

## **Lecture 7: Managing bond portfolios**

In this lecture we will give an overview of the manner in which institutional investors can profit from bond portfolio management. We begin with an overview of the term structure relation before outlining determinants of interest rate risk and duration, and finally some passive and active investment strategies.

## Bond basics

Bonds are *fixed income*. Pricing depends crucially on market rates  $r$ :

$$P_B = \sum_{t=1}^T \frac{C_t}{(1+r)^t} + \frac{ParValue}{(1+r)^T}$$

Yield to maturity; interest rate that makes the present value of the bond's payments equal to its price.

Holding period return

$$HPR = [ I + ( P_0 - P_1 ) ] / P_0$$

Term structure - the relationship between yield to maturity and maturity. Information on expected future short term rates can be derived from the yield curve. The yield curve is a graph that displays the relationship between yield and maturity (technically for zero coupon bonds).

Corporate versus Treasury bonds, former subject to default and interest rate risk, latter only interest rate risk.

Chart 3: Corporate Yields vs Treasury Yields (%)

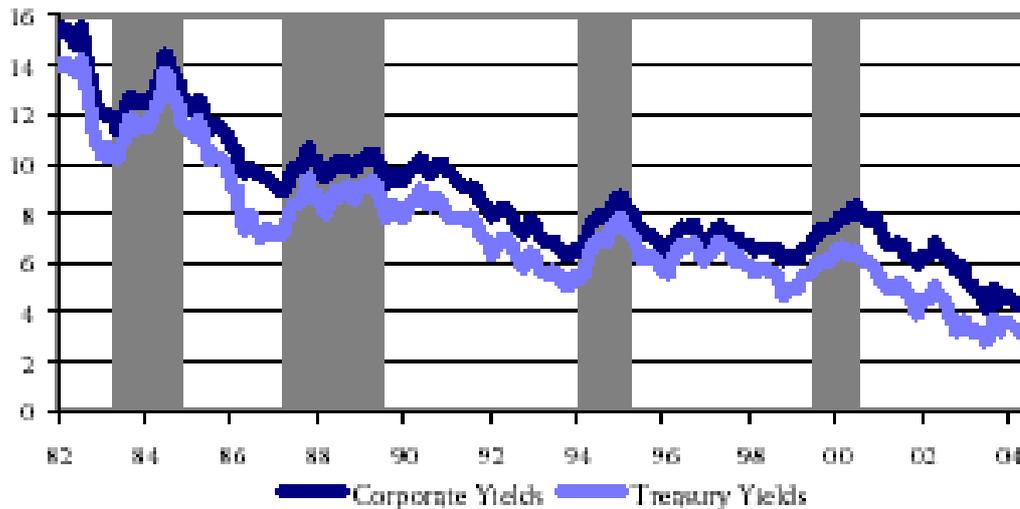
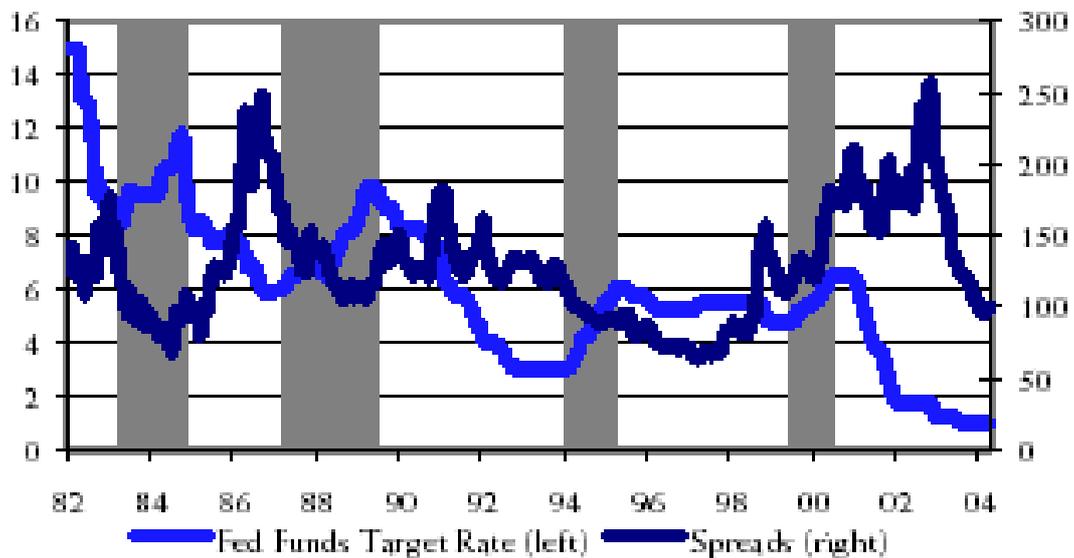


Chart 1: Spreads vs. Fed Funds – Shaded Areas denote Tightening Cycles



Other types of bond:

- FRNs – Callable – Convertible - Zero

(1) Basic derivation of term structure under certainty – assumption of no riskless arbitrage

$$(1 + i_0^2)^2 = (1 + i_0^1)(1 + i_1^1),$$

$$(1 + i_0^2) = \sqrt{(1 + i_0^1)(1 + i_1^1)}.$$

Inverting,

$$\frac{1}{[1 + i_0^2]^2} = \frac{1}{[1 + i_0^1][1 + i_1^1]}$$

Expectations hypothesis - implied forward rate equals future spot rate to preclude riskless arbitrage

(2) Derivation under uncertainty  
Importance of risk aversion affecting yields to maturity

Use of a probabilistic approach and no arbitrage – so can analyse problem as if investors risk neutral

Expectations hypothesis under uncertainty, assessing two investment strategies and applying subjective probabilities ( $\hat{\theta}$ )

$$\frac{1}{[1+i_0^2]^2} = \frac{\hat{\theta}}{[1+i_0^1][1+i_1^1(+)]} + \frac{[1-\hat{\theta}]}{[1+i_0^1][1+i_1^1(-)]}$$

$$\hat{\theta} = \frac{u-r}{u-d}$$

where

$$u = [1+i_0^2]^2/[1+i_0^1(-)]$$

$$d = [1+i_0^2]^2/[1+i_1^1(+)]$$

$u$  is 1+one period return from buying a two period bond now and selling next period after price has moved up and  $d$  is analogous value when price has moved down

# **Theories of term structure**

## **1 Expectations hypothesis**

Observed long-term rate is a function of today's short-term rate and expected future short-term rates.

Long-term and short-term securities are perfect substitutes.

Forward rates that are calculated from the yield on long-term securities are market consensus expected future short-term rates.

## **2 Term premium/liquidity preference**

Long-term bonds are more risky.

Investors will demand a premium for the risk associated with long-term bonds.

The yield curve has an upward bias built into the long-term rates because of the risk premium.

Forward rates contain a liquidity premium and are not equal to expected future short-term rates.

Makes forecasting forward rates from the yield curve very difficult, especially as liquidity premium varies over time.

### **3 Market segmentation theory**

Short- and long-term bonds are traded in distinct markets.

Trading in the distinct segments determines the various rates.

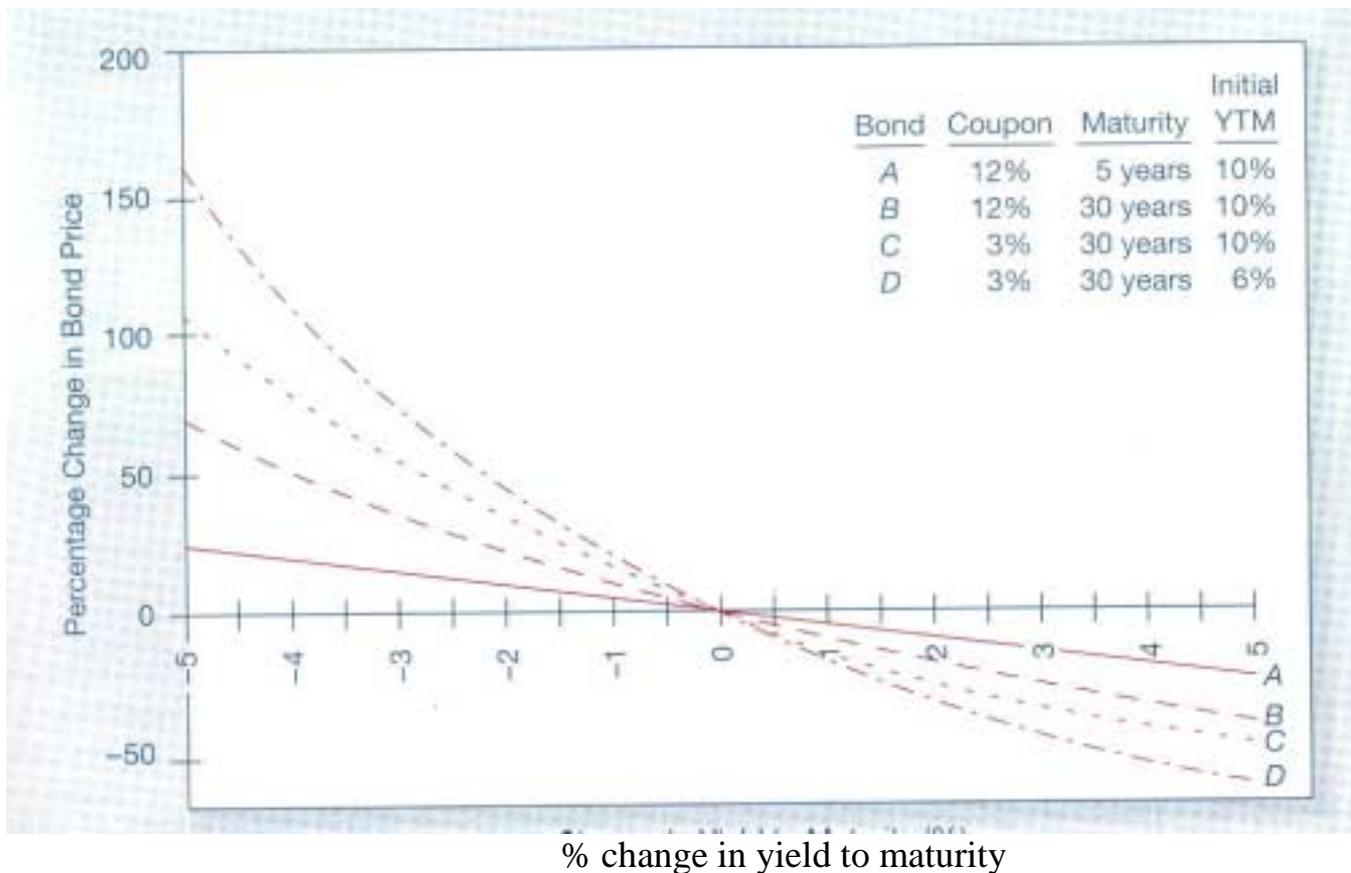
Observed rates are not directly influenced by expectations.

Preferred Habitat:

- Modification of market segmentation
- Investors will switch out of preferred maturity segments if premiums are adequate.

# Portfolio management - interest rate risk

Bond prices respond to interest rates, to a varying degree



The diagram shows the following points:

- 1 Bond prices and yields are inversely related

- 2 An increase in a bond's yield to maturity results in a smaller price change than a similar decrease in yield
- 3 Prices of long-term bonds are more sensitive to interest rates than short term ones
- 4 Sensitivity of bond prices to changes in yields increases at a decreasing rate as maturity increases
- 5 Interest rate risk is inversely related to a bond's coupon price
- 6 Sensitivity of a bond's price to a change in yield is inversely related to the yield to maturity at which a bond is currently selling
- 7 Zero coupon bonds are more sensitive to interest rates than coupon bonds, highlighting the importance of duration rather than maturity. High coupons reduce effective maturity.

# Duration

A measure of the effective maturity of a bond.

The weighted average of the times until each payment is received, with the weights proportional to the present value of the payment.

$$w_t = \left[ CF_t / (1 + y)^t \right] / Price$$

$$D = \sum_{t=1}^T t \times w_t$$

Shorter duration, lower price volatility  
Distinguish duration and maturity  
(bonds, zeros, FRNs)

Duration is key to fixed income portfolio management.

Summarises effective average maturity

Tool for immunising portfolios

Measures interest rate sensitivity of portfolios. Price change is proportional to duration and not to maturity.

$$\Delta P / P = -D * (\Delta(1 + y)/(1 + y))$$

or simplifying

$$\Delta P / P = -D'' * \Delta y$$

where modified duration  $D'' = D / (1+y)$

## **Determinants of duration**

- 1 Duration of zero coupon bond is time to maturity
- 2 Holding maturity constant, duration is higher, lower is coupon rate
- 3 Holding coupon constant, duration increases with maturity
- 4 Other things equal, duration of coupon bond is higher when yield is lower
- 5 Duration of consol is simply  $(1+y/y)$  (with flat yield curve)

6 Duration of annuity is

$$\frac{1+y}{y} - \frac{T}{(1+y)^T - 1}$$

7 Duration of coupon bond

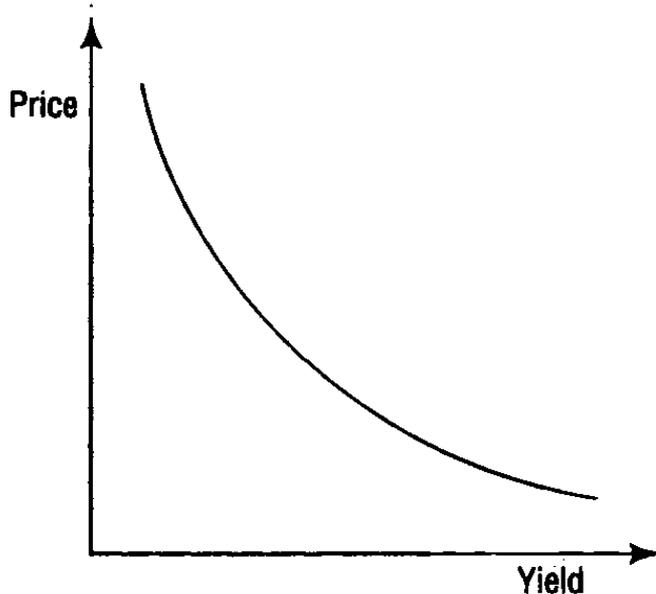
$$\frac{1+y}{y} - \frac{(1+y) + T(c-y)}{c[(1+y)^T - 1] + y}$$

Simplification for par value

$$(1+y)/y - (1 - (1/(1+y))^T)$$

# Convexity

Price/yield curve of a plain vanilla bond is convex - rate price declines as yield falls, declines. Why is it desirable?



Formula for convexity

$$Convexity = \frac{1}{P \times (1+y)^2} \sum_{t=1}^n \left[ \frac{CF_t}{(1+y)^t} (t^2 + t) \right]$$

Correction of duration for convexity

$$\frac{\Delta P}{P} = -D * \Delta y + \frac{1}{2} [Convexity \times (\Delta y)^2]$$

Callable bonds

## **Passive bond management**

Indexation similar to equities but issues arise of large number of securities, thin trading and regular disappearance of bonds as they reach redemption.

Stratified sampling/cellular approach, criteria are maturity, issuer, coupon, credit risk. Then hold each cell in relation to the overall universe.

Immunitisation is means to insulate portfolio from interest rate risk by duration matching between assets and liabilities. Two approaches

(1) Net worth immunization

Duration of assets = Duration of liabilities

(2) Target date immunization

Holding Period matches Duration

Price risk (sale value of bond) and reinvestment risk (accumulated value of coupons) offset one another. Need for rebalancing as duration changes (due to passage of time and as interest rates change).

Difficulties of immunisation when yield curve is not flat, and when there is inflation.

Cash flow matching or dedication: choose bonds that exactly match the cash flows on the liabilities. No need for rebalancing but problem of constraints on selection.

## **Active bond management**

Profits can arise from superior interest rate forecasting (e.g. horizon analysis) and relative mispricing (e.g. of credit risk premium).

Difficulties of interest rate forecasting, see above and refer Lecture 1 – on credit risk see supplementary lecture.

Harvey and Liebowitz taxonomy of active bond management.

Substitution swap: exchange of a bond for almost identical substitute (coupon, maturity etc.) following belief there is temporary mispricing of 2 bonds

Intermarket spread swap: exchange of a type of bond for another when investor believes yield spreads temporarily out

of line with fundamentals, e.g.  
government and corporate bonds.

Rate anticipation swap: if believe rates will fall, change to longer duration bonds (other characteristics identical) or vice versa.

Pure yield pickup swap: seek to increase return by holding higher yield bonds, e.g. shift to longer-term bonds when yield curve upward sloping. Offset is greater interest rate risk.

Contingent immunization: rather than precise duration management, set limit to losses willing to bear. As long as the rate earned exceeds the floor, the portfolio is actively managed. Once the floor rate or trigger rate is reached, the portfolio is immunized.

Use of interest rate swaps to restructure balance sheet.

Generation of new instruments via financial engineering, such as inverse floaters – pays lower interest rate when reference interest rate rises. Divide cash flows from fixed income securities into floating rate and the remainder, which is inverse floating rate. Has very long duration exceeding maturity.

Interest rate and principal only strips which have extreme interest rate exposures – PO long effective duration, high rate sensitivity, IO negative interest rate durations.