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Lecture 7: Bond Valuation

An Application of Time Value of Money

Presentation to Cox Business Students

FINA 3320: Financial Management

Purpose of This Lecture

- **Provide an application of time value of money to bond valuation**
  - (1) Understand basics of bonds
  - (2) Discuss bond valuation
  - (3) Discuss coupon rate, current yield, YTM
  - (4) Review a few special cases

What is a Bond?

- Bond: A security that obligates the issuer to make specific payments to the bondholder
  - Result of money being borrowed with the promise to repay
  - Bond contract specifics the details of the repayment

- Two parties involved:
  - Issuer: Party borrowing money (bond is a liability)
  - Investor (or Bondholder): Party loaning or investing money (bond is an asset)

Coupon Bonds

- Coupon Bond: Obligates the issuer to make…
  - (1) Payments (usually semi-annual) of interest (coupons) to the bondholder for the life of the bond
  - (2) Pay, in addition, the par value (face value) at maturity
- Coupon Rate: Usually set at an initial level that enables issuer to sell securities at or near par value (i.e., $1,000)
  - In practice, bond buyer must pay the asked price for the bond plus any accrued interest
  - If bond is purchased between coupon payments, buyer must pay seller for the prorated share of the upcoming coupon
  - Sale (i.e., ***invoice price***) of the bond would equal stated price plus accrued interest

Types of Coupon Bonds

- Types of coupon bonds:
  - (1) U.S. Treasury bonds (and notes)
  - (2) Corporate bonds (investment grade)
  - (3) Junk bonds
  - (4) Municipal bonds
  - (5) International bonds

U.S. Treasury Bonds and Notes

- Prototype ***default-free*** coupon bonds (not ***risk-free***)
  - **T-notes**
    - Maturities range from 1 year up to 10 year
    - Make semiannual coupon payments
  - **T-bonds**
    - Issued with maturities ranging from 10 to 30 years
    - Also make semiannual coupon payments
    - Callable for a given period, usually during last 5 year of bond's life

Investment-Grade Corporate Bonds

- To compensate investors for the possibility of bankruptcy, corporate bonds offer a ***default premium***
    - Premium is a differential in promised yield between the corporate bond and an otherwise identical T-bond that is risk free in terms of default
- Bonds rated BBB and above (S&P) or Baa and above (Moody's) are considered investment grade bonds

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Junk Bonds

- Bonds rate below BBB (S&P) or below Baa (Moody's) are classified as ***speculative grade*** or ***junk bonds***
- Before 1977 almost all junk bonds were "fallen angels"
  - Junk bonds constituted only 3.7% of corporate bond market in 1977
- In 1977, Michael Milken (Drexel Burnham Lambert) began to issue original-issue junk bonds
- Junk bonds gained notoriety in 1980s when used to finance leveraged buyouts and hostile takeover attempts
  - Junk bonds accounted for 23% of corporate bond market by 1987

Municipal Bonds

- Issued by state and local governments (municipalities)
- Exempt from federal taxes (on interest only) if issued to build roads, schools, hospitals, finance deficits, etc.
  - Exempt from state and local taxes if financed within the state
- Lower coupon rate because of tax status
- The rate taxable must pay to match the after-tax yield on "munis" is:

$$rate_{taxable} = rate_{muni}/(1-t)$$

where t = tax rate of investor (in decimal form)

International Bonds

- Issued by foreign governments or foreign corporations
- Types:
  - **Sovereign Bonds**: Issued by governments
    - e.g., UK ***gilts***, Japanese ***JGBs***, German ***Bunds***, and US ***Treasuries***
  - **Foreign Bonds**: Issued by an issuer in a currency other than its national currency
    - e.g., ***Yankee bonds***: bonds issued in US in US $s by foreign issuers, or ***Samurai bonds***: yen denominated bonds issued in Japan by foreign issuers, etc.
  - **Eurobonds**: Denominated in single currency, euro
    - World's largest corporate bond market
    - World's only unregulated market

Contract Details

- Face Value: The amount of the debt to be repaid at some future date (i.e., the maturity date)
  - Aka – **Par Value**
  - Typically $1,000
- Coupon Payments: Periodic interest payments to be made while the bond is outstanding
  - Name came from physical coupons
  - Typically happens once every 6 months (i.e., semi-annually)
- Coupon Rate: Percentage of par value paid in coupon payments each year (expresses as an APR)

Contract Details continued…

- Bond Indentures: Contract between the issuer and the bondholder
  - Part of indenture is a set of restrictions on the firm issuing the bond to protect the rights of the bondholders (recall ***bondholders' wealth expropriation*** issue!)
  - Such restrictions include provisions relating to collateral, sinking funds, dividend policy, and allowed further debt

Bond Indenture Details

- **Sinking Funds**: Help ensure that repayment does not create a cash flow crisis, operate in one of three ways:
  - (1) Firm repurchases a faction of outstanding bonds in the open market each year
  - (2) Firm purchases a fraction of outstanding bonds at a special call price each year (bonds chosen for recall randomly)
  - (3) Although uncommon, periodic payments to trustee with these payments invested

- **Dividend Restrictions**: Limit dividend payouts
  - Protect bondholder from ***liquidating dividend***
  - Forces firm to retain assets rather than paying them to shareholders

Bond Indenture Details continued…

- **Collateral**: Provides assets that can be used to repay bondholders in the event of a liquidation
  - ***Mortgage bond***: has collateral in the form of PP&E
  - ***Collateral trust bond***: collateral takes the form of other securities held by the firm
  - ***Debenture***: has no specific collateral – they are unsecured

- **Subordination of Further Debt**: Restricts the amount of additional borrowing
  - Prevents firm from harming existing bondholders by issuing significant amounts of debt with equal priority
  - In event of bankruptcy, subordinated or junior bondholders will not be paid unless and until senior bondholders are fully repaid

Coupon Bond: Example

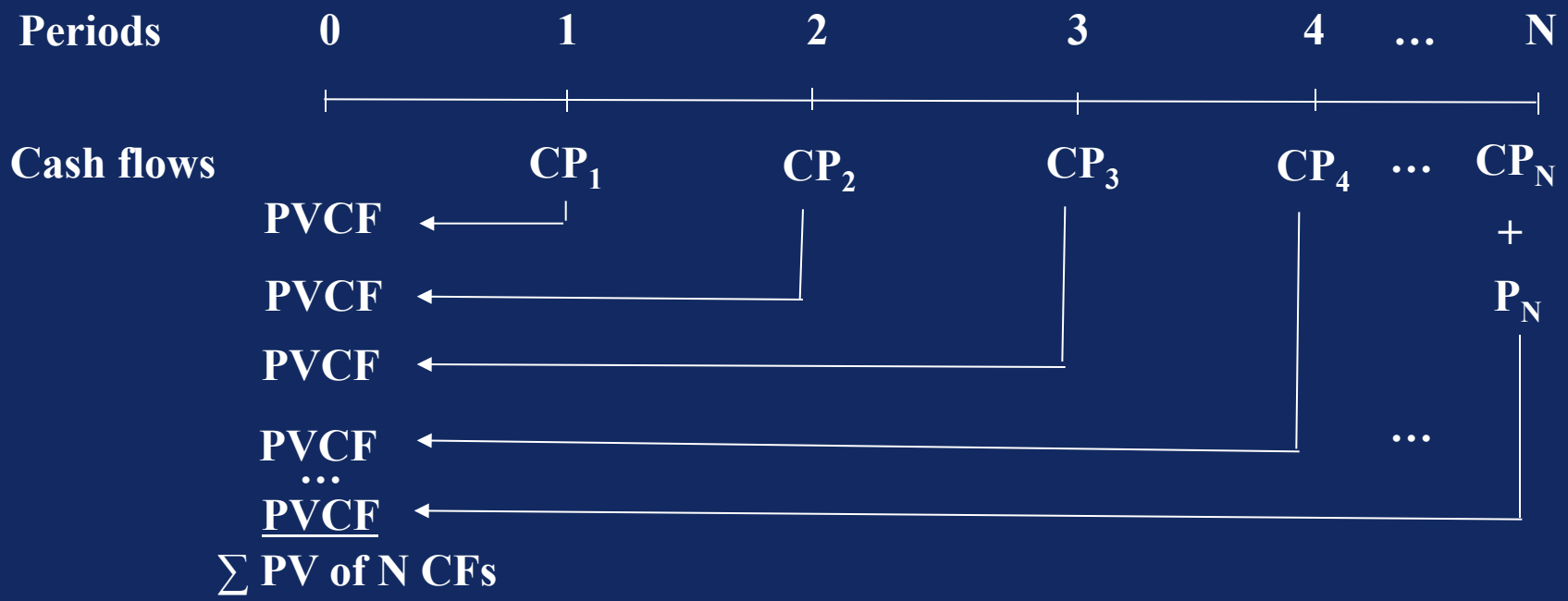
- Consider a 10-year bond with a 6% coupon rate
  - Annual coupon payments are 6% of $1,000 or $60
  - If coupons are made semi-annually, then each would be $30
- Note: Coupon rate is a feature of the bond contract… Unless specified in the contract, it is constant throughout the life of the bond

Valuing a Bond

- A bond generates a stream of cash flows for its owner
  - Can be represented as a timeline
  - Can be valued just like any other asset by finding the present value of its cash flows
- Two components to the bond's cash flows:
  - Coupon payments are an annuity
  - Repayment of principal at maturity is a single cash flow
- The present value of the cash flows represent the price of the bond

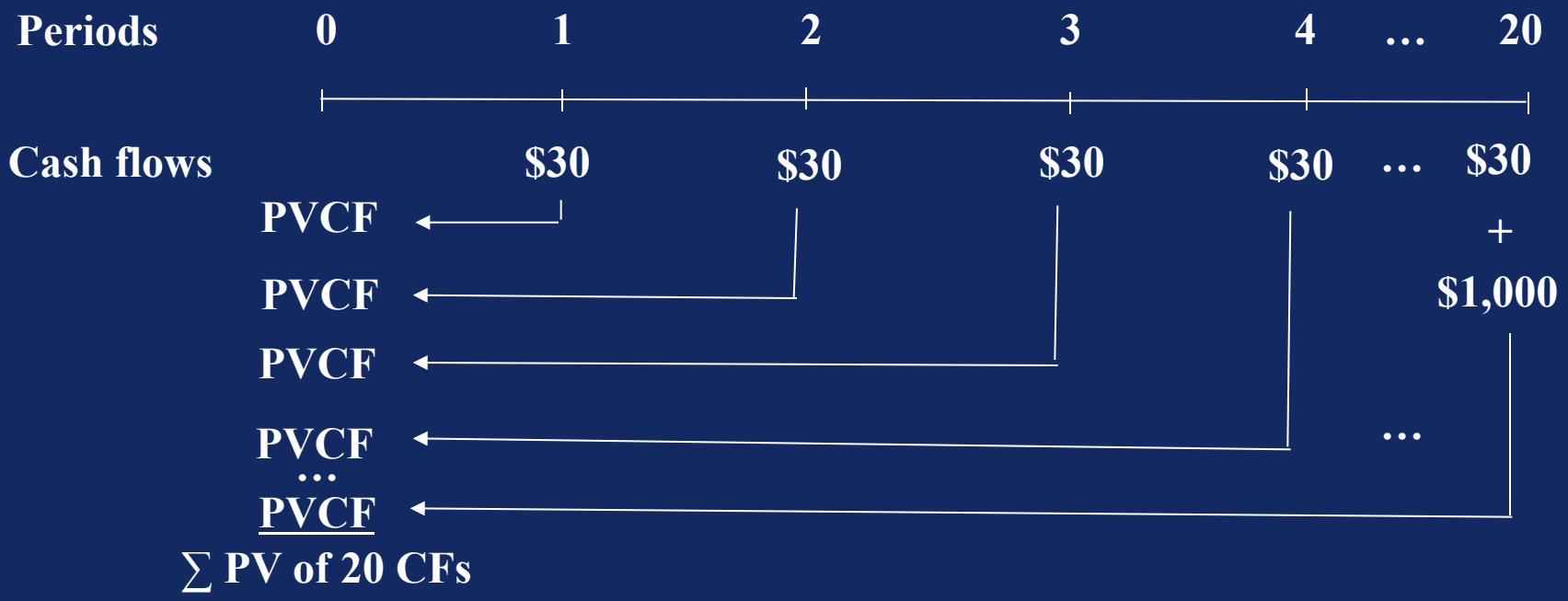
Bond Valuation and Time Lines

- Determining present value of the cash flow stream from a coupon bond involves discounting 2 items
  - Present value of an annuity (coupon payments or CPs)
  - Present value of a single cash flow (principal or P)



Bond Valuation and Time Lines: Example

- Example: Consider a 10-year bond with a 6% coupon rate payable semi-annually
  - Present value of an annuity (coupon payments of $30 S/A)
  - Present value of a single cash flow (principal of $1,000)



Bond Valuation: Mechanics

- Assume 6% discount rate (i.e., 3% semiannual rate)
- Component 1: Present Value of an Annuity
  - Example: $30 semi-annual coupon payments
  - **Formula**: $30*[1-1/(1.03)^{20}]/0.03 = $446.32
  - **Financial Calculator**: 20n; 3i; 30PMT; PV = $446.32
- Component 2: Present value of a Single Sum
  - Example: $1,000 principal
  - **Formula**: $1,000/(1.03)^{20} = $553.68
  - Financial Calculator: 20n; 3i; 1,000FV; PV = $553.68
- Bond Value = Σ of PVs of 2 Components
  - Bond Value = $446.32 + $553.68 = $1,000

Bond Valuation: Mechanics

- Question: Is there an easier way to calculate a bond's value???
- Answer: Yes!!!
- **Financial Calculator**: 20n; 3i; 30PMT; 1,000FV; PV = $1,000
- What did this do?
- It calculated ***both*** the annuity and the single cash flow at the same time!

What Discount Rate Should be Used?

- The coupon rate (i.e., the discount rate we assumed on the previous example)?
  - Not usually, because this is determined at the time the bond is issued and may or may not reflect current market conditions
  - Defined based on cash flows and par value

- Instead, use a market-determined discount rate
  - Should reflect the risk of the cash flows
  - We'll call it the ***market rate*** for now
  - Rate changes when market conditions change

Example

- A 3-year bond has a 6.5% coupon rate and makes payments semi-annually
- Find the present value if the market rate (expressed as APR) is:
  - 3.95%
  - 6.5%
  - 10%

Example: 3.95% APR Discount Rate

- A 3-year bond has a 6.5% coupon rate and makes payments semi-annually

- **Formula**: $32.50*[1-1/(1.01975)^6]/0.01975 = $182.20
- **Financial Calculator**: 6n; 1.975i; 32.50PMT; PV = $182.20

- **Formula**: $1,000/(1.01975)^6 = $889.28
- **Financial Calculator**: 6n; 1.975i; 1,000FV; PV = $889.28

- Bond Value = $182.20 + $889.28 = $1,071.48

Example: 6.5% APR Discount Rate

- A 3-year bond has a 6.5% coupon rate and makes payments semi-annually

- **Formula**: $32.50*[1-1/(1.0325)^6]/0.0325 = $174.61
- **Financial Calculator**: 6n; 3.25i; 32.50PMT; PV = $174.61

- **Formula**: $1,000/(1.0325)^6 = $825.39
- : 6n; 3.25i; 1,000FV; PV = $825.39

- Bond Value = $174.61 + $825.39 = $1,000.00

Example: 10% APR Discount Rate

- A 3-year bond has a 6.5% coupon rate and makes payments semi-annually

- **Formula**: $32.50*[1-1/(1.05)^6]/0.05 = $164.96
- **Financial Calculator**: 6n; 5i; 32.50PMT; PV = $164.96

- **Formula**: $1,000/(1.05)^6 = $746.22
- **Financial Calculator**: 6n; 5i; 1,000FV; PV = $746.22

- Bond Value = $164.96 + $746.22 = $911.18

Example: Using the Easier Way

- A 3-year bond has a 6.5% coupon rate and makes payments semi-annually

  Market rate of 3.95% (1.975% semiannual)
  Financial Calculator: 6n; 1.975i; 32.50PMT; 1,000FV; PV = $1,071.48

  Market rate of 6.5% (3.25% semiannual)
  Financial Calculator: 6n; 3.25i; 32.50PMT; 1,000FV; PV = $1,000.00

  Market rate of 10% (5% semiannual)
  Financial Calculator: 6n; 5i; 32.50PMT; 1,000FV; PV = $911.18

Coupon and Market Rates

- In general, how will the price of the bond vary with the market rate of interest?

- Specific scenarios:
  - Market rate = Coupon rate – implies price = par value
  - Market rate > Coupon rate – implies price < par value
    - Bond sells at a ***discount***
  - Market rate < Coupon rate – implies price > par value
    - Bond sells at a ***premium***

Bond Yields

- Bonds are traded in the market, so price can be viewed as the market's assessment of the present value of its cash flows

- Yield-to-Maturity (YTM): Discount rate that equates bond price to the present value of all promised cash flows
  - When solving for price, we took the cash flows and the discount rate as given
  - When solving for YTM (i.e., the discount rate), we now take the cash flows and price as given

Example

- Consider a 10% coupon bond with semiannual payments, 10 years to maturity, and a market price of $1,200

- Statements we made before hold in the other direction too:
  - Price = par – implies Market rate = Coupon rate
  - Bonds sells at a ***Discount*** – implies Market rate > Coupon rate
  - Bond sells at a ***Premium*** – implies Market rate < Coupon rate

Bond Equivalent Yield and Semiannual Coupons

- WSJ quotes YTM calculated based upon annual percentage rate (APR)
  - APR sometimes referred to as ***bond equivalent yield***
- What does this mean?
- Bond equivalent yield takes semiannual yield and multiplies by 2 (i.e., 2*r)
- Unlike effective annual rate (EAR), which is calculated as $EAR = [1+ (r/2)]^2 - 1$

Example

- Consider a 10% coupon bond with semiannual payments, 10 years to maturity, and a market price of $1,200. What is the yield to maturity?
- YTM (i.e., bond equivalent yield) would be 7.17%

Financial Calculator: 20n; -1,200PV; 50PMT; 1,000FV; i = 3.58228%
3.58228% x 2 = 7.17%

- EAR would be 7.30%

$[1+(.0717/2)]^2 - 1 = 7.30\%$

As Maturity Approaches

- At maturity, the only cash flows for the bond are the par repayment and the final coupon
  - If sold at maturity, the buyer is not entitled to the coupon
  - Price at maturity = Par Value = $1,000
- Implications:
  - Premium bond has built-in capital loss
  - Discount bond has built-in capital gains

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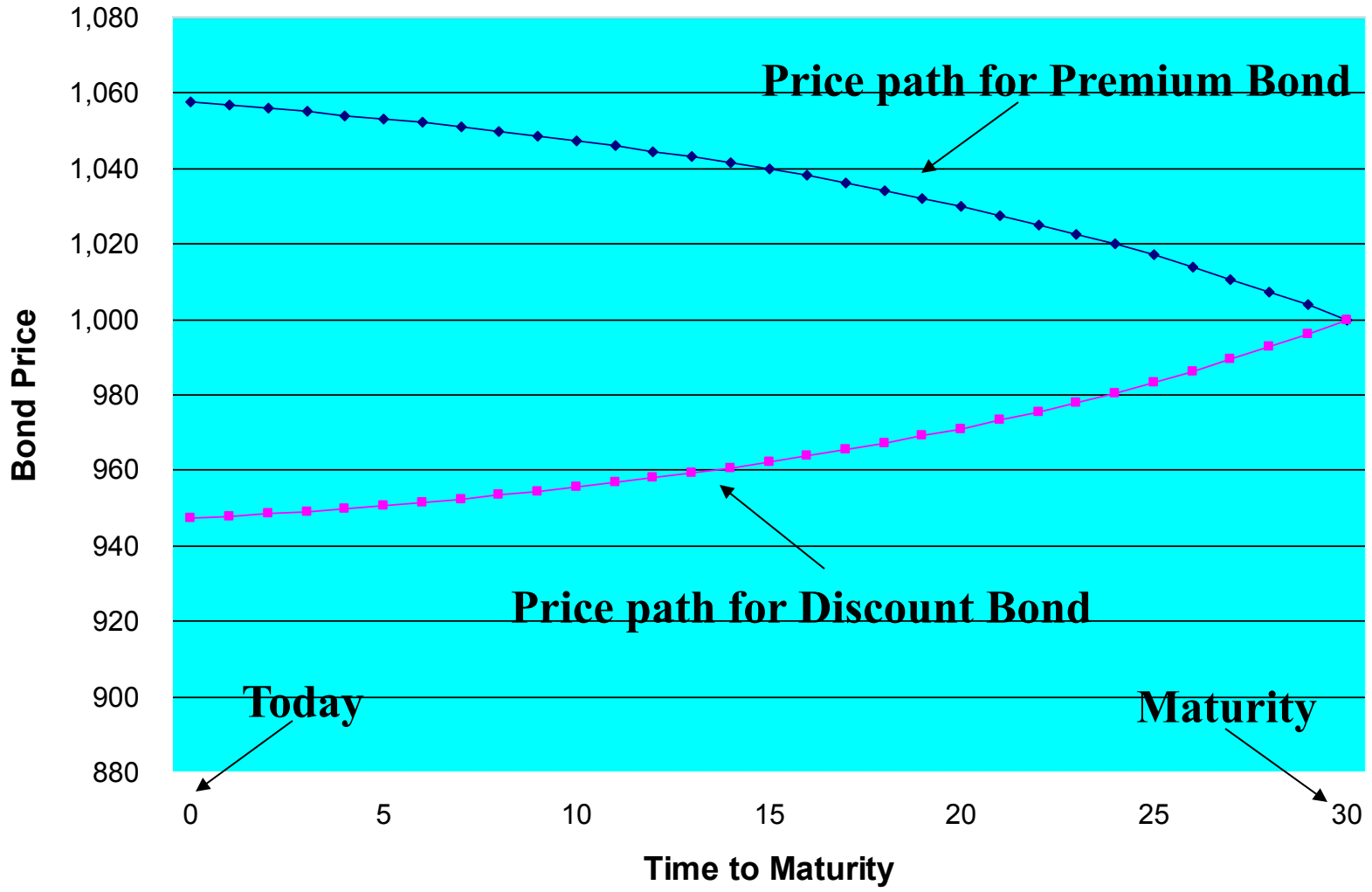
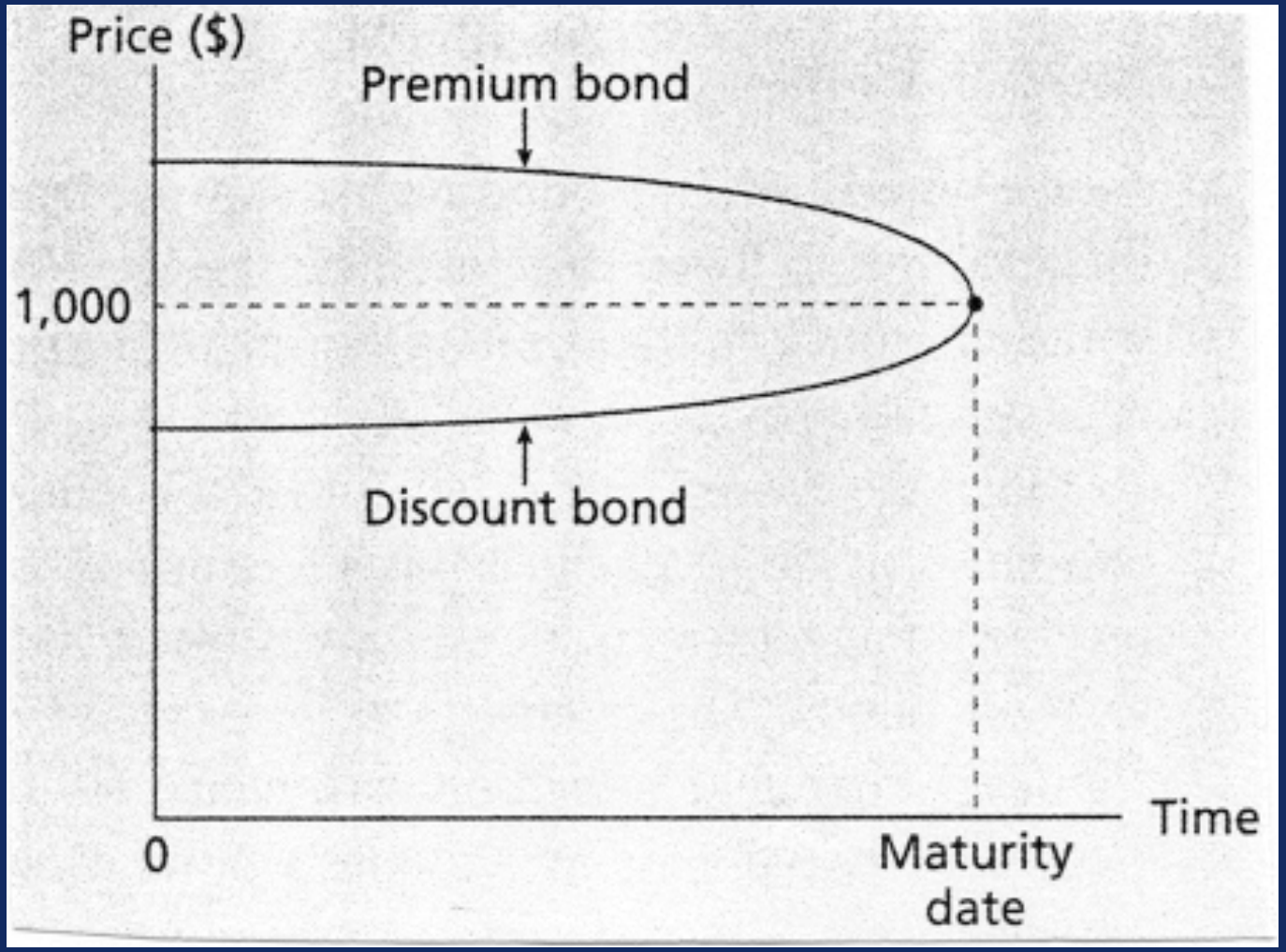
As Maturity Approaches



As Maturity Approaches



Current Yield (CY)

- Current Yield (CY) = annual coupon scaled by price
  - Current Yield = $Annual Coupon Payment/Current Price
- For a discount bond:
  - CY < YTM (due to built-in capital gains in YTM)
- For a premium bond:
  - CY > YTM (due to built-in capital loss in YTM)

Selling a Bond Early

- Recall that YTM is yield promised to an investor who holds the bond until maturity
- Question: What if you sell the bond early?
  - Bond prices change when interest rates change
  - If you sell prior to maturity, calculate return based on price at which you sell the bond
- Example: Pay $1,100 for a bond, hold for 6 months and receive coupon payment of $50, then sell for $1,050

Selling a Bond Early

- Example: Pay $1,100 for a bond, hold for 6 months and receive coupon payment of $50, then sell for $1,050

- **Formula**: $i = [FV/PV]^{1/t}-1 = [(1,050+50)/1,100]^{1/1}-1 = 0\%$
- **Financial Calculator**: 1n; $1,100PV; $50PMT; $1,050FV; i = 0%

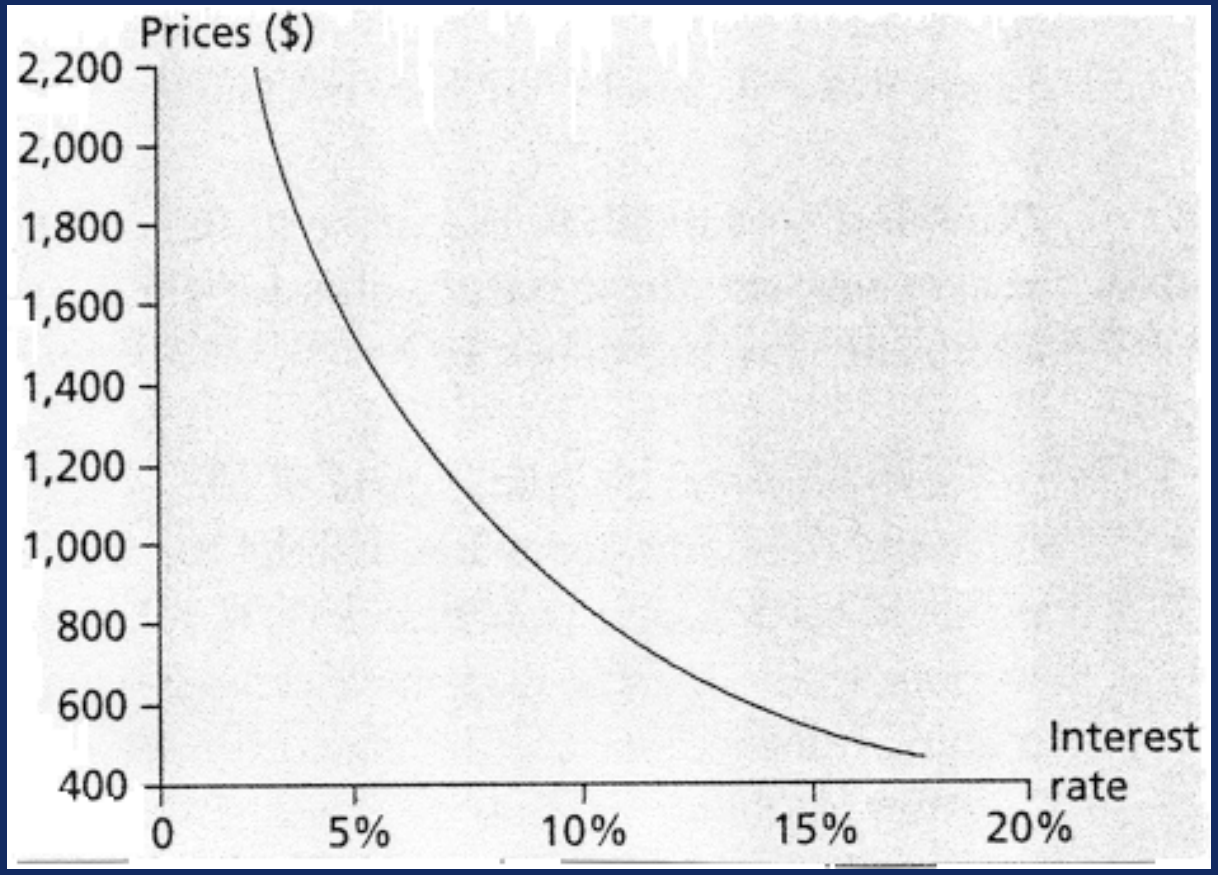
Risks Faced by Bond Investor

- Is bond investing risky?
  - Yes!
- Three risk faced by bond investor:
  - ***Interest rate risk*** (or ***price risk***) – Risk associated with price fluctuations caused by interest rate changes
  - ***Reinvestment rate risk*** – Risk associated with the rate at which coupons are reinvested
  - ***Default risk*** (or ***credit risk***) – Risk associated with issuer's ability to make payments as specified

Interest Rate Risk

- Price moves inversely with interest rates
  - Interest rates increase – Bond prices decrease
  - Interest rates decrease – Bond prices increase
- Longer-term bonds have greater interest rate risk
- Lower-coupon bonds have greater interest rate risk
- If a bond is held to maturity, interest rate risk is irrelevant

Interest Rate Risk



Negative slope illustrates inverse relationship between bond prices and interest rates

Reinvestment Rate Risk

- YTM calculation: Coupons are reinvested at the YTM
  - Think back to the annuity formula…Same is true there
  - What if you cannot reinvest at YTM…Then you cannot earn the YTM!

- Example: Purchase 1-year bond with a 10% coupon for $1,050
  - YTM =???
  - $1,050 and the bond are equivalent in value…Each ***should*** give you the same FV at the end of year 1
  - For this to be true, you must invest all coupons at YTM

Reinvestment Rate Risk

- Reinvestment risk is the risk related to the rate at which coupons are reinvested
- Note: Interest rate risk and reinvestment risk work in opposite directions
    - Long-term bonds are subject to greater interest rate risk (also called maturity risk) on principal than are short-term bonds
    - Short-term bonds are subject to greater reinvestment rate risk on principal than are long-term bonds
    - Both L-T and S-T bonds are subject to reinvestment risk on coupons!

Default Risk

- Default risk is the risk issuer won't make payments as specified in the contract
  - Default = not paying the full amount
  - Default = not paying at the appropriate time
- Bond rating agencies assess the default risk of borrowers
- Default premium = higher interest rate to compensate the bondholder for the risk of default

Bond Ratings

Moody's	Standard & Poor's	Safety
Aaa	AAA	The strongest rating; ability to repay interest and principal is very strong.
Aa	AA	Very strong likelihood that interest and principal will be repaid
A	A	Strong ability to repay, but some vulnerability to changes in circumstances
Baa	BBB	Adequate capacity to repay; more vulnerability to changes in economic circumstances
Ba	BB	Considerable uncertainty about ability to repay.
B	B	Likelihood of interest and principal payments over sustained periods is questionable.
Caa	CCC	Bonds in the Caa/CCC and Ca/CC classes may already be
Ca	CC	in default or in danger of imminent default
C	C	C-rated bonds offer little prospect for interest or principal on the debt ever to be repaid.

Financial Ratios and Default Risk

	Three-Year (1998–2000) Medians						
	AAA	AA	A	BBB	BB	B	CCC
Operating income/sales (%)	24.6	23.4	18.1	14.7	15.9	13.9	9.4
Free cash flow/sales (%)	14.8	10.9	7.8	5.6	3.9	1.3	-0.9
EBITDA int. + div. coverage	4	3.9	4.11	4.5	3	1.7	1
Total liabilities/net worth (%)	70.3	123.6	138.8	152.6	198.7	206.9	-208.3
EBITDA/total assets (%)	22.2	21.2	16.3	13.7	12.9	10.3	6.9
Total debt/market capitalization (%)	0.5	8.1	17.2	27.5	43.5	55.8	79.7
Historical default rate (%)	0.5	1.3	2.3	6.6	19.5	35.8	54.4

Note: EBITDA is earnings before interest, taxes, depreciation, and amortization.
Sources: Default rates from "Statement of Standard & Poor's on Credit Rating Agencies to SEC," Public Hearing, November 2002; all other data from Standard & Poor's

YTM and Expected Return

- Promised YTM = Calculation based on what is specified in the contract

- Expected Return (i.e., expected YTM) = Calculation based on expected payments
  - If default becomes more likely, expected payments go down
  - Example: 10% coupon bond with 5 years remaining has a price of $700…Promised maturity payment is $1,000, but market expects only $800…Recalculate yield using $800 as final cash flow rather than $1,000

- Expected Return ≤ Promised YTM

Special Cases

- Zero-Coupon Bonds: Coupon rate of 0%
  - Par repayment is only cash flow
  - Sells at a discount
  - All else equal, they have greater interest rate risk

- Floating-Rate Bonds: Coupon payments change over the bond's life
  - Rate typically indexed to some market rate
  - Reduce interest rate risk

Bonds with Options Attached

- Option gives one party the ability to change the terms of the contract

- How does this affect the interest rate?
  - Option benefits the borrower…Higher interest rate
  - Option benefits the lender (investor)…Lower interest rate

Convertible Bonds

- Conversion option gives the bondholder the ability to convert the bond into a specified number of shares of the issuer's stock
  - Often issued by young firms
  - If stock price increases, bondholder converts
  - If stock price doesn't increase, bondholder does nothing (i.e., continues to hold the bond)

- Convertible bond will have a lower interest rate, all else equal

Callable Bonds

- Call option allows issuer to pay bond off early at a pre-specified price and time (call it in)
  - Call price typically greater than par value
  - Call period is typically later in the bond's life
  - If interest rates go down, issuer can call the bonds in and then re-issue new bonds at a lower rate
  - Yield-to-Call (YTC) = yield calculation that assumes bond will be called in
  - Call price serves as a ceiling for the market price of the bond
- Callable bond will have a higher interest rate, all else equal

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Thank You!

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