Chapter 22 – Part 2
Options and Corporate Finance: Basic Concepts

- Options
- Call Options
- Put Options
- Selling Options
- Reading *The Wall Street Journal*
- Combinations of Options
- Valuing Options
- An Option-Pricing Formula
- Stocks and Bonds as Options
- Capital-Structure Policy and Options
- Mergers and Options
- Investment in Real Projects and Options
- Summary and Conclusions

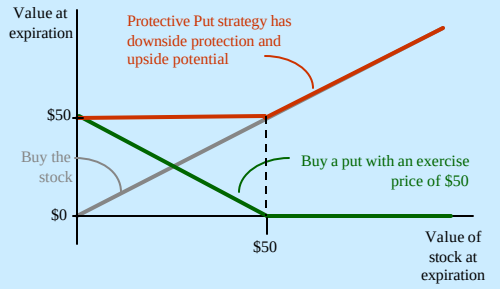
0

Combinations of Options

- **Puts and calls can serve as the building blocks for more complex option contracts.**
- **If you understand this, you can become a financial engineer, tailoring the risk-return profile to meet your client's needs.**

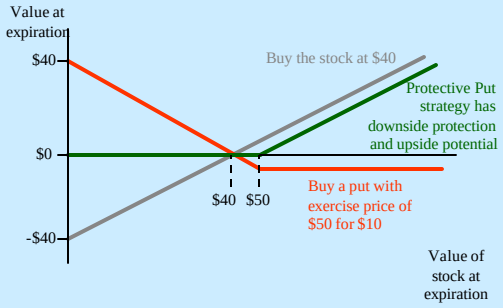
1

Protective Put Strategy: Buy a Put and Buy the Underlying Stock: Payoffs at Expiration



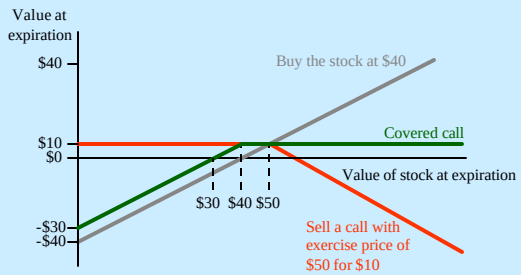
2

Protective Put Strategy Profits



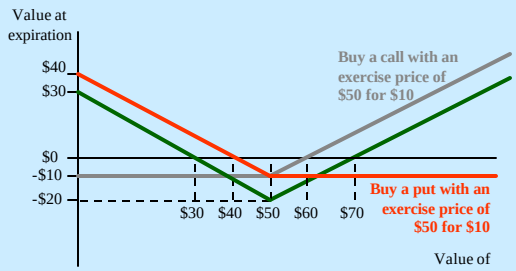
3

Covered Call Strategy



4

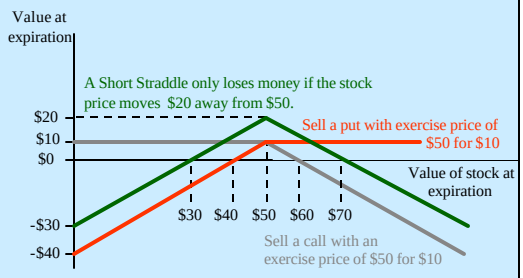
Long Straddle: Buy a Call and a Put



A Long Straddle only makes money if the stock price moves $20 away from $50.

5

Short Straddle: Sell a Call and a Put



6

Put-Call Parity

$$S + P = C + Ee^{-rT}$$

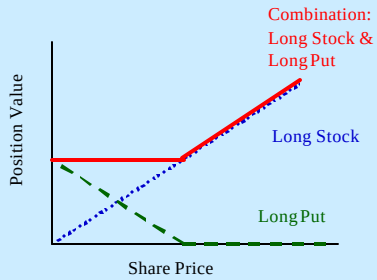
C = Call option price
S = Current stock price
r = Risk-free rate
P = Put option price
E = Option strike price
T = Time until option expiration

Buy the stock, buy a put, and write a call; the sum of which equals the strike price discounted at the risk-free rate

$$S + P - C = Ee^{-rT}$$

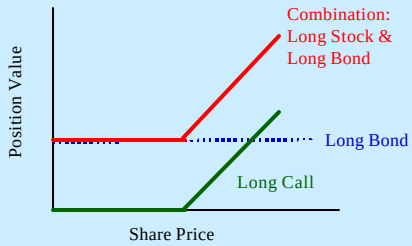
7

Put-Call Parity
Buy Stock & Buy Put



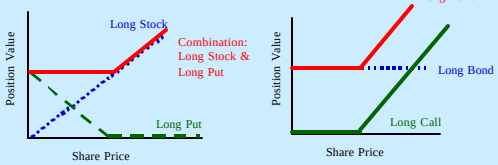
8

Put-Call Parity
Buy Call & Buy Zero Coupon Risk-Free Bond @ Exercise Price



9

Put-Call Parity



In market equilibrium, it must be the case that option prices are set such that:

$$S + P = C + Ee^{-rT}$$

Otherwise, riskless portfolios with positive payoffs exist.

10

The Black-Scholes Model

Value of a stock option is a function of 6 input factors:
1. Current price of underlying stock.
2. Strike price specified in the option contract.
3. Risk-free interest rate over the life of the contract.
4. Time remaining until the option contract expires.
5. Price volatility of the underlying stock.

The price of a call option equals:

$$C = SN(d_1) - Ee^{-rT}N(d_2)$$

11

Black-Scholes Model

$$C = S\,N(d_1) - E\,e^{-rT}\,N(d_2)$$

Where the inputs are:
S = Current stock price
E = Option strike price
r = Risk-free interest rate
T = Time remaining until option expiration
s = Sigma, representing stock price volatility, standard deviation

Black-Scholes Model

$$C = S\,N(d_1) - E\,e^{-rT}\,N(d_2)$$

Where d_1 and d_2 equal:

$$d_1 = \frac{\ln\left(S/E\right) + \left(r + \frac{s^2}{2}\right)T}{\sqrt{s^2 T}}$$

$$d_2 = d_1 - \sqrt{s^2 T}$$

Black-Scholes Models

Remembering put-call parity, the value of a put, given the value of a call equals:

$$S + P = C + E\,e^{-rT}$$

$$P = C - S + E\,e^{-rT}$$

Also, remember at expiration:

$$C = S - E$$

$$P = E - S$$

The Black-Scholes Model

Find the value of a six-month call option on the Microsoft with an exercise price of $150
The current value of a share of Microsoft is $160
The interest rate available in the U.S. is *r* = 5%.
The option maturity is 6 months (half of a year).
The standard deviation of the underlying asset is 30% per annum.

The Black-Scholes Model

Assume S = \$160, X = \$150, T = 6 months, r = 5%, and σ = 30%, calculate the value of a call.

First calculate d_1 and d_2

$$d_1 = \frac{\ln(S/E) + (r + .5s^2)T}{s\sqrt{T}}$$

Then d_2,

$$d_2 = d_1 - s\sqrt{T} =$$

The Black-Scholes Model

$$C_0 = S \times \mathrm{N}(d_1) - Ee^{-rT} \times \mathrm{N}(d_2)$$

Another Black-Scholes Example

Assume S = \$50, X = \$45, T = 6 months, r = 10%, and σ = 28%, calculate the value of a call and a put.

From a standard normal probability table, look up $N(d_1)$ = 0.812 and $N(d_2)$ = 0.754 (or use Excel's " normsdist" function)

18

Stocks and Bonds as Options

- **Levered Equity is a Call Option on the firm.**
  - **The underlying asset are the assets of the firm.**
  - **The strike price is the payoff of the bond.**
- **Two scenarios:**
- **At the maturity of the debt, the assets of the firm are greater in value than the debt:**
- **Shareholders have an in-the-money call, they will pay the bondholders and "call in" the assets of the firm.**
- **At the maturity of the debt, the assets of the firm are lower valued than the debt:**
- **Shareholders have an out-of-the-money call, they will not pay the bondholders and let the call expire. (*i.e.* the shareholders will declare bankruptcy)**

19

Stocks and Bonds as Options

- **Levered Equity is a Put Option on the firm.**
  - **The underlying asset are the assets of the firm.**
  - **The strike price is the payoff of the bond.**
- **Two scenarios:**
- **At the maturity of their debt, the assets of the firm are less in value than the debt:**
- **Shareholders have an in-the-money put and they will put the firm to the bondholders. (*i.e.* declare bankruptcy)**
- **At the maturity of the debt, the assets of the firm are greater in value than the debt:**
- **Shareholders have an out-of-the-money put they will not exercise the option (*i.e.* NOT declare bankruptcy) and let the put expire.**

20

Stocks and Bonds as Options

- It all comes down to put-call parity.

$$C_0 = S + P_0 - X e^{-rT}$$

Value of a call on the firm = Value of the firm + Value of a put on the firm – Value of a risk-free bond

Stockholder's position in terms of call options

Stockholder's position in terms of put options

21

Stocks and Bonds as Options

Value of a call option on firm (to stockholders):

Value of a call on the firm = Value of assets (V) – Value of debt (B)

Value of Call = V – B

Where B = exercise price

22

Capital-Structure Policy and Options

- **Recall some of the agency costs of debt: they can all be seen in terms of options.**
- **For example, recall the incentive shareholders in a levered firm have to take large risks.**
- **Why?**

23

Balance Sheet for a Company in Distress

Assets	BV	MV	Liabilities	BV	MV
Cash	$200	$200	LT bonds	$300	?
Fixed Assets	$400	$0	Equity	$300	?
Total	$600	$200	Total	$600	$200

What happens if the firm is liquidated today?

24

Low-Risk vs High-Risk Projects

(firm has $300 in debt outstanding)

Low-Risk Project						
State of Econ.	Probability	Value of Firm	=	Stock	+	Bond
Recession	50%	$300	=	0	+	$300
Boom	50%	$700	=	$400	+	$300

High-Risk Project						
State of Econ.	Probability	Value of Firm	=	Stock	+	Bond
Recession	50%	$100	=	0	+	$100
Boom	50%	$2,000	=	$1,700	+	$300

Which project is preferred by Bondholders? By Stockholders? Why?

Firm with high-risk project has higher volatility, what does that do to the price of the call option (value of the firm)?

25

Investment in Real Projects & Options

- **Classic NPV calculations normally ignore the flexibility that real-world firms typically have.**
- **The next chapter will discuss this further.**
- **Whenever management can decide in the future how best to operate a project (expand, contract, delay, or abandon), the project contains a real option.**

26

Real Options

- **Real estate developer buys 70 acres in a rural area. He plans on building a subdivision when the population from the city expands this direction. If growth is less than anticipated, the developer thinks he can sell the land to a country club to build a golf course on the property.**
- **The development option is a _____ option.**
- **The golf course option is a _____ option.**
- **How would these real options change the standard NPV analysis?**

27