THE MANAGEMENT OF SINKING FUNDS: THE WORLD BANK EXPERIENCE

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In May of 1991, the World Bank had among its liabilities twelve U S dollar-denominated sinking fund bonds, of which roughly $1 8 billion remained outstanding By August of 1992, all these securities had been retired through an active debt management program, which included both open market purchases and option exercise The actions taken in the management of one of these bonds, the 8 85s due 2001, are a good illustration of the complexity of sinking fund management

The option exercise decision poses a dilemma for the debt manager act too soon, and rates may continue to move favorably, fail to act, and rates may move away In the case of sinking fund provisions, the decision is compounded by interactions among multiple embedded options Exercise of one option today requires forfeit of the possibility of exercising another option tomorrow

State-of-the-art valuation technology rather than the traditional cash flow analysis is required to quantify the option value forfeited in the transaction The *refunding efficiency* — the percentage of the forfeited option value actually realized as savings — is the accepted approach to resolving the refunding dilemma, although its application to sinking fund bonds is more detailed than for ordinary callable "bullet" bonds (see Boyce and Kalotay [1979] and Howard and Kalotay [1988])

First we review the options embedded in sinking funds and discuss a conceptual framework for their management We then explore one option exercise decision made by the World Bank Interestingly, it was the first in the sequence of decisions made over that year and the decision in fact was *not* to transact

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I. SINKING FUND BONDS

Sinking funds are common to both long-term domestic industrial and gas pipeline bonds and preferred shares They are also found in many bank and finance bonds The sinking fund provides a mechanism for retiring an issue gradually over time, rather than in a single payment at maturity For example a thirty-year $100 million issue may have annual $5 million sinking fund payments beginning at the end of the eleventh year

The options embedded in a sinking fund bond afford the issuer substantial flexibility in the extinguishment of the debt (see Kalotay and Williams [1992]) The issuer may generally meet a mandatory sinking fund requirement either by making a cash payment in the specified amount or by delivering securities of equal face amount purchased in the open market This so-called delivery option can have great value in periods of high interest rates, when the issuer can make open market purchases at prices below par (see Dunn and Spatt [1984])

Sinking fund bonds typically carry a conventional call provision and may also have an acceleration option allowing the issuer to increase the mandatory sinking fund payment by some multiple When the multiple is two, the option is called a double-up In technical terms, the call provision is an American option struck at a declining premium to par, and the acceleration option is a sequence of non-cumulative European options struck at par

A typical industrial sinking fund bond has a thirty-year maturity, with 5% of the principal scheduled for retirement in each of years eleven through thirty Such a bond generally becomes callable at the end of year ten at a price of par plus half a year of interest The call premium then declines annually until year twenty, after which time the call price remains at par

The World Bank issues were atypical in some respects, with a twenty-five-year maturity and a call premium that declined in an unusual fashion — twice over a seven-and-a-half-year period Some of the bonds had large balloon or final payments The bond features are summarized in Exhibit 1

The seven bonds issued before 1971 had fourteen principal payments In the typical structure, the first payment was 2% of the total principal amount, with the next twelve payments each being 4%, so that the final payment was 50% of the total principal amount, although some bonds had slightly different amortization schedules

These bonds became callable at mid-life at a small premium to par, the typical first call price being 102 The call premium declined by half in year sixteen (i e , the typical call price declined to 101), and the bonds became callable at par in year twenty, so that all but one of these older bonds were by that time callable

EXHIBIT 1 ■ Overview of the U S Dollar-Denominated Sinking Fund Bonds Issued by the World Bank Outstanding as of 5/1/1991

Coupon	Maturity	Issue Date	Face Amount ($MM)	Amount Outstanding ($MM)	Current Call Price (% of Par)	Call Price Change Date	Next Call Price (% of Par)	Final Payment (% of Par)
5 375%	7/1/91	6/28/66	175 0	94 0	100 000			50
5 375%	4/1/92	4/14/67	250 0	125 0	100 000			50
5 875%	9/1/93	8/22/67	150 0	87 0	100 000			50
6 500%	3/15/94	3/21/68	150 0	87 0	100 000			50
6 375%	10/1/94	9/17/68	265 0	164 0	100 000			53
8 625%	8/1/95	7/23/70	200 0	132 0	100 000			50
8 125%	8/1/96	8/11/71	175 0	115 5	101 000	8/1/91	100 000	54
9 350%	12/15/00	12/10/75	250 0	180 0	102 750	12/15/91	100 000	8
8 850%	7/1/01	6/29/76	250 0	212 0	102 750	7/1/92	101 375	8
8 375%	12/1/01	11/17/76	250 0	220 0	102 500	12/1/92	101 250	8
8 250%	5/1/02	4/19/77	200 0	176 0	102 500	5/1/93	101 250	8
8 350%	8/1/02	7/19/77	250 0	240 0	102 500	8/1/93	101 250	8

at par These bonds had maturities staggered by five to twelve months beginning on 7/1/1991 and extending to 8/1/1996, a scheduled average life of 1 9 years, an average coupon of 6 71%, and outstanding face value of $800 million, $87 5 million of which was due on 7/1/1991

The remaining five bonds were issued after 1975 and had thirteen principal payments The first payment was 4% of the total principal amount, with the next eleven payments each being 8%, so that the final payment was again 8% of the total principal amount

These bonds became callable at 102 5 or 102 75 at mid-life The call premium declined by half in year sixteen, and the bonds became callable at par in year twenty These bonds also had double-up provisions — 100% acceleration options Maturities were staggered by three to seven months beginning on 12/15/2000 and extending to 8/1/2002, and the bonds had a scheduled average life of 5 6 years, an average coupon of 8 64%, and outstanding face value of roughly $1 billion

II. MANAGEMENT OF SINKING FUND BONDS

Debt managers can use the three types of options embedded in sinking fund bonds to reduce the cost of borrowing When rates are high, and bonds can be purchased at a discount, the delivery option comes into play When rates decline, the conventional call option allows the issuer to refinance all or perhaps only some of the outstanding bonds The acceleration option can also be applied when rates are low

Beyond exercising the contractual options, the issuer may make open-market purchases of bonds in anticipation of satisfying future sinking fund requirements In fact, issuers sometimes buy several years ahead when the price appears attractive If the issuer has some freedom in applying these bonds, this gives rise to a fourth option, the designation option (see Kalotay and Tuckman [1992])

When an issuer acquires bonds in excess of current requirements — whether by a partial call, exercise of the double-up, or open-market purchase — the bonds must be designated in a manner specified in the indenture (Finnerty [1983])

In the World Bank's case, bonds obtained through open market purchase may be held in treasury until designated by the Bank Those obtained through a conventional call can be designated against any payment, but the designation must be made at the time of the call, and those obtained via acceleration must be applied against the longest remaining sinking fund payment

Refunding Methodology: Savings and Efficiency

The contractual options embedded in a sinking fund bond may enable the issuer to reduce the cost of servicing the debt Those savings are generally expressed in terms of net present value

The contractual cash flows are unambiguously defined for a callable bullet bond, so appropriate measures of savings can readily be defined One accepted methodology is to discount the differential cash flows at individual "spot" or zero-coupon rates as determined from the issuer's non-call life yield curve

Any flexibility an issuer may have in applying bonds acquired against a sinking fund makes the definition of savings more elusive For example, the net present value savings resulting from satisfying a near-term payment tend to be smaller than those from meeting the balloon, *ceteris paribus* In practice the shape of the yield curve dictates which payment should be canceled to maximize the net present value savings

But savings provide only one side of the picture One must also take into account the optionality forfeited in the transaction Indeed, common sense says that, in general, an option should be exercised only if the resulting benefits provide adequate compensation for its forfeiture

For a bullet bond, the trade-offs are summarized by the notion of refunding efficiency, which is defined as

$$\text{Efficiency} = \frac{\text{Present Value Savings}}{\text{Forfeited Option Value}}$$

An option should definitely be exercised when the efficiency is 100%, but a risk-averse manager may act at an even lower level An appropriate cut-off can be determined by comparing the achievable savings against what could be realized by synthetic transactions in other markets We advocate 90% efficiency as the bare acceptable minimum Note that exercise of a contractual option cannot result in an efficiency in excess of 100%

The notion of efficiency can be extended to sinking funds by considering incremental rather than absolute effects

$$\text{Efficiency of Transaction} = \frac{\text{PV of Contractual Flows Before} - \text{PV of Contractual Flows After}}{\text{Total Option Value Before} - \text{Total Option Value After}} = \frac{\text{Present Value Savings}}{\text{Forfeited Option Value}}$$

It is important to recognize that the present value of the contractual cash flows after a transaction must include the *financed* cost of the refunded portion of the debt If the acquisition cost is funded with fairly priced debt, however, on a pre-tax basis the financed cost of a dollar is still a dollar, perhaps scaled up by transactions costs (Kalotay [1976])

Note that the designation of the bonds acquired through option exercise affects both numerator and denominator of the efficiency ratio The manager's objective should then be to maximize efficiency rather than net present value savings, and the determination of optimal designation may require some effort Thus it is the menu of available designation strategies and their corresponding efficiencies that dictates the manager's appetite for a particular refunding transaction

Valuation Technology

Bond valuation has progressed from discounting all flows at a single rate — the coupon on a new issue of matching maturity — through discounting each flow at its own zero-coupon rate to discounting all flows at appropriate volatility-dependent forward one-period rates In this latest technique, future interest rates are assumed to diffuse about the forward interest rate structure This allows the proper valuation of options in a consistent manner

The model we use begins with a volatility-dependent forward rate structure that is embedded in a discrete tree corresponding to an arbitrage-free set of future interest rate environments Valuation proceeds by backward recursion from the security's ultimate maturity, with cash flows — whether contractual or resulting from exercise of an option — discounted along paths connecting interest rate environments at one time with those at some earlier time For examples, see Black, Derman, and Toy [1990] and Kalotay, Williams, and Fabozzi [forthcoming]

EXHIBIT 2 ■ Data for the World Bank 8.85% Sinking Fund Bonds Due 7/1/2001

Issue Date	6/29/1976	Maturity Date	7/1/2001
Coupon	8 85%	Interest	
Face Amount	$250,000,000	Frequency	Semi-annual
		Amount Outstanding	$212,000,000

Call Schedule	
1/1/1989	102 750
7/1/1992	101 375
7/1/1996	100 000

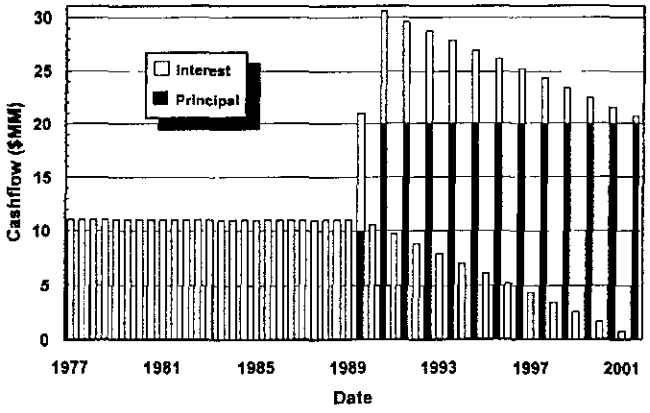
Sinking Fund Provisions
Acceleration 100%
Delivery Option

Amortization Schedule	
7/1/1989	$10,000,000
7/1/1990	$20,000,000
7/1/1991	$20,000,000
7/1/1992	$20,000,000
7/1/1993	$20,000,000
7/1/1994	$20,000,000
7/1/1995	$20,000,000
7/1/1996	$20,000,000
7/1/1997	$20,000,000
7/1/1998	$20,000,000
7/1/1999	$20,000,000
7/1/2000	$20,000,000
7/1/2001	$20,000,000

III. TO DOUBLE-UP OR NOT TO DOUBLE-UP. THE 8.85s OF 2001

In May of 1991, the World Bank treasury staff began to address the issue of whether to double-up the 7/1/1991 principal payment of the 8 85s due 2001 The terms of this bond are shown in Exhibit 2, with its contractual cash flows depicted in Exhibit 3 In months prior the Bank had purchased discount bonds corresponding to a little less than half of the impending mandatory $20 million payment Now interest rates had begun to fall, and the 8 85s were trading at a

EXHIBIT 3 ■ Contractual Cash Flows of the International Bank for Reconstruction and Development (World Bank) 8 85% Sinking Fund Bonds Due 7/1/2001



modest premium to par Indeed, in mid-May, bid-ask prices for the bond were 100 844-101 344

The World Bank informally discussed this problem with several Wall Street professionals who unanimously recommended that the Bank double-up on the next payment for the simple reason that exercising the double-up allowed the Bank to buy for 100 something the market valued at 101 Even better, they said, discounting at the Bank's cost of funds to the average life — 8 11% for five years — suggested net present value savings from doubling-up of around $600,000

None of these advisors addressed the issue of forfeited optionality, however When the Bank attempted to quantify the option value, it quickly became apparent that the answer depended on knowing which bonds would be canceled by exercise of the double-up The indenture provided the answer that the doubled-up bonds must be applied to the *back end* or balloon portion of the amortization schedule

Because the 8 85s were issued after 1975, and the last principal payment was itself $20 million, one immediate effect of doubling-up would be that the *de facto* maturity of the bond would fall one year earlier, in 2000

Because the acceleration option is exercised when rates are low relative to the coupon, it is easy to overlook the way its exercise affects the delivery option, which becomes valuable when interest rates are above the coupon and the market price is below par

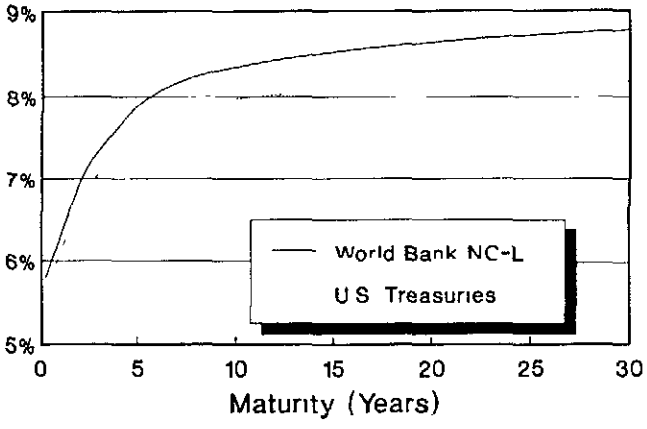
In general, when rates are high, investors lacking information to the contrary will expect to hold sinking fund bonds to maturity, and the longer the maturity, the lower the price In option valuation terms, the value of the delivery option is effectively the net present value of the discounts to par on future sinking fund payment dates, so a longer maturity leads to a more valuable delivery option Thus doubling-up reduces the value of the delivery option

The relationship between acceleration and the conventional call is more direct The risk now is that doubling-up precludes taking advantage of even lower refunding rates in the future But this can be quantified as the value of the call option on a bullet issue of the same maturity as the extinguished payment

In summary, acceleration reduces the values of both the call and delivery options The total call optionality is reduced by the value of a call option on the retired portion of the bonds, while the value of the delivery option is reduced because the shortened maturity will support the market price should rates rise above the coupon

The prevailing yield curve on 5/1/1991 is shown in Exhibit 4 Although the option exercise date was 7/1/1991, the indenture required that the trustee be notified of the decision by 6/1/1991, and internal approval required additional time While 5/1/1991 was the interest rate environment in which the decision was made, for simplicity, we evaluate the transaction as of 7/1/1991 under the assumption that rates

EXHIBIT 4 ■ On-the-Run Treasury Yield Curve and the World Bank's Non-Call Life Full-Coupon Yield Curve on 5/1/1991



remained unchanged until that date

The contractual outstanding amount on 6/30/1991 was $220 million bonds, but the Bank had been buying ahead, and the amount outstanding was $212 million bonds World Bank internal policy in effect at the time precluded the purchase of sinking fund bonds beyond current requirements, so that if the double-up were not exercised the amount outstanding on 7/1/1991 would be $200 million, if it were to be exercised the amount outstanding on that date would fall to $180 million

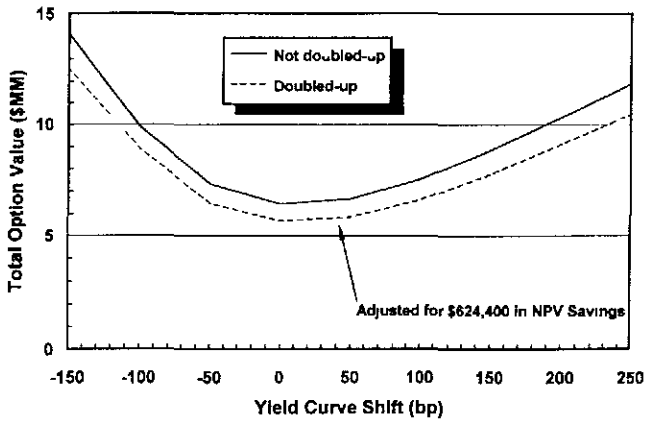
As indicated in Exhibit 5, the sinking fund bond valuation model used finds the option value forfeited by exercising the double-up to be $1 379 million About $0 543 million of this comes from the call option, and the remainder — $0 836 million — is the effect on the delivery option The net present value savings to be realized is only $0 624 million, so the efficiency of doubling-up is only 45 3% On this basis, the World Bank decided not to double-up on the sinking fund payment

On a pre-tax basis, the theoretical flat price represents both the value of the security to the investor as well as the expected cost to the issuer of servicing the debt Note how doubling-up would lead to an *increase* in the theoretical flat price, and thus a transfer of wealth from the World Bank to its lenders of 0 45 points on each of the remaining outstanding bonds

Exhibit 6 shows how the total option value embedded in the 8 85s behaves when the yield curve is subjected to an instantaneous parallel shift The calculations have been carried out under both scenarios — doubling-up and not doubling-up — and the net present value savings locked in by the exercise of the double-up have been added to the remaining option value The graph clearly indicates that no matter what rates do after 7/1/1991, the World Bank will be better off *not* having doubled-up The graph also shows how the call and delivery options — which are applied in opposite rate environments — act together to create a straddle on rates for the issuer

One year later, rates were sharply lower across the curve — the yield on the ten-year Treasury had fallen 90 b p , while the yield on the six-month bill had fallen 215 b p — and credit spreads had tightened considerably In this more favorable rate environment,

EXHIBIT 6 ■ Total Option Value Embedded in the World Bank 8.85s of 2001 After Instantaneous Parallel Shifts of the Yield Curve Used in the Study



Note Values are shown both with and without having doubled-up on the 1991 principal payment The option value for the case of having doubled-up has been increased by $624,400, the net present value savings locked in by the option exercise

EXHIBIT 5 ■ Analysis Results for the 8 85s as of 7/1/1991

	Per Bond Values						
Face Amount Outstanding	Theoretical Flat Price	Theoretical Option Value	NPV of Contractual Cash Flows	NPV of Contractual Cash Flows	NPV Savings	Theoretical Option Value	Forfeited Option Value
$200,000,000	100 281	3 219	103 499	$206,998,200		$6,437,200	
$180,000,000	100 731	2 810	103 541	$206,373,800*	$624,400	$5,058,000	$1,379,200

*Includes $20,000,000 cost of exercising the double-up option

Note The first line summarizes the valuation results under the assumption that the sinking fund payment is not doubled-up, while the second line represents the assumption that the payment is doubled-up Note that the net present value of the contractual flows after doubling-up includes the cost of purchasing (and financing) the $20 million balloon portion The efficiency of the transaction is then $624,400/$1,379,200 = 45 3%

the World Bank retired $40 million of the 8 85s at par through the sinking fund and double-up option, and called the remaining $160 million at 101 375 retiring the entire issue at a refunding efficiency of 100%

IV. CONCLUSIONS

Sinking fund bonds are a challenge for the active debt manager While their multiple interrelated options may provide opportunities to reduce the cost of debt, injudicious option exercise may squander valuable optionality The notion of refunding efficiency sees widespread application in the management of bonds with but a single embedded American option — callable bullet bonds being the most notable example The refunding efficiency model indicates when the intrinsic value of the option — the realizable net present value savings — dominates its incremental time value

We have extended the notion of refunding efficiency to sinking fund bonds, where refunding transactions typically retire only a portion of the outstanding debt The appropriate signal is sent when the realizable savings would provide adequate compensation for the optionality to be forfeited by the debt manager's action

The World Bank applied the techniques we have illustrated as it extinguished some $1 8 billion of sinking fund debt in 1991 and 1992 As the financial press noted, the Bank liberalized its internal policies to allow more aggressive actions by its debt managers, particularly with regard to open-market purchases of high-coupon debt

ENDNOTE

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