Unit 07. Fixed-Income Securities: The Bond Market and Bond Evaluation

Reading Chapters 13 and 14

Chapter 13. The Bond Market

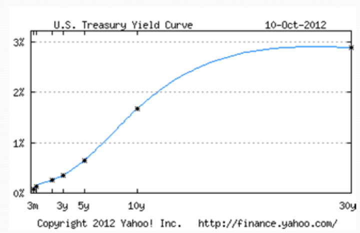
1. Bond basics
2. Risk
3. The mechanics of purchasing bonds
4. Variety of corporate bonds
5. High-yield securities
6. Accrued interests, zero coupon bonds, original-issue discount bonds, and income taxation
7. Retiring debt

1. Bond Basics

- Bonds are debt instruments (i.e. IOUs issued by companies)
- Terms used in bonds
  - Coupon rate: the specified interest rate on bonds
  - Principal amount: the face value of the bond (i.e. the amount owed)
  - Maturity date: the time of which the debt is due and the principal amount must be paid
  - Current yield: annual income divided by the current price of the security.
  - Yield to maturity: the yield that the investor earned on a bond from the time it is acquired until the maturity date
  - Yield curve: the relationship between yield and the length of time to maturity (see next slide)

Yield Curve

- Typically the longer the time to maturity, the higher the yield, as illustrated in the yield curve graph on the right.
- There has been times when the yield curve is downward sloping or flat. Typically those are periods of very high inflation.



1.1.The Indenture

- Indenture is the document that specifies the terms of a bond issue. For publically held bonds the indenture is filed with the SEC. The indenture specifies
  - The coupon rate
  - The date of maturity
  - The collateral, if any
  - Common loan restrictions:
    1. limits on paying dividends
    2. limits on issuing additional debt
    3. restrictions on merging or significantly changing the nature of the business without the prior consent of the creditors.
- A trustee, usually a commercial bank, is often appointed to be responsible for upholding the terms of a bond's indenture.
- Failure to meet the terms of the indenture puts a company in default.

1.2. Forms of Debt

- Bearer bonds (also called coupon bonds)
  - A bond with coupons attached or a bond whose possession denotes ownership.
- Registered bonds (also called book-entry bonds)
  - A bond whose ownership is registered with the commercial bank that distributes interest and principal payments. There is no other physical evidence of the bond.

2. Risk to Bondholders

- The same sources of risk that apply to stockholders apply to bonds.
- Just like stocks, different bonds carry different risks. So there is a credit rating system for bonds.
- Most important ratings are Moody's and Standard & Poor's.
  - Moody's rate bonds uses Aaa, Aa, A, Baa, Ba, B, Caa, Ca, C, indicating the best credit to the worst.
  - Standard and Poor's rating uses AAA, AA, A, BBB, BB, B, CCC, C, D, indicating the best to the worst.
- A low rating means the issuing company has to offer a higher interest rate to compensate for the risk investors will have to take.
- A bond that is rated BBB or better is called "investment grade" bond.
- A bond that is rated below BBB is called "junk bond" or "high yield bonds"

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3. Mechanics of Purchasing Bonds

- Bonds are purchased in much the same way as stocks.
- If you see a bond referred to as "ATT 8.125 22" , it means this AT&T bond has a coupon rate of 8.125% and matures in the year 2022.
- Bonds earn interest every day, but typically the firm distributes the interest payments only twice a year.
  - When a bond is sold, the buyer owes the seller accrued interest .
  - If a bond is currently in default and is traded without accrued interest, it is said to "trade flat".

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4. The Variety of Corporate Bonds

- Mortgage bonds
  - Secured by property, especially real estate.
- Equipment trust certificates
  - Secured by specific equipment, such as airplanes
- Other asset-backed securities (securitization)
  - Backed up by other assets such as accounts receivable. Securitization is the process of converting an illiquid asset such as account receivable into a marketable asset.
- Debentures
  - An unsecured bond
- Income bonds
  - Interest is only paid if income is earned. High risk and rarely issued.

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- Convertible bonds
  - A bond that may be converted to common stock.
- Variable interest rate bonds
  - A long term bond with changing interest rate, often tied to rate of Treasury Bills.
  - Another interest rate often used is LIBOR – an interest rate established daily by the British Banker's Association.
- Zero coupon and discount bonds
  - Bought at a price lower than its face value, with the face value repaid at the time of maturity
- Eurobonds
  - Denominated in U.S. dollars but issued aboard.

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5. High-Yield Securities

- High-yield bonds (junk bonds) are bonds that are rated below BBB or Baa. They are high risk bonds that offer a high yield to compensate for the risk.
- High-yield bonds may be divided into two classes.
  - (1) Fallen angels: Initially investment grade bonds but rating were lowered as a result of financial problems.
  - (2) Initial bonds issued by firms with less than investment grade ratings.
- The spread in the yields between high-yield bonds and investment-grade bonds can be substantial.

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- Additional forms of high-yield bonds
  - Split coupon bonds (also called "deferred interest bonds") combines a zero or low initial coupon followed by a period with a high coupon.
    - Example: A bond that pays no interest for the first four years and then pay 10% for the next six years, until the bond matures.
  - Reset securities and increasing rate bonds – bonds whose coupon is periodically reset.
  - Extendible securities – Bonds whose maturity date may be extended into the future.

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6. Accrued interests, zero coupon bonds, original-issue discount bonds, and income taxation

- Bond interest earnings are subject to income tax. Whoever ultimately receives the interest payment is responsible for the tax on that interest payment.
- For zero-coupon bonds and original-issue discount bonds, accrued interest is taxed as if they were received.
- This makes zero-coupon bonds and original-issue discount bonds less attractive, unless they are used in tax-deferred retirement accounts.

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7. Retiring Debt

- Debt issues must ultimately be retired.
- When a bond is issued, a method for periodic retirement is usually specified.
- Typical methods of retirement specified at the time of issuing
  - Serial bonds
    - Some bonds mature each year.
  - Sinking funds
    - A fund into which periodic payments can be deposited, so that over time the company's debt can be retired
  - Call feature
    - The issuer has the right to retire the debt before its maturity. Often a premium is paid for exercising a call feature. This premium is called a "call penalty".
  - Repurchasing debt
    - If bond price declines and the bond is selling at a discount, the firm may try to retire the debt by purchasing it back in the open market.

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Chapter 14. The Valuation of Fixed Income Securities

1. Perpetual securities
2. Bonds with maturity dates
3. Fluctuations in bond prices
4. The valuation of preferred stocks
5. Yields
6. Risk and fluctuations in yields
7. Realized returns and the reinvestment assumption
8. Duration
9. Bond price convexity and duration
10. Management of bond portfolios

Basics of Bond Valuation

- The price of bond depends on the interest paid, the maturity date, and the return offered by comparable bonds (i.e., similar risk and similar terms).
- Bond valuation is essentially the same as stock evaluation: future cash flows are discounted back to the present.
- The discount rate is what investors can earn on comparable securities

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1. Perpetual Securities

- Consider a special case: perpetual security – a security that will pay a fixed amount of money every year forever.
  - Example: preferred stocks
- The price or value of perpetual security (P) is determined as

$$P = \frac{PMT}{i}$$

PMT = annual interest payment
i = discount rate

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Example of Perpetual Securities

- A perpetual bond that pays $80 a year forever. What should be the price of this bond?
- The answer will depend on the discount rate, which is defined as the interest rate that can be earned on similar investments.
- Assume i=10%, then

  P = PMT/i =$80/10%= $800

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Inverse Relationship Between Discount Rate and the Price of a Perpetual Bond

- The higher the discount rate, the lower the value of the bond.
- Note again that the discount rate is the current interest rate that can be earned on similar investments.

Current Interest Rate (i)	Annual Interest Paid by the Bond (PMT)	Present Price of the Bond $\left(P = \frac{PMT}{i}\right)$
4%	$80	$2,000
6	80	1,333
8	80	1,000
10	80	800
15	80	533
20	80	400

2. Bonds with Maturity Dates

- The price of a bond with a maturity date is the present value of all future payments, including
  - PMT = Interest payments each year
  - FV = Final principal payment
- Assume annual compounding and
  - i=annual discount rate
  - n= number of years to maturity
  - PFVS = Present Value Factor Sum (see review notes for Week 1)
- The price of the bond (P) is

$$P = PMT \times PVFS(i,n) + FV * PVF(i,n)$$

$$= PMT \times \frac{1-\frac{1}{(1+i)^n}}{i} + FV \times \frac{1}{(1+i)^n}$$

An Example of Bond Price with Maturity – Price at Issuing

- A firm has a $1000 bond that matures in 30 years with a 10% coupon rate ($100 interest payment annually). At the time of issuing, what should the price of the bond be, assume annual compounding?
- Answer: At the time of issuing, the coupon rate is the ongoing market rate so it equals to the discount rate. So PMT=100, FV=1000, n=30, i=10%.

$$P = PMT \times PVFS(i,n) + FV * PVF(i,n)$$

$$= PMT \times \frac{1-\frac{1}{(1+i)^n}}{i} + FV \times \frac{1}{(1+i)^n}$$

$$= 100 \times \frac{1-\frac{1}{(1+10\%)^{30}}}{10\%} + 1000 \times \frac{1}{(1+10\%)^{30}}$$

$$= \$1{,}000$$

Note at issuing, discount rate=coupon rate. As such, the price of the bond is the same as the issuing value, which is $1,000 in this case.

An Example of Bond Price with Maturity- Premium Current Value

- Now assume three years down the road, the interest rate on new bonds of same risk has decreased to 6%. So the discount rate is 6% now. What is the new price of this old bond?
- Answer: PMT=100, FV=1000, n=27, i=6%.

$$P = PMT \times PVFS(i,n) + FV * PVF(i,n)$$

$$= PMT \times \frac{1-\frac{1}{(1+i)^n}}{i} + FV \times \frac{1}{(1+i)^n}$$

$$= 100 \times \frac{1-\frac{1}{(1+6\%)^{27}}}{6\%} + 1000 \times \frac{1}{(1+6\%)^{27}}$$

$$= \$1495.16$$

Note when interest rate goes down, old bonds with higher interest rate become more valuable. In this case, the price of this old bond increased from $1,000 to $1495.16.

An Example of Bond Price with Maturity- Discounted Current Value

- Now assume six years down the road, interest rate on new bonds of same risk has increased to 12%. So the discount rate is 12% now. What is the new price of this old bond?
- Answer: PMT=100, FV=1000, n=24, i=12%.

$$P = PMT \times PVFS(i,n) + FV * PVF(i,n)$$

$$= PMT \times \frac{1-\frac{1}{(1+i)^n}}{i} + FV \times \frac{1}{(1+i)^n}$$

$$= 100 \times \frac{1-\frac{1}{(1+12\%)^{24}}}{12\%} + 1000 \times \frac{1}{(1+12\%)^{24}}$$

$$= \$844.31$$

Note when interest rate goes up, old bonds with lower interest rate become less valuable. In this case, the price of this old bond decreased to $844.31

Bond Valuation for Nontraditional Bonds

- How to value nontraditional bonds such as zero-coupon bonds?
  - Bonds may vary in features but the idea of valuation is the same: The price of a bond is the present value of all future cash flows discounted at the discount rate.
- Example: What is the price of a $1,000 zero-coupon bond that matures in 10 years, if the current interest rate on similar investments is 8%?
  - Answer:
    - Zero-coupon bonds do not have annual payments. The only payment is a final payment of $1,000 after 10 years.
    - P=FV/(1+i)^n=$1000/(1+8%)^10=$463.19

Additional Notes on Bond Value

- Note the inverse relationship between bond prices and current interest rates.
  - When current interest rate rises, old bond prices fall.
  - When current interest rate declines, old bond prices go up.
- In most cases bond interest is paid twice a year. The computation of bond price gets a bit more complicated with semiannual compounding but the approach is the same. In this course we will NOT get into semiannual compounding.

3. Fluctuations in Bond Prices

- Amount of price fluctuation depends on:
  - amount of interest paid by the bond
  - the length of time to maturity
  - risk
- Prices of bonds with lower coupons fluctuate more.
- Prices of bonds with longer terms to maturity fluctuate more.

4. The Valuation of Preferred Stock

- The fixed dividend implies the model for valuation of bonds applies to preferred stocks.
- The textbook gives both a perpetual case and a finite maturity date case. Note these are exactly the same as valuation of perpetual bonds and bonds with a maturity date.
- However because preferred stocks are technically stocks, tradition is different for notations.

D=annual dividend (same as PMT for perpetual bond)
k=discount rate (same as i for perpetual bond)

5. Yields - Measurement of Return on Bonds

- The term "yield" is frequently used with regard to investing in bonds. There are three important types of yields:
  - Current yield: The percentage that the investor earns annually.
  - Yield to maturity: Considers current income as well as changes in its value when held to maturity. This is a more accurate measure of return on bonds than current yield.
  - Yield to call: Considers current income, its value at the expected call date, and call penalty.

5.1. An Example of Current Yield Computation

- If a $1,000 bond with a 9% coupon (paid annually) and a maturity date of ten years is selling for $939, what is the current yield?
- Answer:
  - Current yield = Annual Interest Payment / Price of the bond= 90/$939 = 9.58 %

5.2. An Example of Yield to Maturity

- If a $1,000 bond with a 9% coupon (paid annually) and a maturity date of ten years is selling for $939, what is the yield to maturity?
- Answer: Finding the yield to maturity is to find the discount rate in the valuation of bond we just discussed. This time we know the P, PMT, and n, so we try to find i = yield to maturity.
- There is no simple way of computing i. One has to use a financial calculator or Excel (by trying different values of i until the right-hand side of the equation equals to the left hand side of the equation). In this case i=10.06%

$$P = PMT \times \frac{1 - \frac{1}{(1+i)^n}}{i} + FV \times \frac{1}{(1+i)^n},$$

$$939 = 90 \times \frac{1 - \frac{1}{(1+i)^{10}}}{i} + 1000 \times \frac{1}{(1+i)^{10}},$$

$$i = 10.06\%$$

5.3. Current Yield and Yield to Maturity

- The current yield does not consider final repayment of the bond, nor reinvestment.
  - A premium (selling higher than face value) reduces the yield to maturity so current yield exceeds yield to maturity.
  - A discount (selling lower than the face value) increases the yield to maturity so yield to maturity exceeds the current yield.
- On next slide one can see this relationship between current yield and yield to maturity on a 10-year bond with a 8% coupon rate.
  - When current bond price is over $1,000, the bond is selling at a premium. Current yield is higher than yield to maturity.
  - When current bond price is less than $1,000, the bond is selling at a discount. Yield to maturity is higher than current yield.

Current Yields and Yields to Maturity for a Ten-Year Bond with an 8 % Annual Coupon

Price of Bond	Current Yield	Yield to Maturity
$1,100	7.27%	6.60%
1,050	7.62	7.28
1,000	8.00	8.00
950	8.42	8.77
900	8.89	9.60
850	9.41	10.49
800	10.00	11.46
750	10.67	12.52

5.4. Yield to Call

- The yield to call is the yield earned on a bond from the time it is acquired until the time it is called and retired by the firm.
- The yield to call is calculated the same way as the yield to maturity, except that
  - 1. the expected call date is substituted for the maturity date
  - 2. the principal plus the call penalty (if any) is substituted for the principal.

An Example of Yield to Call

- **A $1,000 bond with a 9% coupon (paid annually) and a maturity date of ten years is selling for $939, We computed the yield to maturity to be 10.06%. Now the bond is called after 5 years with a $50 call penalty. What is the yield to call?**
- **Answer: The setup is the same as yield to maturity, except n=5 in stead of the n=10, and the FV is (1000+50) instead of just 1000.**
- **Again, there is no simple way of computing i. Use a financial calculator or Excel. In this case i=11.46%**

$$P = PMT \times \frac{1-\frac{1}{(1+i)^n}}{i} + FV \times \frac{1}{(1+i)^n},$$

$$939 = 90 \times \frac{1-\frac{1}{(1+i)^5}}{i} + (1000+50) \times \frac{1}{(1+i)^5},$$

$$i = 11.46\%$$

5.5. Relationship Between Yield to Maturity and Yield to Call

- In the example on the previous slide, the yield to call is higher than the yield to maturity because
  - 1. The investor receives call penalty
  - 2. The $1000 principal is redeemed early thus there is less discounting.
- Typically a firm will not call a bond when it is selling at a discount. The firm would be better off buying the bond in the open market so instead of paying $1000+$50, it would only need to pay $939.
- The firm would typically call a bond if it is selling at a premium. In that case, the yield to call is typically lower than the yield to maturity.

5.6. Yield on Zero-Coupon Bonds

- A zero-coupon bond sells for $600 and matures after 3 years. What is the current yield and the yield to maturity?
- Answer:
  - Since the bond does not pay any interest, there is no current yield.
  - The yield to maturity is determined as follows:

    $600 = \$1{,}000 * (1/(1 + i)^3)$,

    $(1 + i)^3 = 1{,}000/600 = 1.6667$

    $i = 1.6667^{1/3} - 1 = 18.56\%$

6. Risk and Fluctuations in Yields

- The inverse relationship of risk and return holds for all investments, including bonds.
  - The lowest yields are paid by bonds with the highest credit ratings, such as the U.S. Treasury bonds, while low credit ratings are associated with high yields, such as junk bonds (high-yield bonds).
- Interest rate changes over time, thus the anticipated yield on all debts fluctuate.
  - However, the yield on debt involving greater risk tends to fluctuate more.
  - This means the yield spread between bonds of different quality tends to increase when interest rates rise.
- The graph on next slide shows these relationships.

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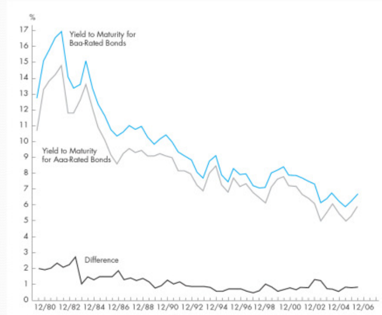
Fluctuations in Yield to Maturity for Moody's Aaa- and Baa-Rated Industrial Bonds (1980-2006)



- Yield on Baa-rated bonds (blue line) is higher than yield on Aaa-rated bonds (gray line).
- Yield spread (black line) is larger in 1980s when interest rates were higher, compared to later years when interest rates were lower.

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7. Realized Return & the Reinvestment Assumption

- Note that yield to maturity assumes all cash inflows are reinvested at the yield to maturity.
- If the assumption holds, the realized rate and the yield to maturity are the same.
- If yields decrease, the actual realized rate over the lifetime of the bond is less than the yield to maturity.
- If yields increase, the actual realized rate over the lifetime of the bond exceeds the yield to maturity.

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8. Duration: An Alternative Technique of Comparing Bonds

- Yield to maturity as a method of comparing bonds has its limitations such as the reinvestment assumption.
- An alternative method is call "duration".
- Duration is the average time required to collect a bond's interest and principal repayment. It weighs the present value of each payment by the timing of the payment.

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Example of Determination of Duration of a Bond

- This is an example of a $1,000 bond with 3 years to maturity and a 9% coupon. So it will pay $90 for the first two years, and $1090 for the third year. Currently, the discount rate is 12% so the current price of the bond is $927.95. The Duration is determined as follows:

Number of Each Payment		Amount of Payment		Present Value Interest Factor at 12 Percent		
1	×	$ 90	×	0.893	=	$80.37
2	×	90	×	0.797	=	143.46
3	×	1,090	×	0.712	=	2,328.24
						$2,552.07

$$\text{Duration} = \frac{\$2,552.07}{\$927.95} = 2.75 \text{ years.}$$

Note Present Value Factor is 1/(1+i)^n

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Formal Definition of Duration

$$D = \frac{\sum_{t=1}^{n}(PV(CF_t) \times t)}{P_B}$$

- Notations:
  - D=duration
  - PV=present value
  - t=time (from 1 to m where m is maturity time)
  - CFt=cash flow for year t.
  - PB =price of bond
- Duration facilitates comparisons of price volatility of bonds with
  - different coupons and
  - different terms to maturity
  - The larger the numerical value of Duration, the greater is the price volatility

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A "Simplified" Formula for Duration Computation

- When the term of the bond is long, say, 30 years, duration computation can be tedious. An alternative method simplifies the formula:

$$D = \frac{1+y}{y} - \frac{(1+y)+n(c-y)}{c[(1+y)^n - 1]+y}$$

- ***c*** **= the annual coupon (as a percentage)**
- ***n*** **= the number of years to maturity**
- **y = the yield to maturity (reinvestment rate)**

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Computing Duration Using the Simplified Formula

- For the previous example of a $1,000 bond with 3 years to maturity and a 9% coupon, we can compute the duration using the simplified formula. Note the discount rate is still 12%.
- C=9%, n=3 years, y=12%

$$D = \frac{1+y}{y} - \frac{(1+y)+n(c-y)}{c[(1+y)^n - 1]+y}$$

$$= \frac{1+12\%}{12\%} - \frac{(1+12\%)+3(9\%-12\%)}{9\%[(1+12\%)^3 - 1]+12\%}$$

$$= 2.75$$

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Duration and Portfolio Immunization

- Pension plan managers can use duration as a tool of risk management by timing the bond's duration with when the funds will be needed. This practice is referred to as portfolio immunization.
- An example: If one needs funds to be distributed in 7 years, instead of buying a bond that matures in 7 years, buy a bond that has a duration of 7 years. That way the reinvestment risk and interest risk are both eliminated.
- We will not get into the details of portfolio immunization in this class, but there is an example in the textbook if you are interested in how it's done.

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9. Forecasting Bond Price Changes

- When market interest rate changes, bond prices change.
- While one can compute the exact changes in bond prices, one can also use duration to forecast such changes.
- The duration method is easier, but forecasting error gets larger and larger when the change in interest rate gets larger.

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9.1. Forecasting Bond Price Change for Small Changes in Interest Rate Using Duration

- ΔP_B= -D x $\frac{\Delta y}{1+y}$ x P_B
  - Where
    - ΔP_B = changes in the price of the bond
    - D = duration
    - Δy = change in yield to maturity
    - y = current yield to maturity
    - P_B = current price of the bond
- Example: Using the same bond, D=2.75, P_B=927.95, y=12%.
  - If the yield is increased by 1% (i.e. new y=13%) so Δy =1%, then change in bond price is
  - ΔP_B=-2.75*(1%/(1+12%)*927.95= -22.78

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9.2. Errors in Using Duration for Forecasting and Bond Price Convexity

- For any given bond, a graph of the relationship between price and yield is convex. This means that the graph forms a curve rather than a straight-line (linear). The degree to which the graph is curved shows how much a bond's yield changes in response to a change in price.
- The accuracy of the duration method varies with the amount of the fluctuation in interest rates.
  - Forecast error is small for small interest rate changes
  - Forecast error is large for large interest rate changes
- Figure 14.3 on page 480 shows that the source of error is the convexity of the actual price change, compared to the linear forecast line using the duration method.
- Bottom line is that in order to use duration as a tool for bond portfolio management, the investor must adjust for changes in the value of a bond's duration.

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10. Management of Bond Portfolios

- Individuals may passively or actively manage a bond portfolio.
- Passive strategies include
  - Buy and hold
  - Laddered portfolio: Buy bonds with different maturity dates.
- Active strategies include
  - Bond swapping: Selling of one bond and using the proceeds to acquire a different bond. May be used to save on taxes, increase yields, or change the quality (risk) of the portfolio.
  - The barbell strategy: A portfolio consisting of very long- and very short-term maturities.
  - The matching strategy: Duration matching (portfolio immunization) and cash flow matching.

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