International Business and Finance
Seminar 4

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Derivatives

- Risk-free is good, but the world is full of risks.
- The simplest (as it only involves probability and numeric value) example will be the price of a stock can go up or down.
- A derivative is a security with a price that is dependent upon or derived from one or more underlying assets.
- The derivative itself is a contract between two or more parties based upon the asset or assets. Its value is determined by fluctuations in the underlying asset.
- To cater for people's *different perception of risks*, derivatives, a contract that derives its value from the performance of an underlying entity, are created

Terminology Recap

- Option contracts: the right, not the obligation, to buy or sell something at some price.
  - Call option: the right to buy at the strike price
  - Put option: the right to sell at the strike price
  - American options: can be exercised at any time between the date of purchase and the expiration date.
  - European options: can only be exercised at the end of their lives on their expiration date.
  - In-the-money: Describes an option whose value, if immediately exercised, would be positive

Terminology Recap

- Future contracts: the obligation to buy or sell an asset at a predetermined future date and price.
  - Crude oil futures give the buyer the obligation to buy the underlying market, and the seller the obligation to sell at, or before, the contract's expiry.

To make matters worse, a price war erupted between oil giants Saudi Arabia and Russia in early March after OPEC and its allies failed to reach an agreement on deeper supply cuts. As supply remained steady while demand struck record-breaking lows, the industry quickly began running out of storage space to put their oil. This was devastating news for investors of WTI futures who are expected to take physical possession of the oil when the contract expires.

"WTI is special in a way because it's so tightly connected to physical oil," said Derrick Morgan, senior vice president of American Fuel & Petrochemical Manufacturers.

As the delivery date for WTI grew near, investors began a massive sell-off to take the contract off their hands, prompting an unprecedented crash into the negative territory.

Intuitive Example

- AAPL is trading at $193.13 currently
- Let's see a couple of options that expire today

In The Money

Contract Name	Last Trade Date	Strike	Last Price	Bid	Ask	Change	% Change	Volume
AAPL230721C00182500	2023-07-20 3:57PM EDT	182.50	10.79	0.00	0.00	0.00	-	568
AAPL230721C00185000	2023-07-20 3:59PM EDT	185.00	8.15	0.00	0.00	0.00	-	7,448
AAPL230721C00187500	2023-07-20 3:59PM EDT	187.50	5.90	0.00	0.00	0.00	-	1,200
AAPL230721C00190000	2023-07-20 3:59PM EDT	190.00	3.45	0.00	0.00	0.00	-	9,363
AAPL230721C00192500	2023-07-20 3:59PM EDT	192.50	1.35	0.00	0.00	0.00	-	34,440
AAPL230721C00195000	2023-07-20 3:59PM EDT	195.00	0.30	0.00	0.00	0.00	-	178,507
AAPL230721C00197500	2023-07-20 3:59PM EDT	197.50	0.05	0.00	0.00	0.00	-	124,096
AAPL230721C00200000	2023-07-20 3:59PM EDT	200.00	0.02	0.00	0.00	0.00	-	88,258
AAPL230721C00202500	2023-07-20 3:59PM EDT	202.50	0.01	0.00	0.00	0.00	-	10,410
AAPL230721C00205000	2023-07-20 3:54PM EDT	205.00	0.01	0.00	0.00	0.00	-	7,257
AAPL230721C00207500	2023-07-20 3:58PM EDT	207.50	0.01	0.00	0.00	0.00	-	1,930
AAPL230721C00210000	2023-07-20 3:59PM EDT	210.00	0.01	0.00	0.00	0.00	-	1,551
AAPL230721C00212500	2023-07-20 12:55PM EDT	212.50	0.01	0.00	0.00	0.00	-	181
AAPL230721C00215000	2023-07-20 2:35PM EDT	215.00	0.01	0.00	0.00	0.00	-	1,212
AAPL230721C00217500	2023-07-20 9:30AM EDT	217.50	0.01	0.00	0.00	0.00	-	1
AAPL230721C00220000	2023-07-20 9:30AM EDT	220.00	0.01	0.00	0.00	0.00	-	2
AAPL230721C00225000	2023-07-20 9:30AM EDT	225.00	0.01	0.00	0.00	0.00	-	5

Intuitive Example

- AAPL is trading at $193.01 currently
- Let's see a couple of options

In The Money

Contract Name	Last Trade Date	Strike	Last Price	Bid	Ask	Change	% Change	Volume
AAPL230721P00172500	2023-07-20 2:03PM EDT	172.50	0.01	0.00	0.00	0.00	-	228
AAPL230721P00175000	2023-07-20 3:55PM EDT	175.00	0.01	0.00	0.00	0.00	-	123
AAPL230721P00177500	2023-07-20 3:43PM EDT	177.50	0.01	0.00	0.00	0.00	-	353
AAPL230721P00180000	2023-07-20 3:55PM EDT	180.00	0.01	0.00	0.00	0.00	-	2,179
AAPL230721P00182500	2023-07-20 3:58PM EDT	182.50	0.02	0.00	0.00	0.00	-	1,770
AAPL230721P00185000	2023-07-20 3:59PM EDT	185.00	0.03	0.00	0.00	0.00	-	2,126
AAPL230721P00187500	2023-07-20 3:59PM EDT	187.50	0.05	0.00	0.00	0.00	-	10,075
AAPL230721P00190000	2023-07-20 3:59PM EDT	190.00	0.14	0.00	0.00	0.00	-	51,590
AAPL230721P00192500	2023-07-20 3:59PM EDT	192.50	0.65	0.00	0.00	0.00	-	90,586
AAPL230721P00195000	2023-07-20 3:59PM EDT	195.00	2.04	0.00	0.00	0.00	-	62,790
AAPL230721P00197500	2023-07-20 3:59PM EDT	197.50	4.35	0.00	0.00	0.00	-	7,809
AAPL230721P00200000	2023-07-20 3:58PM EDT	200.00	6.73	0.00	0.00	0.00	-	891
AAPL230721P00202500	2023-07-20 3:43PM EDT	202.50	9.25	0.00	0.00	0.00	-	130
AAPL230721P00205000	2023-07-20 2:25PM EDT	205.00	11.60	0.00	0.00	0.00	-	167
AAPL230721P00207500	2023-07-20 10:30AM EDT	207.50	12.80	0.00	0.00	0.00	-	4
AAPL230721P00210000	2023-07-20 11:15AM EDT	210.00	15.22	0.00	0.00	0.00	-	9
AAPL230721P00212500	2023-07-19 1:26PM EDT	212.50	17.90	0.00	0.00	0.00	-	53

Options

- Strike price: the price that you can buy/sell the stock
- Trading price: the price for the ***option contract***
- Why would a "contract" have value?

Person 1

Person 2

Call option: buy Apple at the price of $195 before the end of the next week

Expected payoff: $5 per contract

Nah

Put option: sell Apple at the price of $195 before the end of the next week

Nah

Expected payoff: $5 per contract

Options

- Put-call parity

Current Stock Price = Call Option Contract Price - Put Option Contract Price + Present value of strike price

$$S = C-P+PV(K)$$

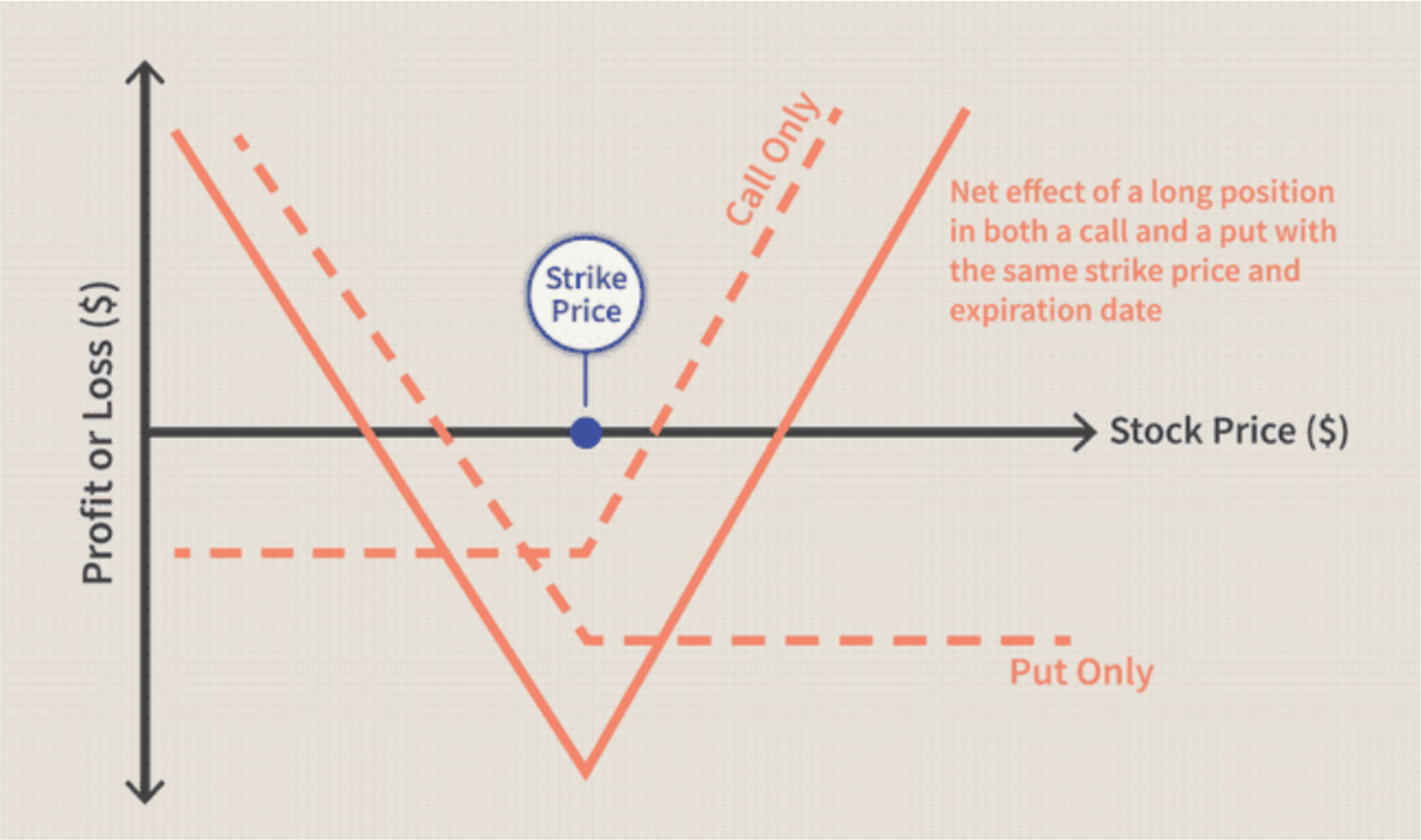
Question 1: Suppose Nokia shares are selling for £10.95. A three-month call option with a £10.95 strike price goes for £0.35. The risk-free rate is 0.5% per month. What is the value of a 3-month put option with a £10.95 strike price?

Answer: Using the put-call parity equation we have

$$P=-S+C+PV(K) \Longrightarrow P=-£10.95+£0.35+£10.95/(1.005)^3 =£0.1873$$

AAPL230721C00195000	2023-07-20 3:59PM EDT	195.00	0.30
AAPL230721P00195000	2023-07-20 3:59PM EDT	195.00	2.04

Combinations of Options: an Example



Quiz Questions

Question 8: Answer the following questions:

a) Suppose that **S=£100**, **P=£10**, and **C=£15**. What must be the one-year interest rate?
b) If the one-year, risk-free interest rate is 4%, is there an arbitrage opportunity? If so, what would you do to obtain risk-less profit?

Question 8:

a) Assuming the option (put or call) is at-the-money (i.e. its exercise price is equal to the current stock price), then K=£100.
Using the put-call parity:

$$S - PV(K) = C - P \Longrightarrow 100 - \frac{100}{1+r} = 15 - 10 \Longrightarrow r = 0.053 = 5.3\%$$

b) If r=4%, then one could make risk-less arbitrage profit by i) borrowing at 4% and ii) investing in a synthetic one-year bond with 5.3% return.

Using the put-call parity we know that $PV(K) = S + P - C$. Therefore, a synthetic one-year bond consists of a share of stock, a European put option, and a short position in a European call option. This synthetic bond would cost $PV(K) = S + P - C = 100 + 10 - 15 = £95$, and its payoff is £100 at maturity in one-year.

The principal and interest on the £95 synthetic bond would be $£95 \times 1.04 = £98.8$. So, there would be a pure risk-less profit of £1.2=£100-£98.8 per bond a year from now.

Quiz Questions

Question 7: Today's price of three traded call options on BackBay.co.uk, all expiring in one month, are as follows:

Strike Price (£)	Options Price (£)
50	**7.5**
60	**3**
70	**1.5**

You are considering buying a "butterfly spread" consisting of the following positions:

- Buy **1** call at the strike price of **£50**
- Sell (write) **2** calls at a strike price of **£60**
- Buy **1** call at the strike price of **£70**

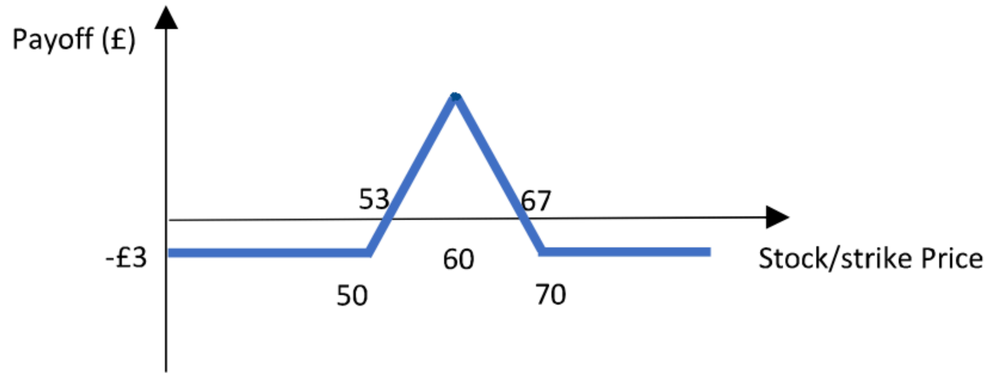
a) How much investment is required to establish the spread?
b) Plot the payoff of your total position for different values of the stock price on the maturity date.
c) What range of stock prices on the maturity date does make a profit for you?

Quiz Questions

a) The investment cost is:

$$Cost = (Long\ 50\ call) - 2 \times (short\ 60\ call) + (Long\ 70\ call)$$
$$= £7.5 - 2 \times £3 + £1.50 = £3$$

b) The payoff graph:



c) There will a positive profit for stock prices at option maturity between £53 and £67.

Quiz Questions

Question 9: In mid-February **2016**, European-style options on the **S&P 100** index (OEX) expiring in December **2017** were priced as follows:

Dec 2017 OEX Index Options		
Strike Price	Call Price	Put Price
840	**88.00**	
860	**76.30**	**102.21**
880		**111.56**

Given an interest rate of **0.40%** for a December **2017** maturity (**22** months in the future), use put-call parity (with dividends) to determine:

a) The price of a December **2017** OEX put option with a strike price of **840**.
b) The price of a December **2017** OEX call option with a strike price of **880**.

Question 9:

a) From put-call parity:

$$S - PV(Div) = C - P + PV(K)$$

From the 860 calls and puts:

$$S - PV(Div) = 76.30 - 102.21 + \frac{860}{1.004^{22/12}} = 827.82$$

Therefore, for the 840 put:

$$P = C + PV(K) - (S - PV(Div)) = 88.00 + \frac{840}{1.004^{22/12}} - 827.82 = 94.05$$

b) And for the 880 call:

$$C = P - PV(K) + (S - PV(Div)) = 111.56 - \frac{880}{1.004^{22/12}} + 827.82 = 65.80$$