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Option Modeling for Leveraged Finance Part I

*Although high yield bonds and bank loans can provide attractive yields, one must properly account for the additional credit risk borne by the investor. This task becomes even more complex when the bond or bank loan is callable. Existing standard models for computing option-adjusted spreads (OAS), such as those found in Bloomberg's yield and spread analysis (YAS) screen, account for the interest rate optionality, but assume that credit spreads remain constant. Such models provide reasonable results for most investment grade bonds, but in today's high yield market—where credit spreads routinely account for the majority of the bond's yield—we believe a call is most likely to be driven by a tightening of the spread. To **properly** model the value of embedded optionality in high yield bonds and bank loans, we have developed a framework that considers both interest rate and spread movements and also accounts for defaults.*

This paper is the first of a two-part series where we begin by providing a brief background on the high yield bond market and show that, indeed, the proportion of high yield bonds that are callable is large and that it is imperative that the high yield bond investor models the call feature appropriately. We follow that with a description and demonstration of the model, and show that accounting for spread risk when analyzing high yield callable bonds can lead to an average decrease of 60 bps in option adjusted spread. Part II of this series will cover a Q&A with the Portfolio Managers who apply the model on a daily basis.

Modeling Callable Instruments In The High Yield and Bank Loan Markets

The current low interest rate environment has attracted significant attention to the high yield bond and bank loan markets. Although the higher yield that these asset classes provide make them attractive, one must properly account for the additional risks borne by the investor. Large proportions of high yield bonds are callable and almost all bank loans are callable and floating-rate. While bond investors have dealt with callable bonds for years, the commonly available analysis tools were designed with fixed-rate, investment-grade bonds in mind. These models typically hold spreads constant, they do not model defaults, and they assume that any callability will only be triggered by changes in Treasury or swap yields.

By definition, a high yield bond or leveraged bank loan is rated BB or lower, which means the investor is subject to non-trivial credit risk as well as the typical interest rate risk borne by high grade bond investors. This additional credit risk is reflected in higher and more volatile credit spreads. Further, the additional volatility increases the value of embedded options in callable high yield bonds and bank loans. To overcome limitations of existing models, and allow us to better analyze high yield bonds and bank loans, we have developed a model that simultaneously considers both interest rate and spread movements, and also accounts for defaults.

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Modeling The Call Option Matters

Before addressing the issue of analyzing callable bonds and loans, it is useful to consider why modeling the optionality in callable bonds is so important, and why it is especially relevant to the high yield market.[1]

THE HIGH YIELD BOND MARKET

(As of June 28, 2013)

	Count	Market Value (B)	Yield to Worst	Average Life
Callable	931 (66.2%)	$537 (64.4%)	6.6%	3.9
NonCallable	476 (33.8%)	$296 (35.6%)	5.1%	7.2

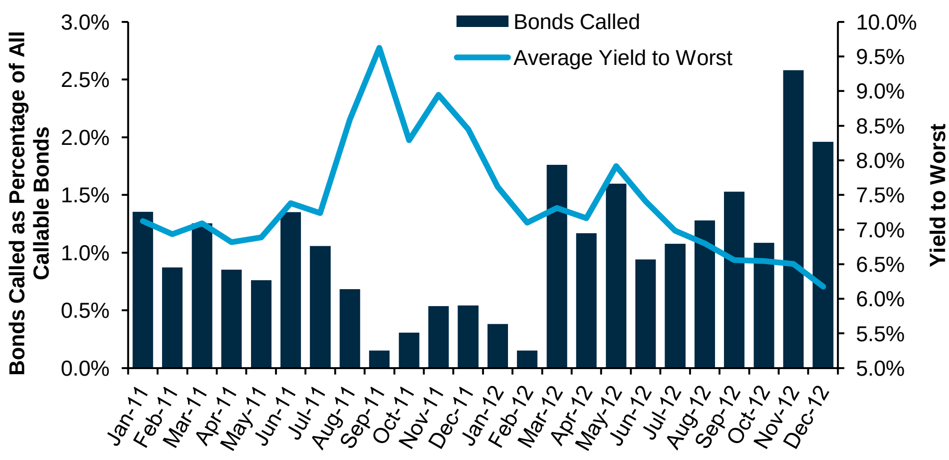
Source: Barclay's US High Yield 1% Issuer Constrained Index.

The table above shows a brief summary of statistics for the high yield bond market. At first glance, it appears that callable bonds represent a better investment because of the higher yield-to-worst. However, we should take care to recognize the significant, one-sided risk of callable bonds. When the yield on the bond decreases, price appreciation is limited by the strike price of the call option, and the expected life of the bond decreases. Conversely, when the yield on the bond increases, price depreciation is not limited and the expected life of the bond increases. Clearly neither of these outcomes bodes well for the investor in the callable bond, so we feel that it is imperative that this risk be accounted for when pricing the callable bond.

We can get a feel for the sensitivity of the call risk to changes in yield. As the chart below illustrates, the fraction of bonds called seems to increase as yield decreases and vice-versa.

RELATIONSHIPS BETWEEN BONDS CALLED AND YIELD

(2011-2012)



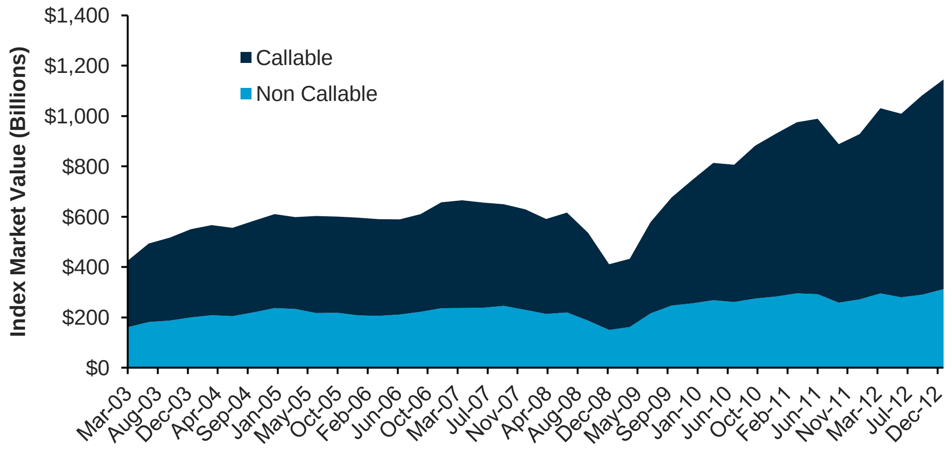
Source: Barclays' US High Yield 1% Issuer Constrained Index (Yield), Pramerica Fixed Income (# Bonds called).

Further examination of the high yield bond universe shows additional important specifics as is illustrated in the following chart—we can see that 66% of the market value of the high yield universe is composed of callable bonds and that there has been a strong recent increase in the proportion of callable bonds outstanding since 2009. Given the large proportion of the callable bonds in the high yield bond universe and the significant risk of the call option, we believe it behooves the high yield investor to appropriately consider the call option when evaluating these bonds.

[1] *We use the Barclay's US High Yield 1% Issuer Constrained Index universe, as of 6/28/2013. The following conditions are used to filter the bonds: 1) Fixed coupon, 2) American style call schedule or not callable, 3) S&P rating CCC- or higher, 4) average life greater than 0.5 years and 5) OAS less than 1500 bps. In total, 1407 bonds are used.*

HIGH YIELD MARKET VALUE COMPOSITION—CALLABLE VS. NON-CALLABLE BONDS

(March 2003 – December 2012)



Source: Barclay's US High Yield 1% Issuer Constrained Index.

Model Description

When we consider investing in corporate bonds or loans, we would generally like to know the spread they offer in compensation for their credit risk as well as their sensitivity to moves in credit spread and interest rates, typically expressed as durations. High yield bonds, for the most part, are issued as fixed rate bonds with a call schedule. Leveraged loans usually have coupons that are floating at LIBOR plus a spread, they are callable at par after a short period of mild call protection, and about half of recently issued loans have embedded LIBOR floors. The presence of these options make it difficult to calculate and interpret credit spreads as well as credit spread and interest rate durations. Existing standard models, such as those found in Bloomberg's YAS screen, account for the interest rate optionality, but ignore the often much more significant optionality with respect to credit spreads. We believe they also do not properly account for default risk when valuing the embedded options.

Callable High Yield Bond Example

Identifier:	BOND A
Coupon:	7.625%
Maturity:	11/15/2022
Call Schedule:	5/15/2017 @ 103.81
	5/15/2018 @ 102.54
	5/15/2009 @ 101.27
	5/15/2010 @ 100.00

Callable Bank Loan Example

Identifier:	LOAN A
Libor Spread:	300 bps
Libor Floor:	0.75%
Maturity:	9/30/2020
Call Schedule:	3/31/2014 @ 101.00
	9/30/2014 @ 100.00

In the development of an arbitrage free model to analyze high yield bonds and leveraged loans, we believe the incorporation of stochastic interest rates, stochastic credit spreads, and jump to default risk is essential. The model should provide estimates of the option adjusted spread (PRU-OAS), the option adjusted interest rate duration (PRU-OAD), and the option adjusted spread duration (PRU-OASD) for instruments with embedded call and/or interest rate floor options, and should be able to explicate the value of these embedded options in terms of upfront points or running spread.

Following is a description of the thought process considered at Pramerica Fixed Income for the development of a proprietary arbitrage free model.

Interest Rate Component

Our model takes the initial default-free yield curve as a starting point, such that deterministic cash flows not subject to default risk will be valued the same as in other financial analyses. We fit a parametric model to interest rate swap quotes, which produces a closed form expression for the forward rate curve. The assumed term structure dynamics around this curve are, in our view, stylized and simple—rates can basically go up or down, in near-parallel shifts of the yield curve, only adjusted for convexity effects. The volatility of interest rates is chosen to be in line with the market for caps, floors, and swaptions of relevant maturities.

Credit Spread Component

We take as the starting point an existing structural credit model that we fit to more than three thousand issuers' CDS and/or bond price data daily. If the issuer in question already has a credit curve fit we will use this, otherwise we will start with a generic credit curve fit based on the issuer's credit rating. In either case, there is a single parameter in the credit model, related to the expected rate of growth of the value of the issuer's asset, that we will calibrate in such a way that the model value equals the market price for the instrument we are analyzing. Given the absence of observable option prices for single name credit spreads, we recommend using credit spread volatilities in line with historical observations, typically in the order of 40%-60% of the credit spread level.

Default Component

Along with the stochastic evolution of interest rates and credit spreads in the model, we also account for the possibility that the issuer may undergo an event of default. In this case, investors in the instrument we analyze will receive a recovery amount, given as a certain fraction of par. The likelihood of a default event taking place is nearly proportional to the credit spread at a particular point in time (technically, we model the dynamics of the local risk neutral hazard rate, that is the default probability at a point in time, given that no default has yet taken place).

Model Calibration and PRU-OAD

We calibrate the model in such a way that its valuation agrees with the market price. In doing so, we take the perspective of the issuer and solve for an exercise policy of the embedded call option that minimizes the present value of the issuer's liability. We obtain the PRU-OAD by making a small parallel change in the initial yield curve and recalculating the value of the bond. This duration will typically be shorter than that of the corresponding bullet bond, reflecting the possibility of early redemption in scenarios where rates and/or spreads have dropped to make refinancing attractive.

Calculating PRU-OAS and PRU-OASD

Now that the model has been calibrated, we calculate the sensitivity of the callable bond or loan to the parameters of the credit model. Given these sensitivities, we construct a replicating portfolio of cash and positions in hypothetical non-callable bonds or loans with various terms up to the maturity of the callable bond, such that the replicating portfolio matches the credit model sensitivities of the callable bond. We take the PRU-OAS to be the spread duration dollar weighted average of the spread of the bonds or loans in the portfolio. We take the PRU-OASD to be the market value weighted average of the spread duration of the bonds or loans in the portfolio.

Valuing The Call Option

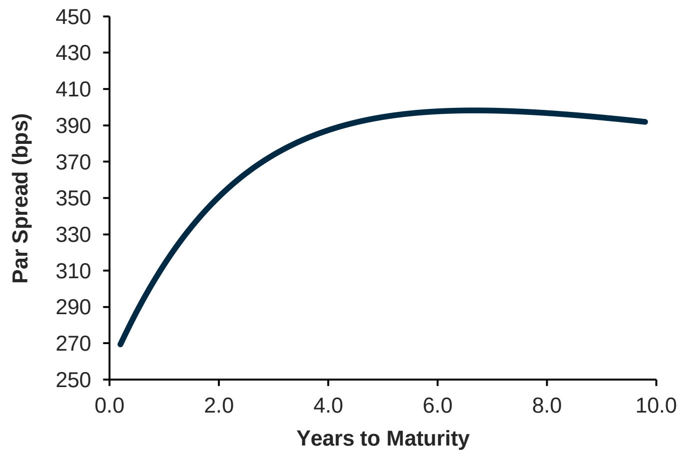
In order to get a sense of how much the call feature is worth, we could of course compare the market value of the callable bond to that of the bullet bond with the same maturity and coupon. However, callable bonds are often simplistically treated by traders as if they were bullet bonds maturing on the call date that minimizes yield or spread, and as such are sometimes referred to as "yield-to-call" bonds. To determine this call date, we start by asking the question: if the issuer had to commit to a particular call date relying only on today's information ("pre-committed call"), which would they choose? Having solved this problem, we calculate the corresponding model value, which will generally be higher than that of the freely callable bond. The difference between the two values is the "time value" of the call option—the value of the option to wait for the optimal time to call.

Spread Risk Significantly Increases Option Value

We have argued that the credit risk of high yield bonds significantly contributes to the value of the optionality in callable bonds. To make the case, we analyze the example bond and loan in detail and quantify the effect on option-adjusted values of modeling the credit risk. We also analyze a subset of the high yield bond universe[1] using the proposed model and compare the PRU-OAS with the traditional OAS obtained from Barclays.[2]

The exhibits below show the model analytics for Bond A. We can see that modeling the credit spread dynamics results in a reduction in the OAS of 50bps.

CALIBRATED PAR BOND SPREAD CURVE FOR ISSUER OF BOND A

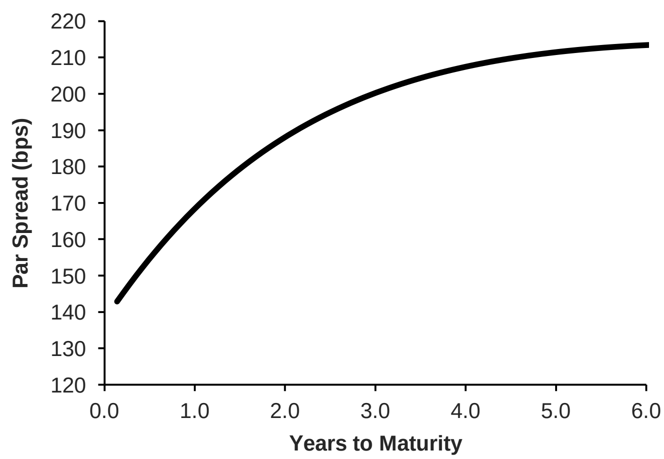


Identifier:	Bond A
Market Price:	$107.00
Traditional OAS:	**465 bps**
Traditional OAD:	5.9 years
Model Analytics	
PRU-OAS:	**415 bps**
PRU-OASD:	5.8 years
PRU-OAD:	4.6 years
Time Value:	$4.91

Source: Pramerica Fixed Income.

The following exhibits show the model analytics for the Loan A. We can see that modeling the credit spread dynamics results in an PRU-OAS of 208 bps (110 bps lower than the OAS), which is roughly what a non-call 2 year loan would earn, according to the fitted spread curve. This, plus the fact that the loan has a PRU-OASD of around 3.1 years, implies that this loan has significant probability of being called before 3 years.

CALIBRATED PAR LOAN SPREAD CURVE FOR ISSUER OF LOAN A



Identifier:	LOAN A
Market Price:	$100.00
Traditional OAS:	**318 bps**
Traditional OAD:	4.7 years
Model Analytics	
PRU-OAS:	**208 bps**
PRU-OASD:	3.1 years
PRU-OAD:	1.0 years
Time Value:	$1.82

Source: Pramerica Fixed Income.

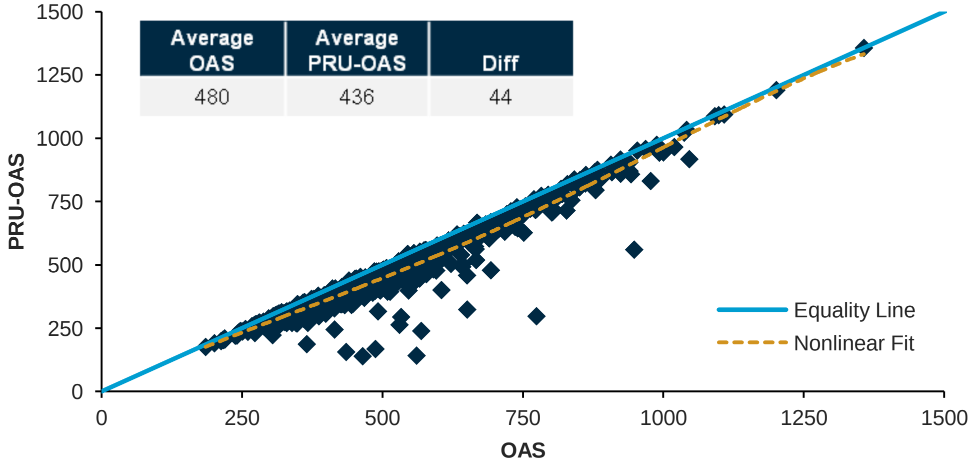
1 *We use the Barclays US High Yield 1% Issuer Constrained Index universe, as of 6/28/2013. The following conditions are used to filter the bonds: 1) Fixed coupon, 2) American style call schedule or not callable, 3) S&P rating CCC- or higher, 4) average life greater than 0.5 years and 5) OAS less than 1500 bps. In total, 1407 bonds are used.*

2 *The traditional OAS considers interest rate volatility but not spread volatility or default risk.*

The figure below shows a scatter plot of PRU-OAS vs. OAS for all the callable bonds analyzed.[1]

COMPARING PRU-OAS VS. OAS

(June 28, 2013)



Source: Barclays US High Yield 1% Issuer Constrained Index. PRU-OAS: Pramerica Fixed Income.

The vertical distance from the "equality line" is the additional time value of the option associated with the additional spread risk modeled in the PRU-OAS vs. OAS. Two patterns clearly emerge. First, we can see that the PRU-OAS is always lower than the OAS[2], which is expected as the time value of the call option should increase when properly accounting for the credit optionality. Second, we can see how the difference is not uniform across different levels of OAS. The difference converges to zero as the OAS approaches zero or increases beyond 1200 bps. This is also not surprising as the call option becomes deep in the money when the OAS approaches zero and deep out of the money when the OAS gets "large." On average, the PRU-OAS is 44 bps lower than the OAS.

In Conclusion

- Currently, over 66% of the high yield bond market is callable. This proportion has been trending higher the last few years and can be reasonably expected to remain high.
- We present a model that provides estimates of option adjusted spread (PRU-OAS), option adjusted interest rate duration (PRU-OAD) and option adjusted spread duration (PRU-OASD) for instruments with embedded call and/or interest rate floor options, and also explicates the value of these embedded options in terms of upfront points or running spread.
- We show that for high yield bonds the average PRU-OASD was 44 bps lower than the average OAS as of June 28, 2013.

1 We use the Barclay's US High Yield 1% Issuer Constrained Index universe, as of 6/282013. The following conditions are used to filter the bonds: 1) Fixed coupon, 2) American style call schedule or not callable, 3) S&P rating CCC- or higher, 4) average life greater than 0.5 years and 5) OAS less than 1500 bps. In total, 1407 bonds are used.

2 In some cases, the calculated PRU-OAS may be slightly higher than the OAS due to differences in interest rate assumptions and/or issues of numerical precision.

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