Primer on Callable Zeroes and Vol

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We discuss hedging of callable zero coupon notes and its possible impact on vol.

Callable zeroes and vol

Before we delve into the properties of a callable zero coupon note, and how it is hedged, let us address why it is important for vol investors.

Like any other callable security, a callable zero (as it is commonly called) embeds optionality. But these are long-term notes and therefore accompany supply of long-dated options. By nature, longer-dated options have large vega and so issuance of a callable zero coupon note delivers a large amount of vol to the option market.

Admittedly, the option supply from callable zeroes is only one factor driving the vol market, but in the absence of other factors, this supply could weigh on the vol market and the skew.

With this motivation, let us dig further. First, we discuss the basic terms of the note with an example and how the optionality ends up with the Street. Then we lay out the issuance trends. And finally, we discuss how the embedded optionality is hedged.

Piyush Goyal
+1 212 412 6793
piyush.goyal@barcap.com

www.barcap.com

Nuts and bolts

Basic terms

First, consider a straight zero coupon note.

To compensate for the zero coupons of these notes, they trade at a discount to redemption value. For example, a 30y zero coupon security with $100 redemption value might be purchased for $20. Conversely, a zero coupon security with an initial price of $100 might be redeemed at $500. The size of discount primarily depends on the (remaining) maturity and the IRR of the note. For example, the initial price of a 30y zero coupon note is substantially lower than a 10y zero coupon note. And IRR is simply the rate at which the note accretes from the purchase to the redemption price. For the note described above, the IRR = 5.511%[1].

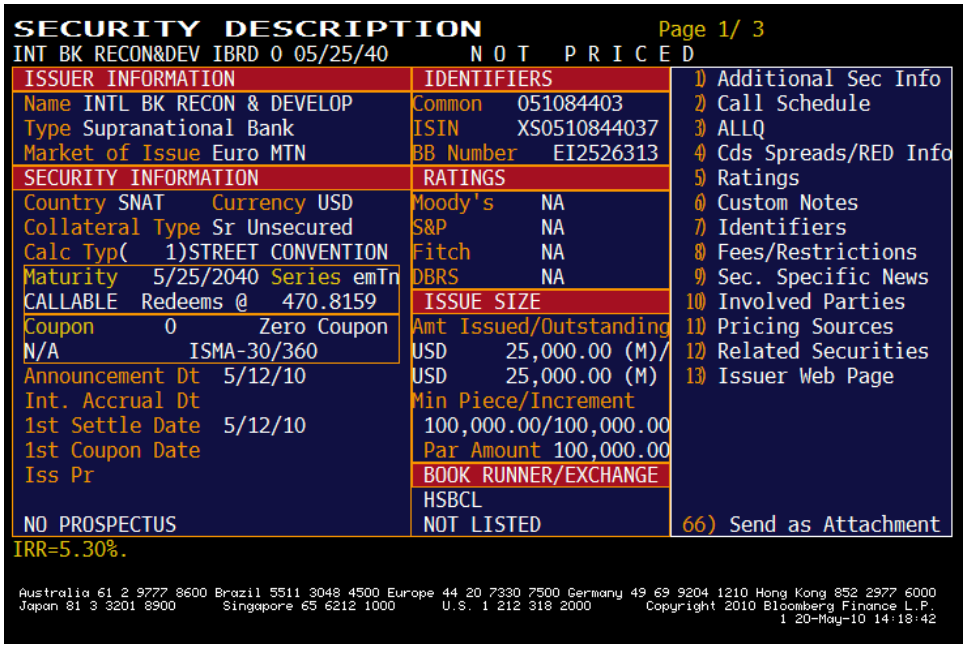
Next, let's add callability to the zero coupon note (a callable zero).

The difference between a bullet zero coupon and a callable zero coupon is that the issuer has the option to redeem (call) the security before final maturity, under favourable circumstances. Since the security can be called before the final maturity, it has a redemption schedule. The best way to understand the nitty-gritty of callable zero is to consider an example, which we do next.

An example

One can view and track details of zero coupon note issuance on Bloomberg.

For example, a callable zero issued by IBRD with details as shown in the figure below can be viewed by typing EI252631 Corp DES <Go> on Bloomberg.



Source: Bloomberg

[1] $100 = $20*(1+5.511%)^30

This is a 30y zero coupon note that is non-callable only for the first year and redeemable at $470.8159 in thirty years. Given the initial price of $100 and the final redemption price of $470.8159, the note has an IRR of 5.30%.[2] Accordingly, the issuer can redeem the security at specified dates as shown below.

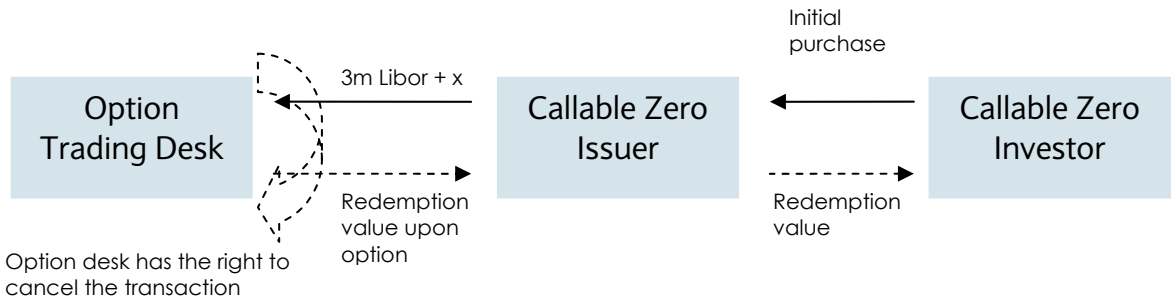
Source: Bloomberg

From an issuer's perspective, this is initial and final funding of $25mn and $117.704mn, respectively ($117.704mn = $25mn x $4.708159).[3] In other words, the issuer receives $25mn at issuance and, if redeemed in thirty years, has to return $117.704mn.

From callable zero to vol

To reduce the cost of funding, the issuer can sell the optionality to an option trading desk. And this is how the callable zero and the vol market become interconnected. In practice, the issuer can execute a callable swap with the desk, with dynamics as shown in the figure below.

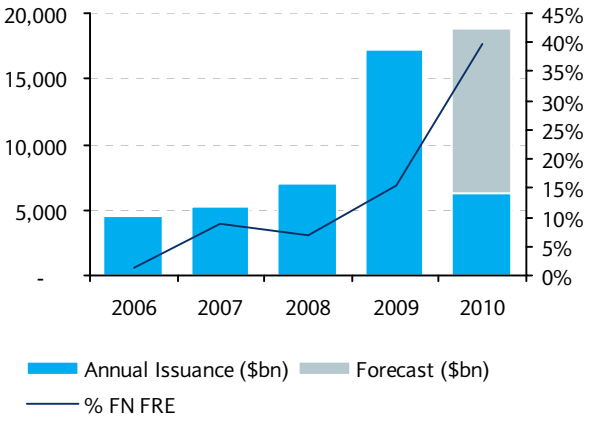
By taking the other side of the callable swap, the option trading desk ends up being long options. In order to examine the nature and size of the optionality, let us look at the issuance trends.



[2] The IRR is the annual rate at which the note accretes. At 5.30%, the note would accrete to $105.30 (=$100 x (1+5.30%)) in one year, and $110.8809 (=$100 x (1+5.30%)^2) in two years.

[3] Final Notional = Initial Notional x Redemption Price

Figure 1: Strong pickup in callable zero issuance



Source: Bloomberg

Figure 2: Most of these notes are 30y NC 1y

		Term (yrs)			
Non Call Period	Initial Notional ($mn)	5	20	30	Total
	6m	723	16	1,053	1,791
	1y	57	859	12,785	13,702
	2y	-	-	598	598
	3y	166	-	899	1,065
	Total	946	875	15,336	17,156

Source: Bloomberg, Barclays Capital

Issuance trends

A few things are noteworthy about the issuance of callable zero coupon notes.

One, the issuance has picked up lately. About $17bn in initial notional was issued during 2009 (Figure 1). The issuance continues to be high in 2010. At the current pace, we estimate the 2010 issuance could equal that in 2009, or may even be more. A simple explanation for the surge in issuance is the increasing investor appetite for these securities given the lack of yield (and spread) in other asset classes. High vol allows investors to pick extra yield and achieve higher yield targets. A steeper curve also increases the investor interest in such notes.

A variety of financial institutions issue callable zeroes. But investors who are wary of issuer's credit risk can mitigate the credit risk (at least the perception) embedded in these notes via purchasing only those issued by US agencies such Fannie Mae and Freddie Mac, which have US government support.

Two, a typical note matures in 30y and is non-callable for the first year. The breakup of the 2009 issuance by term and non-call period is shown in Figure 2. Almost all the notes (89%) mature in thirty years and are non-callable for the first year only (80%). A similar trend is observed for issuance in 2010 and other years.

Hedging, in practice

So a typical callable zero, as discussed above, can be represented by a 30y note non-callable for the first year. If the issuer sells the callability of the note via a callable swap, the option desks receive a supply of 1y X 30y high-strike Bermudan options.

Three features of these options are noteworthy: these are 1) long-dated; 2) Bermudan; and 3) high-strike.

By virtue of being long-dated, the embedded options have large vega sensitivity, for example, $100mn 30y non-call 1y callable zero embeds ~ $1.5mn log vega. The figure below shows the bucketed vega sensitivity of a $100mn initial notional 1x30 Bermudan receiver swaption.

Figure 3: Bucketed vega sensitivity of a $100mn initial notional 1x30 Bermudan receiver swaption

Expiry \ Tails	2	5	10	15	20	30
3m	0	0	0	0	0	-1
6m	0	0	0	0	0	-1
1y	-911	-6,944	-12,115	-27,395	-47,967	**218,531**
2y	-1,925	-12,524	-20,867	-46,097	-83,109	**304,304**
5y	-5,494	-30,918	-48,976	-105,540	**186,276**	**379,015**
10y	-2,462	-13,355	-20,764	-44,536	**212,604**	0
15y	-4,930	-26,746	-41,894	**273,728**	0	0
20y	-8,646	-47,058	**292,980**	0	0	0
30y	**93,903**	0	0	0	0	0

Source: Barclays Capital

The supply could manifest itself as downward pressure on vols

The supply ends up with active hedgers like dealers if the option market is unable to find a home for these options. Dealers typically sell a combination of 1y*30y, 10y*20y, 15y*15y and 20y*10y European swaption to neutralize the vega sensitivity.

As detailed in Appendix A, the overall demand for optionality has been smaller than the supply over the past few months, and is one reason vols have drifted lower lately.

The "Bermudan" and "high-strike" nature contribute to a more nuanced dynamic (see Appendix B for a detailed description):

- As rates rally and/or the curve flattens, Bermudans lose vega exposure faster than European swaption. As a result, the hedger becomes short vol in rate rallies.
- Vice versa, hedgers become long vol as Bermudans gain vega exposure faster than Europeans in a rising rates/curve steepening environment.

Given this phenomenon, the payer skew is vulnerable to cheapening whenever there is a large supply of options from callable zeroes. In addition, dealers could worsen the rate decline/curve flattening by delta hedging their ensuing short vol position.

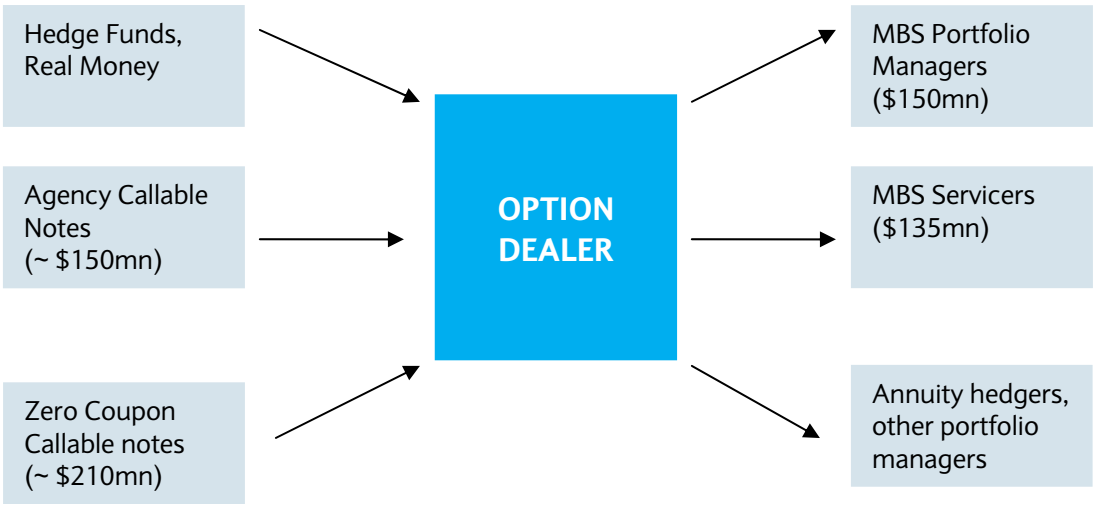
Appendix A: The supply-demand picture

The overall picture for option supply/demand is shown in the figure below. We have annualized the log vega numbers for 2010 in order to determine the overall picture.

The demand side is primarily mortgage hedgers, primarily the GSEs and mortgage servicers. We have estimated the demand using the current convexity profile and assuming 30-40% of the convexity is hedged via explicit purchase of options.

The supply side is primarily agency callable notes and callable zeroes. We have annualized the gross issuance of FHLB callable debt and callable zeroes to determine the total supply for 2010.

These estimates suggest the demand for options could be outweighed by the supply and barring interim shocks (such as the euro-region sovereign concern in the first week of May 2010) vols may drift lower.



Appendix B: Vega exposure of a Bermudan option

A Bermudan option can be thought of as a portfolio of probability-weighted European options. For example, a 1x5 Bermudan receiver swaption is equivalent to a weighted portfolio of 1y*4y, 2y*3y, 3y*2y and 4y*1y European receiver swaption.

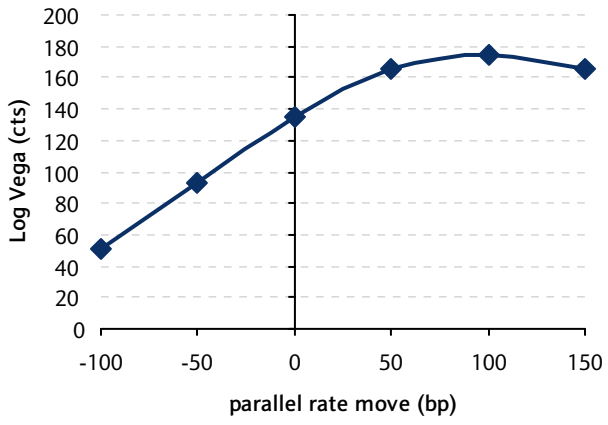
- As rates fall, the Bermudan swaption will likely be exercised at the first exercise date. As a result, the option becomes less sensitive to vol, or vega. In the equivalent European swaption portfolio, the weight of the short-dated swaption increases while that of a long-dated swaption decreases in such a scenario. A short-dated option has less vega than a long-dated swaption, and so, the vega of the Bermudan decreases.
- In contrast, as rates increase, the Bermudan receiver would be less likely be called on the first exercise date and, accordingly, the vega exposure increases. In the equivalent European swaption portfolio, the weight of the longer-dated swaption increases, tying in with the increase in vega exposure of the Bermudan option.

Figure 4 shows the log vega of a 1x30 Bermudan receiver for various parallel shift in rates. As seen, the Bermudan option loses vega exposure quickly in a declining rate environment.

The curve dynamic can also play a significant role. Figure 5 shows the vega exposure of a 1x30 Bermudan receiver for various curve changes. Again, the Berm could become less vega sensitive very quickly if the curve flattens. The simple explanation is the Bermudan would more likely be exercised on the first call date if the curve flattens and so has more short-dated optionality.

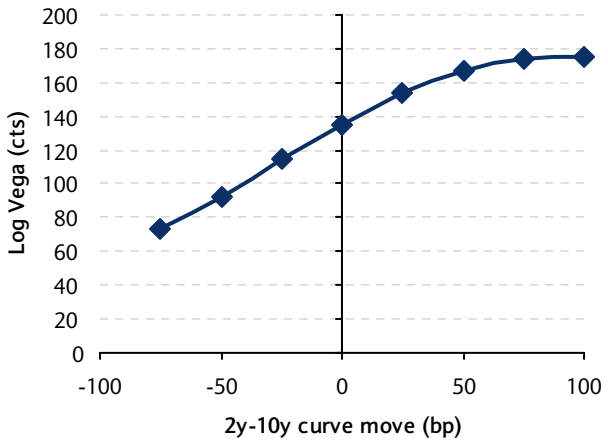
The phenomenon causes the dealer desks, which receive a supply of Bermudan options from callable zeroes, to become short vol quickly if rates fall.

Figure 4: 1x30 Bermudan option loses vega exposure as rates rally



Note: The above chart shows the log vega exposure of 1x30 Bermudan receiver swaption. Source: Barclays Capital

Figure 5: 1x30 Bermudan option loses vega exposure as the curve flattens



Note: The above chart shows the log vega exposure of 1x30 Bermudan swaption. Source: Barclays Capital

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