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Callable Bonds: Better Value Than Advertised?

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Callable bonds have been around since the dawn of the industrial age. Today, issuers of such bonds view the call feature as a way to manage interest rate risk (as we do in the bulk of this article). But that was not the original purpose of the feature. An industrial corporation would issue bonds to raise capital to build a plant and would anticipate servicing the debt from production revenues. But what if the plant burned down? Insurance would cover the loss of the plant, but not the remaining debt service. The solution was to make the bonds callable and use the insurance payment to cover the cost of redeeming the bonds.

However, alert treasurers began to use the same provision for a different purpose—namely, to reduce interest expense when rates declined. From an investor's perspective, having the bonds prematurely redeemed in a low interest rate environment is fundamentally different from having the bonds redeemed due to an event unrelated to interest rates. The former puts the investor in the position of having to reinvest at lower rates. As a result, it became necessary to distinguish between the permitted uses of call options. Bonds with these options were either strictly callable or callable and refundable. Those that were strictly callable could not be replaced with lower-cost bonds.

Unfortunately, the distinction did not turn out to be as clearcut as intended. In a landmark 1983 case, some investors sued Archer Daniels Midland after it called its 16% non-refundable bonds, arguing that the bonds had been de facto refunded. The case, which was eventually settled in ADM's favor, established that the "non-refundable clause" was not legally enforceable.[1] Since then, issuers and investors have become accustomed to the call provision being used for any purpose, including refunding to take advantage of lower interest rates. And, of course, investors charge for this flexibility—in the form of a higher coupon rate on a callable bond than on an otherwise comparable noncallable bond.

What if the borrower needs to be able to retire debt prematurely as, for example, in the case of a merger? Nowadays, the standard way to accommodate this eventuality is with a "make whole" provision. In essence, a make-whole call allows the issuer to redeem its bonds at or close to the price of Treasury bonds of the same maturity. Because of their superior credit, Treasury bonds are always worth more than like corporate bonds, and thus investors could never suffer a loss of value when such a call is exercised—in fact, they are likely to gain. As a consequence, investors charge little if anything for a make-whole provision.

In this article we confine ourselves to callable bonds that provide issuers with a valuable option they can use in managing their interest rate risk. If rates decline, this option benefits the issuer by allowing it to refund at a lower coupon. If rates rise, investors benefit from having received a higher coupon than they would have had for a noncallable, or optionless, bond.

Callable Bonds Today

In the U.S. at present, government-sponsored enterprises (GSEs) such as Fannie Mae, Freddie Mac, the Federal Home Loan Banks, and the Federal Farm Credit Banks are by far the largest issuers of callable bonds. Among other uses, the call options serve as a hedge against the prepayments of mortgages and loans held on their asset side. Meanwhile, in the tax-exempt (municipal) market, most bonds maturing beyond ten years are callable. Tax-exempt issuers tend to get a good deal with these structures because less sophisticated investors generally undercharge for the option.

In the taxable bond market, however, the volume of callable corporate bonds as a percentage of total issuance has been declining steadily during the past two decades. This decline can be attributed to several factors. First, in the 1970s and '80s, bonds issued by regulated utilities—telephone and electric company 30- or 40-year maturities, usually callable at a premium after five- or ten-years—dominated the long end of the corporate market. Today, utility issuance represents a much smaller percentage of the corporate market.

The second reason is the globalization of the bond market. While the U.S. has a long history of callable bonds, overseas investors, shunning reinvestment risk, have shown much less appetite for them. The inclusion of a call feature in a global bond offering would likely jeopardize its success.

A third reason is the emergence of option valuation technology. Even though callable bonds have been around for a long time, the theory needed to value them properly (the

1. *Yale Journal on Regulation*, January 1, 2006.

Figure 1 **10-Year Treasury Rates**

so-called "arbitrage-free valuation" approach) was not introduced until the mid-'80s. Until then, there was no rigorous way to determine how much to charge for a call option or when the right time was to exercise it. (The Black-Scholes stock option valuation model, published in 1973, was of limited use for bonds.)[2] It had been a widely held opinion that call options were a good deal for the issuer (that is, investors undercharged for it). But, as things turned out, from the end of World War II until the mid-'70s, interest rates generally headed upward and there was little or no opportunity to benefit by refunding a long-term bond callable after five years (see Figure 1). In fact, the first opportunity to benefit from lower rates did not arise until mid-1976, when high-coupon bonds issued in 1970 could be economically refunded.

Once the theory to determine the "fair" value of the call option became generally accepted by professionals, many believed that there would be no further incentive to issue callable bonds. But, in fact, as we shall see, differential tax treatment between issuer and investor continues to provide an incentive for companies to issue callable bonds.

The final reason for the declining volume of callable bonds is the emergence of interest rate derivatives. Today one can create a callable bond synthetically by issuing a noncallable or optionless bond and overlaying an appropriately structured interest rate derivative, such as a swaption, which is purchased from a bank. The payoff pattern of a swaption is similar to that of a call option: the issuer benefits if swap rates decline.

But this synthetic structure is an imperfect substitute for a callable bond, because swap rates and the issuer's borrowing rates may not move in tandem, giving rise to "basis risk." An even more important concern is the cost: because the bank that sells the swaption acts as a principal, to earn a profit it must charge more than the fair value of the instrument. In addition to proper software, the valuation of interest rate derivatives requires market information that is available only to the most sophisticated financial institutions; most issuers cannot independently determine the value of a derivative. The predictable consequence of this uneven playing field is that banks tend to promote transactions that use derivatives rather than conventional embedded options.[3]

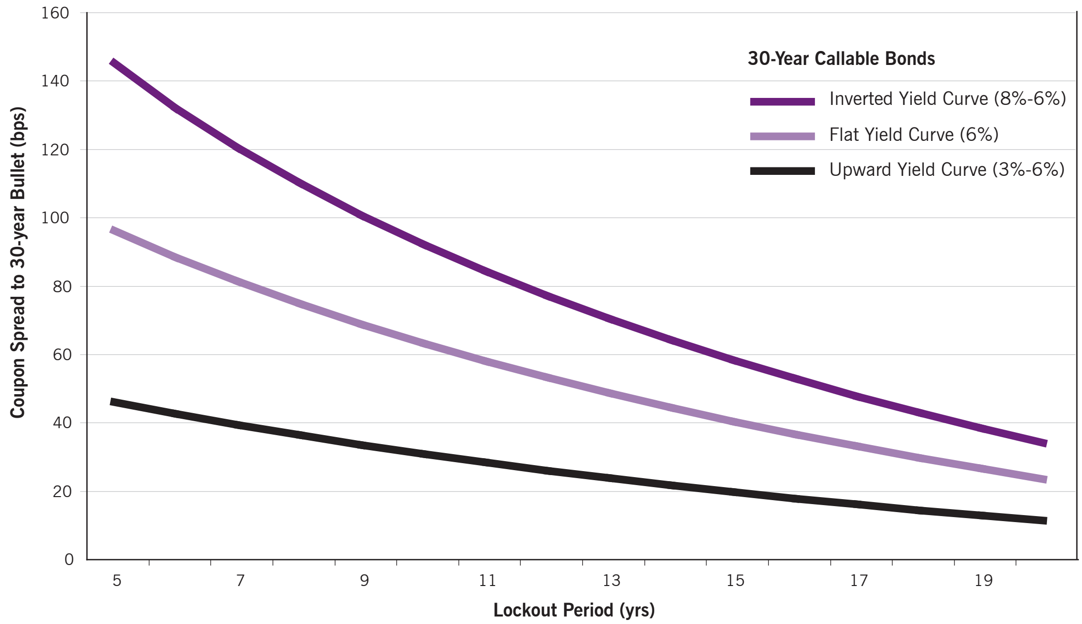
Topics Considered

As mentioned above, today there is an accepted analytical approach for valuing callable bonds. The basic idea is to decompose a security into simple components (for example, a callable bond can be broken down into a collection of interest and principal payments plus a call option), value each component, and obtain the value of the security by summing the parts. Thus the value of a callable bond equals that of the underlying optionless bond less the value of the call option. There are two main inputs required to value a callable bond: (1) an optionless yield curve appropriate for the credit and (2) an estimate of interest rate volatility. The yield curve determines the value of the underlying optionless bond. The volatility describes possible evolutions of the yield curve over

2. See Kalotay, A. J. (1993) "The Sure Thing – Bond Refunding: How Operations Research Made Its Mark on Wall Street," *OR/MS Today*, April.

3. For an example of this, see Kalotay, A. J., and Abreo, L., "Putable/Callable/Reset Bonds: Intermarket Arbitrage with Unpleasant Side Effects," *Journal of Derivatives*, Summer, 1999.

Figure 2 **Yield Curve Shape and Lockout Length Have Pronounced Effect on Call Premium**



time (that can be represented as an "interest rate tree"). The higher the volatility, the wider is the dispersion of rates on the tree and the greater is the value of the option.[4]

In the rest of this article, we will examine the two key considerations related to callable bonds. The first concerns how much a call option should cost in terms of the incremental coupon over the optionless rate, and whether it makes sense for the borrower to accept this extra cost. The second is how to determine the best time to exercise a call option.

The Cost of the Call Option

By how much should the fair coupon of a callable bond exceed that of an otherwise identical optionless bond? The answer depends on the maturity of the bond and on the specifics of the call option (lock-out period, call price schedule). It should obviously increase with maturity, decrease with length of lockout period, and decrease as call prices increase. The answer also depends on market inputs: the level and shape of the issuer's yield curve, and interest rate volatility. Volatility increases the probability that rates decline to lower levels prompting investors to demand a higher coupon. The shape of the yield curve indicates the expected trend of interest rates. An upward sloping curve conveys the market perception that rates are more likely to increase than to decline. But if rates increase, the option will not be exercised. Therefore when the yield curve is upward sloping, the call option should cost less than when the curve is flat, not to mention downward sloping.

Let us briefly discuss the appropriate interest rate volatility. First, for option valuation purposes, the relevant volatility is that implied by the prices of "similar" securities (market volatility)—historical volatility is irrelevant. Second, the volatility varies over time. For example, when short-term rates are low, the implied (log normal) volatility is likely to be high. Third, volatility depends on the issuer's credit: in general, the better the credit, the higher is the volatility. Fourth, volatility is market-specific: all other factors being the same, the volatility in the taxable market is higher than in the tax-exempt (municipal) market.

As mentioned above, the better the issuer's credit, the higher is the volatility and therefore the greater will be the cost of the call option. Just how high can volatility go? We can obtain an upper bound from the derivatives market: the implied volatility of a callable bond will never exceed that of a like cancelable swap (or swaption). The implied volatility of a large callable bond issued by a strong credit, say a housing agency, will be close to that of a like swaption.

But why should the implied volatility decline for weaker credits? It's easiest to see this by considering the low-rated end of the credit spectrum. As the probability of default increases, so does the cost of borrowing: the yield of a BB-rated bond is much higher than that of one rated AAA. In the case of the BB-rated bond, the investors' primary concern is loss of

4. Kalotay, A. J., Williams, G. O. and Fabozzi, F. J. (1993) A Model for Valuing Bonds and Embedded Options, *Financial Analysts Journal*, 49, 35–46.

Table 1 **Pre-Tax Value of 30NC10 Bond**

Date	Cashflow	Disc. Factor	Spot Rate	Present Value
2/5/2009	3.43	0.97087	6.00	3.33
8/5/2009	3.43	0.94260	6.00	3.23
2/5/2010	3.43	0.91514	6.00	3.14
8/5/2010	3.43	0.88849	6.00	3.05
8/5/2018	3.43	0.55368	6.00	1.90
2/5/2019	2.50	0.53755	6.00	1.34
8/5/2019	2.50	0.52189	6.00	1.30
2/5/2038	2.50	0.17483	6.00	0.44
8/5/2038	102.50	0.16973	6.00	17.40
Total				**100.00**

Table 2 **After-Tax Value of 30NC10 Bond**

Date	Cashflow	Disc. Factor	Spot Rate	Present Value
2/5/2009	2.13	0.98174	3.72	2.09
8/5/2009	2.13	0.96381	3.72	2.05
2/5/2010	2.13	0.94621	3.72	2.01
8/5/2010	2.13	0.92893	3.72	1.98
8/5/2018	2.13	0.69171	3.72	1.47
2/5/2019	1.55	0.67908	3.72	1.05
8/5/2019	1.55	0.66668	3.72	1.03
2/5/2038	1.55	0.33712	3.72	0.52
8/5/2038	101.55	0.33096	3.72	33.61
Total				**98.41**

principal through default. They are unlikely to be disappointed by an early redemption, even though it limits their upside. Consequently they charge less for the option (implying a lower volatility).

To gain an appreciation of the cost of the call option, let's consider 30-year bonds with various lockout periods. Figure 2 shows the fair call premium in terms of incremental coupon for three yield curve scenarios, each anchored in Year 30 at 6%. The volatility is 12% and the call price is always at par. As predicted, the call option always costs less when the curve is upward sloping than when it is inverted. For example, if the bond is callable in Year 5, the cost is about 45 basis points if the yield curve slopes upward from 3% to 6%. Under a flat 6% yield curve scenario, the cost is 95 basis points. If the yield curve were sloping downward from 8% to 6%, the cost would be 144 basis points. The graph also illustrates the effect of lockout on call premium. For example, under the flat scenario a 30NC5 (30-year bond callable at any time after 5 years) costs 33 basis points more than a 30NC10.

Tax Considerations

The above results were based on the assumption that investors do not pay income taxes. This assumption is customary and reasonable since institutional investors in taxable bonds are pension funds and mutual funds. For such investors, the just-cited coupons of the callable bonds are fair in the sense that the value of the callable bond is the same as that of an optionless bond with a lower coupon.

But what if the issuer is a taxable corporation? There is no reason to assume that the issuer should also be indifferent between callable and optionless bonds. In fact, taxes provide a clear incentive in favor of callable bonds. As demonstrated in a 1979 paper[5]—and as we will show here—what is a fair coupon for the investor can be a bargain for the issuer.

After-tax Valuation

We begin with a high-level description of after-tax bond valuation. There are two reasons why the pre-tax and after-tax values should be different in general: cash flows and discount rates. As will be clear in the example below, there is no reason why pre-tax flows discounted at pre-tax rates should equal after-tax flows discounted at after-tax rates.

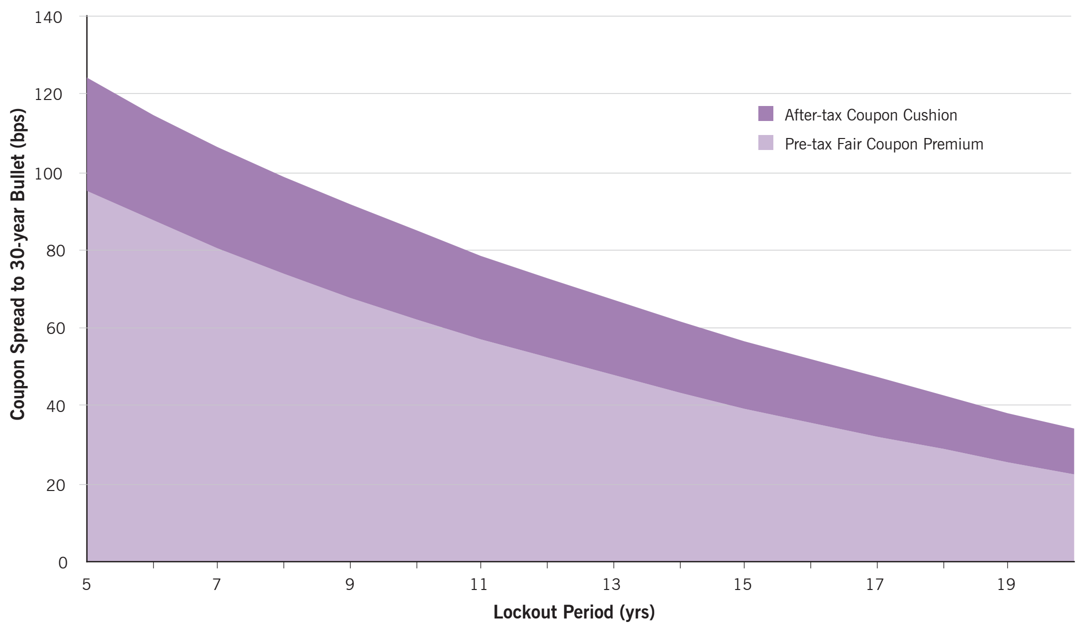
In the case of bonds, interest expense is tax deductible (as is the amortized original issue discount, not considered here). As in any capital budgeting project, the appropriate discount rate is the risk-adjusted cost of capital. From the perspective of the borrower, bond refunding is a risk-free project because the resulting savings are certain (ruling out the possibility of default). Therefore the appropriate discount rate is the marginal after-tax cost of debt—in essence, the current after-tax borrowing rate.

Each cash flow should be discounted using the appropriate spot rate. The after-tax rate is the pre-tax rate reduced by the tax rate. For example, if the issuer's tax rate is 38%, the after-tax rate corresponding to a 6% pre-tax rate is 3.72% (6 x (1 - 0.38)).

Taxes Favor Callable Bonds: Example Assume that the current 30-year optionless rate is 6% and that ten years from now the 20-year rate is certain to be 5%. What is the fair coupon on a 30-year bond callable at par ten years from

5. Boyce, W. M. and Kalotay, A. J. (1979b) Tax Differentials and Callable Bonds, *Journal of Finance*, 34, 825-38.

Figure 3 **After-tax Advantage of 30-Year Callable Bonds***



*Requires after-tax lattice-based valuation (available from specialized software vendors).

now? The reader can confirm that it is 6.86%. As shown in Table 1, the 6.86% bond is called after 10 years and replaced with a 20-year 5% bond. Every cash flow is discounted at 6%, compounded semi-annually, giving a present value of par. (The use of proceeds from the new bonds to pay for the called bonds in Year 10 is a "wash" and therefore not shown.)

In Table 2, we discount the after-tax cash flows at the after-tax discount rate. Both the cash flows and the discount rate are calculated by reducing the pre-tax values shown in Table 1 by the tax break of 38%. For example, pre-tax interest of 3.43 (6.86% semiannually) is represented as 2.13. Similarly, the pre-tax discount rate is reduced from 6% to 3.72%. The resulting after-tax value of the 30NC10 bond is 98.41% of par. Comparing this to the after-tax value of a fair optionless 30-year bond, which is 100 (cash flows of 3.72/2 + principal, discounted at 3.72%), we see that the callable bond of this example has an after-tax advantage of 1.59% of par (100 - 98.41).

Quantifying the Tax Incentive

In the previous section we displayed the fair coupons of various callable bonds. Let us now consider the same bonds from the perspective of a taxable issuer. We will limit the discussion to the case where the yield curve is assumed to be 6% flat, the interest rate volatility is 12%, and the issuer's marginal tax rate is 38%.

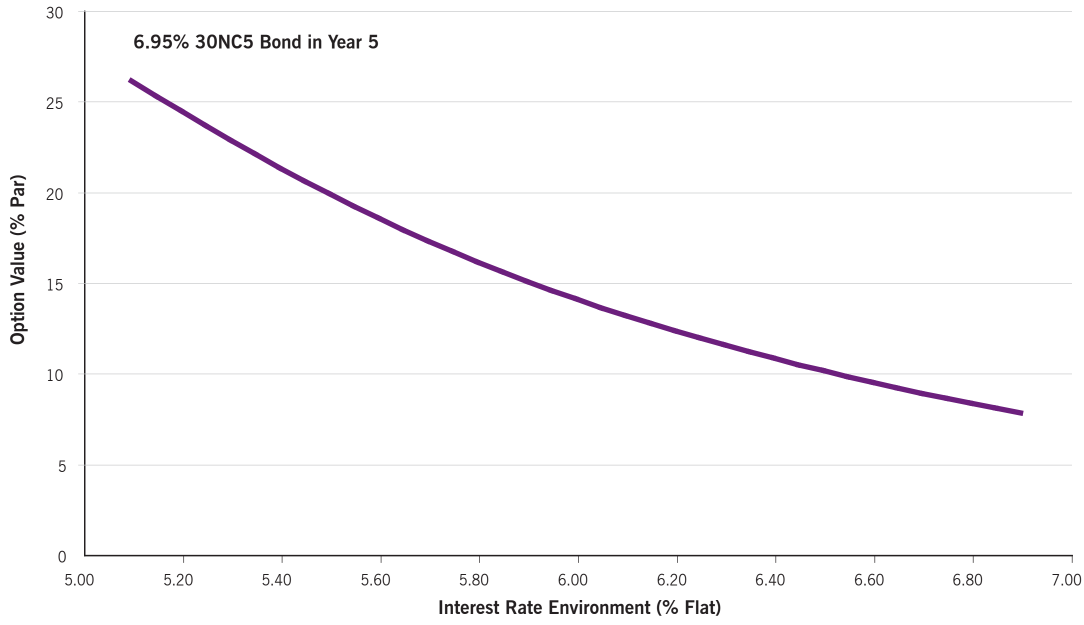
As before, the after-tax value of a 30-year 6% optionless bond is 100. The coupon of a callable bond whose after-tax value is 100 will obviously be higher than 6%, the question is by how much. Figure 3 below shows the required spreads, both pre-tax (as in the flat 6% scenario in Figure 2) and after-tax. We observe that the after-tax spread is always higher than the pre-tax spread and that the difference is quite substantial when the lockout period is short. For example, when the bond is callable after five years, investors may demand only 95 basis points, while a tax-paying issuer has "wiggle room" of another 30 basis points. In other words, on an expected value basis, a 30NC5 callable bond with a spread anywhere between 95 and 124 bps would be beneficial to both investor and issuer over a fairly priced optionless bond.

Optimal Bond Calling

Until now our focus has been on the cost of the call option, in terms of the number of basis points investors charge for this feature in excess of the optionless rate. When the borrower issues a callable bond, it agrees to pay this excess coupon, but in turn acquires an asset whose value can be determined precisely using standard, widely accepted calculation methods.[6] Like any other financial asset, the call option in essence can be "marked to market." Of course, because the call option is embedded in the bond, we can determine only its fair (theoretical) value; it

6. Kalotay, A. J., Williams, G. O. and Fabozzi, F. J. (1993) A Model for Valuing Bonds and Embedded Options, *Financial Analysts Journal*, 49, 35–46.

Figure 4 **Value of Call Option Increases as Rates Decline**



does not have an independently observable market price. The value of the option depends on the same variables that determined its original cost: the borrower's (optionless) yield curve and interest rate volatility. As the yield curve and volatility change over time, so does the value of a given call option. The lower the borrower's yield curve and the higher the volatility, the larger will be the value of the call option.

The value of the call option can be extracted synthetically or "monetized" at any time through an appropriate derivative transaction.[7] However in this paper we will consider only the call decision. It is useful to monitor the value of the call option at all times, but it becomes critical to do so once the option becomes exercisable. By calling, the borrower forfeits the opportunity to refund the same bond in the future, possibly under more favorable conditions, and therefore it is important to know the value of what is being given up.

Let us consider a 6.95% 30NC5 bond in Year 5, just when the option becomes exercisable. (The coupon of 6.95% is that shown in Figure 2 under a flat 6% yield-curve scenario.) Figure 4 shows the value of the call option under various interest rates scenarios. (For simplicity we assume the shape of the yield curve remains flat.) The option value, positive even if rates exceed the bond's coupon of 6.95%, increases substantially as interest rates decline below 6%. For example, if the prevailing refunding rate is 5.75%, the value of the call option is 16.62% of par. The issuer can thus be aware of the value of the asset being given up if it decides to call and refund at this rate.

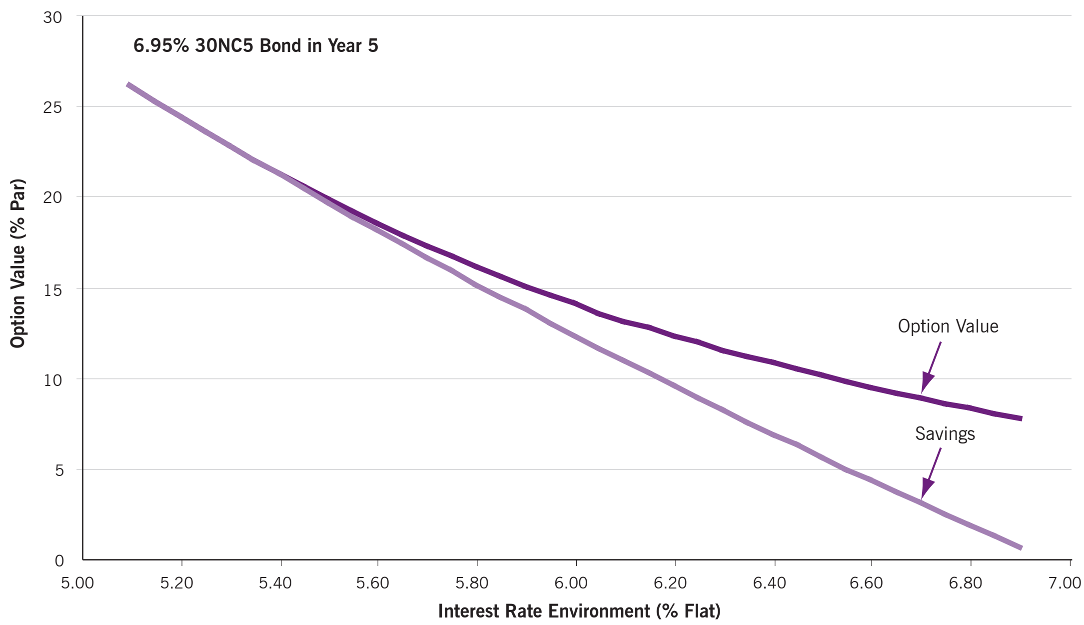
Under the same assumptions, we can calculate the savings from refunding. We assume that the refunding bond is an optionless maturity-matched bond—in this case, a 25-year bullet. (But, as we will discuss below, there is no compelling reason to confine the analysis to such a restrictive structure.) Figure 5 overlays the savings on the corresponding option value shown in Figure 4. We observe that when interest rates are high, the option value exceeds savings by a relatively large margin; but as rates decline, the savings asymptomatically approach option value and the two lines meet at roughly 5.33%.

In considering whether or not to refund a bond, some borrowers tend to focus only on how much is saved—for example, for a bond with 25 years remaining to maturity, they may set a target such as 5% NPV. But, as Figure 5 makes clear, such savings are by no means free: in exchange, the borrower forfeits the future exercise opportunities afforded by the call option. The refunding transaction should be a good trade in the sense that the present savings are adequate compensation for giving up the option to realize even greater savings in the future. The recommended way of quantifying adequacy is to use the concept of refunding efficiency (that I helped develop in 1979):[8]

7. Kalotay, A. J. and Williams, G. O. (1993) How to Succeed in Derivatives without Really Buying, Journal of Applied Corporate Finance, Fall.

8. Boyce, W. M. and Kalotay, A. J. (1979) Optimum Bond Calling and Refunding, *Interfaces*, 9, 36-49.

Figure 5 **Savings Should Be Compared to Forfeited Call Option**



$$\text{Refunding Efficiency} = \frac{\text{PV Savings}}{\text{Option Value}}$$

The refunding efficiency corresponding to various new issue levels is shown in Figure 6. While efficiency can never exceed 100%, it can reach this level when rates decline sufficiently.

Refunding in the Real World

The textbook refunding analysis assumes that the refunding issue matches the maturity of the issue being called and that it is optionless. Under these restrictive assumptions the cash-flow savings are locked in; therefore the refunding transaction has no interest-rate risk. But there is no practical or theoretical reason to refund with an optionless maturity-matched bond. In fact, maturity is usually extended, and housing agencies routinely refund with bonds that are also callable. Our recommendation is that the structure of the refunding issue should be dictated by liability portfolio management considerations—and that the terms of the outstanding issue are largely irrelevant.[9]

But refunding with an arbitrary structure introduces a new consideration: interest rate risk. Suppose, for example, that a bond with ten years left to maturity is refunded with a 30-year bond. Whether or not this turns out to be a good decision depends on the course of interest rates. Extending the maturity will be seen as a wise decision if rates subsequently rise, but not if they decline. Similarly, making the replacement bond callable (at a higher coupon) will look good only if rates decline.

The notion of efficiency can be extended to arbitrary refunding structures using the following formulation:[10]

$$\text{Generalized Refunding Efficiency} = \frac{\text{PV Savings}}{\Delta\,\text{Option Value}}$$

Note that in the "textbook" case, the generalized efficiency reduces to the older formula. Also, if the refunding bond is callable, its coupon will be higher and therefore the cash-flow savings will be less. On the other hand, the option embedded in the refunding bond is a valuable asset that partially offsets the value of the option forfeited by calling the outstanding bond. The reduced denominator reflects net loss of option value.[11]

Suboptimal Calling

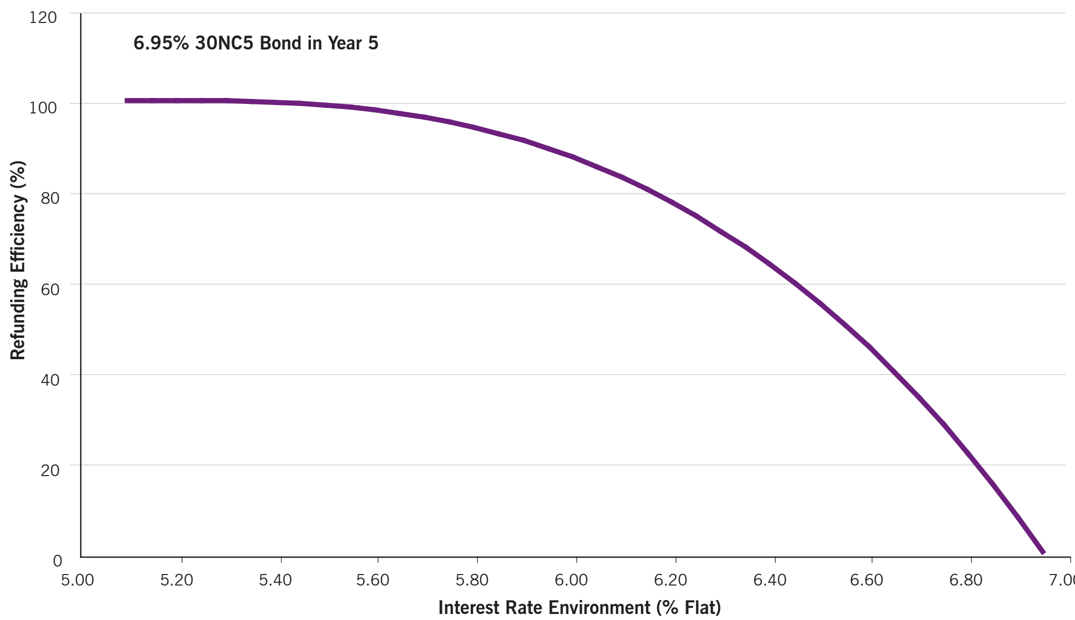
As discussed above, the optimal time to exercise the call option is when efficiency reaches 100%. Following this recommendation does not guarantee success every time; for example, rates could decline further after the bond has been

9. For a discussion of liability management performance measurement, see Kalotay, A. J. (2005), A Framework for Corporate Treasury Performance Measurement, *Journal of Applied Corporate Finance*, 17, 88-93.

10. Kalotay, A. J., Yang, D. and Fabozzi, F. J. (2007) Refunding Efficiency: A Generalized Approach, *Applied Financial Economics Letters*, 3, 141–6.

11. As an aside, we observe that generalized refunding efficiency is applicable to situations beyond the bond world. One interesting application is to determine if it makes sense to refinance a residential mortgage. Kalotay, A. J., Yang, D. and Fabozzi, F. J. (2007) Optimal Mortgage Refinancing: Application of Bond Valuation Tools to Household Risk Management, *Applied Financial Economics Letters*, 3, 141–6.

Figure 6 **Refunding Efficiency Plateaus at 100% As Rates Decline**



called. But it is the right way to play the odds. By following the optimal policy, we can expect, on average, to extract the full value of the option.

There are two basic ways to deviate from the optimal policy: "leapers" refund when the efficiency is below 100%, and "laggards" keep on waiting for rates to drop even when the efficiency reaches 100%. Leapers are risk averse; they are willing to lock in savings below the value of the forfeited option. In contrast, laggards are risk lovers; they are willing to keep on paying a rate that is considerably higher than the prevailing market level while hoping to hit a home run later down the road.

How much money does a suboptimal policy leave on the table? While the answer depends on several factors, including the terms of the call option, the general conclusion is that, on average, leaping is less wasteful than lagging.[12]

Transaction Costs

In the examples above, we did not consider the transaction costs associated with calling and refunding. In fact, these issuer costs can be substantial. The largest component is the underwriting fee/selling concession of the refunding issue, which varies between 0.5% and 1% for long-term investment grade bonds. There are additional fixed costs that arise in the course of calling, including rating fees, legal expenses, and management time and effort. Because transaction costs reduce the value of the call option, their potential impact should be considered and quantified at the time of issuance. For example, if the issue size is small, the fixed transaction costs could overwhelm any potential savings; in such cases issuing a callable bond would not make sense.

Table 3 **"Automatic Refunding"**

TVA Ratchet Bond Rate Reset History

Year	6.75's of 2028 30-Yr CMT + 94bps	6.50's of 2029 30-Yr CMT + 84bps
2003	5.952%	Still in lockout
2004	Unchanged	5.618%
2005	5.490%	Unchanged
2006	Unchanged	Unchanged
2007	Unchanged	Unchanged
2008	5.460%	5.174%

Is there any way to capture the benefit of the call feature and eliminate the cost associated with refunding? In an article published earlier in this journal, we proposed a ratchet structure that offers a solution.[13] The coupon of a ratchet bond is tied to an index, such as the 30-year Treasury rate, plus a

12. This question was considered in Kalotay, A. J. (2006) When It's Time to Get off the Tree, *Financial Engineering News*, November/December.

13. Kalotay, A. J. and Abreo, L. (1999) Ratchet Bonds: Maximum Refunding Efficiency at Minimum Transaction Cost, *Journal of Applied Corporate Finance*, 12, 40-7.

spread. The coupon is reset periodically, say annually, but only if the reset formula results in a lower coupon; otherwise it remains the same. Table 3 shows the history of the two Tennessee Valley Authority ratchet bonds.

Conclusion

Callable bonds, which have been around for a long time, are useful for managing the interest rate risk of an issuer's debt portfolio. Investors demand a higher coupon than on comparable optionless bonds. Today, there are generally accepted tools to calculate the fair coupon premium for callable bonds with precision. Importantly, due to the tax differential between corporate issuers and institutional investors, callable bonds can be mutually attractive; the issuer can afford to pay a higher than fair coupon and, on an after-tax basis, still be better off than issuing a bullet with the same maturity.

We have also considered the optimal exercise of the call option. The recommended approach is to call the bond when the "refunding efficiency" reaches 100%. This happens when savings from calling equals the loss of option value.

Finally, we discussed the effect of transaction costs associated with refunding. These costs, which reduce the value of the call option, should be taken into account both at the time the bond is issued and when it is refunded. Ratchet bonds provide an elegant way to retain the benefit of callable bonds without the transaction costs associated with refunding.

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