# LECTURE 7

## INTRO TO OPTIONS AND AS THEY APPLY TO VALUE EQUITY

### CALL OPTIONS

The right to purchase an asset for a specific price (exercise price or strike price) on or before some specified expiration

i.e. March Call OPTION for IBM stock with exercise price of $100 entitles its owner to **PURCHASE** IBM stock for $100 at any time up to and including the expiration S=Day in March (third Friday). The purchase price option is called **PREMIUM** (like insurance) - the seller that owns the stock receives the premium

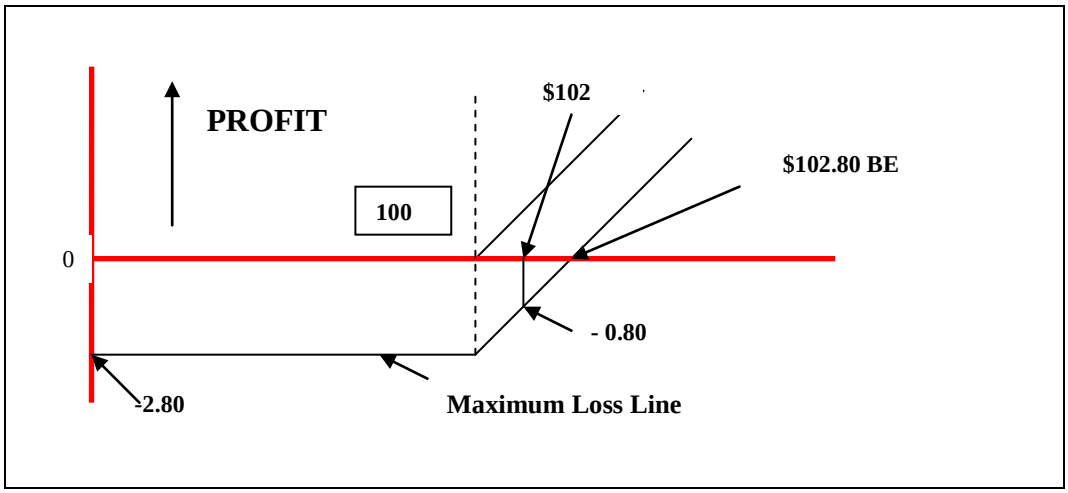
EXAMPLE 15.1 – Call 3/20 third Friday of the Month (MARCH 2010) Call option IBM $100 with Premium for $2.80

Until March 20, the holder of the option may buy the stock (10 shares per option) for $100. On February 6, IBM sells for $96.14 – Not a good time to exercise – If IBM is selling at $102 on March 20 – The option will be exercised (even though you will loose money – but not as much as not exercising)

102 – Buy 100 = $2

Profit = Final Value – Original Investment = 2- 2.80 = -.80

**CALL OPTION**:



## PUT OPTIONS

Gives the holder the right to SELL an Asset for a specific exercise or stock price on or before a specific date (exercise date)

i.e. MARCH $100 - Sell IBM at $100 even if the stock price less than $100 – The owner of the PUT option does not need to own the shares to exercise the option

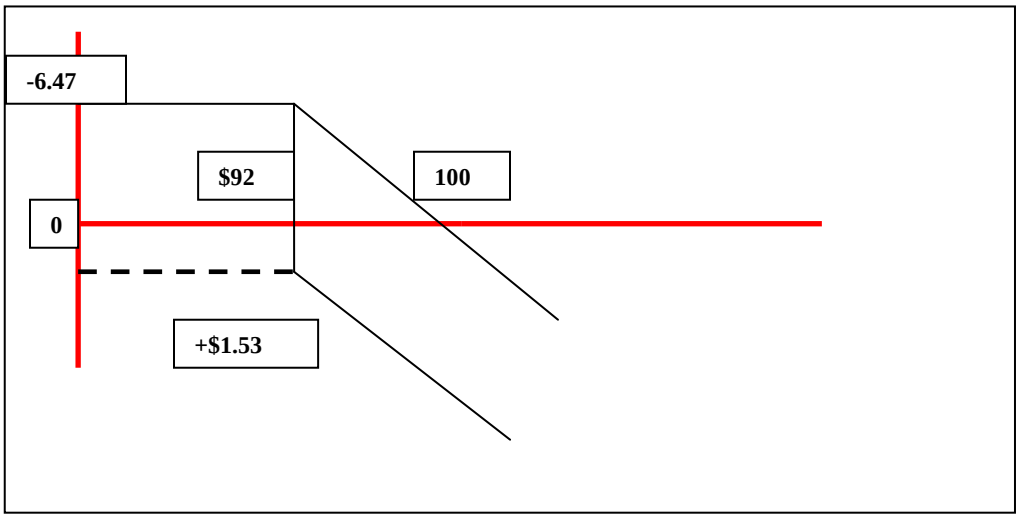
Example 15.2 PUT

PUT OPTION w/ exercise price $100 sell on 2/6/10 for $6.47. Entitles the owner of the option to sell IBM shares at any time, until March 20, to sell the stock at $100

If price on 2/6/10 is $96.14 – an immediate exercise will loose money – wait until the expiration date March 20 – If March 20, the price of the IBM stock is $92, then you exercise the option – buying the stock at $100 and sell it at $92

100 – 92 = $8 gross profit
$8 – 6.47 = $1.53 -----net profit of HPR of 1.53/6.47 = 23.6%

PUT OPTION



CHAPTER 30

APPLICATIONS OF OPTION PRICING THEORY TO EQUITY VALUATION

- Most equity analysts do not associate option pricing theory with equity or asset valuation.
- This Lecture will aim to show that option pricing theory has an important role o play in valuation and that it provides a very different perspective that can be useful in understanding and analyzing troubled firms, natural resource firms, and high-technology firms.

Valuing Equity as an option

- Traditional methods for valuing equity include DCF, Trading and Acquisition Multiples,
- The equity in a firm is a residual claim – that is, euity holders lay claim to all cash flows over after financial claimholders (debt, preferred stock) have been satisfied.
- The payoff to equity investors, on a liquidation basis (bottom of the waterfall) can therefore be written as:

Payoff to equity on liquidation = EV – D if EV > D
and = 0 if EV ≤ D

where EV = Enterprise Value and D = Debt

- A Call option with strike price (X) on an asset with a current value of stock (S) has the following payoffs:

Payoff on Exercise = S – X if S > X
And = 0 if S ≤ X

Equity can thus be viewed as a call option on the firm, where exercising the option requires that the firm be liquidated and the face values of the debt (which corresponds to the exercise price) be paid off.

***Example***

- Asset Value / Enterprise Value of the firm = $100 million
- Standard Deviation in the asset value = 40%
- Face Value of the Debt = $80 million (10 year – zero coupon debt at 10%) – (estimated PV of $80 million at 10% for 10 years = $30.84 not using e compounding)

How much is the equity worth today?
What should the interest rate on debt be?

The use of option pricing approach provides a solution:

- Value of underline asset = S = Value of the firm = $100 million
- Exercise Price = X = Face Value of outstanding Debt = $80 million
- Life of the option = t = Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset = $\sigma^2$ = Variance in EV = $.4^2$ =.16
- Riskless Rate = i = 10 year T-Bonds rate to option life = 10%

d1 = 1.5994 and d2 = .3345
N(d1) = .9451 and N(d2) = .6310

Value of the Call using Black-Scholes:

(100 x .9451) – ($80 $e^{-.10x.10}$ x .6310) = $75.94 million

Value of outstanding debt = $100 - $75.94 = $24.06 million

Increase rate on debt = ($80 / $24.06) $^{1/10}$ -1 = **12.77**%

## Valuing Equity in a Troubled Firm using Option Pricing

- The first implication is that equity will have value, even if the value of the firm falls well below the face value of the outstanding debt
- Such a firm will be viewed as troubled by investors, accountants and analysts, but that does not mean that it's equity is worthless.
- There is a possibility that the underlying value might increase by expiration day.

***Example – (using the example above)***

- Asset Value / Enterprise Value of the firm = $50 million

- Standard Deviation in the asset value = 40%
- Face Value of the Debt = $80 million (10 year – zero coupon debt at 10%) – (estimated PV of $80 million at 10% for 10 years = $30.84 not using the e compounding)

The $50mm is well below the $80 million outstanding debt (due 10 years from now)

The use of option pricing approach provides a solution:

- Value of underline asset = S = Value of the firm = $50 million
- Exercise Price = X = Face Value of outstanding Debt = $80 million
- Life of the option = t = Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset = $\sigma^2$ = Variance in EV = $.4^2$ =.16
- Riskless Rate = i = 10 year T-Bonds rate to option life = 10%

d1 = 1.0515 and d2 = - .2135
N(d1) = .8534 and N(d2) = .4155

Value of the Call using Black-Scholes:

(50 x .8534) – ($80 $e^{-.10x.10}$ x .4155 = $30.44 million

Value of outstanding debt = $50 - $30.44 = **$19.56 million**

The Equity in this firm has substantial value, because of the option characteristics of equity. This might explain why stock in firms that are in "Chapter 11" and essentially bankrupt still has value.

## The Conflict between Bondholders and Stockholders

- Different objectives between Stockholders and Bondholders (Risk)
- This conflict can be illustrated dramatically using the option pricing model.

***Example – (using the example above)***

- Asset Value / Enterprise Value of the firm = $100 million
- Standard Deviation in the asset value = 40%
- Face Value of the Debt = $80 million (10 year – zero coupon debt at 10%) – (estimated PV of $80 million at 10% for 10 years = $30.84)

- Value of the Equity = E = $74.94 million
- Value of the Debt = D = $24.06 million
- Value of the Firm = EV = $100 million

Now assume that the stockholders have the opportunity to take a project with negative net present value of - $2 million, but assume that this project is very risky project that will push up the standard deviation in firm value to 50%. The equity as a call option can then be valued using he following inputs:

- Value of underline asset = S = Value of the firm = $98 million (100-2)
- Exercise Price = X = Face Value of outstanding Debt = $80 million
- Life of the option = t = Life of zero-coupon debt = 10 years
- Variance in the value of the underlying asset = $\sigma^2$ = Variance in EV = $.5^2$ =.25
- Riskless Rate = i = 10 year T-Bonds rate to option life = 10%

Based on Black-Scholes:

- Value of the Equity = E = $77.71million
- Value of the Debt = D = $20.29 million
- Value of the Firm = EV = $98 million

The value of equity rises from $75.94 million to $77.71 million, even though the firm value declines by $2 million. The increase in equity value comes at the expense of bondholders, who see their wealth decline from $24.06 million to $20.19 million.

## Valuing Equity as an Option: Wang Labs

**File for Bankruptcy 1993**

| **DEBT ASSUMPTIONS** | | | **VALUE ASSUMPTIONS (Pre-bankrupcy)** | |
|---|---|---|---|---|
| Debt Outstanding = | 529.4 | | Stock Montly Var. (1987 - 1991) = | 0.0262 |
| Weighted Average Duration= | 5.1 | years | Bonds Monthly Var. (1987 - 1991) = | 0.0126 |
| Weighted Average maturity= | 8.7 | years | Correlation between Stock/Bond | 0.27 |
| WACC= | 10% | | Debt proportion (1987 - 1991) = | 86.10% |
| Tax Rate = | 36.0% | | | |

| **Discount Cash Flow Analysis** | | **1993** | **1994** | **1995** | **1996** | **1997** |
|---|---|---|---|---|---|---|
| Revenue | | 1,300.0 | 1,010.0 | 1,067.0 | 1,121.0 | 1,177.0 |
| CoGS | | (1,000.0) | (658.0) | (705.0) | (741.0) | (778.0) |
| Oper. Exp. | | (750.0) | (279.0) | (267.0) | (269.0) | (282.0) |
| **EBIT** | | **(450.0)** | **73.0** | **95.0** | **111.0** | **117.0** |
| **EBIT (t)** | | **(162.0)** | **26.3** | **34.2** | **40.0** | **42.1** |
| **EBIT (i-t)** | | **(288.0)** | **46.7** | **60.8** | **71.0** | **74.9** |
| Less Capex (offset by Depreciation | | - | - | - | - | - |
| Less W/C | | - | - | - | - | - |
| Cash Flow | | (288.0) | 46.7 | 60.8 | 71.0 | 74.9 |
| Terminal Value assumption | 6.8x | | | | | 794.0 |
| **EV (PV) of the firm** | **$410.5** | **(288.0)** | **46.7** | **60.8** | **71.0** | **868.9** |

**Step 1 - Find the annualized in stock and bond prices:**

| | | | |
|---|---|---|---|
| Annualized Variance in Stock Price σ^2 = | 0.3144 (annual) | St. Dev.= | 0.560714 |
| Annualized Variance in Bond Price σ^2 = | 0.1512 (annual) | St. Dev.= | 0.388844 |

**Step 2 - Find the annualized variance in firm value**

**(we^2 x σe^2) + (wb^2 x σb^2) + (we x wd x ped x σe x σd)**

| | |
|---|---|
| **We=** | 13.90% |
| **Wd=** | 86.10% |
| Annualized Varaince in firm value | 0.132253 |

The five-year bond rate (corresponding to the weighted average duration of 5.1 years) is 6.0%

**Stet 3 - Find the value of call based upon the following parameters of equity as a call option**

| | | | |
|---|---|---|---|
| Value of the underlying asset = S = Value of the firm = | $410.5 | | |
| Exercise Price = X = Face Value of outstanding debt = | $529.4 | | |
| Life of the option = t = Weighted average duration of debt= | 5.1 | years | |
| Variance in the value of the underlying asset = σ^2 = | 0.132253 | | |
| Riskless Rate = I = T-Bond for option life = | 6.00% | | |
| d1= | 0.473506 | N (d1) = | 0.682074 |
| d2= | -0.347767 | N (d2) = | 0.364008 |

**Value of the call = 137.9534**

Wang's equity was trading at $85 milion in March 1993

# CASE STUDY: Airline Company

| | | |
|---|---|---|
| NYSE Stock Standard Deviation= | 25% | |
| Debt average % o EV= | 90% | |
| Bond Rating = | B | bonds are not traded |
| Other B ratednames Stand Dev= | 10% | |
| Correlation Stock/Bond market | 0.3 | |
| Dividends = | 0 | |
| T-Bond | 8.00% | |

| **Enterprise Value** | |
|---|---|
| North America | 400 |
| Europe | 500 |
| South America | 100 |
| | 1000 |

| **Debt** | **Amount** | **% Total** | **Coupon** | **Duration** | **WA Dur** |
|---|---|---|---|---|---|
| 20-yr debt | 100 | 8.33% | 11.0% | 14.1 | 1.1750 |
| 15-yr debt | 100 | 8.33% | 12.0% | 10.2 | 0.8500 |
| 10 yr debt | 200 | 16.67% | 12.0% | 7.5 | 1.2500 |
| 1-yr debt | 800 | 66.67% | 12.5% | 1.0 | 0.6667 |
| Total Debt | 1200 | 100.00% | | | 3.9417 |

| **Variance of the Firm** | % W | σ | W^2 | σ^2 | W^2xSD^2 | We.Wd.σe.σd |
|---|---|---|---|---|---|---|
| Equity % of Cap | 10% | 25% | 0.01 | 0.0625 | 0.00063 | |
| Debt % of Cap | 90% | 10% | 0.81 | 0.01 | 0.00810 | |
| | | | | | 0.00873 | 0.00225 |
| | | | | | Variance = | 0.01098 |
| | | | | | Stand Dev= | 0.104761634 |

**Value of Equity using Option Priocing (Black-Scholes)**

| | | Ln (EV / Debt) | (i + σ^2/2)*t | σ?t | d1 and d2 |
|---|---|---|---|---|---|
| d1= | 0.7435 | -0.182321557 | 0.34 | 0.21 | 0.7435 |
| d2= | 0.5355 | | | | 0.5355 |
| N(d1)= | 0.7714 | | | | |
| N(d2)= | 0.7039 | | | | |
| **Value of the Call=** | **154.63** | | | | |