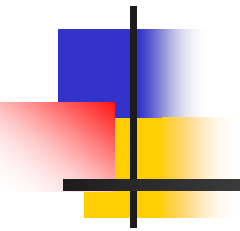


Convertibles

Agenda: Convertibles

- What are convertibles
- How they are traded
- Convertible valuation
- Convertible markets

Convertibles

- Hybrid Debt-Equity Instruments
  - Convertible Bonds
    - Debt which investor may exchange for stock
  - Convertible Preferreds
    - Preferred stock paying qrtly dividend, again with conversion option

Convertible Bond

- Fixed income obligation of company
  - Subordinated debentures
  - Most junior corporate debt
- Returns face value at maturity
  - Usually issued at par: Price = FV = $1,000
- Pays fixed annual or semi-annual coupon
- Pricing: quoted clean, as % of FV
- Specified *conversion ratio*
    - How many shares of common stock are received in exchange for the bond

Convertible Bond: Allied Westminster Example

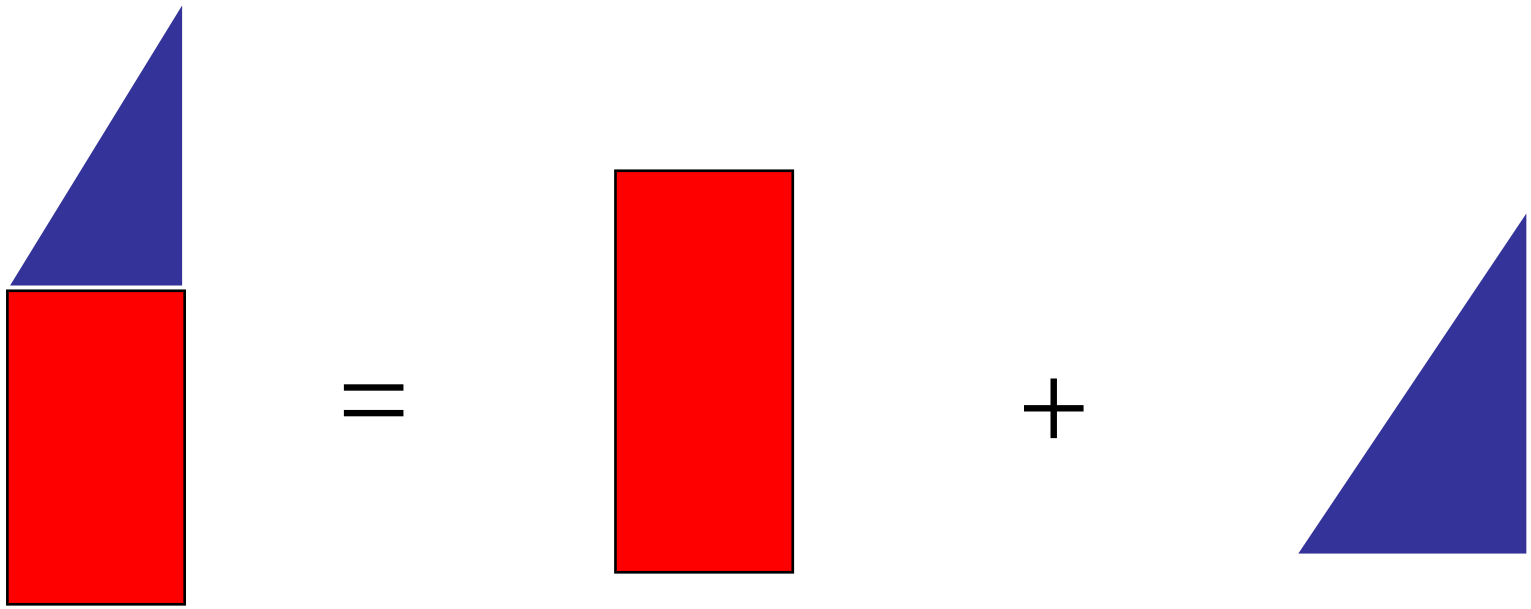
- Dec 1994, Allied Westminster Convertible Issue:
  - 100,000 Bonds maturing June 2002
  - Face value $1,000
  - Coupon 5.75%
  - Credit rating A-. Straight bonds from similar companies & maturities yielded 9.00%
  - Conversion ratio: 25.32 per bond
  - Stock Price in Dec 94 was $32.50
  - Current market price of bond was $1,151

Convertible Provisions

- Change of Control
  - Cash mergers sometimes resulted in loss of value
  - “Poison puts” added to provide cash value at par plus accrued interest
    - Usually only for hostile, cash-only offers for voting control
- Screw Clause
  - “No adjustment for dividends or interest on conversion”
  - Problems arise at first call date if convertible is ITM
    - Company decides to call
    - First call date often coincides with first coupon/dividend date
    - Not uncommon for conversion option to expire a couple of days before redemption date
    - Many issues require that is conversion occurs between a record date and a pay date, all interest has to be repaid to issuer.

Components of a Convertible

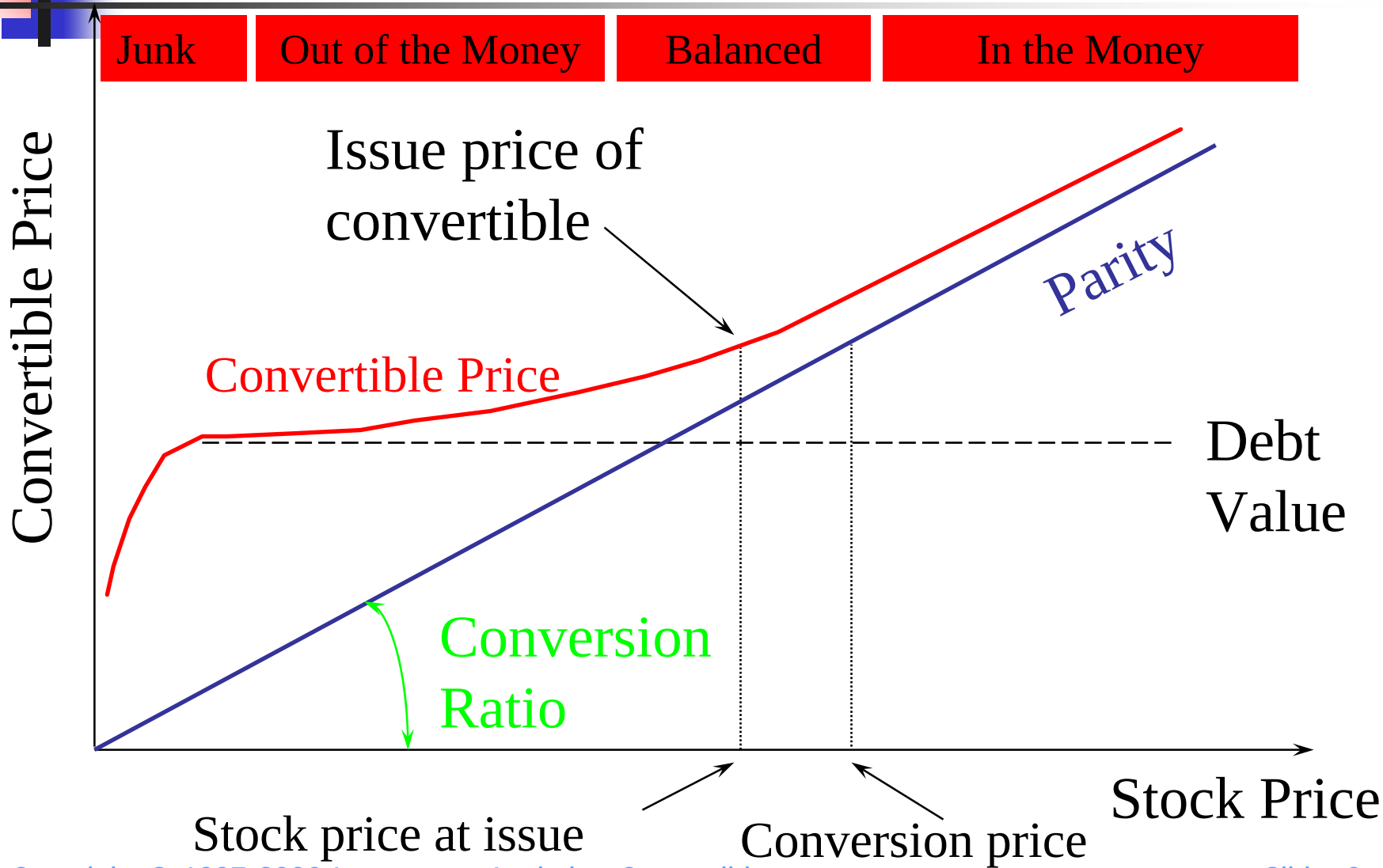
- Convertible = Straight Bond + Conversion Option



Characteristics of Convertibles

- Convertibles are Hybrid Instruments:
  - Combine return & return characteristics of bonds & options
- As Stock Price Rises: behaves like a stock
  - Option value increases with stock price
  - Bond value unaffected
  - Option value dominates
- As Stock Price Falls: behaves like a bond
  - Option value low
  - Bond value dominates
  - If stock falls too far, trades like junk due to risk of default

Characteristics of Convertibles



Warrants vs Convertibles

	Warrants	Convertibles
Issue	Private placement	Public Offering
	Can be standalone	Cum Bond
Option	Detachable	Embedded
Exercise	Cash	Stock
Tax		
Company:	Lower	Higher
Investor	Higher	Lower

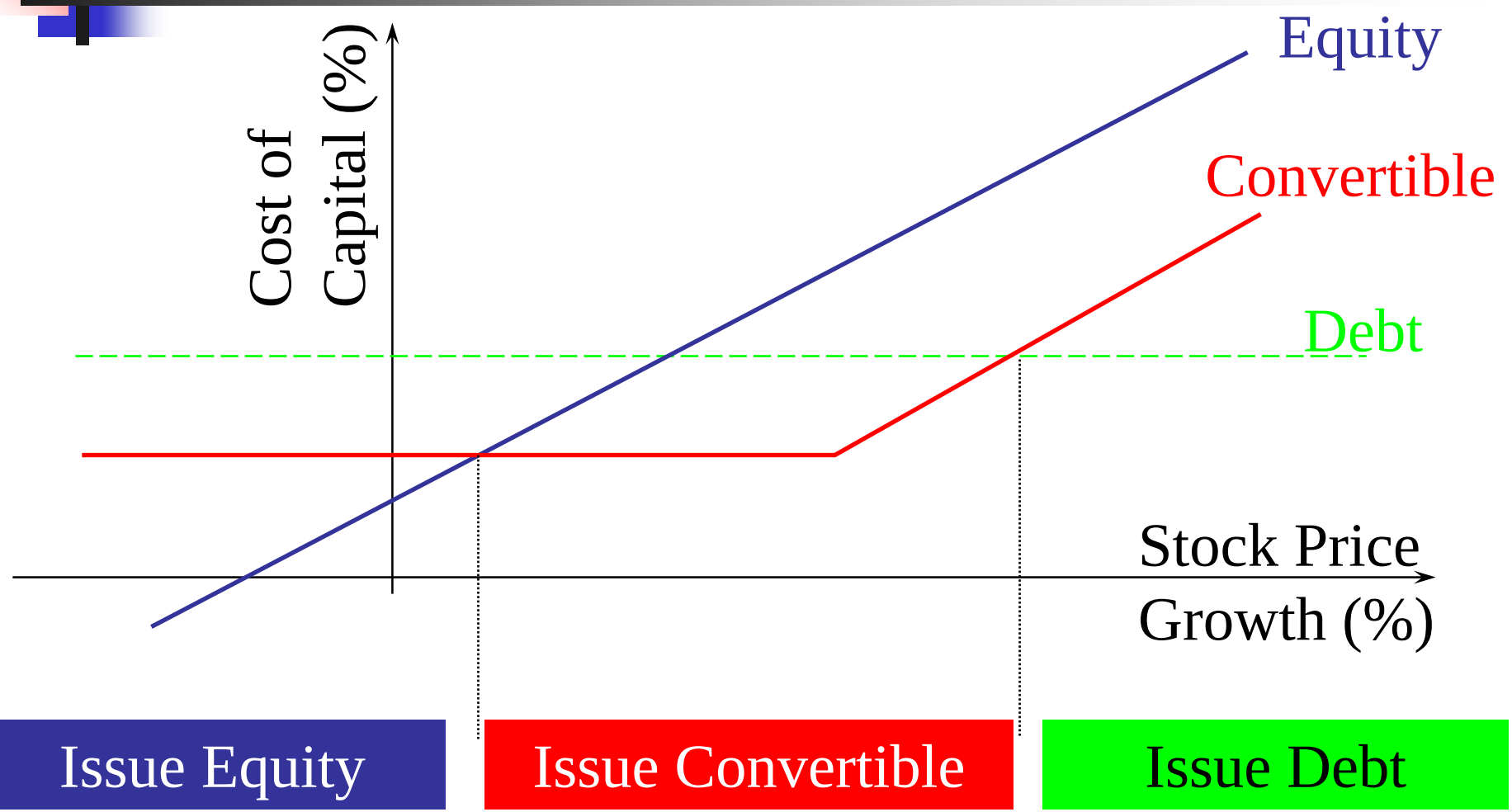
Issuer's Perspective

- Erroneous Argument:
  - Conversion price set at a premium:
    - If conversion takes place issuer will get a better price for its stock
  - Coupon cost is less than straight debt:
    - If no conversion takes place issuer will have raised debt more cheaply

Why this argument is wrong:

- If conversion takes place:
  - Would have done better to issue straight debt
- If no conversion takes place:
  - Would have done better to issue equity

Issuer's Cost of Capital



Issuer's Rationale

- Cost of Capital
  - Cheapest way of raising capital if stock growth anticipated to lie within a certain range
- Access to Capital Markets
  - Broader investor base
    - Appeal of high income & capital gain
  - Weak credit rating
    - Convertible market accustomed to greater risk
- Tax
  - Dividends are paid after tax - expensive
  - YTM is interest expense - tax deductible

Investor's Perspective

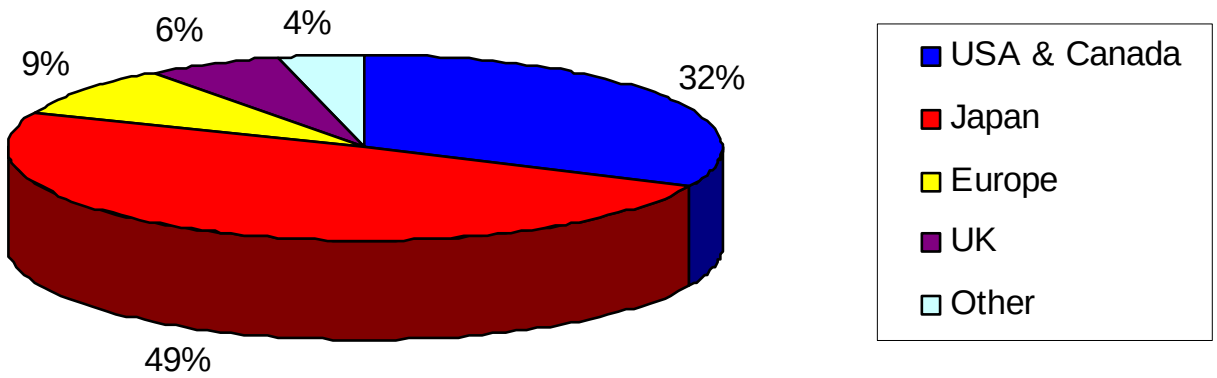
- Convertibles vs. Bonds
  - Offer degree of upside participation
- Convertibles vs. Stocks
  - Offer degree of downside protection
  - Typically have yield advantage
- Asymmetry Property
  - Higher stock volatility, greater upside participation

Convertible Asymmetry

	Case A	Case B
Time to maturity	1 year	1 year
Convertible price	110	110
Parity	100	100
Expected 1-year movement	+/- 20%	+/-40%
Convertible max upside	120	140
Convertible min downside	100	100
Upside Participation	10 pts 50%	30 pts 75%
Downside Participation	10 pts 50%	10 pts 25%

Convertible Markets

- Total Market Size $320Bn



Asset Returns, USA 1957-92

Asset Class	Annual Return (%)	Standard Deviation
S&P500	10.53	16.41
Convertibles	8.30	14.07
Corporate Bonds	6.85	10.72

Source: Lummer & Riepe, Journal of Fixed Income, Sept. 1992

Current Market Trends

- USA - mature market
- Europe - perfect conditions for rapid growth
  - Rising stock markets, falling yields
- Asia
  - Hurt by stock market meltdown
    - Issuers had regarded convertibles as way to issue equity at premium
    - Failed to provide adequately for debt exposure
- Japan
  - Big growth in reset-convertibles

Convertible Trading Strategies - Equity Investors

- Market Timing
  - Buy Balanced or In the Money Convertible
    - Gives stock exposure
    - Downside protection
- Market Retrenchments
    - Switch from stock to convertible
    - If stock declines, conversion premium should expand
- Special Situations
    - Recovery stock
    - Technology stocks

Convertible Arbitrage

- Most convertibles over valued
  - 5% is typical
  - Due to retail buyers(?)
- Synthetic convertibles
  - Convertibles created by 3rd parties (banks)
  - Sell convertible at high implied vol.
  - Hedge by purchasing OTM call options on the stock at low vol.

Convertible Trading Strategies - Fixed Income Investors

- Typically use Out of the Money & Balanced
  - Fixed income element = 85%-90% of value
  - Large degree of downside protection
- Upside Equity Participation
  - Gain equity exposure from fixed income fund
- Improving Credit Quality
- Take advantage of tightening credit spreads during economic recovery
- Economic Recovery
  - Increase weightings in convertibles to compensate for bonds under-performing equities during recovery

Convertible Analysis & Valuation

- Conventional Analysis
- Option Analysis

Conventional Analysis

- Conversion Price
- Conversion Value
- Market Conversion Price
- Market Conversion Premium
- Income Differential per Share
- Breakeven Time (Payback)

Conversion Price / Value

- Conversion Price = Par Value / Conversion Ratio
  - Set by the issuer
  - Like a strike price, or subscription price on a warrant
- Conversion Value
  - Current Share Price x Conversion Ratio

Market Conversion Price

- Market Conversion Price
  = Market Price of Bond / Conversion Ratio
  - The price per share which an investor would pay by purchasing the bond and converting immediately

Market Conversion Premium

- Market Conversion Premium
  - MCP = Market Conversion Price - Current Share Price
    - The premium an investor would pay by purchasing stock via the convertible rather than in the market
    - Can also be expressed as a percentage
    - Like premium on a warrant
    - Suggests: an option premium

Income Differential Per Share

- Income Differential Per Share
  - = $\frac{(\text{Coupon} \times \text{FV}) - (\text{Share Price} \times \text{Dividend Yield})}{\text{Conversion Ratio}}$
  - Compares coupon income (per share) with dividends per share

Break-Even Time (Premium Payback Period)

- BET= $\frac{\text{Market Conversion Premium}}{\text{Income Differential per Share}}$
  - How many years before income differential covers the cost of market premium
  - Ignores time value of money

Lab: Allied Westminster - Conventional Analysis

- Worksheet - Allied Westminster
- Compute:
  - Conversion Price
  - Conversion Value
  - Market Conversion Price
  - Market Conversion Premium
    - $ terms and % terms
  - Income Differential
  - Breakeven Time

Solution: Allied Westminster - Conventional Analysis

- Conversion Price
  - Par Value / Conversion Ratio
  - $1,000 / 25.32 = $39.49
- Conversion Value
  - Current Share Price x Conversion Ratio
  - Value as a straight bond
  - $32.50 x 25.32 = $822.90
- Market Conversion Price
  - Market Price of Bond / Conversion Ratio
  - $1,151 / 25.32 = $45.46

Solution: Allied Westminster - Conventional Analysis

- Market Conversion Premium
  - Market Conversion Price - Stock Price
  - $45.46 - $32.50 = $12.96
  - As a %age: 12.96 / 32.540 = 39.9%
- Income Differential
  - $\frac{\text{Coupon x FV}}{\text{Conversion Ratio}}$ - Stock Price x Dividend Yield
  - (5.75% x $1000)/25.32 - (32.50 x 3%) = $1.30 per share
- Breakeven Time
  - Market Conversion premium / Income Differential
  - $12.96 / $1.30 = 10 years

Conversion Option in a Convertible Bond

- Convertible = Straight Bond + Conversion Option
- Conversion Option:
  - Like a package of call options on the stock
  - Number included with each bond = Conversion Ratio
  - Conversion Option = Conversion Ratio x Call Option

Allied Westminster:

- Each bond has 25.32 call options
- What is call option worth?

Call Option in Convertible Bond:

- Call Option & Market Conversion Premium
  - Effectively buying stock at the Market Conversion Price ($45.46)
  - Paying a premium of ($45.46 - $32.50) = $12.96
- Market Conversion Premium is value of Call Option

Allied Westminster:

- Call Option Value = $12.96
- Conversion Option Value is:
  - Conversion Ratio x Call Option Value
  - 25.32 x $12.96 = $328.10

Adding the Components

- Convertible = Straight Bond + Conversion Option
- Convertible Value:
  - Straight Bond Value + Conversion Option Value
  - Conversion Value + (Conversion Ratio x Market Conversion Premium)

Allied Westminster:

Conversion Value	$822.90
Conversion Option value	$328.10
TOTAL	$1,151.00

Convertibles: Option Analysis

- Market Valuation:
  - Straight bond $822.90
  - Conversion option $328.10

    TOTAL $1,151.00

Independent Valuation:

- Straight Bond
  - Use Conventional Formula
- Conversion Option
  - Use Black-Scholes (adjusted for dilution)

Straight Bond Valuation

- Notation:
  - Annual Coupon ($) C
  - Face Value ($) F
  - Term (years) N
  - Yield to Maturity Y
- Bond Value:

$$\sum_{1}^{2N} \frac{C/2}{(1+Y/2)^{i}} + \frac{FV}{(1+Y/2)^{2N}}$$

Conversion Option Valuation

- Use adjusted Black Scholes to value call option
- Adjustments (as for Warrants):
  - Dilution Factor
    - $DF = \frac{\text{New Shares Issued}}{\text{(Shares Issues + New Shares Issued)}} = M / (N + M)$
  - Volatility
    - $V^* = \frac{D^* + E^*}{E^*} \times \frac{E}{D + E} \times V$
  - Stock Price
    - Use post-conversion stock price S*

Call Option Valuation

- C = (1-DF) x BS(S*, X, V*, T, R_f , hcost)
  - X is Conversion Price
- Post Conversion Stock Price, S*
  - [(N x S) + (M x C)] / (N + M)
    - S is pre-conversion stock price
    - C is call option value
- Circular definition!

Iteration Method

- Start with estimate of C:
  - Use Market Conversion Premium
- Estimate S*
- Re-estimate C
- Last step:
  - Conversion Option = Conversion Ratio x C

Lab: Allied Westminster - Option Valuation

- Compute:
  - New Shares Issued
  - Dilution Factor
  - Post Conversion Share Price
  - Call Option Value
  - Conversion Option Value
  - Straight Bond Value
  - Value of Convertible
  - Nb. Ignore volatility adjustment
- Does it look rich or cheap?

Solution: Allied Westminster - Option Valuation

- New Shares Issued = No. Bonds x Conversion Ratio
  - New Shares = 100,000 x 25.32 = 2.532MM
- Dilution Factor
  - $$\frac{\text{New Shares Issued}}{(\text{Shares Issues} + \text{New Shares Issued})}$$
  - 2.532 / (47.35 + 2.532) = 5.08%

Solution: Allied Westminster - Option Valuation

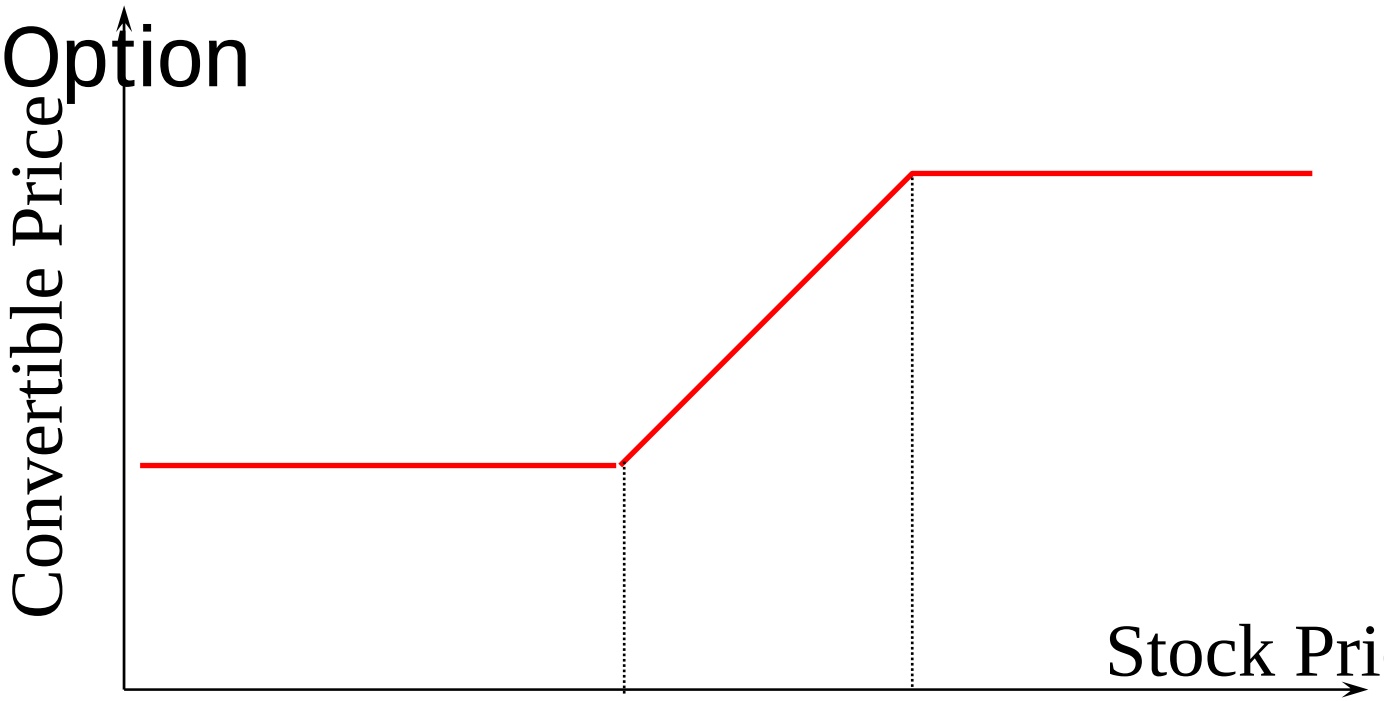
Post Conversion Share Price	$31.50
Call Option Value	$12.86
Straight Bond Value	$825.48
Conversion Option Value	$325.57
Total Convertible Value	$1,151.05

Additional Features

- Call Feature
  - Right of issuer to redeem convertible prior to maturity
- Call Protection
  - Hard: bond stipulated non-callable for non-call period (2 - 5 years)
  - Soft: callable if stock trades at specified premium to conversion price
- Put Feature
  - Right of investor to redeem convertible prior to maturity
- Premium Put Convertible
  - Convertible with put feature, strike at premium to par
- Rolling Premium Put Convertible
  - Convertible with several premium puts
- LYONS (Merrill Lynch)
  - Zero coupon convertible, with call and put features

Call Feature

- Convertible = Bond + Warrant - Call Option



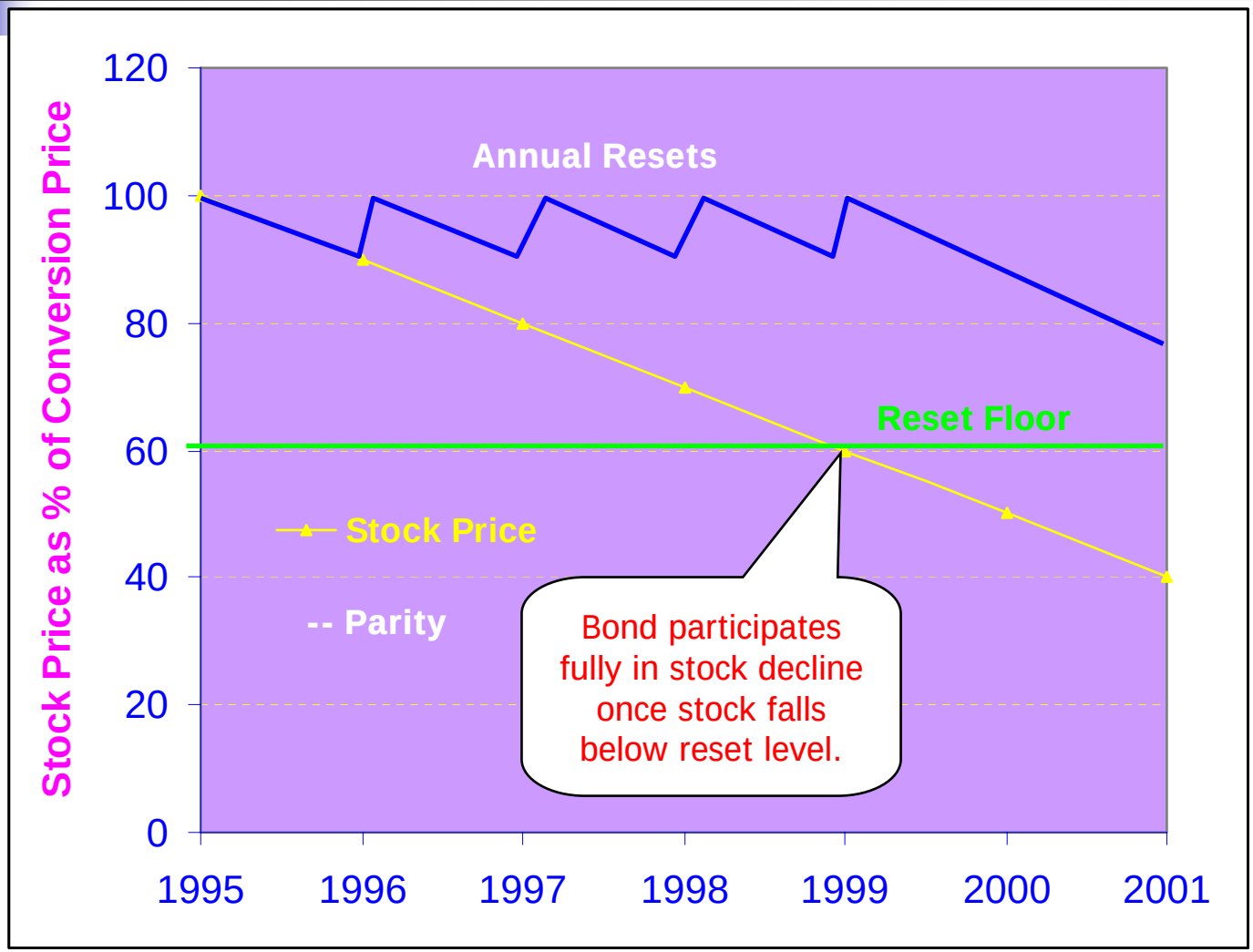
Lower Strike = Conversion price

Upper Strike - depends on specifics of call feature

Reset Convertibles

- Conversion price is “resettable”
  - Typically downwards only, annual adjustments
  - Depends on performance of stock
  - Nominal value of bond is unchanged
  - Effect is is increase conversion ratio (#shares/bond)
  - Typically a floor is set at (80%) of original conversion price
- Rationale for Resets
  - Retain degree of equity sensitivity so that probability of conversion remains high

Illustration of a Reset Convertible



Origins of the Japanese Reset Market

- Issues
  - Pioneered by Mitsubishi Bank, $2Bn 1995
  - Ten Japanese Bank Jumbos between ‘95 – ’98
- Market Conditions
  - Falling asset prices (equity & real estate)
  - Higher write-offs, lower profitability
  - Seriously depleted capital base of many Japanese banks
  - Resets helped maintain min. BIS capital ratios
    - Treated as Tier 2 capital

Valuation & Risk Management of Resets

- Valuation
  - Typically use 3-D lattice model
    - Time, stock price, conversion price
- Risk
  - Typically U-shaped Deltas
  - Negative Gamma
    - Delta increasing as stock drops through floor

Lab: Convertible Sensitivities

- What factors influence convertible values?
  - Are they positively or negatively correlated?
- Test your intuition:
- Worksheet: Convertibles Sensitivities
- Answer questions
- Then discuss

Positive Correlation

- Stock Price
  - Higher the stock price, greater the intrinsic value of the conversion option
- Volatility
  - Upside participation / option value increases with volatility
- Credit Quality
  - Higher quality means lower credit spread and higher fixed income value
- Call Protection
  - The longer the call protection the shorter dated, and less valuable, is the call option which investors are short

Negative Correlation

- Interest Rates
  - Higher interest rates reduce fixed income value
  - Positive for option component
  - But, debt component typically dominates
- Stock Yields
  - Higher stock yields reduces option value
  - Reduces yield enhancement

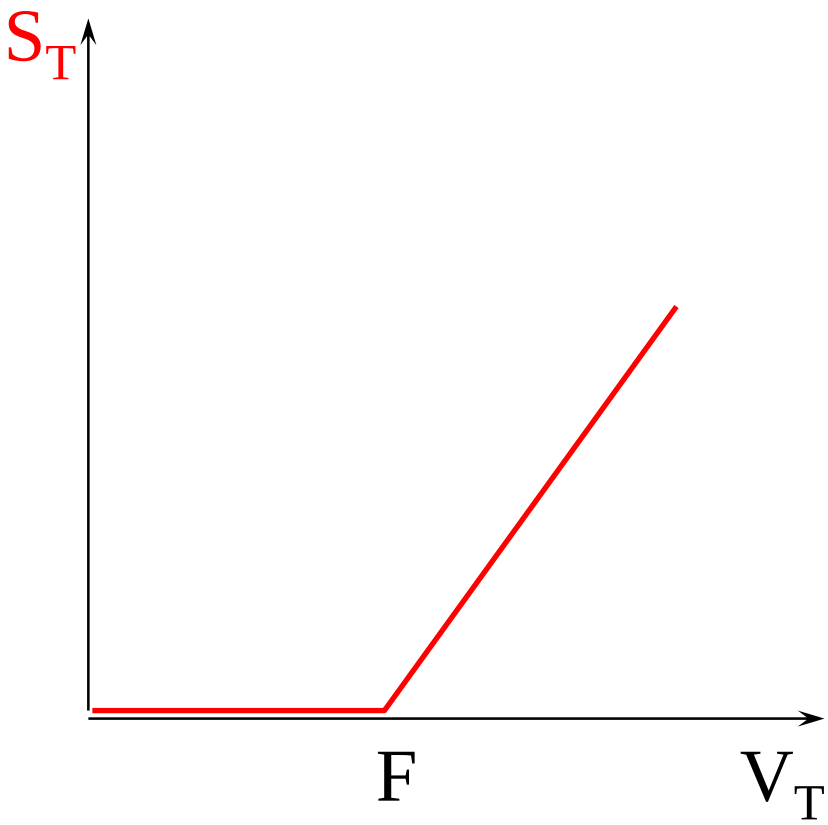
Valuation of Convertibles with Additional Features

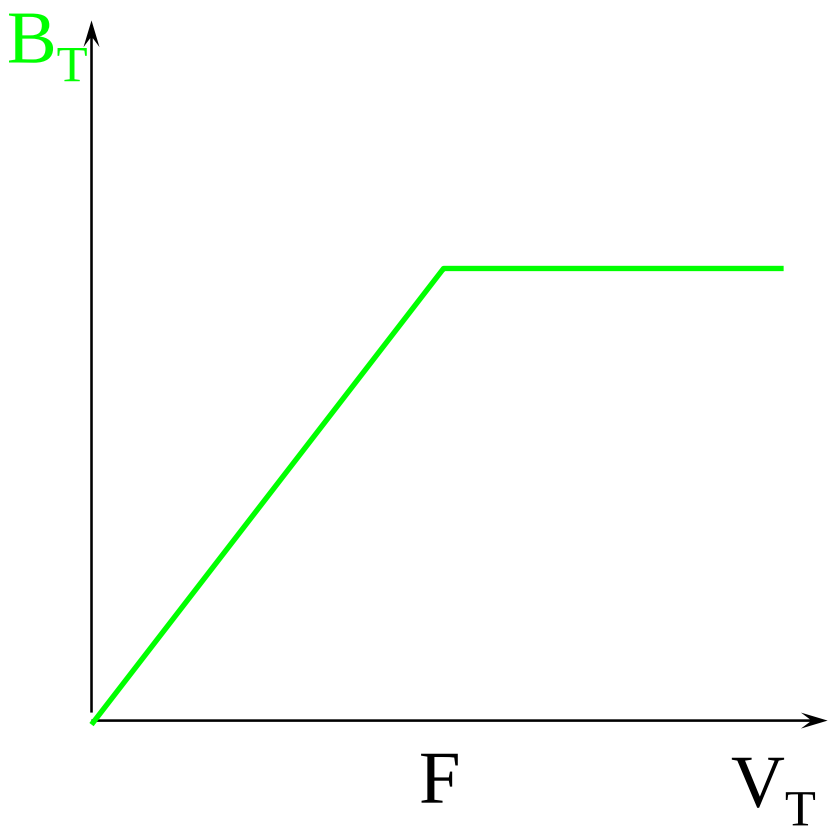
- Too complex for Black-Scholes
  - Binomial Tree
    - General method, used for simple & complex options
- Alternative Methods:
  - Brennan & Schwartz
    - Numerical solution of pdf equation
    - “Analyzing Convertible Bonds”, JFQA, Nov 1980
  - Ingersoll, 1977 solves Merton’s pde
  - Ramanlal, 1998
    - Extends Ingersoll to allow for deferred callability
      - Pricing error < 20bp

The Option Theory of the Firm

- V = S + B
  - V = Market value of firm
  - S = Market value of stock
  - B = Market value of bond
  - Bond is zero coupon, pays face value F at T
- Payoff
  - $B_T = \min [V_T, F]$
  - $S_T = \max[V_T - F, 0]$

Payoffs to Stocks & Bonds





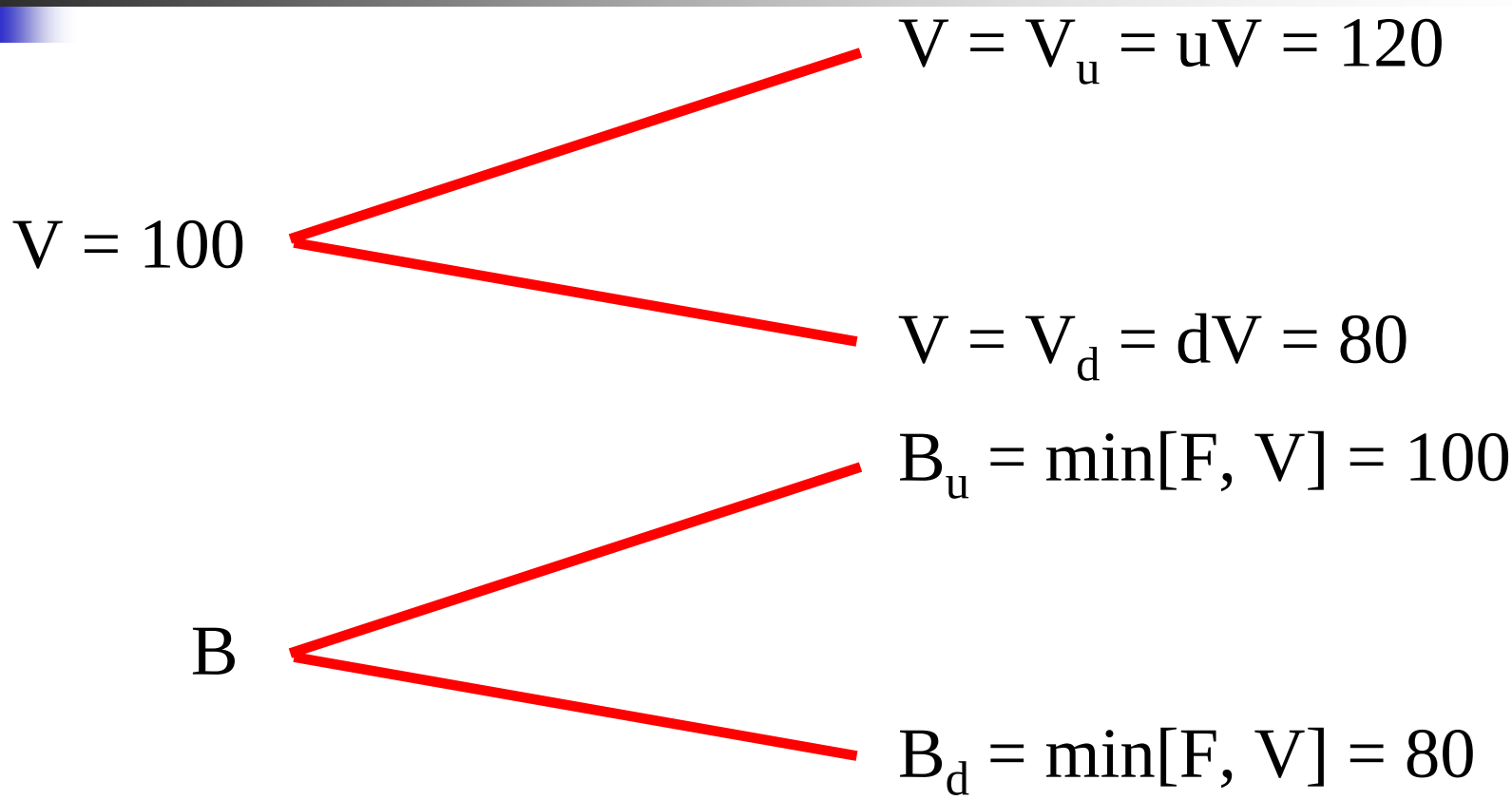
Option Valuation of the Firm

- Stocks:
  - Stock is like a call option on value of the firm
  - Residual claim, with limited liability
  - $S = C(V, F, T)$
- Bonds:
  - Like being short a put option (the limited liability of shareholders)
  - $B_T = F - \max[F - V_T, 0] = F - P_T$
  - $B_T = PV(F) - P(V, F, T)$

Put-Call Parity

- Put-Call Parity for Corporate Securities:
  - $V = S + B = C(V, F, T) + PV(F) - P(V, F, T)$

Binomial Risk-Neutral Valuation



- p = [(1+r) - d] / (u-d) = [1.1 - .8] / (1.2 - 0.8) = 0.75
- $B = \frac{B_u p + B_d(1-p)}{1 + r} = \frac{100 \times 0.75 + 80 \times 0.25}{1.1} = 86.36$

Binomial Risk-Neutral Valuation

- Value of Stock:
  - S = V - B = 100 - 86.36 = 13.64
- Risky vs Riskless Debt
  - Value of riskless bond = F / (1 + r)
    = 100 / 1.1 = 90.91
  - Risk premium = 90.91 - 86.36 = 4.55
  - Yield on risky bond = (100 / 86.36) -1 = 15.79%
  - Yield premium = 15.79% - 10% = 5.79%

Example: Valuing a Callable Convertible Coupon Bond

- Firm: V = $150
  - Shares outstanding = 40
  - No existing debt
  - u = 1.2, d = 0.8
  - Risk Free Rate, r = 5%

Bond Issue:

- Face Value, F = $100
- Coupon, c = $6.02 per annum
- Call Price K = $100, callable at any time
- Convertible into 60 shares
- Term = 2 years

Lab: Callable Convertible

- Worksheet: Callable Convertible
  - Compute:
    - Risk neutral probability, p
    - Dilution Factor, a
    - Expected Return
    - Standard Deviation

Solution: Binomial Calculations

- Risk Neutral Probability

  $p = [(1+ r) - d] / (u - d) = [1.05 + .8] / (1.2 - 0.8)$

  $= 0.625$

- Dilution Factor

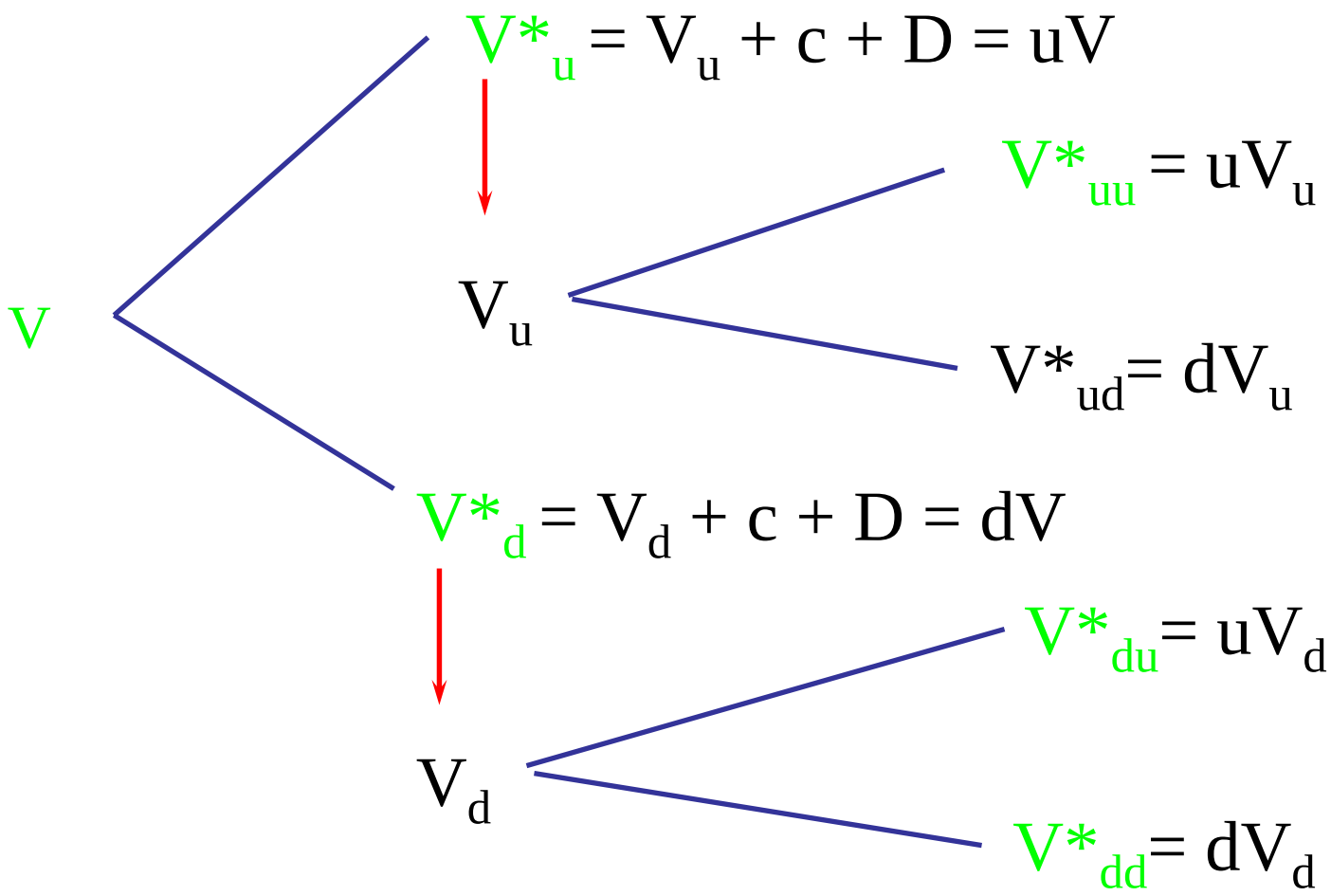
  $a = \text{New Shares} / (\text{Existing} + \text{New Shares})$

  $= 60 / (60 + 40) = 60\%$

Solution: Binomial Calculations

- Expected Return on the Firm:
  $p(u-1) + (1-p)(d-1) = 0.625(1.2 - 1) + 0.375(0.8 -1) = 5.0\%$
- Standard Deviation of Return:
  $[p(1-p)]^{1/2}(u - d) = [0.625(0.375]^{1/2}(1.2-0.8) = 19.36\%$

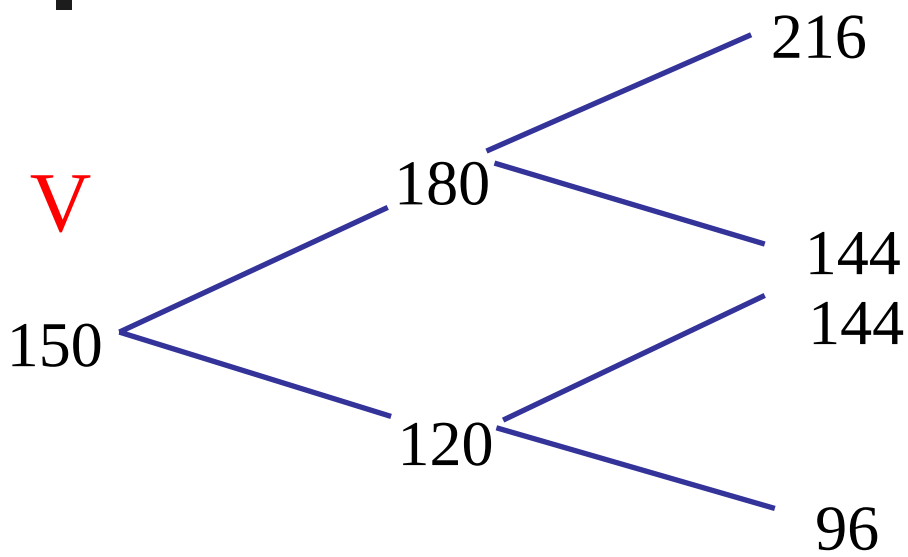
Evaluating Binomial Tree of Firm Value

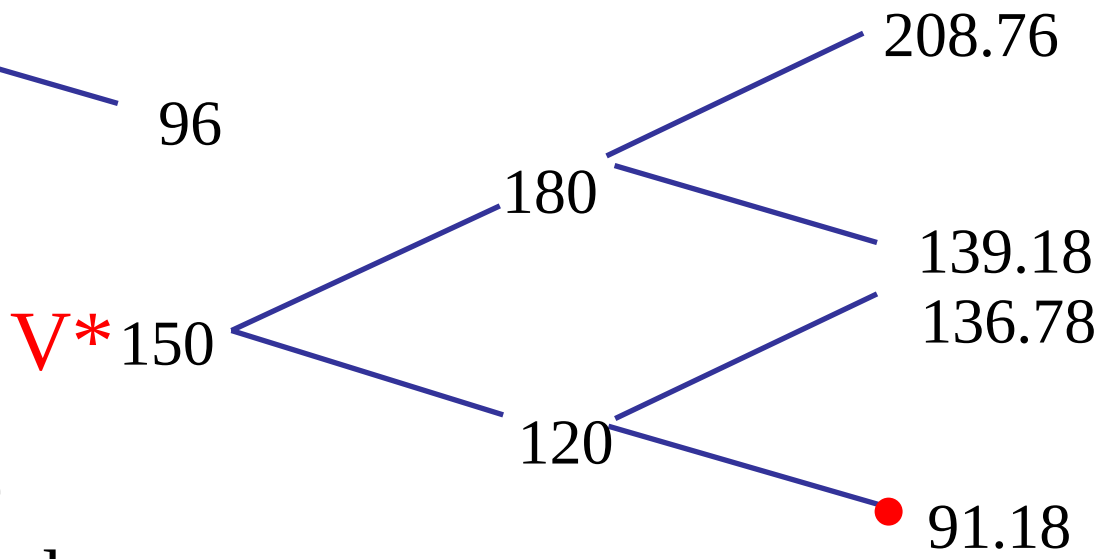


Lab: Draw Binomial Tree

- V
- V, Ex-Coupon
- V* = Value of firm before coupon paid
- aV* = Diluted value of firm before coupon is paid

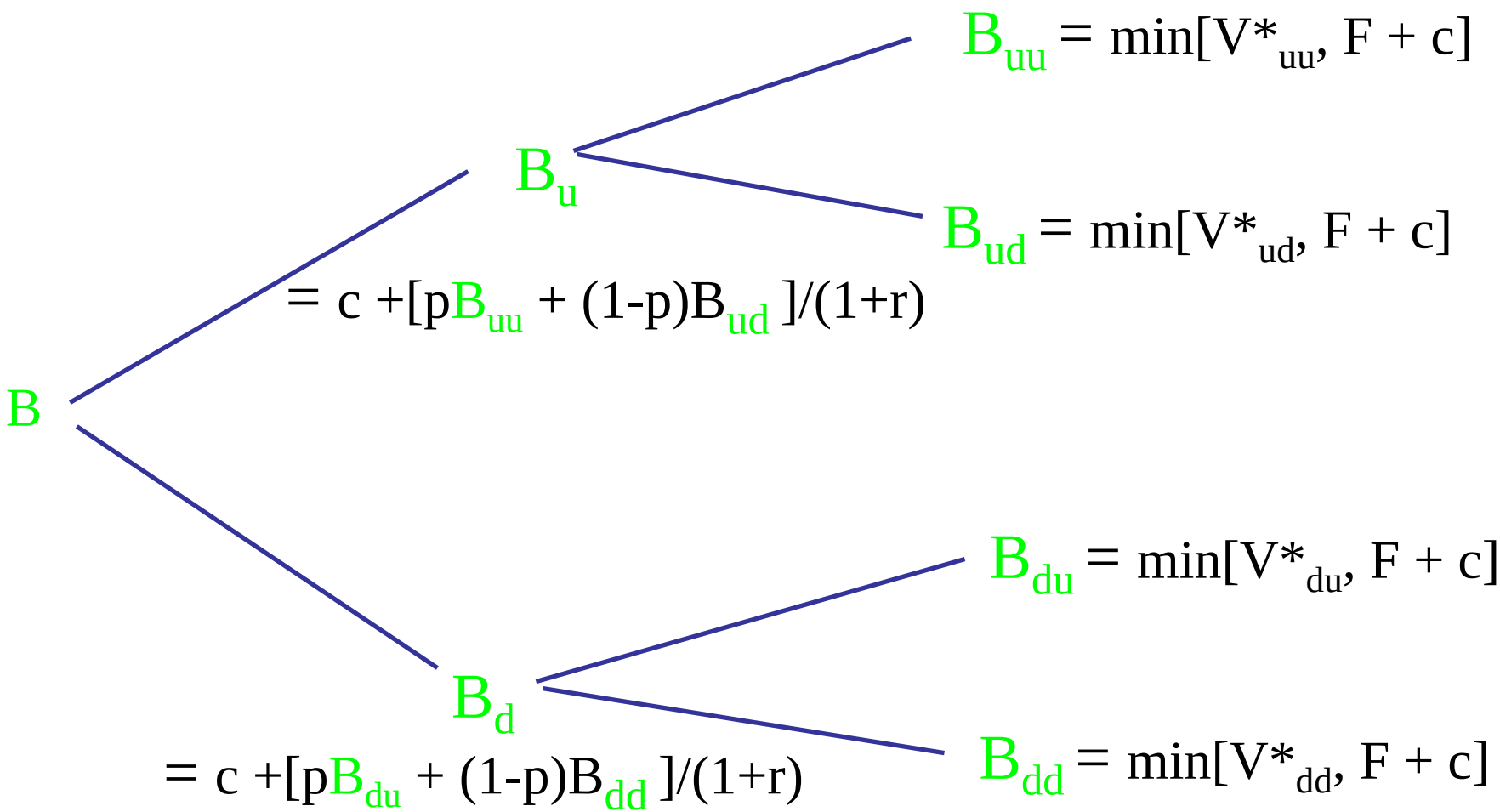
Solution: Binomial Trees





aV* is the value of the convertible, if converted

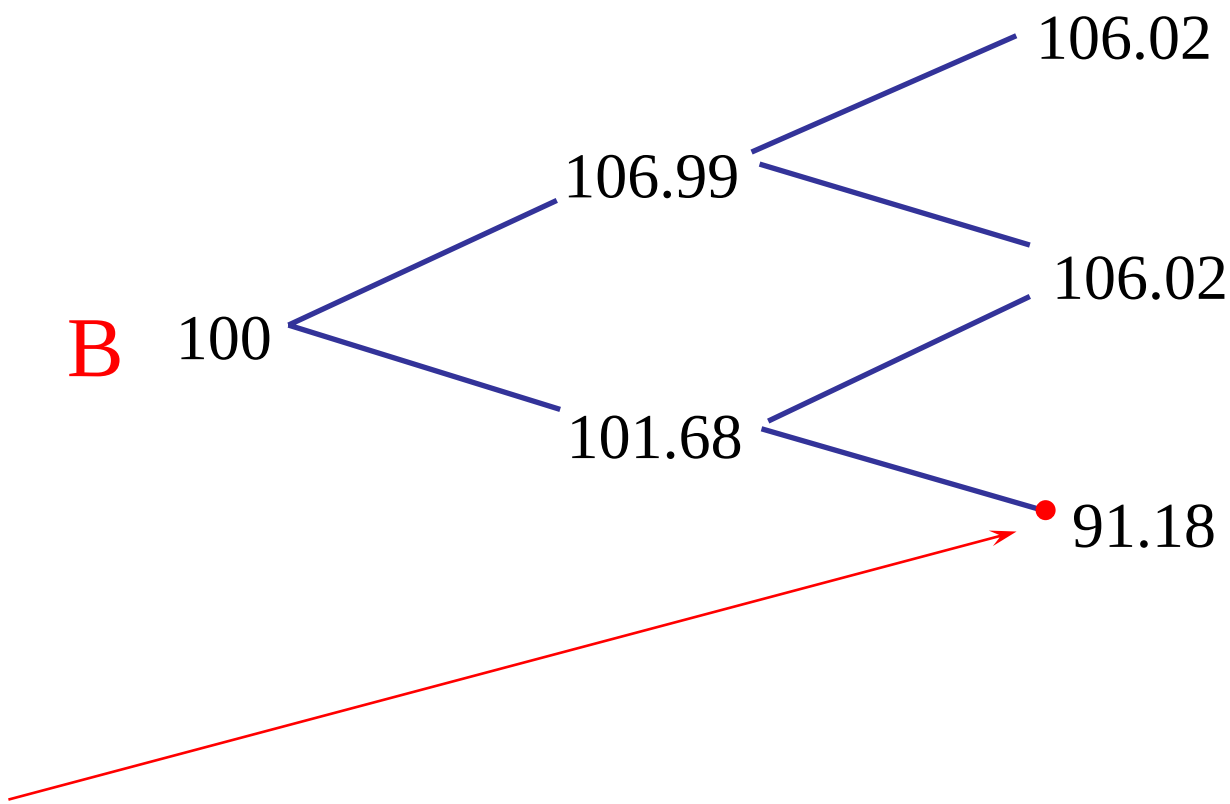
Valuing a Straight Bond



Lab: Valuing a Straight Bond

- Worksheet - Callable Convertible
  - Section on Straight Bond
- Create Binomial Tree for Bond:
  - Start at end of Bond tree
  - Use V* binomial tree
  - Work forwards

Solution: Valuing Straight Bond



- Note: default at this node

Valuing a Convertible Bond

- Can Show: Current Bond Value = c + B

  = aV + PV[(1-a)c - aD] + PV{max[0, F+c - aV_T]}

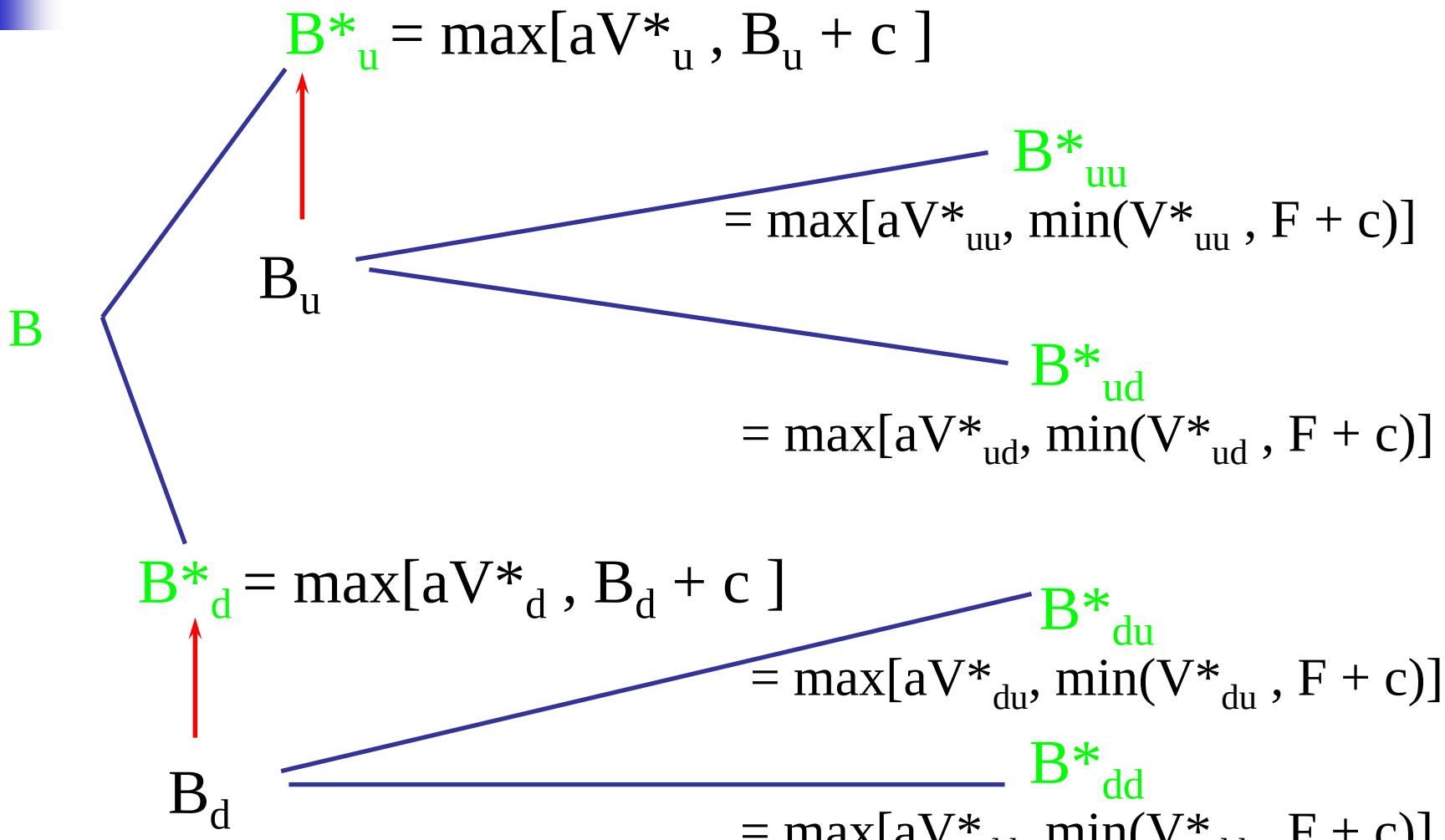
Conversion Value

Yield Advantage

Put Option on Conversion Value

- Never convert if yield advantage positive
  - E.g. if no dividends, convertible should not be converted prematurely, as for American option
  - If dividends are large enough, *may* pay to convert

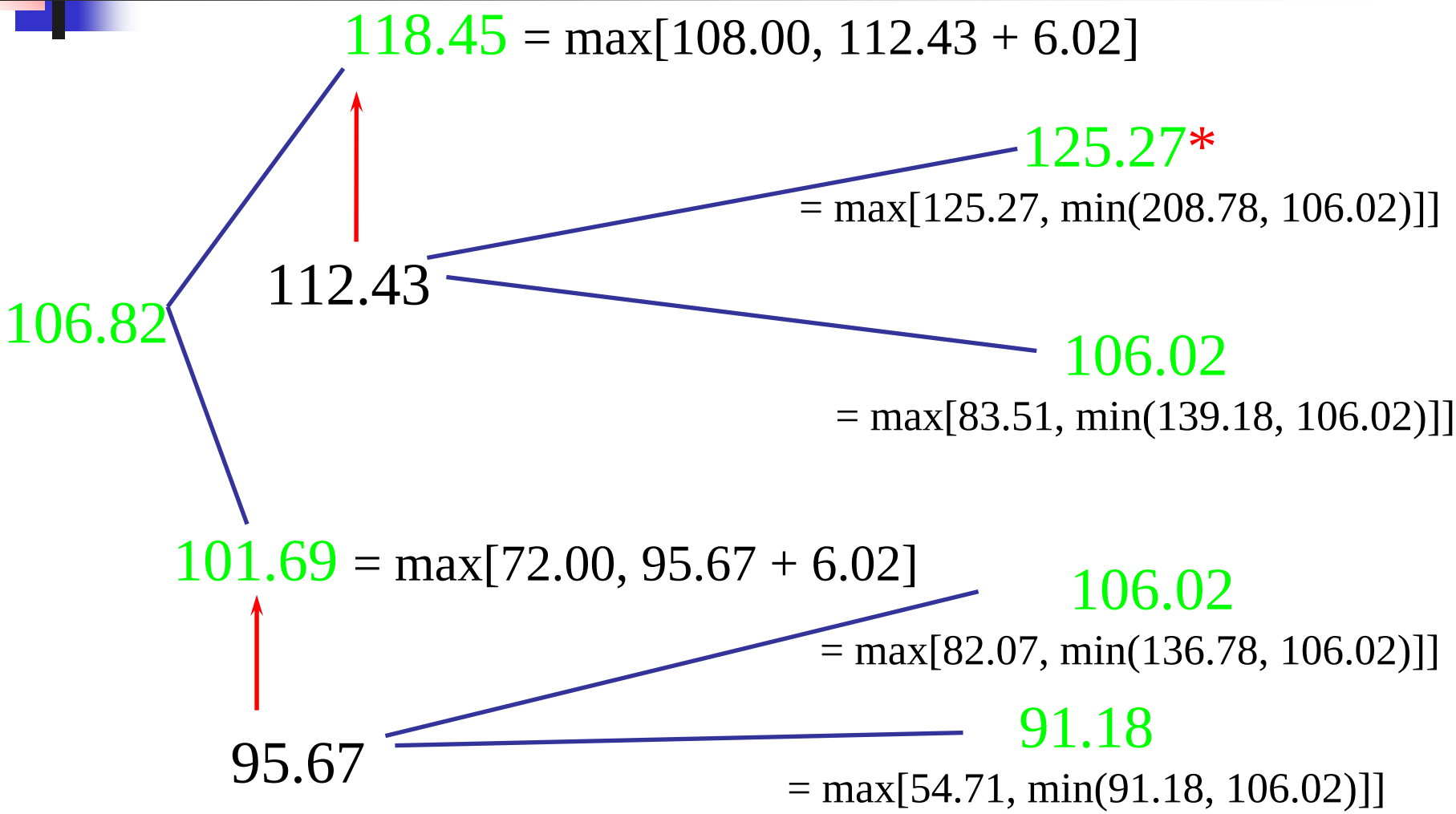
Binomial Tree for Convertible



Lab: Value Convertible Bond

- Create Binomial Tree for Convertible
  - Start at end of Bond tree
  - Use V* binomial tree
  - Work forwards
- Decision Process:
  - At each note, check whether to convert:
    - If aV* > B + c, convert
    - Otherwise retain bond

Solution: Convertible Bond



Convertible vs Straight Bond

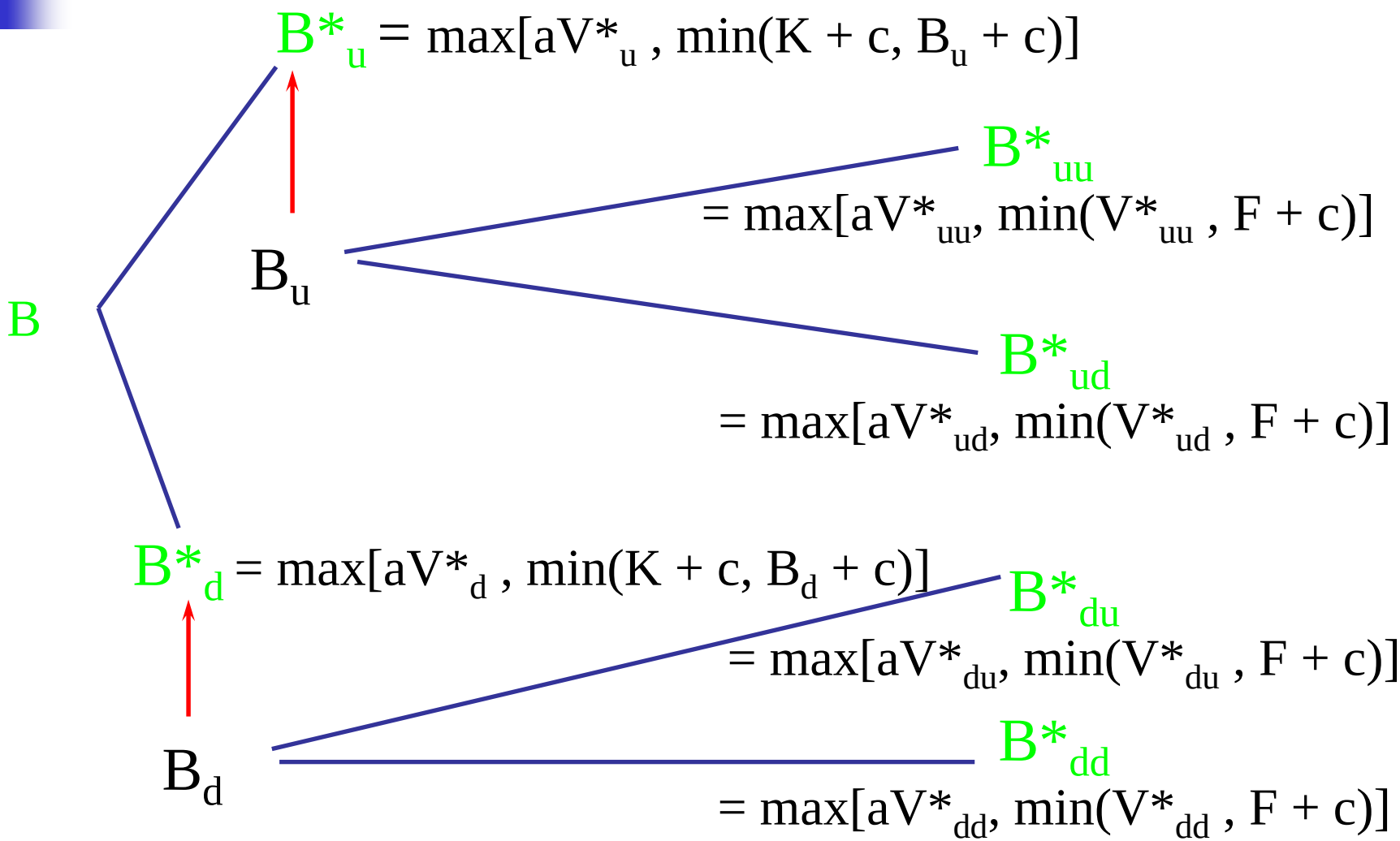
- Convertible Bond Value 106.82
  Straight Bond Value 100.00

  Value of conversion option 6.82

The Decision Process for a Callable Convertible

- Notation:
  - B* = Bond value + coupon
  - K* = Call price, plus coupon
  - aV* = Conversion value
- Convert Voluntarily: aV* > B*
- Do Not Convert Voluntarily: aV* < B*
  - Call to Force Conversion: K* < aV* < B*
  - Call to Refinance: aV* < K* < B*
  - Do Nothing: aV* < B* < K*

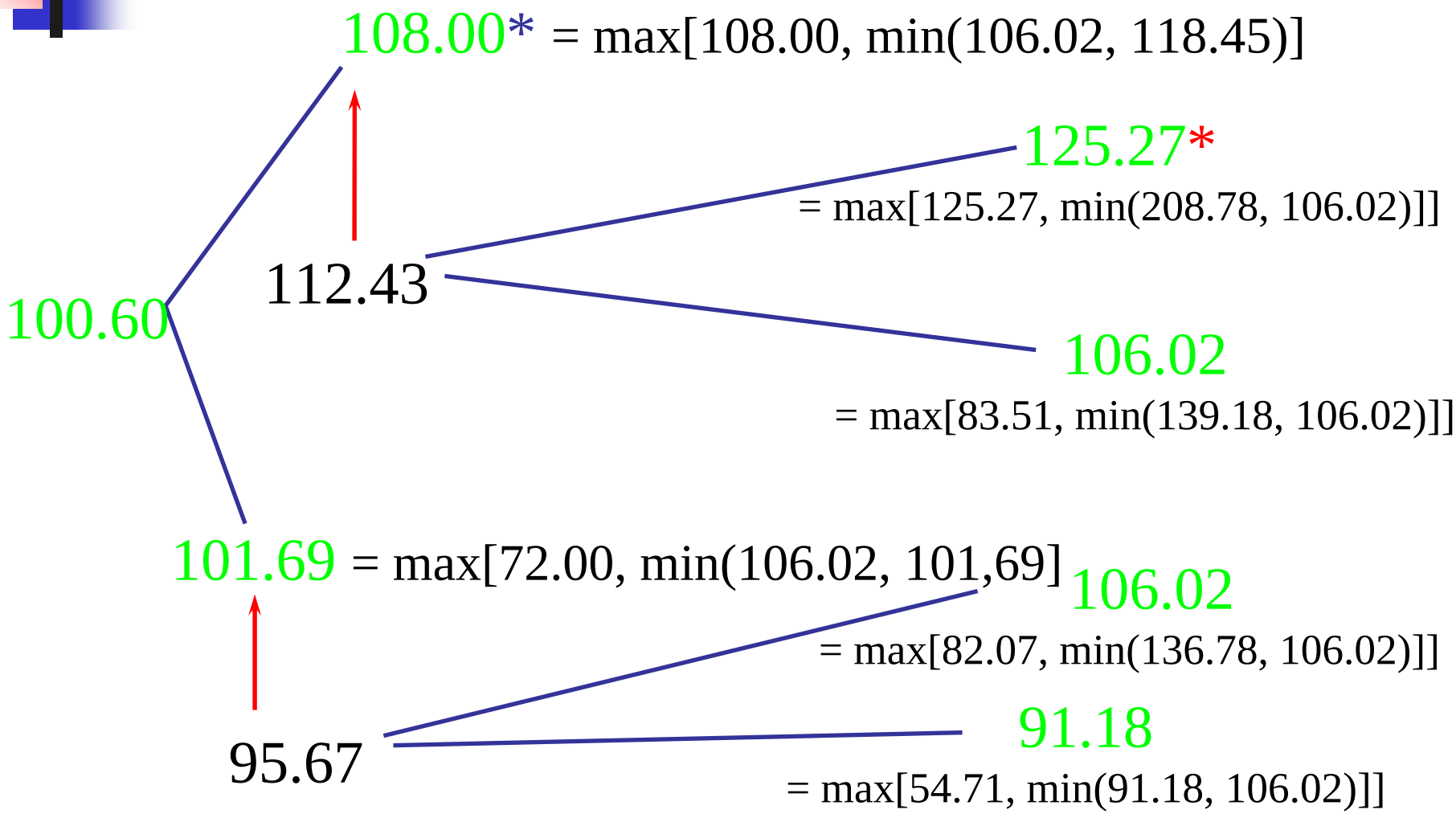
Tree for Callable Convertible



Lab: Value Callable Convertible

- Create Binomial Tree for Callable Convertible
  - Start at end of Bond tree
  - Use V* binomial tree
  - Work forwards
- Decision Process:
  - Terminal bond value same as for convertible
  - Check whether to call at 1st period nodes

Solution: Callable Convertible



Callable Convertible vs Convertible

- Convertible Bond Value 106.82
  Straight Bond Value 100.00
  Value of conversion option 6.82

- Convertible Bond Value 106.82
  Callable Convertible 100.60
  Value of call option 6.22

- Callable Convertible
  - Straight Bond + Conversion Option - Call Option
  - 100 + 6.82 - 6.22 = 100.60

Callable Convertible with Dividends

- Effect of Dividends:
  - Reduces Straight Bond Value
    - Increased risk of default
  - Reduces Convertible Bond Value
    - Straight bond value is lower
    - Conversion option value is lower
  - Callable Convertible Bond Value
    - Also lower
- Check results in solution with D = 25

Summary: Convertibles

- Convertibles are Hybrids
  - Straight debt + option features
  - Behave like mix of debt & call options
- Issuer: lower cost of capital
- Investor:
  - Upside participation with downside protection
- Valuation:
  - Adjusted Black-Scholes for simple cases
  - All others: Binomial Model or variants