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Back-to-Basics: Which Duration Is Best?

by Teri Geske

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Over the past 10 years, most fixed-income professionals have come to rely on duration as the primary measure of interest rate risk. Yet this widely accepted concept is still subject to misinterpretation and misuse because there is more than one form of "duration" out there. In this Back-to-Basics article, we review some of the different types of duration in use and the implications of relying on the wrong one when managing a portfolio's exposure to interest rate risk.

There are (at least) three types of durations which might be used to describe a bond and/or portfolio's sensitivity to changes in interest rates: Modified (Macaulay's Duration; Effective Duration (also known as option-adjusted duration); and Duration-to-Worst. These are defined as follows:

- **Modified Duration.** The percentage change in a bond's price given a change in its yield, assuming the investor receives a fixed set of cash flows (principal and interest payments) to the bond's final maturity date.

- **Effective Duration.** The average percentage change in a bond's price, given an upward and downward parallel shift in the Treasury (spot) curve, where the change in price reflects any exercise of embedded call or put options, optional prepayments, and/or changes in adjustable rate coupons according to formulas which may include periodic or lifetime rate caps/floors, etc.

- **Duration-to-Worst.** (Note that for puttable bonds, one would use a "duration-to-best" computed from cash flows to the maturity date or to the put date, whichever results in the highest yield to the investor.)

The primary objective of duration is to explain a bond's or portfolio's price sensitivity to changes in interest rates; however, *neither Modified Duration or Duration-to-Worst can be used for this purpose, because neither one reflects the fact that a bond's cash flows can change in response to a change in interest rates.* Modified Duration assumes a bond will survive to the stated maturity date, regardless of any call or put options (or in the case of a mortgage-backed security, that prepayments will be received according to a single, static forecast expressed in terms of PSA% or CPR%). This approach ignores the value of the embedded option(s) and thus overstates a bond's actual price sensitivity to changes in interest rates. If Modified Duration is used to compare a portfolio's interest rate sensitivity relative to a benchmark and the portfolio (or benchmark) contains securities with any type of embedded options, a significant tracking error is likely to occur.

How about using Duration-to-Worst? Even though Duration-to-Worst appears to recognize the presence of an embedded option, it does not reflect the fact that the value of the option fluctuates as interest rates change. Therefore, Duration-to-Worst also misestimates a bond's or portfolio's interest rate sensitivity and can be a highly unstable and misleading measure. Consider a bond which is callable one year from now at a price of 102, currently priced at 102.484. The yield to the first call date (which is the worst call date in this example) is 7.60% versus a yield-to-maturity of 7.80%, so the bond is trading to call. The bond's Duration-to-Worst is 0.94, reflecting the time to call that Duration-to-Worst assumes will be exercised with certainty.

Note that the embedded call is essentially "at-the-money"—a small rise in interest rates would cause the bond to "crossover" and trade to maturity. If

ates rise by only 10 bps, the bond's yield-to-maturity would be slightly lower than its yield-to-call; therefore, the Duration-to-Worst would be based on the cash flows to the maturity date (and equal to the Modified Duration), jumping from 0.94 out to 5.61. Of course, neither Duration-to-Worst nor Modified Duration provides a good indication of the actual change the bond's price would experience given the 10 bp parallel shift in the yield curve; for this, we must use Effective Duration, which reflects the change in value of any embedded options on the bond's price.

Although Duration-to-Worst is not an accurate measure of interest rate risk for securities and portfolios that contain embedded options, it is commonly used in

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the municipal market. This may be due to the fact that municipal portfolios have traditionally been managed to maximize reported yield, rather than on a total-return basis. In last month's *On the Edge,* we discussed how the average tax-exempt bond mutual fund has underperformed its benchmark over the past decade. We proposed the hypothesis that relying on Duration-to-Worst has caused a widespread misestimation of the interest rate sensitivity of these funds, leading to this pervasive underperformance. Duration-at-Worst is also used by those who do not have access to the modeling tools needed to compute Effective Duration.

Effective Duration is the only one of the three duration measures discussed here which reflects the impact of embedded options on a bond's interest rate sensitivity.

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