10

Bond Prices and Yields

Chapter

Bond Basics, I.

• **A Straight bond** is an IOU that obligates the issuer of the bond to pay the holder of the bond:
  – A fixed sum of money (called the principal, par value, or face value) at the bond’s maturity, and sometimes
  – Constant, periodic interest payments (called coupons) during the life of the bond.

• **U.S. Treasury bonds are straight bonds.**

• Special features may be attached:
  – Convertible bonds
  – Callable bonds
  – Putable bonds

Bond Basics, II.

• Two basic yield measures for a bond are its **coupon rate** and its **current yield**.

  \[
  \text{Coupon rate} = \frac{\text{Annual coupon}}{\text{Par value}}
  \]

  \[
  \text{Current yield} = \frac{\text{Annual coupon}}{\text{Bond price}}
  \]

Straight Bond Prices and Yield to Maturity

• The price of a bond is found by adding together the present value of the bond’s coupon payments and the present value of the bond’s face value.

• The **Yield to maturity (YTM)** of a bond is the discount rate that equates the today’s bond price with the present value of the future cash flows of the bond.

The Bond Pricing Formula

• The price of a bond is found by adding together the present value of the bond’s coupon payments and the present value of the bond’s face value.

• The formula is:

  \[
  \text{Bond Price} = \frac{C}{\text{YTM}} \left[ 1 - \frac{1}{(1 + \text{YTM})^M} \right] + \frac{FV}{(1 + \text{YTM})^M}
  \]

• In the formula, C represents the annual coupon payments (in $), FV is the face value of the bond (in $), and M is the maturity of the bond, measured in years.

Premium and Discount Bonds, I.

• Bonds are given names according to the relationship between the bond’s selling price and its par value.

  • **Premium bonds:** price > par value
    YTM < coupon rate

  • **Discount bonds:** price < par value
    YTM > coupon rate

  • **Par bonds:** price = par value
    YTM = coupon rate
In general, when the coupon rate and YTM are held constant:

**For premium bonds:** the longer the term to maturity, the greater the premium over par value.

**For discount bonds:** the longer the term to maturity, the greater the discount from par value.

### Relationships among Yield Measures

**For premium bonds:**
- coupon rate > current yield > YTM

**For discount bonds:**
- coupon rate < current yield < YTM

**For par value bonds:**
- coupon rate = current yield = YTM

### A Quick Note on Bond Quotations, I.

- We have seen how to calculate bond prices.
- Note: If you buy a bond between coupon dates, you will receive the next coupon payment (and might have to pay taxes on it).
- However, when you buy the bond between coupon payments, you must compensate the seller for any accrued interest.

### A Quick Note on Bond Quotations, II.

- The convention in bond price quotes is to ignore accrued interest.
  - This results in what is commonly called a clean price (i.e., a quoted price net of accrued interest).
  - Sometimes, this price is also known as a flat price.
- The price the buyer actually pays is called the dirty price
  - This is because accrued interest is added to the clean price.
  - Note: The price the buyer actually pays is sometimes known as the full price, or invoice price.

### Callable Bonds

- Thus far, we have calculated bond prices assuming that the actual bond maturity is the original stated maturity.
- However, most bonds are **callable bonds**.
- A **callable bond** gives the issuer the option to buy back the bond at a specified call price anytime after an initial call protection period.
- Therefore, for callable bonds, YTM may not be useful.
Yield to Call

• Yield to call (YTC) is a yield measure that assumes a bond will be called at its earliest possible call date.

• The formula to price a callable bond is:

\[
\text{CallableBondPrice} = \frac{C \cdot \frac{1}{YTC} - 1}{1 + \frac{YTC}{2}} \times \frac{CP}{1 + \frac{YTC}{2}}
\]

• In the formula, \(C\) is the annual coupon (in $), \(CP\) is the call price of the bond, \(T\) is the time (in years) to the earliest possible call date, and \(YTC\) is the yield to call, with semi-annual coupons.

• As with straight bonds, we can solve for the YTC, if we know the price of a callable bond.

Interest Rate Risk

• Holders of bonds face interest rate risk.

• Interest rate risk is the possibility that changes in interest rates will result in losses in the bond’s value.

• The yield actually earned or “realized” on a bond is called the realized yield.

• Realized yield is almost never exactly equal to the yield to maturity, or promised yield.

Malkiel’s Theorems, I.

• Bond prices and bond yields move in opposite directions.
  – As a bond’s yield increases, its price decreases.
  – Conversely, as a bond’s yield decreases, its price increases.

• For a given change in a bond’s YTM, the longer the term to maturity of the bond, the greater the magnitude of the change in the bond’s price.

Malkiel’s Theorems, II.

• For a given change in a bond’s YTM, the size of the change in the bond’s price increases at a diminishing rate as the bond’s term to maturity lengthens.

• For a given change in a bond’s YTM, the absolute magnitude of the resulting change in the bond’s price is inversely related to the bond’s coupon rate.

• For a given absolute change in a bond’s YTM, the magnitude of the price increase caused by a decrease in yield is greater than the price decrease caused by an increase in yield.

Duration

• Duration is a widely used measure of a bond’s sensitivity to changes in bond yields.

Duration Properties

• All else the same, the longer a bond’s maturity, the longer is its duration.

• All else the same, a bond’s duration increases at a decreasing rate as maturity lengthens.

• All else the same, the higher a bond’s coupon, the shorter is its duration.

• All else the same, a higher yield to maturity implies a shorter duration, and a lower yield to maturity implies a longer duration.
**Dedicated Portfolios**

- A dedicated portfolio is a bond portfolio created to prepare for a future cash payment, e.g. pension funds.
- The date the payment is due is commonly called the portfolio’s **target date**.

**Reinvestment Risk**

- **Reinvestment rate risk** is the uncertainty about the value of the portfolio on the target date.
- Reinvestment rate risk stems from the need to reinvest bond coupons at yields not known in advance.
- **Simple solution**: purchase zero coupon bonds.
- **Problem with simple solution**:
  - U.S. Treasury STRIPS are the only zero coupon bonds issued in sufficiently large quantities.
  - STRIPS have lower yields than even the highest quality corporate bonds.

**Price Risk**

- **Price risk** is the risk that bond prices will decrease.
- Price risk arises in dedicated portfolios when the target date value of a bond is not known with certainty.

**Price Risk versus Reinvestment Rate Risk**

- For a dedicated portfolio, interest rate **increases** have two effects:
  - Increases in interest rates **decrease** bond prices, but
  - Increases in interest rates **increase** the future value of reinvested coupons
- For a dedicated portfolio, interest rate **decreases** have two effects:
  - Decreases in interest rates **increase** bond prices, but
  - Decreases in interest rates **decrease** the future value of reinvested coupons

**Immunization**

- **Immunization** is the term for constructing a dedicated portfolio such that the uncertainty surrounding the target date value is minimized.
- It is possible to engineer a portfolio such that price risk and reinvestment rate risk offset each other (just about entirely).

**Immunization by Duration Matching**

- A dedicated portfolio can be immunized by **duration matching** - matching the duration of the portfolio to its target date.
- Then, the impacts of price and reinvestment rate risk will almost exactly offset.
- This means that interest rate changes will have a minimal impact on the target date value of the portfolio.
Dynamic Immunization

• **Dynamic immunization** is a periodic rebalancing of a dedicated bond portfolio for the purpose of maintaining a duration that matches the target maturity date.

• The advantage is that the reinvestment risk caused by continually changing bond yields is greatly reduced.

• The drawback is that each rebalancing incurs management and transaction costs.