Chapter 11

Managing Bond Portfolios

Copyright © 2010 by The McGraw-Hill Companies, Inc. All rights reserved.

11.1 Interest Rate Risk

Interest Rate Sensitivity

1. Inverse relationship between bond price and interest rates (or yields)

2. Long-term bonds are more price sensitive than short-term bonds

3. Sensitivity of bond prices to changes in yields increases at a decreasing rate as maturity increases

Interest Rate Sensitivity (cont)

4. A bond's price sensitivity is inversely related to the bond's coupon

5. Sensitivity of a bond's price to a change in its yield is inversely related to the yield to maturity at which the bond currently is selling

6. An increase in a bond's yield to maturity results in a smaller price decline than the gain associated with a decrease in yield

Summary of Interest Rate Sensitivity

The concept:

- Any security that gives an investor more money back sooner (as a % of your investment) will have lower price volatility when interest rates change.

- Maturity is a major determinant of bond price sensitivity to interest rate changes, but

- It is not the only factor; in particular the coupon rate and the current ytm are also major determinants.

Change in Bond Price as a Function of YTM

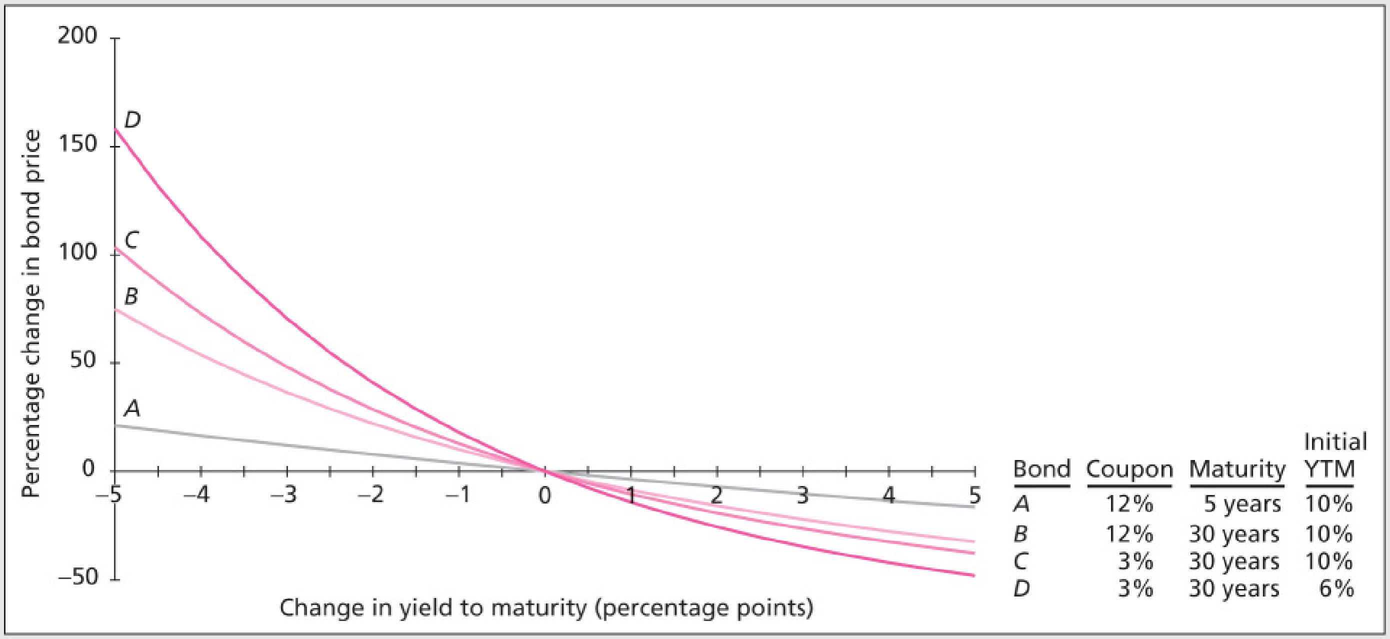


FIGURE 11.1

Change in bond price as a function of change in yield to maturity

Duration

Consider the following 5 year 10% coupon annual payment corporate bond:

1	2	3	4	5
$100	$100	$100	$100	$1100

- Because the bond pays cash prior to maturity it has an "effective" maturity less than 5 years.
- We can think of this bond as a portfolio of 5 zero coupon bonds with the given maturities.
- The average maturity of the five zeros would be the coupon bond's effective maturity.
- We need a way to calculate the effective maturity.

Duration

- Duration is the term for the effective maturity of a bond
- Time value of money tells us we must calculate the present value of each of the five zero coupon bonds to construct an average.
- We then need to take the present value of each zero and divide it by the price of the coupon bond. This tells us what percentage of our money we get back each year.
- We can now construct the weighted average of the times until each payment is received.

Duration Formula

$$W_t = \frac{\sum_{t=1}^{N} \frac{CF_t}{(1+ytm)^t}}{Price} \qquad Dur = \sum_{t=1}^{N} W_t \times t$$

W_t = Weight of time t, present value of the cash flow earned in time t as a percent of the amount invested

CF_t = Cash Flow in Time t, coupon in all periods except terminal period when it is the sum of the coupon and the principal

ytm = yield to maturity; Price = bond's price

Dur = Duration

Calculating the duration of a 9% coupon, 8% ytm, 4 year annual payment bond priced at $1033.12,

$$W_t = \frac{\sum_{t=1}^{N} \frac{CF_t}{(1+ytm)^t}}{Price} \qquad Dur = \sum_{t=1}^{N} W_t \times t$$

Year (T)	Cash Flow	PV @8% $CF_T / (1+ytm)^T$	% of Value PV/Price	Weighted % of Value (PV/Price)*T
1	$ 90	$83.33	8.06%	0.0806
2	90	77.16	7.47%	0.1494
3	90	71.45	6.92%	0.2076
4	$1090	$801.18	77.55%	3.1020
Totals		$1,033.12	100.00%	3.5396 yrs

Duration = 3.5396 years

More on Duration

1. Duration increases with maturity

2. A higher coupon results in a lower duration

3. Duration is shorter than maturity for all bonds except zero coupon bonds

4. Duration is equal to maturity for zero coupon bonds

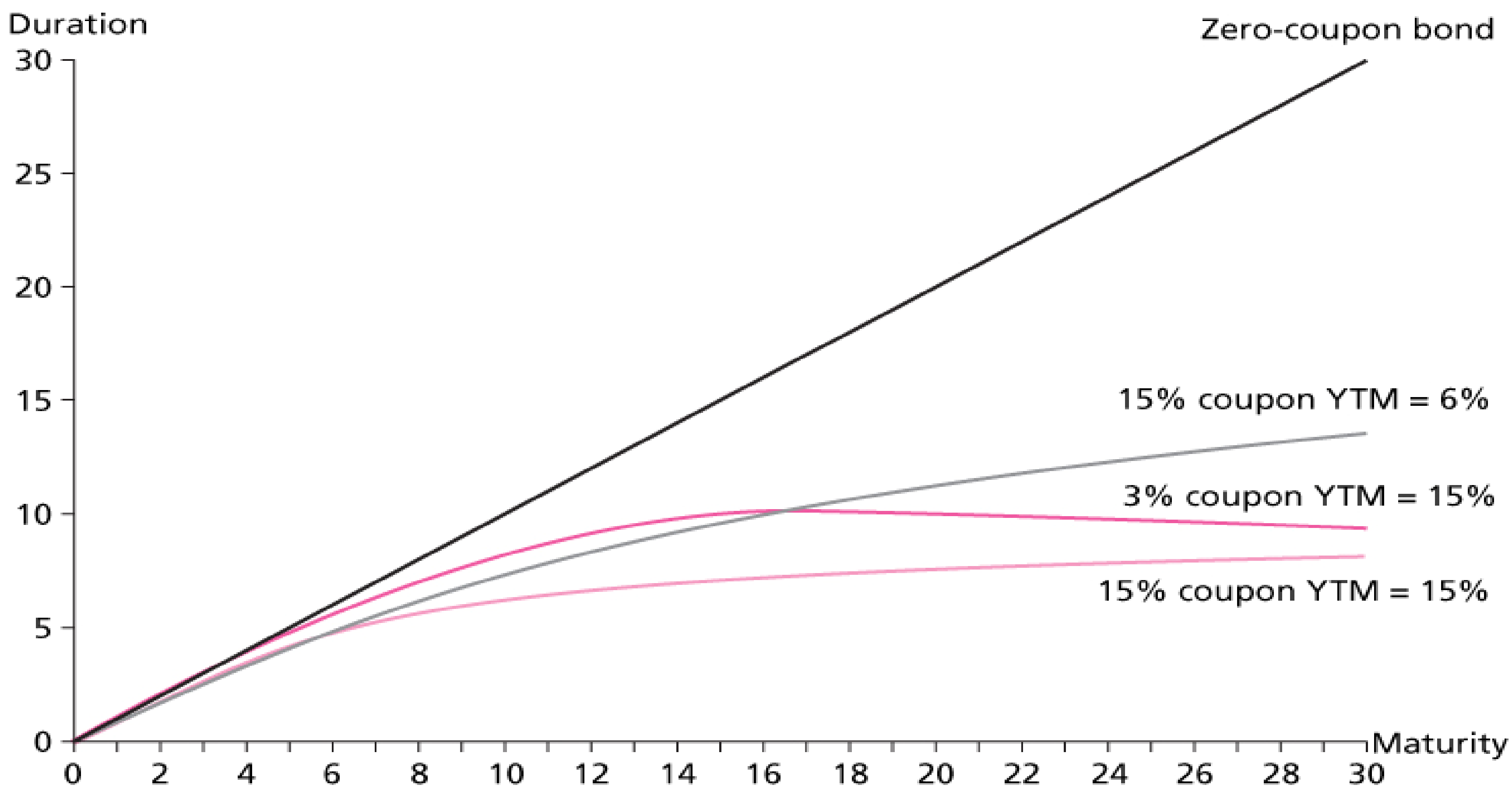
5. All else equal, duration is shorter at higher interest rates

More on Duration

5. The duration of a level payment perpetuity is:

$$D_{perpetuity} = \frac{1+y}{y}; \qquad y = ytm$$

Figure 11.3 Duration as a Function of Maturity



Duration/Price Relationship

- Price change is proportional to duration and not to maturity

$\Delta P/P = -D \times [\Delta y / (1+y)]$

$D^* = D / (1+y)$: *modified duration*

$\Delta P/P = - D^* \times \Delta y$

So, D^* represent interest rate elasticity of bond's price.

11.2 Passive Bond Management

Interest Rate Risk

Interest rate risk is the possibility that an investor does not earn the promised ytm because of interest rate changes.

A bond investor faces two types of interest rate risk:

1. Price risk: The risk that an investor cannot sell the bond for as much as anticipated. An increase in interest rates reduces the sale price.

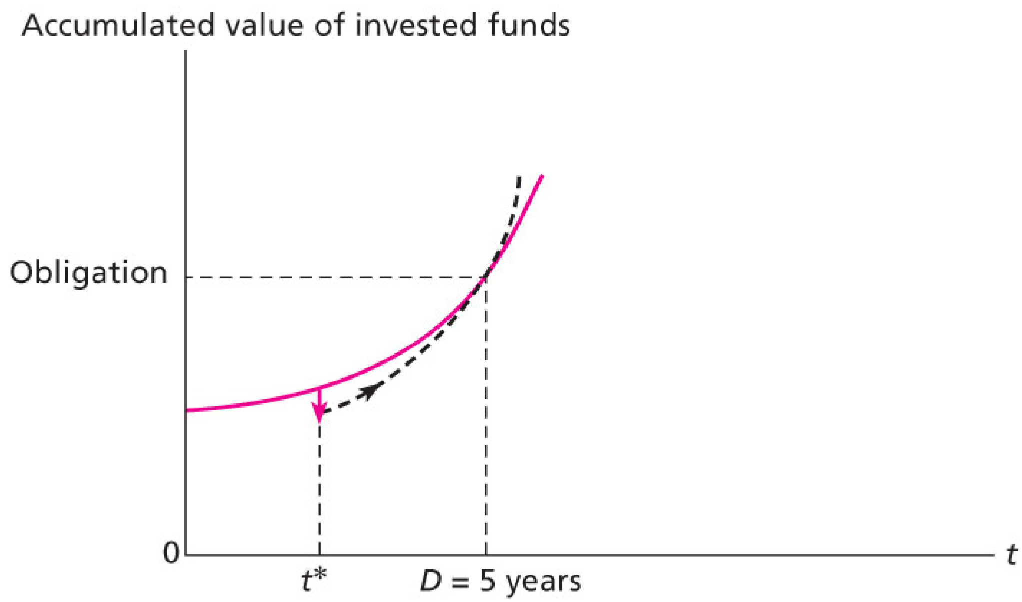
2. Reinvestment risk: The risk that the investor will not be able to reinvest the coupons at the promised yield rate. A decrease in interest rates reduces the future value of the reinvested coupons.

The two types of risk are potentially offsetting.

Immunization

- Immunization: An investment strategy designed to ensure the investor earns the promised ytm.
- A form of passive management, two versions
  1. Target date immunization
     - Attempt to earn the promised yield on the bond over the investment horizon.
     - Accomplished by matching duration of the bond to the investment horizon

Growth of Invested Funds

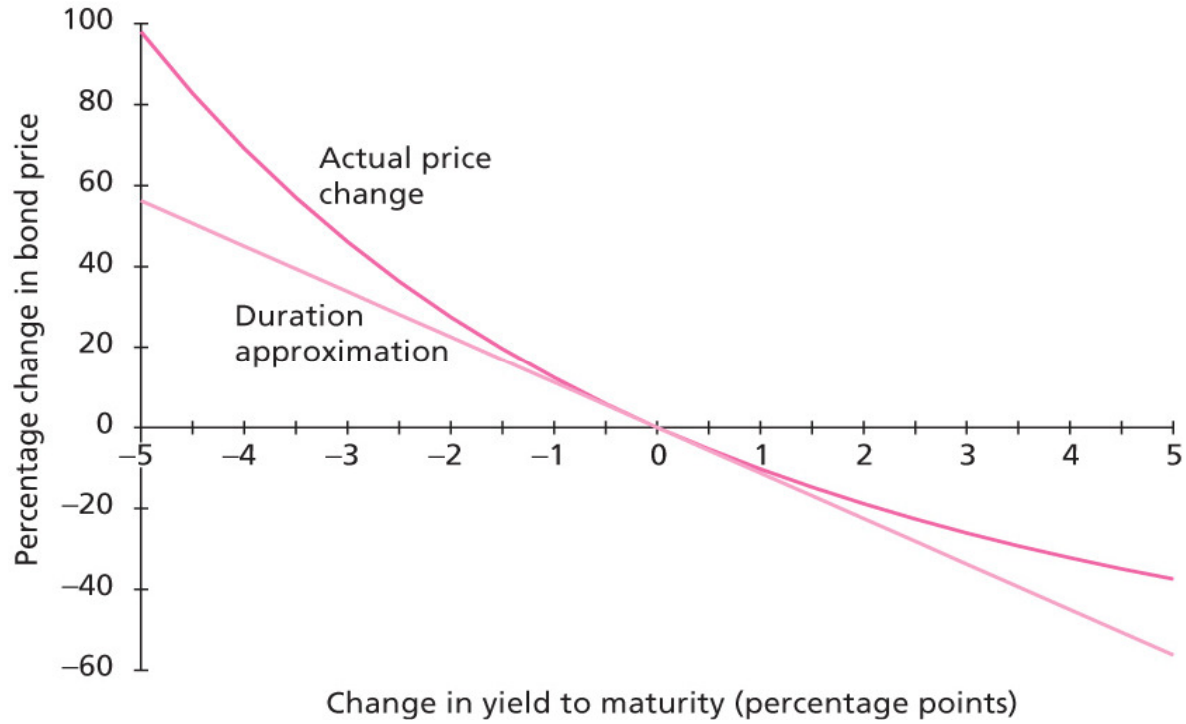


11.3 Convexity

The Need for Convexity

- Duration is only an approximation
- Duration asserts that the percentage price change is linearly related to the change in the bond’s yield
  - Underestimates the increase in bond prices when yield falls
  - Overestimates the decline in price when the yield rises

Pricing Error Due to Convexity



Convexity: Definition and Usage

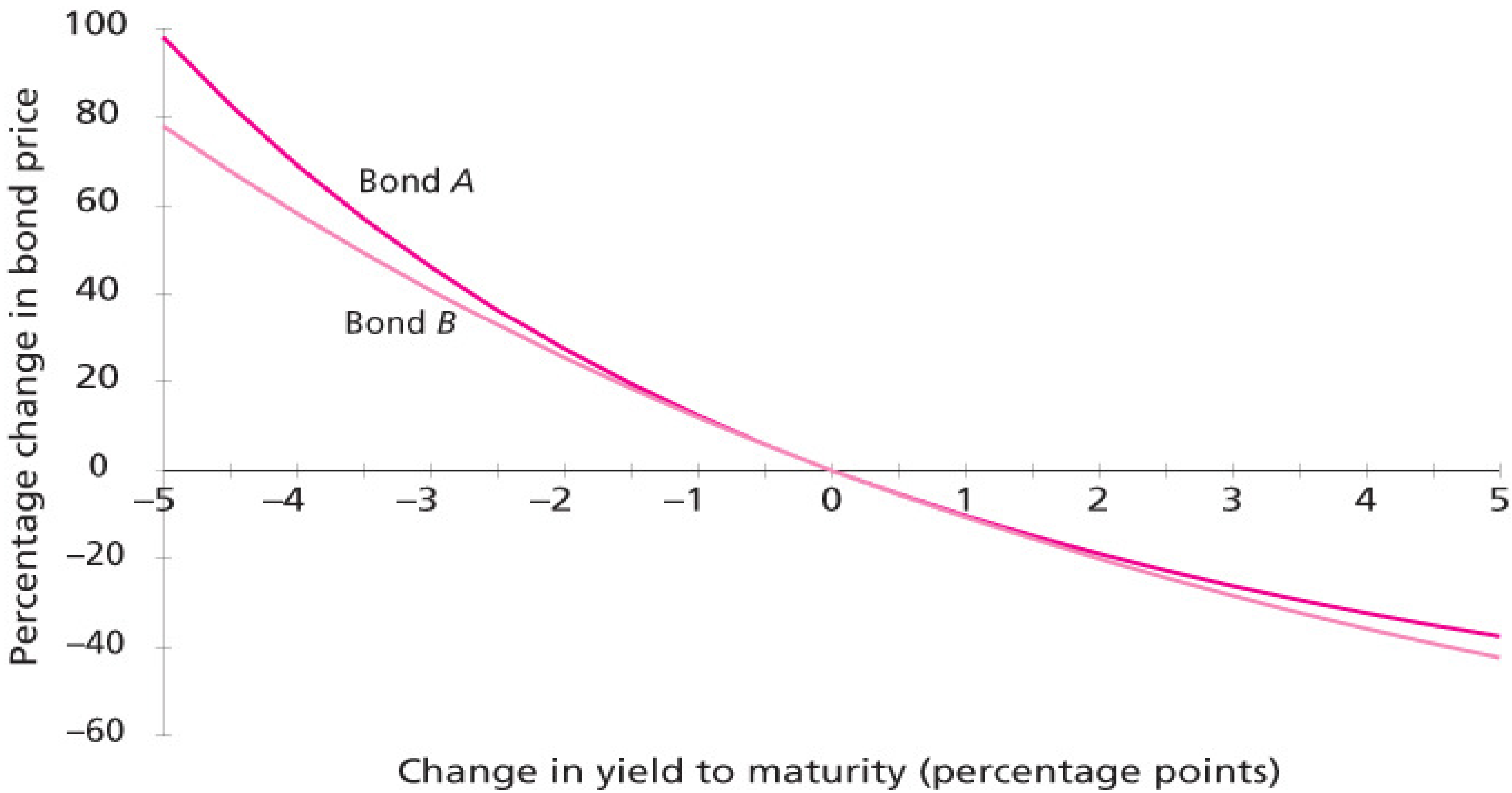
$$\text{Convexity} = \frac{1}{P \times (1+y)^2} \sum_{t=1}^{n} \left[\frac{CF_t}{(1+y)^t} (t^2 + t) \right]$$

Where: CF_t is the cash flow (interest and/or principal) at time t and y = ytm

The prediction model including convexity is:

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

Convexity of Two Bonds



Prediction Improvement With Convexity