How Long Is Your Bond?

Bond basics you'll need for the duration

SATURNA CAPITAL

FROM THE YARDARM

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SEXTANT MUTUAL FUNDS

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Bonds, *sigh*. Their schedules of contracted payments lack the glamour of equities — where you get the excitement of being part owner of a company doing business in a competitive world in constant change. Most investors have only indirect dealings with bonds because they trade over-the-counter in sizes too large for all but the wealthiest investors. However, the size of the bond market is comparable to the size of the stock market, which demonstrates bonds also play an important role in funding economic activity.[1] Because of the contractual technicalities that distinguish individual bonds, and the fact that bond trades can be difficult and unwieldy, the management of bond portfolios tends to be left to professional investors. Yet, an understanding of some of their technical details is vital, even for the "amateurs," when selecting bond funds or making asset allocation decisions.

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Bonds are essentially loans, but instead of a single lender (like a bank), the loan is securitized to allow investors to own (lend) fractional pieces of the total amount borrowed. And as with loans, there is the possibility the borrower will not honor the terms of repayment and default. "Credit risk" refers to this risk of default. The creditworthiness of the borrower is important, but so is the "seniority" of a lender's claim within an individual borrower.

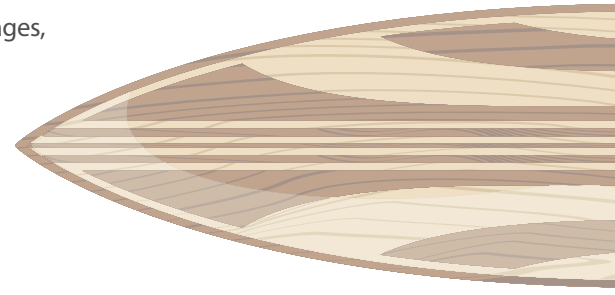
In the event of a bond issuer's default or bankruptcy, an established hierarchy works out the competing claims, an example of which is given in order of seniority below:

1. **Secured debt:** Companies can pledge specific assets as collateral for bonds and loans; in the event of default, the secured creditors are entitled to the liquidation value of these assets.

2. **Senior (unsecured) debt:** After settling secured claims, senior creditors, such as banks and senior bondholders, have priority claims for the remaining assets. Because no assets are pledged as collateral, these types of claims are based on the idea of "full faith and credit" — the value of the borrower's promise to repay. Senior debt can also include unpaid wages, taxes, and trade payables.

3. **Junior or subordinated debt:** These types of bonds or loans have a claim on assets only after settling secured and senior claims. Subordinated bonds are often issued by companies in the financial sector, such as banks and insurers; they are also common in bonds manufactured from collections of smaller loans, such as mortgages, auto loans, and credit card receivables.

4. **Preferred stock:** Preferred stock has become less common as a funding source, although it tends to be used in times of distress when companies' ability to obtain funding with higher seniority is limited. Its priority level is superior only to common stock.



5. **Common stock:** Equity owners may make claims on common stock only after all other funding sources have been satisfied. A default or bankruptcy typically occurs when a company has not been able to meet payment obligations to more senior creditors, which implies its assets are worth less than its liabilities. If this is the case, in liquidation the common stock owners would get nothing.

Setting aside the risk of default (credit risk), one of the most important sources of risk is called "interest rate risk," which refers to the inverse relationship between interest rates and bond prices. Specifically, when interest rates rise, they reduce the value of fixed payments expected in the future. Because fixed-rate bonds represent a promise of future interest and principal payments, the current value of those fixed payments declines when interest rates rise. A bond's level of interest rate risk is, in turn, determined by the length of its remaining life — the dates and quantities of its remaining interest and principal payments. Duration is a technical term for this remaining life. Maturity, the date of the final payment — the date after which the bond ceases to exist — is related to duration, but there are important distinctions.

Maturity

The maturity date of a bond is a straightforward concept, and it is also very easy to find because it is typically stated directly in a bond's title. Literature intended for the general investing public commonly refers to "time to maturity" as a defining feature of a bond, often with respect to setting a maturity benchmark (e.g., 7-10 years) for bond funds and other fixed-income investment vehicles.

Duration as a measure of a bond's remaining life

Duration is commonly defined in two different ways, which can lead to confusion, not to mention the additional confusion as to how duration is related to maturity. The first definition, which is more intuitive from its name, is the weighted average time (in years) to the remaining payments due. A bond's duration is always less than or equal to its time to maturity (if a bond is "zero coupon" and makes no interest payments, its duration and time to maturity are the same).

Imagine a hypothetical 10-year bond that makes annual interest payments of 5% of the principal value plus the repayment of principal (and final interest payment) on the maturity date. For each $1,000 of "face value," the issuer will make 10 interest payments of $50 and a principal repayment of $1,000 that add up to $1,500 over the bond's life. The $50 annual interest payments each have a "weight" of 3.33% ($50 ÷ $1,500). The final principal payment has a weight of 66.67% ($1,000 ÷ $1,500). The length of time between today and the payment dates are 1, 2, …, 10 years. If we multiply the weight of each payment by the time until it is due, and then add up those weighted times, we get a duration of 8.5, which is less than the 10 years until maturity.

TIME (YEARS)	LIFETIME INTEREST & PRINCIPAL PAYMENTS	% OF LIFETIME PAYMENTS (WEIGHTS)	YEARS X WEIGHT
1	$50	3.33%	0.03
2	$50	3.33%	0.07
3	$50	3.33%	0.10
4	$50	3.33%	0.13
5	$50	3.33%	0.17
6	$50	3.33%	0.20
7	$50	3.33%	0.23
8	$50	3.33%	0.27
9	$50	3.33%	0.30
10	$50	3.33%	0.33
10	$1,000	66.67%	6.67
	$1,500	**100%**	**8.50**
	TOTAL LIFETIME PAYMENTS		WEIGHTED DURATION

Duration as a measure of interest rate sensitivity

The second definition for duration derives from the first, and ties back to interest rate risk. In this definition, duration is a bond's sensitivity to a shift in interest rates.[2] For our hypothetical 10-year bond, its duration of 8.5 tells us that if interest rates increase by 1%, the bond's value is likely to decrease by 8.5% (i.e., 1% of its duration). The connection between duration as a measure of time and as a measure of interest rate sensitivity is as follows: we quote interest rates in annualized terms. If we observe interest rates rise from 3% to 4%, that 1% increase in rates applies to each year of the bond's remaining life. Therefore, if the bond's duration is 8.5, its value should fall by roughly 8.5% (a bond's price changes in the opposite direction of changes in interest rates).

The Limits of Maturity and Duration

So far, we have only looked at fixed-rate bonds (i.e., bonds that make fixed coupon payments over a preset schedule). We can also look at bonds that represent extreme cases:

- **Zero-coupon bonds:** Few individual investors will ever have occasion to own a zero-coupon bond (ZCB), which is simply a bond that is purchased at a discount to its principal and makes no payments until the repayment of the full principal value at maturity. But ZCBs are useful as an example because their duration is the same as their time to maturity. Because they make no interest payments and their price represents the discounted value of the prevailing interest rate through the maturity date, their prices are highly sensitive to interest rate changes.
- **Floating-rate bonds:** Floating-rate bonds reset their interest payments at every payment date, typically in relation to some reference rate such as LIBOR (London Interbank Offered Rate for 3-month deposits). The duration of a floating-rate bond is simply the time remaining until the next interest payment date. Therefore, even if a floating-rate bond matures in 50 years, its duration is typically only a matter of months. Floating-rate bonds' low durations and interest payments that adjust with changes in interest rates make their prices much less sensitive to interest rate swings than the prices of fixed-rate and zero-coupon bonds.

Changes in duration, or "convexity"

Convexity can provide a more accurate reading of a bond's risk exposure than duration alone. Readers familiar with calculus may recognize that duration's definition as the change in a bond's price given a change in interest rates is known as a derivative. For some types of bonds, it is useful to go further, and look at the changes in duration as interest rates change — the second derivative. The change in duration is known as convexity. Below are some examples where it is important:

- **Callable bonds:** Many bonds allow their issuers to "call" (i.e., buy back) the bonds before they mature. This is typically a defense against falling interest rates — the issuer of a callable bond can issue new bonds at a lower interest rate and use those proceeds to redeem the bonds previously issued at higher interest rates, thereby keeping the difference and saving money. As a bond becomes more likely to be called, its duration will decrease, and it will become less sensitive to interest rates because there would be fewer payments to make in the future.
- **Mortgage-backed securities (MBS):** Mortgage borrowers are similar to issuers of callable bonds. If they can refinance their mortgage at a lower rate, they pay off the existing mortgage, which then receives no more interest and principal payments in the future. As interest rates fall, the opportunity for borrowers to refinance at attractive rates may increase, pushing down the duration of MBS portfolios.

Even without owning callable bonds or MBS, however, it may be useful for bond mutual fund investors to understand how these call features can impact their funds' underlying portfolios.

The durations of callable bonds and MBS tend to decrease when interest rates decrease, and increase when interest rates increase (negative convexity). What this means for owners of those bonds is that the bonds do not increase in value as much as non-callable bonds when interest rates fall, but their prices may decrease faster than the prices of non-callable bonds when interest rates rise. Because there can be less to gain and more to lose with callable compared to non-callable bonds, callable bonds (and MBS) tend to have a higher yield compared to non-callable bonds.

Most investors will have little reason to become direct owners of callable bonds or MBS. On the other hand, many investors will borrow to purchase a home in their lifetimes and have the option to "call" the mortgage by refinancing at a lower interest rate should that opportunity arise.

About The Author

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Bryce Fegley joined Saturna Capital in 2001 and worked in brokerage/trading and later as an investment analyst. Beginning in 2010, he spent two years as President of our Malaysian subsidiary, Saturna Sdn Bhd, directing its research and fund management operations. In 2012 he returned to Saturna Capital headquarters. Mr. Fegley is a frequent contributor to financial press including The Wall Street Journal, Barron's, Financial Advisor Magazine, ThinkAdvisor, and Advisor Perspectives. Prior to joining Saturna, Mr. Fegley worked in brokerage operations in Seattle from 1997-2000. Originally from upstate New York, he studied at the University of Colorado at Boulder earning his BA in English Literature. Mr. Fegley earned a Certificate in Computational Finance and Risk Management from the University of Washington in 2015. His volunteer activities include a board role with the Whatcom Family YMCA. His hobbies include reading and playing piano, traveling with his family, bicycling, and cooking.

Even without owning callable bonds or MBS, however, it may be useful for bond mutual fund investors to understand how these call features can impact their funds' underlying portfolios. Particularly with the increasing availability of so-called "unconstrained" bond funds and other "alternative" fixed-income funds, portfolio managers may employ strategies and invest in securities where high convexity can cause rapid changes to the portfolio's interest rate sensitivity.

In summary, a bond's stated maturity tells an incomplete story about a bond's life. Even a basic understanding of duration and convexity can fill in the gaps to help investors anticipate how changes in interest rates today may propagate over a bond's life to influence its price. A bond's duration tells you about how the schedule and timing of payments influence its interest rate sensitivity. Convexity tells you how rapidly a bond's duration (along with its schedule of payments) can change, particularly if it can be called or retired early. These characteristics can be rolled up for a portfolio of bonds, their interest payments, maturities, and possible call schedules, to help form a narrative about the interest rate risks of fixed-income portfolios. We hope they will also help you better understand measures like "weighted average maturity" or "portfolio duration" that are often used to characterize bond portfolios.

Footnotes

[1] *For example, at the end of Q3 2017, the Federal Reserve showed US equities had a value of $43.7 trillion outstanding, and US debt securities had a value of $42.4 trillion outstanding.*
Equities: https://www.federalreserve.gov/releases/z1/current/html/l223.htm
Debt: https://www.federalreserve.gov/releases/z1/current/html/l208.htm

[2] *With the important assumption that interest rates increase in parallel for every period between today and the maturity date.*

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