Yields of Bonds and Strips

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Unlike equity investors, bond analysts must have some vague idea of what they're talking about. It's not enough to exhort, "Peak Oil … mumble mumble … buy ConocoPhillips!" With the asymmetrical nature of bond returns (you can lose a lot more than you can possibly win) it requires investors to understand the nature of the risks they're taking and to quantify every penny of their expected return.

Fixed income expected return is usually expressed as yield to maturity (YTM); yield-to-worst (YTW) may be used when considering an instrument with embedded options. Forecasts may be inherent in these calculations (how else to compare a floating rate issue with a real return bond?), but defining these approximations and understanding them is a useful stage in the process. Analyzing a model of expected return and determining its weak points is a stage that some investors in sub-prime paper might well wish they had not skipped over so blithely!

It must be understood that bond yields are calculated according to conventions. There is no "right" or "wrong" way to calculate a yield, any more than it is right or wrong to drive on the right-hand side of the road. If you are either driving or discussing bond yields with a salesman, however, you need to know which convention is being used because, just as is the case with highway driving, you'll be bearing all the consequences of running counter to consensus!

The convention used in Canada is described in loving detail by the Investment Industry Association of Canada in its publication *Canadian Conventions in Fixed Income Markets*, available on-line at http://www.iiac.ca/Upload/Canadian%20Conventions%20in%20FI%20Markets.pdf. The most important things to remember are:

- All coupons are evaluated at the same yield in both YTM and IRR calculations;
- YTM is not equal to the Internal Rate of Return (IRR);
- YTM includes accrued interest; and
- The accrued interest used for YTM calculations is not necessarily the same as the accrued interest used for settlement purposes.

I should also mention that yields reported for money market instruments have a convention all their own:

$P = 100 / (1 + YD/365)$

Where

P = price
Y = yield
D = days to maturity

All Individual Yields are Considered Equal in the Calculation

To realize the posted yield on a particular bond, all coupons must be reinvested at that same posted yield to the maturity of the bond. (There are some variants of yield analysis that attempt to quantify the effect of differing reinvestment rates, but these essentially useless calculations will not be discussed here.)

This is the great weakness of YTM analysis. For serious work, one must use the "zero coupon curve", which is constructed so that every cash flow is assigned a particular yield. There are various methods of performing this mathematical analysis. One may be found in the Winter 2004-05 edition of *The Bank of Canada Review*, available online at http://www.bankofcanada.ca/en/review/winter04-05/johnson.html.

YTM Is Not Equal to the Internal Rate of Return

The compounding frequency of IRR is annual; the compounding frequency of YTM is equal to the period between its coupon payments, which is almost always six months (two coupons annually).

This difference in compounding frequency can lead to dramatic differences. Wikipedia takes as an example (at http://en.wikipedia.org/wiki/Yield_to_maturity) a 30-year zero coupon bond with a face value of $100, priced at a "yield-to-maturity" of 10%, claiming that this implies a price of $5.73 today on the basis of $100 / (1.1)^{30} = \$5.73$. This calculation uses annual compounding, but if one is to calculate yield to maturity in a manner consistent with bond calculation, it is necessary to compound semi-annually, halving the interest rate but doubling the number of periods: $100 / (1.05)^{60} = \$5.35$. A price of \$5.73 implies a semi-annual YTM of 9.76%.

The Microsoft Excel™ XIRR() function may be used to calculate IRR, which may then be converted to YTM. The conversion formula is:

$$(1 + YTM/2)^2 = 1 + IRR$$

So $$YTM = 2 \times ([1+IRR]^{0.5} - 1)$$

It will be noted that the figure "two", used both as a divisor and an exponent on the left hand side of the upper equation, results from the standard coupon frequency – twice per year. YTM is expressed as an annual figure but calculated per period. If we were, for example, converting to the (quarterly) preferred share convention, with quarterly payments, we would substitute "four".

YTM Includes Accrued Interest

Bonds come with coupons, usually paid semi-annually. It is a convention that the amount to be paid when a transaction is settled will include not just the negotiated price (expressed in terms of dollars paid per \$100 par value), but an additional amount to compensate the seller for the period he has held the bond since the previous coupon.

The most common mistake made when calculating YTM is not including the accrued interest in the total cost of the bond. A ten-year bond sold at par with settlement on its coupon date (and therefore with no accrued interest) and semi-annual coupons of \$2 each will have a calculated YTM of 4%, which should not be surprising. But consider the situation when the bond is traded exactly three months later, at the half-way point between coupon receipts.

If the yield on the bond has not changed, the price of the bond will continue to be quoted at 100. If no accrued interest adjustment is made, however, the bond's IRR would be 4.17% and its YTM would be 4.12%. However, when accrued interest in included in the price, to make the total consideration paid for the bond \$101 (the \$100 price plus accrued interest of half a coupon, or \$1) we arrive back at 4% – or as close to it as allowed by our selection of dates to approximate half a year will allow!

Accrued Interest Calculation Conventions

A careful investor, attempting to verify all the information reported to him by his broker, may sometimes run afoul of accrued interest conventions. For the precise rules, the reader must refer to the IIAC publication referenced above. In general, it should be remembered that in Canada the "Actual / 365 (Canadian Bond)" convention is used for calculation of yields. This is different from the "Actual/365 (ISDA)" convention used for swaps and the "Actual/365" convention used for money market instruments. For calculation of accrued interest for settlement purposes, however, the "Actual/Actual" convention is used.

Some corporate bonds trade with accrued interest defined according to another convention. This should be, but is not always, specified in the prospectus or pricing supplement, usually available from the System for Electronic Document Analysis and Retrieval (SEDAR, at http://www.sedar.com).

Like most conventions, the origins of these various conventions are lost in the mists of time, throwbacks to an era when not only was finance a local affair, but when lack of computers meant that traders had to depend on yield books to convert between yield and price. Happily, our traditions are not as old as they are in Europe – U.K. government bonds can trade with negative accrued interest!

Market Yields of Strip Bonds

The credit crunch has affected many things, but strip bond trading does not appear to be one of them. The Investment Industry Association of Canada has reported (at http://www.iiac.ca/Upload/Q4_08%20Debt.pdf) that trading of provincial strip bonds was essentially unchanged in 2008 relative to 2007 at about \$60 billion, while trading of provincial bonds themselves declined 13% to about \$517 billion.

The conventions regarding bond yield calculations have implications for yields and pricing of strip bonds that are important for investors seeking to determine whether strip bonds or coupon bonds are a better choice for their RRSP.

Obviously, the market value of a bond (including accrued interest) should be equal to the sum of the value of its constituent coupons and principal. So, consider the decision by an investment dealer to strip a bond and sell its constituent part to its retail clients in a market environment in which the yield curve is upward sloping (that is, a longer term implies a higher yield).

The dealer may buy the bond at a yield-to-maturity of 5%, which implies that, when each coupon and the principal repayment is discounted at this rate, an investor will be indifferent as to whether he buys the whole or the parts. However, consider the effect on the package when the dealer sells the first coupon, due within six months. This may be sold at a lower yield that reflects its term and hence the dealer will receive a higher price for it than assumed given the 5% yield on the bond as a whole.

In order to compensate for this, and keep the value of the sum equal to the value of the parts, the yield on all the other cash flows must therefore be assumed to be higher. But when the second coupon is sold, its short term again allows a lower yield for the transaction and the longer-term coupons in the position are again increased in yield to compensate. Once this process has been completed, we can draw two important conclusions:

- The zero-coupon curve will be steeper than the nominal yield curve; and
- The yield difference between the zero-coupon curve and the nominal yield curve at the long-term end will be dependent on the steepness of the nominal curve.

This enables brokerages to profit enormously from stripping bonds in a steep-yield curve environment. Investors have reasonably valid benchmarks for the shorter-term strips but, transfixed by spreads that are simply a mathematical consequence of convention, may be willing to accept a lower "spread" against long bonds than should be the case.

Stripping a 10 Year

The table on the right has been calculated using a dealer's bid-side quotations for Ontario bonds and strips as of April 9. An Ontario bond maturing on June 2, 2018 was quoted at 110.024 plus accrued interest for a total of $111.953. It appeared from the dealers strip quotations that strips of up to ten years' term were bid at the yield of a bond of the same term, plus 25 basis points (0.25%).

These yields were used to compute Present Values of each cash flow.

Date	Cash Flow	PV @ 4.17%	Strip Yield	PV@StripYield
2009-6-2	2.75	2.7333	0.48%	2.7480
2009-12-2	2.75	2.6773	0.70%	2.7375
2010-6-2	2.75	2.6228	0.92%	2.7212
2010-12-2	2.75	2.5691	1.14%	2.6990
2011-6-2	2.75	2.5168	1.36%	2.6713
2011-12-2	2.75	2.4653	1.58%	2.6380
2012-6-2	2.75	2.4148	1.79%	2.5995
2012-12-2	2.75	2.3654	2.01%	2.5560
2013-6-2	2.75	2.3172	2.23%	2.5080
2013-12-2	2.75	2.2698	2.45%	2.4553
2014-6-2	2.75	2.2236	2.67%	2.3989
2014-12-2	2.75	2.1780	2.89%	2.3385
2015-6-2	2.75	2.1337	3.11%	2.2750
2015-12-2	2.75	2.0900	3.33%	2.2081
2016-6-2	2.75	2.0472	3.55%	2.1387
2016-12-2	2.75	2.0053	3.76%	2.0670
2017-6-2	2.75	1.9645	3.98%	1.9938
2017-12-2	2.75	1.9243	4.20%	1.9187
2018-6-2	102.75	70.4343	4.42%	68.8594
Total		**111.9528**		**112.5320**

As you may see, even a ten-year bond may be stripped profitably, given the steepness of the yield curve. It may be purchased for $111.95 and the parts sold for $112.53, ignoring costs of stripping the bond, retail markups and even the indication of a capital loss on the last two cash flows!

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Update, 2012-1-18: Assiduous Reader HK points out that in the section “Accrued Interest Calculation Conventions”, my explanation of accrued interest calculations is precisely reversed: in fact, according to the IIAC Conventions, Settlement is calculated according to Actual / 365 and Yield is calculated using Actual / Actual. Oops!