**NPTEL**

**Course Name: Security Analysis and Portfolio Management**

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## Session 34: Bond Price Volatility

**1.** What is Price volatility for bonds? How it has implication for investors?
Ans.

Bond price change is measured as the percentage change in the price of the bond

$$\frac{EPB}{BPB} - 1$$

Where:
EPB = the ending price of the bond
BPB = the beginning price of the bond

Determinants of Price Volatility for Bonds: Par value, Coupon, Years to maturity, prevailing market interest rate

Implications for Investor:

- A bond buyer in order to receive the maximum price impact of an expected change in interest rates should purchase low-coupon and long-maturity bonds.
- If an increase in interest rate is expected an investor contemplating his purchase should consider these bonds with large coupons or short-maturities or both.

**2.** Outline Price-Yield Relationship for Bonds.
Ans.

- The graph of prices relative to yields is not a straight line, but a curvilinear relationship
- This can be applied to a single bond, a portfolio of bonds, or any stream of future cash flows
- The convex price-yield relationship will differ among bonds or other cash flow streams depending on the coupon and maturity
- The convexity of the price-yield relationship declines slower as the yield increases
- Modified duration is the percentage change in price for a nominal change in yield

**3.** Explain Convexity.
Ans.

- Price changes are not linear, but a curvilinear (convex) function. It measures the degree to which the relationship between a bond's price and yield departs from a straight line. It is the term used to refer to the degree to which duration changes as YTM changes. Convexity is desirable.

- The convexity is the measure of the curvature and is the second derivative of price with resect to yield ($d^2P/di^2$) divided by price. Convexity is the percentage change in *dP/di* for a given change in yield.

$$\text{Convexity} = \frac{\frac{d^2P}{di^2}}{P}$$

- Determinants of Convexity: Inverse relationship between coupon and convexity, Direct relationship between maturity and convexity, Inverse relationship between yield and convexity

**4.** Explain Burton Malkiel's Theorem.
Ans.

- The change that occur in the price of a bond (volatility) given a change in yield is because of time to maturity and coupon
- Holding maturity constant a decrease in interest rates will raise bond prices on a percentage basis more than a corresponding increase in rates will lower bond prices.
- Given the changes in market yields changes in bond prices are directly related to time to maturity.
- The percentage price change that occurs at a result of the direct relationship between a bond's maturity and its price volatility at a diminishing rate as the time to maturity increases.
- Other things being equal bond price fluctuations and bond coupon rates are inversely related.

**5.** What is Duration?
Ans.

- It is the weighted average on a present value basis of the time to full recovery of the principal and interest payments on a bond. It measures the weighted average maturity of a bond's cash flows on a present value basis. It is represented as the time period.
- Maturity is an inadequate measure of the sensitivity of a bond's price change to changes in yields because it ignores the coupon payments and principal payment. Therefore, a measure of time designed to more accurately portray a bond's average life, taking into account all of the bond's cash flows, including both coupons and the return of principal at maturity. Such a measure of time is called as Duration.

  Characteristics of Duration:

- Duration of a bond with coupons is always less than its term to maturity because duration gives weight to these interim payments. A zero-coupon bond's duration equals its maturity
- There is an inverse relation between duration and coupon
- There is a positive relation between term to maturity and duration, but duration increases at a decreasing rate with maturity
- There is an inverse relation between YTM and duration

Measure of Duration:

$$D = \frac{\sum_{t=1}^{n} \frac{C_t(t)}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}} = \frac{\sum_{t=1}^{n} t \times PV(C_t)}{\text{price}}$$

Where:

$t$ = time period in which the coupon or principal payment occurs

$C_t$ = interest or principal payment that occurs in period $t$

$i$ = yield to maturity on the bond