CONVERTIBLE BONDS

Introduction to convertibles
Traditional analysis of convertibles
Pricing convertibles

1

2 INTRODUCTION TO CONVERTIBLE BONDS

2

CONVERTIBLE BONDS

- Convertible bonds grant the bondholder the option to convert the bond into a predetermined number of shares of common stock of the issuer
  - Only on corporate bonds
  - Exchangeable bonds
- Most convertible bonds are callable
  - Unprotected call
  - Protected call
- Some convertible bonds are putable
  - Hard put
  - Soft put

3

ELEMENTS OF CONVERTIBLE BONDS

- Convertible bond represents a combination of a straight bond and a call option on the stock of the same issuer
- Conversion ratio (CR)
  - Number of shares to which a bond can be converted
- Conversion price (CP)
  - At the time of issuance, the issuer has effectively granted the bondholder the right to purchase the common stock at the conversion price
  - Bond's par value divided by the conversion ratio

4

CONVERSION PRICE: EXAMPLE 1

Calculate the conversion price of a convertible bond, newly issued at par. The par value is $1000, the coupon rate is 10% paid semiannually, the maturity is 10 years, and the conversion ratio is 20.

- Convertible Price = 1000/20 = $50
- This means that you can effectively buy the issuer's common stock at $50 per share. You will do that buy converting your bond.

5

OPTIMAL CONVERSION STRATEGY

- It is almost always optimal to convert the instant prior to the bond's maturity date
- Would you prefer to be holding the bond or the converted shares at the time the bond matures?
  - Convert now
    - What if the stock price falls on the maturity date?
    - What if the stock price rises on the maturity date?
  - Convert at maturity
    - When would an investor convert?

6

OPTIMAL CONVERSION STRATEGY

- Consider a zero-coupon convertible bond on a stock that pays no dividend. The bond has a par value of $1000 and CR of 20.

Stock price at maturity	A's position: converts before maturity	B's position: decides to convert at maturity
$30	$600	$1000
$40	$800	$1000
$50	$1000	$1000
$60	$1200	$1200
$70	$1400	$1400

7

OPTIMAL CONVERSION STRATEGY

- Consider the same bond but now it pays a coupon C and the underlying stock pays a dividend D

Stock price at maturity	A's position: converts before maturity	B's position: decides to convert at maturity
$30	$600 +FV(20*D)	$1000+FV(C)
$40	$800+FV(20*D)	$1000+FV(C)
$50	$1000+FV(20*D)	$1000+FV(C)
$60	$1200+FV(20*D)	$1200+FV(C)
$70	$1400+FV(20*D)	$1400+FV(C)

8

9 TRADITIONAL ANALYSIS OF CONVERTIBLES

9

TRADITIONAL ANALYSIS

- Minimum value of a convertible
- Conversion premium
- Income differential: difference between the current income of a convertible and that of the common stock
- Downside risk with convertibles

10

CONVERSION VALUE AND STRAIGHT VALUE

- Conversion value (CV) of a convertible bond
  - Market value of bond if conversion takes place at the current market price of the stock.
- Straight value (SV) of a convertible bond
  - Market value of a non-convertible bond with the same characteristics as the convertible bond

11

CONVERSION VALUE: EXAMPLE 2

Calculate the conversion value of a bond with the following characteristics:

Current market price of XYZ common stock = $17
Dividends per XYZ common stock share = $1
Current market price of XYZ bond = $950
Par value = $1,000
Conversion ratio = 50
Coupon rate = 10% (annual)
Maturity = 10 years
Comparable non-convertible yield = 14%

- Conversion Value = 50*17 = 850

12

STRAIGHT VALUE: EXAMPLE 3

Calculate the straight value of a convertible bond with the following characteristics:

- Current market price of XYZ common stock = $17
- Dividends per XYZ common stock share = $1
- Current market price of XYZ bond = $950
- Par value = $1,000
- Conversion ratio = 50
- Coupon rate = 10% (semiannual)
- Maturity = 10 years
- Comparable non-convertible yield = 14%

- Straight Value = PV(N=20,Y=7,PMT=50,FV=1000)=$788.1197

13

MINIMUM VALUE OF A CONVERTIBLE BOND

- The minimum value of a convertible bond is the higher of its conversion value or its straight value
  - What if the SV > CV and the bond trades at the CV?
    E.g. SV=$950 and CV=$850 and the bond trades for $850
  - What if the SV < CV and the bond trades at the SV?
    E.g. SV=$750 and CV=$850 and the bond trades for $750

14

CONVERSION PREMIUM

- The premium effectively paid over the common stock's current market price when purchasing a convertible
  - CPremium per share = Market Cprice – Common Stock Price
- Conversion premium ratio: the conversion premium per share scaled by the common stock's price
  - CPremium ratio = (Market CPrice – Common Stock Price)/ Common Stock Price

15

CONVERSION PREMIUM: EXAMPLE 4

Consider the following convertible bond:

- Current market price of XYZ common stock = $17
- Dividends per XYZ common stock share = $1
- Current market price of XYZ bond = $950
- Par value = $1,000
- Conversion ratio = 50
- Coupon rate = 10%
- Maturity = 10 years
- Comparable non-convertible yield = 14%

- What is the conversion premium ratio for this bond?

16

CONVERSION PREMIUM: EXAMPLE 4

- What is the conversion premium ratio for this bond?
  - Market Cprice = 950/50 = 19
  - Conversion Premium = 19-17 = 2
  - Conversion Premium Ratio = 2/17 = 0.1176 = 11.76%
- Why would an investor be willing to pay a premium?

17

INCOME DIFFERENTIAL

- Conversion premium is offset over time by the difference between the bond's coupon and the stock's dividend
  - Income Diff per share = (Coupon – CR*Dividend per share)/CR
- Premium payback period (or break-even time): the time it takes to recover the premium per share
  - PPP = Conversion Premium per share/Income Diff per share

18

PREMIUM PAYBACK PERIOD: EXAMPLE 5

Consider the following convertible bond:

- Current market price of XYZ common stock = $17
- Dividends per XYZ common stock share = $1
- Current market price of XYZ bond = $950
- Par value = $1,000
- Conversion ratio = 50
- Coupon rate = 10%
- Maturity = 10 years
- Comparable non-convertible yield = 14%

- What is the premium payback period for the XYZ bond?
  - Annual Coupon = 100
  - Income Diff = 100 – 50*1 = 50
  - Income Diff per share = 50/50 = 1
  - PPP = 2/1 = 2 years

19

DOWNSIDE RISK OF A CONVERTIBLE

- SV of a convertible as the floor for its price
- Premium over SV as a measure of downside risk
  - Premium over SV = (Market Price of bond – SV)/SV
- How would we evaluate the upside potential of a convertible?

20

DOWNSIDE RISK: EXAMPLE 6

Consider the following convertible bond:

- Current market price of XYZ common stock = $17
- Dividends per XYZ common stock share = $1
- Current market price of XYZ bond = $950
- Par value = $1,000
- Conversion ratio = 50
- Coupon rate = 10%
- Maturity = 10 years
- Comparable non-convertible yield = 14%

- What is the premium over SV for this convertible?

21

PROFILE/INVESTMENT CHARACTERISTICS OF CONVERTIBLES

- Profile: what dominates the performance of the convertible
  - Stock price?
  - Interest rates and spreads?
- Types of profiles
  - Busted convertible (or credit sensitive): stock price far below CP
  - Equity sensitive (or equity substitute): stock price above CP
  - Hybrid (or balanced or typical): between the above two cases, displaying characteristics of both a fixed income security and common stock

22

23 PRICING CONVERTIBLES

23

PRICING CONVERTIBLE BONDS

- Price of convertible bond = Straight value + Conversion Option
- What are the characteristics/elements of that option?
  - Underlying
  - Exercise Price
  - Expiration
- How does the price of a convertible bond compare to that of a non-convertible bond with the same characteristics as the convertible?
- How does the yield on a convertible bond compare to that on a non-convertible bond with the same characteristics as the convertible?

24

PRICING CONVERTIBLE BONDS

1. Calculate the straight value of the convertible bond
2. Calculate the value of the call option on one share of the common stock (Black-Scholes model)
3. Adjust the call option value by the conversion ratio (CR)
4. Add together the straight value of the convertible bond and the CR-adjusted call option value

25

PRICING CONVERTIBLE BONDS: EXAMPLE 7

- Consider the following information about a convertible bond. Use it to calculate the approximate fair market price for this bond.

Straight Bond Information	Stock Information
Face value: $1,000	Stock price: $40 per share
Annual coupon: $70	Standard dev.: 50%
Maturity: 3 years	Conversion price: $50
YTM: 12%	
Risk free rate: 9%	

26

PRICING CONVERTIBLE BONDS: EXAMPLE 7 (CONT.)

1. Value of bond as a straight debt instrument

   Price of Straight bond = PV(N=3,Y=12,PMT=70,FV=1000)=879.9084

27

PRICING CONVERTIBLE BONDS: EXAMPLE 7 (CONT.)

2. Value of call on one share of stock using Black-Scholes model.

$$\text{Call} = P\,N(d_1) - X\,e^{-rt}N(d_2)$$

where P = price of the underlying security; σ = standard deviation of P; X = strike price; e = base of natural log; r = risk free interest rate; t = time until maturity; N(•) = standard normal cumulative distribution function

$$d_1 = \frac{\ln\left(\frac{P}{X}\right)+(r+0.5\sigma^2)t}{\sigma\sqrt{t}} \text{ and } d_2 = d_1 - \sigma\sqrt{t}$$

28

PRICING CONVERTIBLE BONDS: EXAMPLE 7 (CONT.)

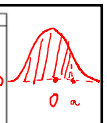
2. Value of call on one share of stock using Black-Scholes model.

d_1 = (ln(40/50)+(0.09+0.5*0.5^2)*3)/(0.5*3^0.5)=0.49

d_2 = 0.49-0.5*3^0.5=-0.38

29

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9924	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9958	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986



d_1 = 0.49

d_2 = -0.38

30

PRICING CONVERTIBLE BONDS: EXAMPLE 7 (CONT.)

2. Value of call on one share of stock using Black-Scholes model.

d_1 = (ln(40/50)+(0.09+0.5*0.5^2)*3)/(0.5*3^0.5)=0.49
d_2 = 0.49-0.5*3^0.5=-0.38

$N(d_1)$ = 0.6879
$N(d_2)$ = 1 – N(0.38) = 1-0.6480=0.3520

Call = $40*(0.6879)-50*(e^{-0.09*3} * 0.3520)$ = 14.0805

31

PRICING CONVERTIBLE BONDS: EXAMPLE 7 (CONT.)

3. Adjust the call option value by the CR

14.0805 * 20 = 281.6104

4. Add together the straight value of the convertible bond and the CR-adjusted call option value

Price of convertible bond = 879.9084 + 281.6104 = $1161.5188

32

WHY BINOMIAL OPTION PRICING?

- Many convertible bonds are also callable/putable
- B-S does not work well for bond options
  - Remember why?
  - How should we value the convertible?

33

PRICING CONVERTIBLE BONDS USING BINOMIAL PRICING: EXAMPLE 8

Consider a 10% convertible bond that has $100 face value, 5 years to maturity, CR = 20, and pays interest annually. The market perceives that 5 years from now the shares of the firm are equally likely to be worth $4 and $6. The term structure is assumed to be flat at 10%. Assume that investors delay conversion until after they receive their last coupon. What is the fair price for this bond?

If stock price is $4, CV =20*4=$80 → No Convert!

→Price = PV(N=5,Y=10,PMT=10,FV=100)=$100

If stock price is $6, CV =20*6=$120 → Convert!

→Price = PV(N=5,Y=10,PMT=10,**FV=120**)=$112.4184

Price of Convertible =0.5*100+0.5*112.4184=106.2091

34

DETERMINANTS OF A CONVERTIBLE'S PRICE

- The price of the underlying stock
- Expected future volatility of equity returns
- Risk free interest rates
- Issue-specific corporate/Treasury yield spread
- Expected volatility of interest rates and spreads
- Co-movement between the underlying stock price, and interest rates and spreads
- Call provisions

35