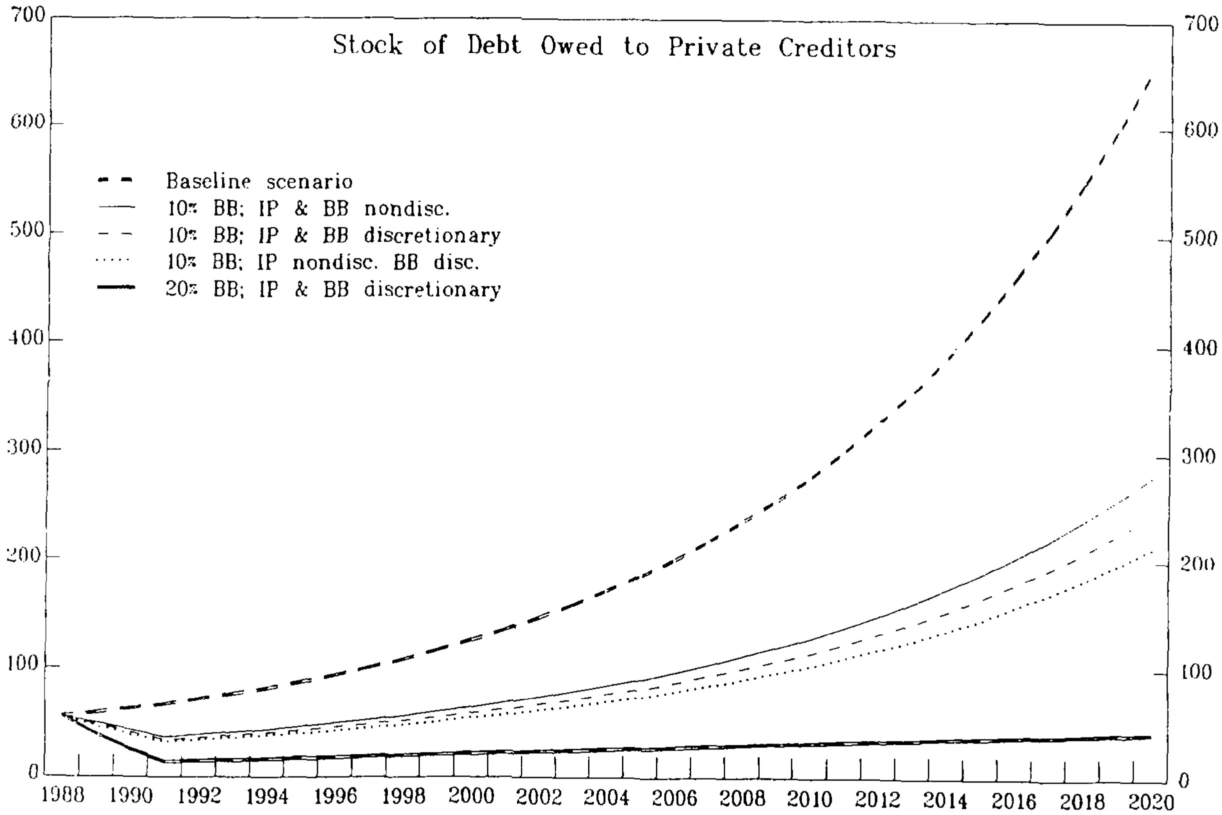


Chart 2

Buy Backs of Various Percentages of Existing Debt Occuring Over 3 Years
With Differing Debtor Discretion
1988 to 2020





use the future loans on something other than interest payments or buy-backs. However, when the time comes, the country uses these funds for buy-backs.

The differential impact of these assumptions is striking. The greatest amount of debt reduction is in the last of these simulations. Since private creditors know that their interest payments will be reduced, yet they do not anticipate buy-backs in the future, the price falls on impact enhancing the impact of the current period's buy-back. A similar story is true for the second year, and by the third year of the buy-back, the debt stock is substantially below the other two cases, and the price is higher. In contrast, full anticipation of future buy-backs in simulation 4, causes the price of debt to rise on impact, mitigating the benefits of the buy-back. The results of simulation 5 lie between these two cases. The lesson from these scenarios is that the optimal buy-back schemes are those that are not anticipated or those that are accomplished by precommitting to superior loans with no agreement that these funds must be used for buy-backs.

In the first six buy-back scenarios, the debt price shows a declining trend over the medium and long run. Since the stated purpose of the buy-backs is to put a debtor on the road to credit worthiness, we construct a scenario similar in design to the scenario 5, but search for the smallest set of three consecutive buy-back where the price path reaches par. As discussed in the theoretical section, if buy-backs and payments are fully anticipated and the price eventually reaches par, it must jump to par today. Only if unanticipated (discretionary) buy-backs occur in the future could the price level eventually reach par without jumping instantaneously to par. By simulating three consecutive buy-backs, each equal to 20 percent of the baseline debt stock, the price hits par in the third year. Somewhat smaller buy-backs (not shown) also produced a rising price path for the first three years, but since par was not attained in those buy-back scenarios, the price level monotonically approached zero. Also, as can be construed from the previous simulations, alternative buy-backs, but with different interest rates, can also bring about par.

In all of the previous simulations, the debt buy-backs were financed at concessional rates. In the final set of simulations it is assumed that the country does not borrow money, but rather withholds interest obligations to pay for the buy-backs. The buy-backs are spread out over six years and are equal to the full amount of funds that were used to make interest payments to private creditors (approximately equal to 20 percent of the existing debt but spread out over six years). In scenario 8, it is assumed that the country announces it will be withholding interest payments for six years, and will use these funds to buy-back debt. In scenario 9, they also announce that interest payments will be withheld, but make no promise about buy-backs past the current year. In contrast to the previous simulations, the decline in the present value of interest payments in simulation 9 is substantially greater than the debt reduction, and the price of debt falls, allowing for a larger amount of debt reduction. However, in later years, the debt price is above the baseline scenario since future interest payments are the same as in the baseline, yet the debt stock has been reduced. In contrast, the price of debt rises on impact in scenario 8 in spite of the withholding of interest payments because market participants realize that the future buy-backs will eventually raise the debt price which increases the current debt price.

Because the model needs future as well as past values of endogenous variables at every point in time, it is necessary to use an algorithm that solves forwards as well as backwards. The algorithm used to solve the model is based on the extended path technique popularized by Fair and Taylor (1983). The model is solved for almost 200 years in order to avoid the problem of arbitrary endpoints affecting the solution.

For contemporaneous buy-backs, the solution is a straightforward application of the Fair-Taylor algorithm and equation (11a) is used at every point in time to determine prices. This is used for the baseline and simulations 1-3. For the completely non discretionary growth simulation future buybacks are used in the present value calculation.

In the fifth and seventh simulation where interest and buy-backs are both assumed to be discretionary, the model is run three different times. To solve for the first year, only the contemporaneous buy-back and the impact of the first year's buy-back on future interest payments are imposed on the solution. The model is then simulated for all 200 years in order to get the results for only the first simulation period. However, when the second year arrives, the model is simulated again because of the additional buy-back, and again for the third year. For the sixth simulation, the model is again simulated three different times reflecting the discretionary assumption on the buy-backs. However, since we assume that it is known that the country will borrow money for all three years, (but the loans granted in years 2 and 3 may not be used for buy-backs), the amount of interest paid to the private creditors decrease by more than the interest on the first year's buy-back. In the simulation, we accomplish this by exogenously decreasing $T\phi$ by the amount of future loans granted in years 2 and 3 multiplied by i_{BB}. The model is then simulated for all 200 years. In order to calculate the actual second year effects, the model is simulated again with the second year's additional buy-back explicitly incorporated into BS and the interest effect of the loan in year 3 decreasing $T\phi$; and similarly for the third year.

The last two simulations use similar techniques regarding the discretionary, non discretionary assumption. However, in order to simulate the effects of buy-backs financed from existing funds, we assume that i_{BB} is zero and that $T\phi$ declines by the amount of the buy-backs.

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