Wells, Canning & Associates

Research Note: *Book Yield/Convexity Trade-off*

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Introduction

The primary objective of an insurance company's investment portfolio usually focuses on maintaining a high book yield or level of income. Book yield rather than total return is the primary objective because the majority of the assets are not marked-to-market and total return which incorporates both realized **and** unrealized gains and losses is not as applicable as it is for other pools of money such as pension assets.

In addition to a reasonable income level, the value of the portfolio is critical to the health of the company. Therefore most insurance companies find themselves with the dual objectives: generate income and positive total return. In pursuit of these dual objectives, the embedded call risk, as expressed in terms of the convexity of a fixed income portfolio, is often overlooked. The $64MM question: if convexity is a market price measure and I hold my fixed income securities at book value, why should I care?

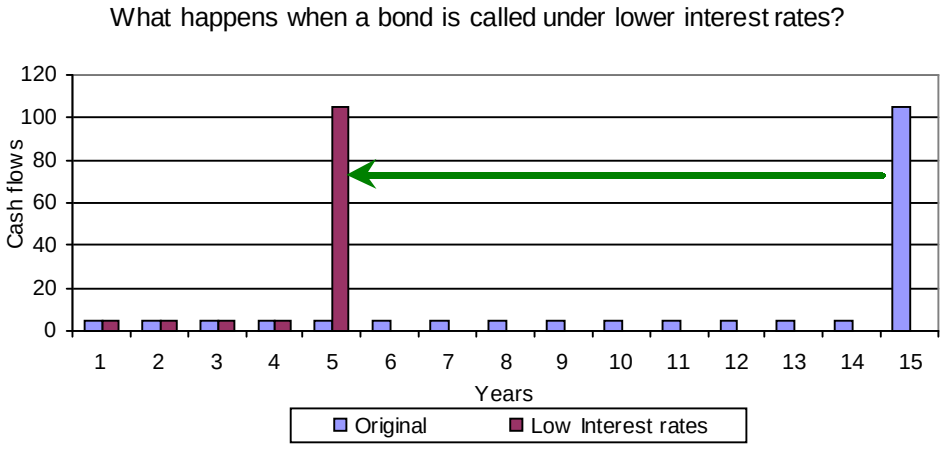
If you are not familiar with convexity, there is a concept box at the end of this document that will help you understand what convexity is and the important role it plays in your fixed income portfolio.

Does convexity really matter when I hold my fixed income securities at book value?

There are a number of reasons why convexity matters, even in a book yield environment. First, even buy and hold insurance companies do sell securities for many reasons: meeting claims, improving the structure of the bond portfolio, shifting assets between fixed and equity. When sales occur, they occur at a market price not a book price. If the price of a security that is a sale candidate has been depressed because of the effects of convexity, there will be a direct impact to the financial condition of the company.

Second, although technically a measure of price sensitivity, convexity can have a direct impact on income. Does book yield translate into income even when a bond is subject to early call? Let's look at what happens to the book yield or income when interest rates fall.

Graph 3. Convexity and Cash Flows



Graph 3 shows the cash flows of a bond that gets called away from an investor. Instead of maturing on the maturity date as expected, lower interest rates cause the issuer to retire the bond early. When this happens, the book yield that you thought you were going to keep in your portfolio for the life of the bond suddenly disappears on the call date. Furthermore, the security you purchase to replace the called bond carries a lower yield (since interest rates have dropped). You can no longer "eat" your high book yield!

What if you find yourself in a low interest rate environment as we are in today? Are you safe if you believe that interest rates have only one way to go and that is up? Unfortunately, no. If you purchase securities to call or own mortgage backed securities (MBS), a higher interest rate environment can result less than optimal income levels because of negative convexity. Let's look at the example of owning slight premium mortgages. When you purchase a mortgage you need to assume a prepayment rate going forward in order to calculate a book yield and income projection on the securities[1]. As interest rates rise and the homeowner's economic incentive to refinance declines, the prepayment rate on your mortgage would be expected to fall and therefore, your original prepayment assumption would be too high for the new economic environment. What this means is that the original book yield would remain outstanding longer than you had originally assumed. Consequently, you would not be able to take advantage of the higher prevailing rates because you would be stuck holding the original MBS longer.

What should an insurance company do?

To mitigate this risk, there are a few actions you can take. First, when you purchase the callable bond or prepayable mortgage, make sure that you are being fairly compensated for taking on the call/prepayment risk. While this sounds obvious, Wall Street has dedicated an army to building prepayment models, interest rate models, and models that link the two. It is relatively easy to structure a security, especially in the mortgage arena, that looks attractive on the surface but has option risks that only become apparent with sophisticated models.

Second, you should be aware of the risks of convexity and put in place the tools or processes to monitor exposure to changing interests rates. As the initial step in this review, you should verify that your securities are modeled with complete information: all call and put options, sinking funds, and any other embedded options. You should address the issue of modeling for both internally and externally managed portfolios. Then analyze the portfolio at the security level to develop an understanding of the convexity of each security and the portfolio as a whole.

Third, you can actively manage the risk of convexity. You should analyze your portfolio to determine if you have too much call risk or negative convexity. If you expect interest rates to rise, you should also look for those securities that have extension risk – the risk that the cash flows become longer than you are currently expecting.

Negative convexity shares the following concept with other types of investment risk: Risk is a portfolio is necessary however you should understand the risk and be paid appropriately for taking the risk.

[1] If you're not familiar with mortgage analysis, for the purposes of this example all you need to know is that the higher the prepayment rate, the faster the investor gets their principal back and conversely, the lower the prepayment rate, the slower is the return of principal.

Concept Box

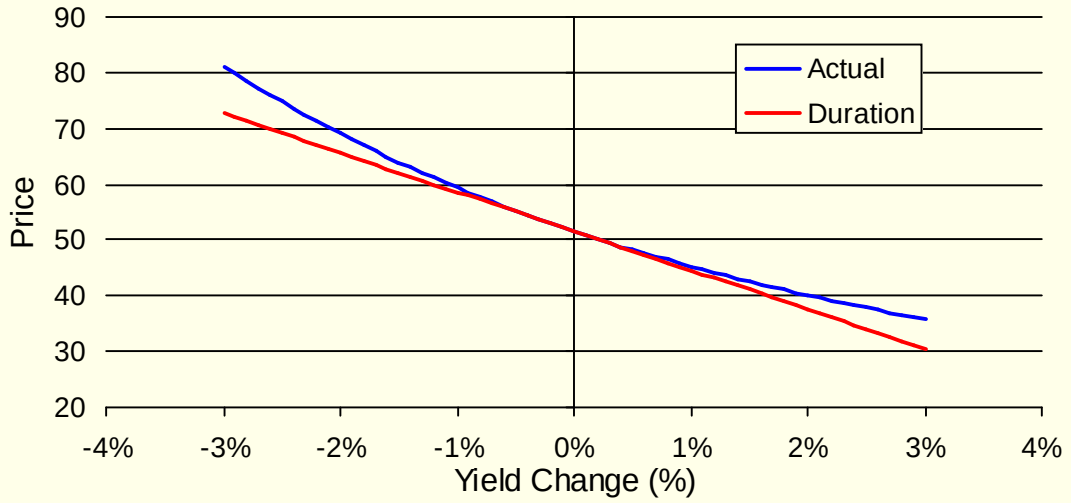
Definition of Convexity

Although everyone involved in insurance investment management should be familiar with the concept of book yield, convexity may be a new term. To understand convexity, you should first learn about duration. Although duration has several definitions, the main interpretation of duration's meaning when used by asset managers is the price sensitivity of a security or portfolio of securities to a given change in yield, otherwise known as modified or effective duration. If a security has a duration of 10 and it's yield changes by +1%, duration would estimate the percentage price change to be -10% (simply multiply the duration by the yield change as shown in *Equation 1*). Why *negative* 10%? If you increase the yield or discount rate, the present value of the security goes down => if yield goes up, price goes down.

$$\%\Delta P \approx -\Delta y D_{\text{mod}} \qquad (1)$$

Another way to show the relationship between yield and price of a bond is to look at graph that maps out a bond's price/yield relationship.

Graph 1. Price/Yield Relationship - Duration Only



Graph 1 maps the price on the vertical axis and yield on the horizontal axis. The blue line is the actual price yield line while the straight red line is the duration predicted relationship. As we would expect, as the yield falls, the price rises and duration provides an estimate of the percentage price change of the bond (follow the red line up and to the left). Notice that this estimate of percentage price change is reasonably good. But reasonably good isn't always good enough. Enter convexity.

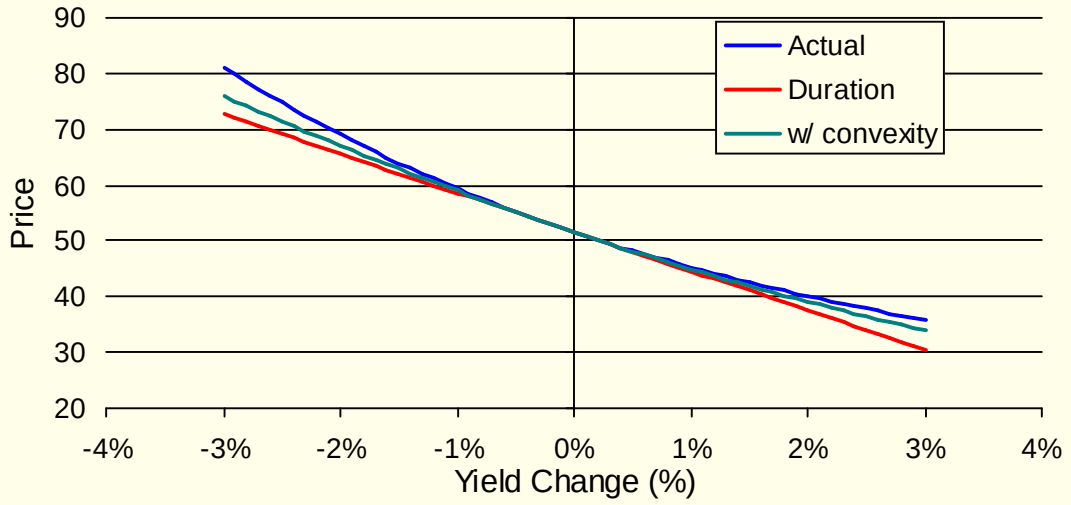
If duration were a perfect measure of price change, we would never have to deal with convexity. Convexity makes the estimate better. Without getting into how to calculate convexity, *Equation 2* spells out how to incorporate convexity to improve the estimate of the price/yield relationship:

$$\%\Delta P \approx -\Delta y D_{\text{mod}} + \frac{1}{2}\Delta y^2 C \qquad (2)$$

The first thing to notice about the equation above is the familiar duration term - the relationship we just discussed. The most important part of the price change is duration. Notice that the implied size of the convexity term will generally be small when compared to the duration term (because of the ½ and squaring a yield change which is a number less than one to start) – in other words, get duration right first! The final term in the equation shows how to build in convexity to improve the price estimate. Notice a few aspects of the ½Δy^2C term. First, there is a positive sign in front of the term. This, combined with the squared yield change term, means that if convexity itself is positive, the convexity impact will be positive and if convexity is negative, it will decrease the price change estimate.

Bringing this equation to life, let's go back to the graph. *Graph 2* adds the impact of convexity in the green line. As you can see, although it's still not perfect, convexity improves the estimate over what duration alone yields.

Graph 2. Adding the Impact of Convexity



There is one last part of the educational background to understand before we can address the issue of how convexity relates to book yield. What is "negative convexity" and how does it arise? As we saw in *Equation 2* above, the convexity term itself is preceded by a plus sign. Therefore, if convexity is positive, no matter what the yield change is, the convexity contribution to price change would be positive. But what if convexity were negative? In this case, no matter what the yield change, the convexity contribution would be negative, it would depress the resulting price. Therefore, all else equal, the greater the convexity the better. How does negative convexity arise? It arises from embedded option positions. Options are embedded in many securities, most commonly in insurance portfolios in the form of either callable corporate and municipal bonds and mortgage backed securities (although some asset backeds, Treasuries, Agencies debentures, high yield bonds are callable and therefore potentially negatively convex). By our informal estimate, upwards of 35-50% of insurance fixed income assets have some form of option that could lead to meaningful negative convexity in many portfolios.