TOPIC 2 - OVERVIEW

1. FUTURES

1.1 Features of a Futures Product

- An agreement to buy or sell an underlying asset at a specified price and future date
- **Exchange traded** with standardized features
- Futures contracts can be for agricultural commodities, but more commonly are for financial assets such as equity, interest rates and foreign currency
- **Initial margin** is paid at the beginning of the contract, with margin calls following, if the position loses sufficient money – daily marking to market will trigger margin calls
- Futures are usually **closed out**, prior to expiry, with a buy being cancelled by a sell and vice versa. A small number are settled by physical delivery
- Futures contract specifications detail items such as:
  - Contract value
  - Contract Price
  - Minimum fluctuation
  - Contract months
  - Last trading (or expiry) day
  - Final settlement (or delivery) day
  - Large open positions
  - Settlement method

  Let's look at each one in turn.

Contract Value

- This refers to the notional value of the contract and is based on **the price of the underlying asset multiplied by the contract multiplier**
- The contract multiplier for the HSI contract is HK$50 per index point
- If the HSI futures were quoted at 26,450 points, the contract value for the HIS futures contract would be HK$1,322,500 (22,450 x HK$50)

Contract Price

- Generally, the futures price is quoted using the same convention as for the pricing of the underlying asset
- The quotation price for the HSI futures contract is whole index points, as is the underlying HSI

Minimum Fluctuation

- This is the minimum movement in the price of the futures contract that can occur
- The amount of a single movement is referred to as a "tick"
- The minimum price fluctuation for HSI futures contract is one index point

Contract Months

- Futures contracts are quoted in terms of the month when they expire – for example, a June 2020 contract will expire in June 2020
- "Contract months" refers to the contracts that are available for trading and the months in which they expire
- Short-dated contract months for HSI futures are the "spot" (current) month, the next calendar month and the next two calendar quarterly months (March, June, September and December)
- If it was November 2020, the short-dated contract months would be November and December 2020 and March and June 2021
- Long-dated contract months for HSI futures are the following five December months. If it were now December 2020, you could trade futures that expire in December 2021, 2022, 2023, 2024 and 2025

Last Trading (or expiry) Day

- The last trading day refers to the day in the month when the contract expires
- For the HSI futures contract, the last trading day is the second-last business day of the month

Final Settlement (or delivery) Day

- This is the date when the buyers and sellers of a futures contract have their open positions settled
- Either cash payments are made/received with the exchange clearing house, or there is a physical delivery/receipt of the underlying assets
- HSI futures: the final settlement day is the last business day of the month

Final Settlement Price

- This is price used to settle expiring contracts
- The final settlement price for the HIS futures contract is the average of quotations taken at: (i) five-minute intervals from five minutes after the start of, and up to five minutes before the end of, the continuous trading session of the SEHK; and (ii) close of trading on the last trading day

Large Open Positions

- This refers to the number of open contracts (in any one contract month) that are required to be reported to the Exchange by an Exchange Participant
- These reportable positions and position limits (the maximum number of contracts that can be held in any one contract month) are determined by the Exchange and may change from time to time
- The large open position for the HSI futures contract is 500 contracts in any one contract month

Settlement Method

- There are two methods of contract settlement: cash settlement or physical delivery
- HSI futures contracts are cash-settled

1.2 Hedging Example

- **Details for this hedging example**:
  - In April 20X1, a fund manager holds a broad portfolio of Hong Kong stocks, weighted to match the performance of the HSI
  - The portfolio is currently valued at HK$800 million
  - The fund manager fears a fall in the value of Hong Kong stocks over the next 3 months and wishes to hedge against a fall in the HSI, which is currently at 25,250

- **Buy or sell futures?**
  - The fund manager will want to profit from a futures trade if the HSI falls. Therefore, he needs to "sell high", so he needs to set up the hedge by selling futures

- **Which contract to sell?**
  - Available contracts are: April, May, June and September
  - Given the fund manager's concerns over the next 3 months, the most appropriate contract is June, which is currently trading at 25,250

- **How many contracts?**
  - Current value of a June HIS futures contract is:
    25,250 x HK$50 = HK$1,262,500
  - Number of contracts needed to hedge the portfolio:
    HK$800 million / HK$1,262,500 = 633.66 (rounded to 634)

- **Implementing the hedge**
  - Sell 634 June 20X1 HSI futures @ 25,250

- **Closing the Hedge**
  - In late June 20X1, the HSI has fallen to 23,167, as has June futures contracts
  - The fund manager's portfolio had fallen in value by 8.25%
  - The fund manager decides it is time to close the hedge and exit his futures position
  - To close the position, he will enter into a reversing trade which will involve buying 634 June 20X1 HSI futures at 23,167

- **Loss in the physical market:**
  - HK$800 million x 8.25% = HK$66 million

- **Profit in the futures market:**
  - Difference in points: 25,250 – 23,167 = 2,083
  - Profit on each futures contract: 2,083 x HK$50 = HK$104,150
  - Overall profit: 634 contracts x HK$104,150 = HK$66,031,100

Physical Market	**Derivatives Market**
1. Fund holds an equity portfolio valued at HK$800 million	
	2. Sells 634 HSI futures @ 25,250
3. HSI falls 8.25%	4. HSI futures fall 8.25%
5. Value of portfolio falls 8.25%	6. Buys back 634 HSI futures for @ 23,167
7. Loss in physical market of HK$66,000,000 offset by profit made on derivatives trade of HK$66,031,100	

1.3 Trading Example

- **Details for this trading example**:
  - In April 20X1, you believe that the next month's economic news is going to be strong and will have a positive effect on the HSI, however this will be short-lived and negative sentiment and profit-taking will then drag the Index back down
  - You decide to proceed with a simple trading strategy using futures to profit from your view

- **Buy or sell futures?**
  - You believe that the HSI will increase over the next 2 months and will need to buy futures to profit from your view

- **Which contract to buy?**
  - Available contracts are: April, May, June and September
  - As your view is short-term, anything longer than 3 months will be unsuitable and liquidity will be important
  - In general, the spot month and the following month are the most active trading contracts
  - You could reasonably buy either the May or June futures – you decide on the June 20X1 HSI futures, which are trading at 25,250

- **How many contracts?**
  - You decide to purchase the limit allowable to you under your own risk management practices, which is 100

- **Implementing the hedge**
  - Buy 100 June 20X1 HSI futures @ 25,250

- **Closing the Hedge**
  - In late June 20X1, the HSI has risen to 26,150, as has June futures contracts
  - You decide it is time to close the hedge and exit your futures position
  - To close the position, you will enter into a reversing trade which will involve selling 100 June 20X1 HSI futures at 26,150

- **Profit in the futures market:**
  - Difference in points: 26,150 – 25,250 = 900
  - Profit on each futures contract: 900 x HK$50 = HK$45,000
  - Overall profit: 100 contracts x HK$45,000 = HK$4,500,000

Physical Market	**Derivatives Market**
	1. Buy 100 June 20X1 HSI @ 25,250
2. Market rises, HSI reaches 26,150	
	3. Sell 100 June 20X1 HSI @ 26,150
	4. Profit on futures trade is HK$4,500,000

1.4 Futures Spread Strategies

- Futures spread strategies can be either intra-market or inter-market
- **Intra-market spread strategies** involve two futures contracts on the same underlying instrument:
  - An investor can buy the March 20X1 HSI futures at 25,000 and sell the April 20X1 HSI futures at 25,200, expecting the spread between the two futures contracts to narrow
  - Also known as the calendar spread or time spread
- **Inter-market spread strategies** involve two futures contracts on different underlying instruments, which have co-related price movements:
  - An investor can buy S&P 500 futures and sell HSI futures
  - In general, inter-market spread strategies tend to be more risky than intra-market spreads because of the different underlying instruments

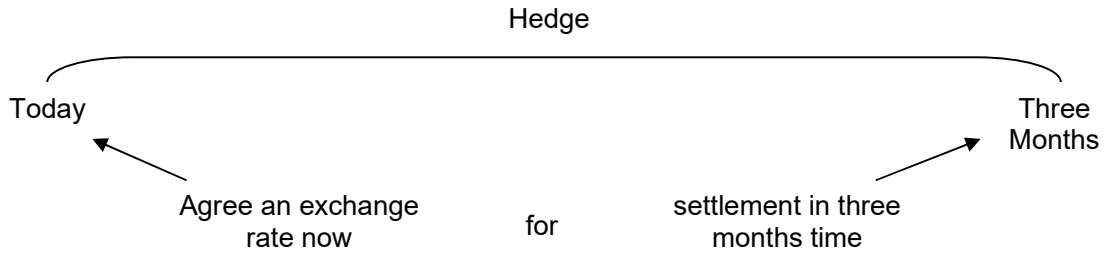
2. FORWARDS

2.1 Features of a Forward Product

- Two parties agree to buy and sell an asset at an agreed price, at an agreed time in the future
- Unlike futures, forward contracts are traded OTC and terms are customised, not standardized

2.2 Hedging Example

- An importer requires GBP1 million in 3 months' time to pay for the delivery of goods
- To hedge against a fall in value of the Hong Kong Dollar against the GBP, the importer can agree now on a rate that he will pay to buy GBP in 3 months' time
- If the 3-month forward rate is HKD10.5/GBP, a 3-month forward contract will guarantee that the importer will pay HK$10.3 million in 3 months to buy GBP1 million
- Currency forwards are agreements to buy or sell a quantity of currency for delivery at some time in the future, at an exchange rate fixed at the time of the agreement



$$F = S \times \frac{(1 + i_{numerator})}{(1 + i_{denominator})}$$

Interest rates

Forward rate — *Spot rate*

Currency Forward Exchange Rate Example
Calculate the forward exchange rate with the following information:

- *GBP/USD spot rate: 1.35*
- *UK interest rate: 3% pa*
- *US interest rate: 0.75% pa*

Answer

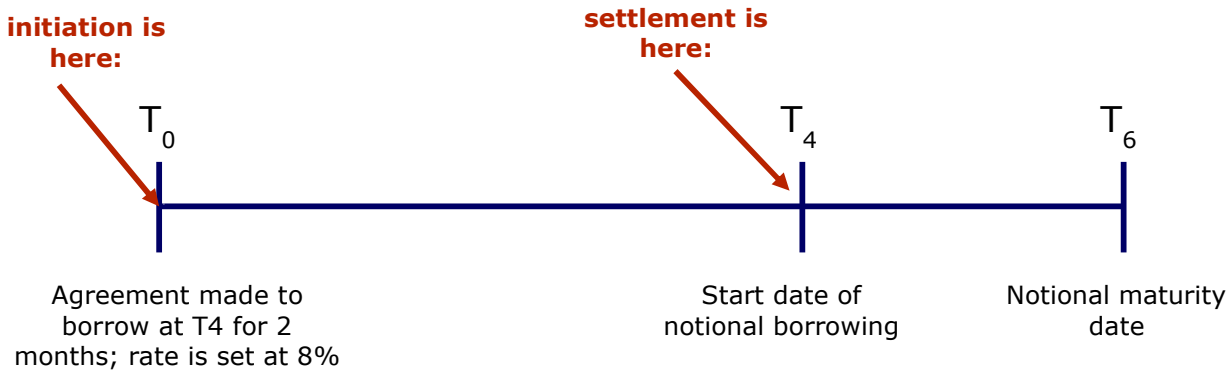
$$F = 1.35 \times \frac{(1 + 0.0075)}{(1 + 0.03)}$$

$$= 1.32$$

2.3 Forward Rate Agreements

- A forward contract to borrow/lend money at a specific rate on a set date in the future
- FRAs settle in cash but no loan is made at the settlement date.
- FRAs are described by the length of the contract and the term of the interest rate in the contract
- If rates rise above the contract rate, the long receives a payment at settlement and the short makes a payment; if the specified rate falls below the contract rate then the short receives from the long
- A borrower entering into an FRA with a bank is the long party (buying an FRA)
- An investor entering into an FRA with a bank is the short party (selling an FRA)

Example: a 4 x 6 FRA at 8% on $1 million notional principal (NP) is an agreement to borrow/lend at 8% in 4 months' time for 2 months.



- The amount paid at expiration is calculated by taking the difference between the agreed interest cost and the interest cost that would have arisen had the loan started at that time in the cash market.
- Note: interest payments are usually at the end of the borrowing period. FRAs settle at the start, and hence discount the payment.

2.3.1 Payment at Expiration of an FRA

$$\text{FRA payoff} = \text{NP} \times \left[\frac{\left(\text{rate}_{\text{expiration}} - \text{rate}_{\text{contract}}\right) \times \left(\frac{\text{Days}}{360}\right)}{1 + \text{rate}_{\text{expiration}} \times \left(\frac{\text{Days}}{360}\right)} \right]$$

- Note: the HKSI Paper 9 study manual uses 365 as the denominator above
- Continuing our example above, after 4 months the interest rate is 9%
- The above calculation can be done in two steps:
  - **Step 1**: **Calculate the difference in interest over 60 days**

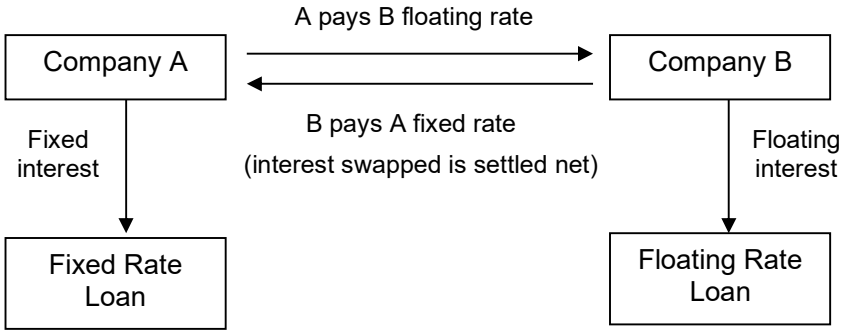
    $1m x (0.09 – 0.08) x 60/365 = $1,643.84
  - **Step 2**: **Discount the payment back 60 days**

    $1,643.84/[1 + (0.09 x(60/365)] = $1,619.88

3. SWAPS

3.1 Features of a Swap

- Two parties agree to exchange (swap) income streams derived from a portfolio of assets or liabilities
- The most popular types are **interest rate swaps** and **currency swaps**, which are traded **OTC** and are **highly customized**
- With interest rate swaps, loan principals are not swapped and net interest is exchanged between parties
- With currency swaps, principals are swapped and gross interest payments are exchanged
- The principles of a fixed for floating interest rate swap are outlined below:



3.2 Hedging Example

- Interest rate swaps can be used by companies to achieve a better rate of borrowing than achieved by borrowing directly
- The price a company pays for floating-rate borrowing is expressed as a margin above the benchmark borrowing rate – in most cases **LIBOR is used for USD**-denominated loans and **HIBOR for HKD**-denominated loans
- The better the credit rating, the lower the margin paid above the benchmark rate

Careful Ltd has borrowed HKD100 million at a floating rate of interest and is concerned that interest rates will rise – it wishes to swap floating interest rate payments for fixed rate payments

The loan is for 2 years with interest payable quarterly at 0% above the benchmark – the benchmark is 3.62%. The company would have had to pay 0.1% above the fixed rate benchmark

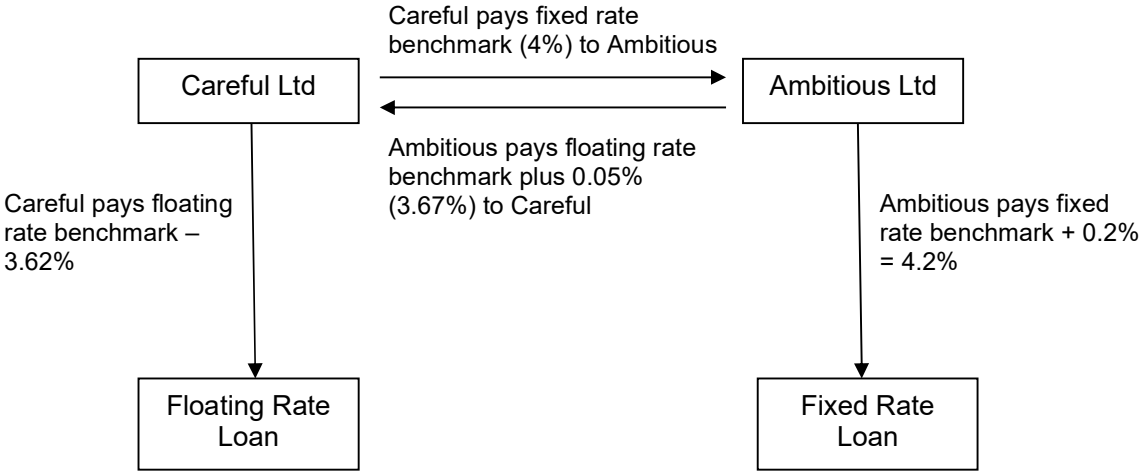
Ambitious Ltd has borrowed HKD100 million at a fixed rate of interest, as borrowing at a floating rate was not feasible, given its credit rating – it wishes to enter into a swap agreement to achieve a lower cost of borrowing at a floating rate

The loan is for 2 years with interest payable quarterly at 0.2% above the benchmark – the benchmark is 4%. The company would have had to pay 0.4% above the floating rate benchmark

Situation before entering into swap

Company	**Floating Rate – benchmark at 3.62%**	**Fixed rate – benchmark at 4%**
Careful Ltd	Pays benchmark at 3.62%	Would have to pay 0.1% above benchmark at 4.1%
Ambitious Ltd	Would have to pay 0.4% above benchmark at 4.02%	Pays benchmark at 3.62% plus 0.2% at 4.2%

Swap Arrangement



Careful Ltd	**Ambitious Ltd**
Floating Rate Receives 3.67% x $100m = $3.67m Pays 3.62% x $100m = $3.62m Gains 0.05% x $100m = $50,000	**Fixed Rate** Receives 4% x $100m = $4m Pays 4.2% x $100m = $4.2m Loses 2% x $100m = $200,000m
Fixed Rate Pays 4% x $100m = $4m	**Floating Rate** Pays 3.67% x $100m = $3.67m
Net fixed payment under swap: $3.95m	Net floating payment under swap: $3.87m
Fixed payment without swap: 4.1% x $100m = $4.1m	Floating payment without swap: 4.02% x $100m = $4.02m
Saving of $150,000	Saving of $150,000

3.3 Credit Default Swap

- The credit default swap (CDS) is the most popular type of credit derivatives
- The notional amount of CDS increased from USD6.4 trillion in 2004 to USD57.9 trillion 2007 and then fell to USD41.9 trillion by the end of 2008
- The buyer of a CDS receives credit protection by making a series of payments (like insurance premiums) to the seller in return for the right to receive a payment if a credit instrument (eg a bond) defaults (like an insurance claim)
- The buyer does not have to own the underlying credit instrument
- The CDS market was originally over-the-counter (OTC) and not regulated, however efforts are now being made to regulate it

4. OPTIONS

As seen in Topic 1:

- A **call option** is the right to buy an underlying asset at a specified price (strike price) on or before a specified date (expiry date)
- A **put option** is the right to sell an underlying asset at a specified price (strike price) on or before a specified date (expiry date)
- Taking up the right is known as **exercising the option**
- The seller (writer) of an option has an **obligation** to sell/buy when the option is exercised by the buyer (holder)
- Unlike futures and forwards, the buyer of an option has **no obligation** to sell or buy the underlying asset, but will exercise if it is profitable to do so
- The price paid to purchase an option is known as the **option premium** and is paid to the option seller
- Examples of **exchange-traded options** are: options on shares; options on indices; and options on futures
- Examples **of OTC options** are: interest rate options; currency options; and exotic options
- A **swaption** is an option to enter into a swap agreement
- **American style options** can be exercised up to and on the expiry date
- **European style options** can only be exercised on the expiry date
- Important contract specifications for the HSI option contract are:

Underlying index	HSI
Contract multiplier	HKD50 per index point
Contract value	Option premium x contract multiplier
Exercise style	European
Settlement on exercise	Cash settlement

4.1 Features of an Option

- Features to be considered:
  - Exercise style
  - Moneyness
  - Cash or physical delivery
  - Valuing options

4.1.1 Exercise Style

- **American style options** can be exercised up to and on the expiry date
- **European style options** can only be exercised on the expiry date
- The value of an American style option **should not be less than** the value of the equivalent European style option
- On the SEHK, **HSI options** are European style and **stock options** are American style

4.1.2 Moneyness

- Depending upon the strike (exercise) price of an option and the current market price of the underlying asset, an option will be:
  - In-the-money
  - At-the-money; or
  - Out-of-the-money

	Call option	Put option
In-the-money	Strike < market	Market < strike
At-the-money	Strike = market	Strike = market
Out-of-the-money	Market < strike	Strike < market

4.1.3 Cash or Physical Delivery

- **On a cash basis**, the party exercising the option receives a cash payment from the option seller – HSI options are cash settled
- **With physical delivery**, the underlying asset is delivered in the event of an option being exercised
- Hong Kong stock options are settled on a physical delivery basis with the exercise date counted as the trade date

4.1.4 Option Premiums

- **Value of an option = intrinsic value + time value**

Value of a Call Option: Example
A call option on the shares of Examinator Online has a strike price of HK$25. If the call option is priced at HK$7.50 per option, what is the intrinsic and time values of the option if the spot price of Examinator Online is:

- *HK$28 per share*
- *HK$22 per share*

Answer
HK$28 per share
Option value = intrinsic value + time value

HK$7.50 = HK$3 + time value

Time value = HK$4.50

HK$22 per share
Option value = intrinsic value + time value

HK$7.50 = HK$0 + time value

Time value = HK$7.50

Value of a Put Option: Example
A put option on the shares of Examinator Online has a strike price of HK$88. If the put option is priced at HK$28.50 per option, what is the intrinsic and time values of the option if the spot price of Examinator Online is:

- *HK$68 per share*
- *HK$100 per share*

Answer
HK$68 per share
Option value = intrinsic value + time value

HK$28.50 = HK$20 + HK$8.50

Time value = HK$8.50

HK$100 per share
Option value = intrinsic value + time value

HK$28.50 = HK$0 + time value

Time value = HK$28.50

- **Factors that affect the time value of an option premium** are:

1. Time to Expiry

- With **American-style options** (as with all SEHK traded stock options), the longer the time to expiration, the higher the value of the option (both call and put)
- With **European-style options** that have long times to expiration, the effect of the time to maturity is less certain than with American-style options

2. Market Volatility

- As the volatility of a stock price increases:
  - The probability of a call option increasing in value is higher
  - The probability of a put option increasing in value is higher
- So, **as the price volatility of an underlying security increases, so does the value of both call and put options**

3. Interest Rate

- Instead of buying a security now, an investor can choose to buy a call option and then exercise, thereby buying the stock. In the interim, funds to buy the stock can be put on deposit, earning interest. The higher the interest rate, the more popular this strategy and the higher the call option price
- So, **call options increase in price when interest rates rise**
- Instead of selling a security now, an investor can choose to buy a put option and then exercise, thereby selling the stock. In the interim, funds required now would need to be borrowed, incurring interest. The higher the interest rate, the less popular this strategy and the lower the put option price
- So, **put options fall in price when interest rates rise**

4. Dividends

- When a dividend is paid, the stock price will fall
- Accordingly, a dividend payment will lower the value of a stock's call option and increase the value of a stock's put option

5. Current Price vs Exercise Price

- The closer an option is to being in-the-money, the higher the time value
- An option that is 100 points out-of-the-money will be worth less than an option that is 10 points out-of-the-money

4.2 Option Markets

4.2.1 Exchange-traded Options (ETOs)

- ETOs have **standardised contract specifications** detailing product features such as expiry dates, exercise prices, quantity of underlying asset and option type
- In Hong Kong, there are six main ETO products:
  - Stock options
  - HIS options
  - Mini-HIS options
  - Hang Seng China Enterprises Index (HSCEI) options
  - Mini-HSCEI options
  - USD/CNH options

  These products are covered in more detail in Topics 3 and 5

4.2.2 Over-the-Counter Options

- Similar to ETOs, except:
  - Strike price, expiry date and quantity and quality of underlying asset are usually tailored to investor needs
  - Pay-off characteristics can be tailored to the investor's needs
- Options with both tailored aspects are known as **exotic options**, including the following seven instruments:

1. Binary Options

- A bet on the movement and/or direction of prices
- A binary option could be based on the HKD strengthening to 10 against the UK Pound – If the HKD strengthens to 10, the option seller must pay out to the buyer an agreed amount (eg 10 or 20 times the premium)

2. Barrier Options

- Options that come into effect (or cease to be in effect) when prices move through a predetermined level, known as a "knock out" feature
- For example, a French importer wants protection from a fall in the value of the Euro, however is comfortable with the Euro anywhere between 1.2 to 1.3 to the USD. As the importer cannot tolerate the Euro weakening beyond 1.1, a barrier option can be used to provide coverage for the importer, if the Euro falls below 1.1
  - There are numerous varieties of barrier options
  - As they provide limited cover, they cost less than a vanilla option

3. **Compound Options**
    - An option on an option
    - For example, a call on a put, where the buyer purchases the right to buy a put option

4. **Lookback Options**
    - An option that gives the buyer the right to buy or sell an asset at the most advantageous price achieved during an elapsed period of time

5. **Chooser Options**
    - An option that gives the buyer the right to choose, at a later date, whether the option will be a put or call option
    - Complex chooser options also allow the buyer to choose the expiry date and strike price

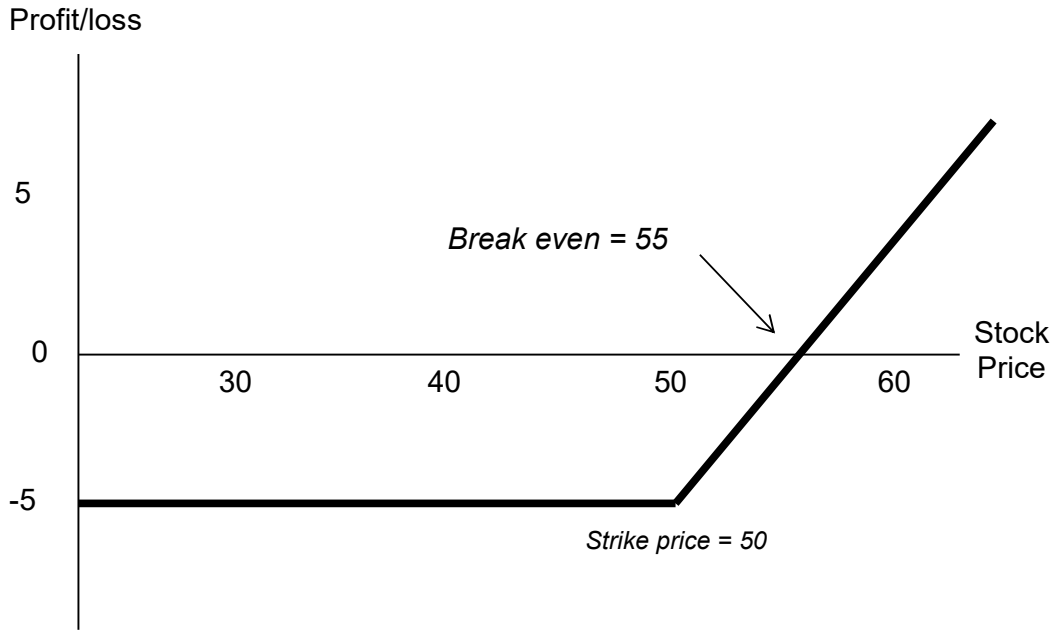
6. **Average-Rate (or Asian) Options**
    - An option that does not have a set strike price – instead, the buyer can exercise the option based on a price that is determined by taking the average of prices over a specified period of time

7. **Rainbow Options**
    - An option that has more than one underlying asset
    - Rainbow options can pay out according to the best, or worst, performing of the underlying assets
    - Spread options are a subset of rainbow options where the payout depends upon the difference in the performance of two or more assets

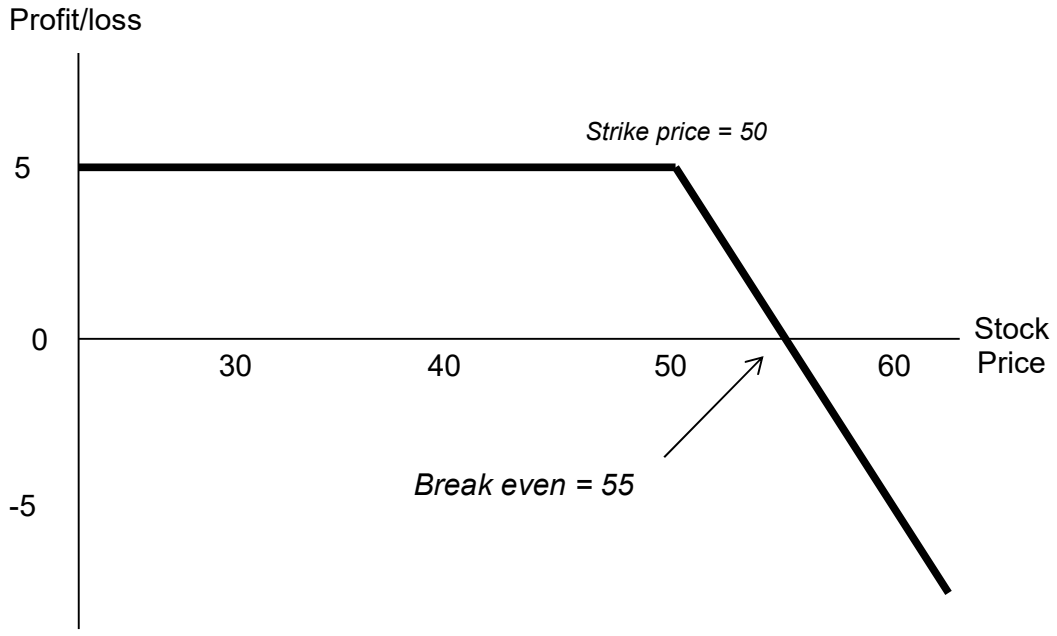
4.3 Pay-off Diagram

- Shows the potential profit or loss depending upon the movement of the price of the underlying stock
- In all **four diagrams that follow**, the option premium is HK$5 and the strike price is HK$50

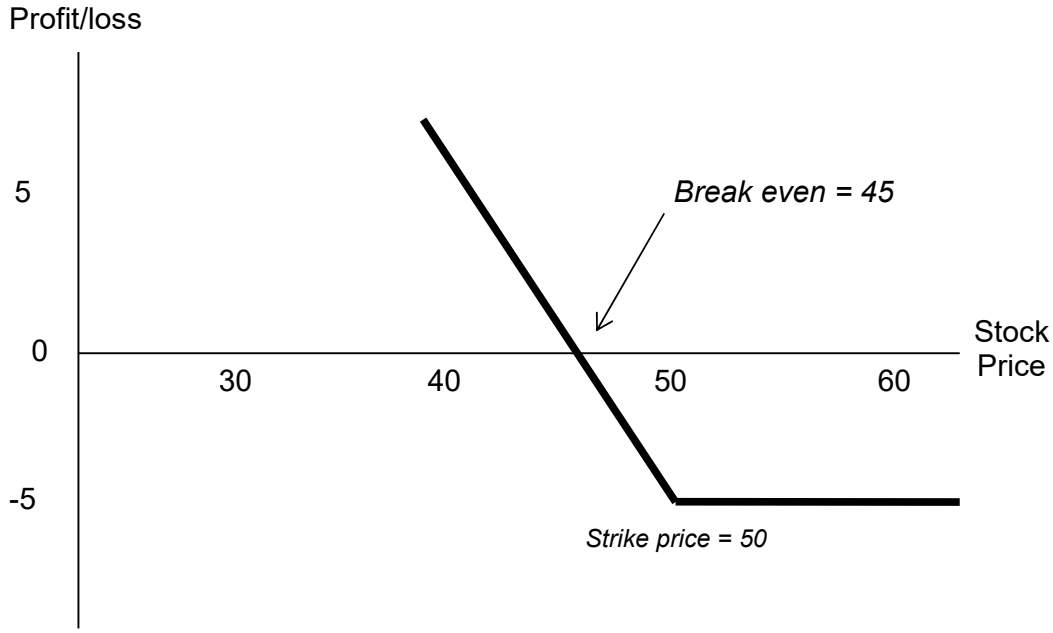
Long Call



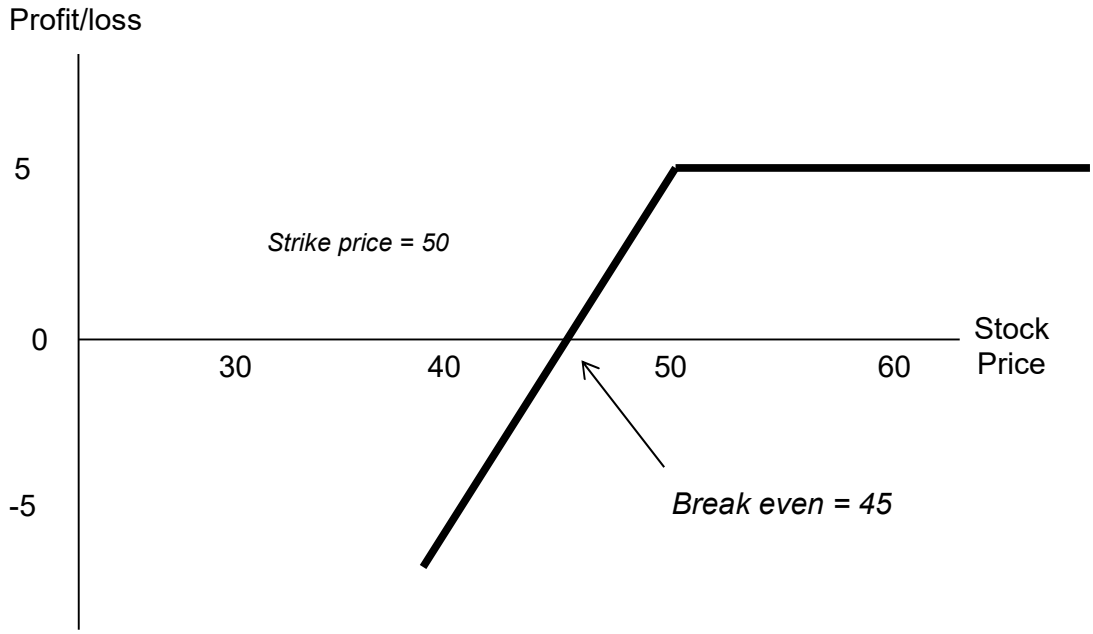
Short Call



Long Put



Short Put



4.4 Hedging Example

- **Details for this hedging example**:
  - In April 20X1, a fund manager holds a broad portfolio of Hong Kong stocks, weighted to match the performance of the HSI
  - The portfolio is currently valued at HK$800 million
  - The fund manager fears a fall in the value of Hong Kong stocks over the next 3 months and wishes to hedge against a fall in the HSI, which is currently at 25,600
  - The fund manager is not permitted to sell options for hedging

- **Call or put?**
  - The fund manager will want to profit if the HSI falls. Therefore, he needs to purchase the right to sell, so he will buy puts

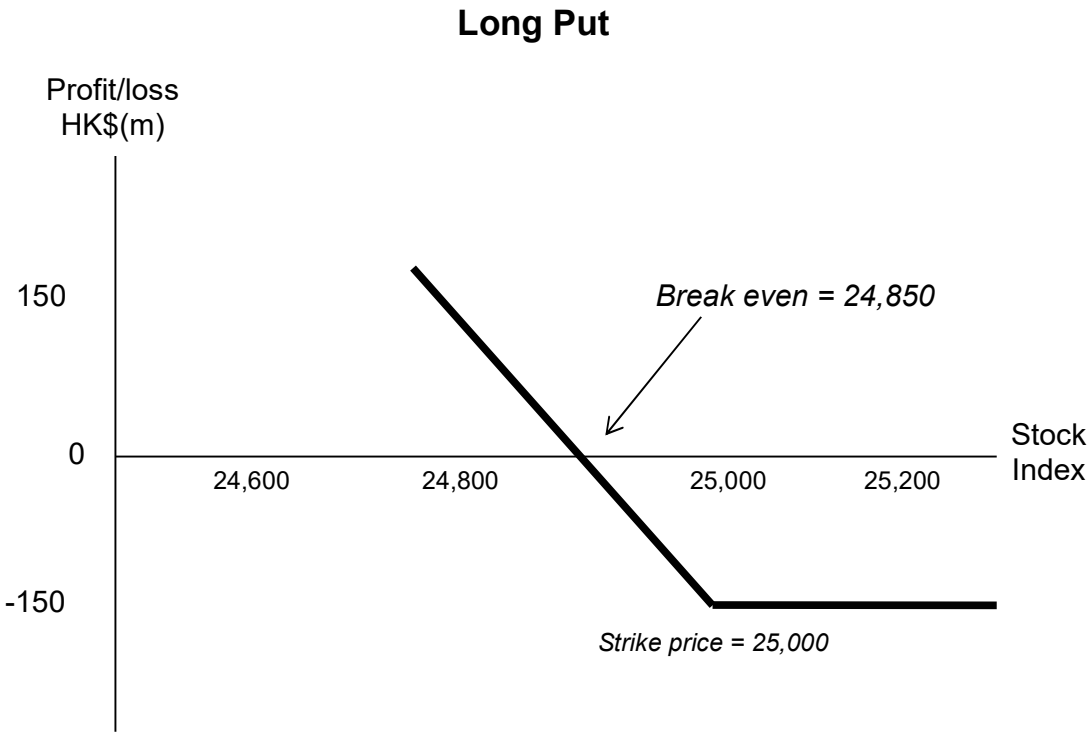
- **Which month?**
  - Available contracts are: April, May, June, September and December
  - Given the fund manager's concerns over the next 3 months, the most appropriate month is June

- **What strike price?**
  - The choices are the HSI at levels between 16,000 and 30,000, at 200-point intervals
  - The fund manager can only tolerate a small decline in the portfolio's value
  - With the index at 25,600, the fund manager decides on a 25,000 strike price

- **How many options**
  - Divide the value of the portfolio by the value of the HSI options contract
  - Value of each options contract: 25,000 x HK$50 = HK$1,250,000
  - Therefore, number of contracts needed:
    HK$800m/HK$1,250,000 = 640

- **How much premium is payable?**
  - Assuming the June 20X1 puts, with 25,000 strike price, are traded at a premium of 150, the total premium payable is:
    150 x HKD50 x 640 = HK$4.8m

- The **pay-off diagram for the June 20X1 put** at 25,000 is as follows:



- **Results of the Hedge**
  - We are at the day before the date of expiry of the April 20X1 options
  - The HSI has fallen to 22,400, which means the fund manager's portfolio is now worth HK$700m (22,400/25,600 x HK$800m); a loss of HK$100m
  - The option now trades at a premium of 2,600 (25,000 – 22,400). With one day to go, there will be little time value remaining
  - The options are sold for 2,600 resulting in a cash settlement of HK$83.2m (2,600 x HK$50 x 640)
  - Profit on the options trade = cash settlement – premium costs
    = HK$83,200,000 - HK$4,800,000
    = HK$78,400,000
  - Although the loss on the portfolio is largely covered by the profit on the options trade, there is still an overall loss of HK$21,600,000 (100m – 78.4m)
  - The loss represents the downside insurance that the fund manager is willing to pay for his view on the market direction
  - If the HSI had risen, instead of falling, the option would have expired worthless and the fund manager would have incurred to premium cost of HK$4.8m. This would have been offset by gains in the portfolio value

4.5 Option Trading Strategies

- Following on from the hedging strategy in 4.4, it should be noted that the fund manager could have made an overall profit by also selling options to generate income. As well as purchasing puts, he could have sold calls
- By selling calls and buying puts at the same strike price, a fund manager is effectively shorting the HIS. If prices fall, a profit is made and, if prices rise, a loss is made

4.5.1 Put-call Parity

- This is a fundamental concept in understanding options and their ability to create synthetic positions
- Put-call parity is based on the assumption that the put and the call options expire at the same time and have the same strike price
- Long put + short call = synthetic short underlying
- Long call + short put = synthetic long underlying

4.5.2 Futures and Options Combined Strategies

- We can combine futures and options on futures to create various futures and options positions
- Benefits of **creating a synthetic long/short futures position** using options on futures:
  - Traders can be more flexible in the execution of their trading strategies – synthetic long or short futures positions can be created by buying and selling options on futures
  - Traders can explore whether there is any mispricing between futures and the options on futures – an arbitrage profit can be made by buying and selling the futures and and options on futures simultaneously

Transaction 1	+	Transaction 2	=	Synthetic Instrument
Long ATM call	+	Short ATM put	=	Long synthetic futures
Short ATM call	+	Long ATM put	=	Short synthetic futures
Long put	+	Long futures	=	Long synthetic call
Short put	+	Short futures	=	Short synthetic call
Long call	+	Short futures	=	Long synthetic put
Short call	+	Long futures	=	Short synthetic put

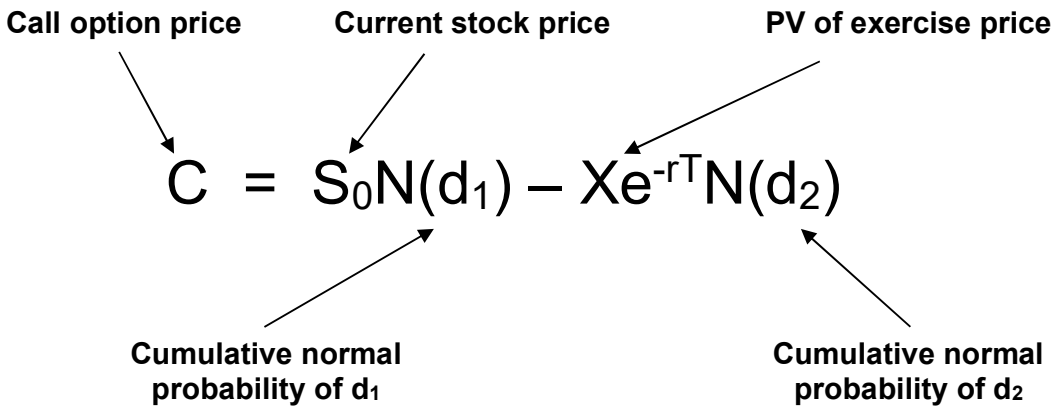
- Benefits of **creating a synthetic long/short position of call or put options** using options on futures and futures contracts:
  - Traders can be more flexible in the execution of their trading strategies
  - Traders can explore if there is any mispricing

4.6 Option Pricing Models

- Two popular option pricing models:
  - **Black-Scholes-Merton (BSM) Model** for calculating price of European options
  - **Binomial Model** for calculating price of American options

4.6.1 Black-Scholes-Merton Model

- The BSM model was first published in the early 1970s and has been one of the most significant developments in the pricing of financial instruments
- The option price is affected by five variables in the BSM model:
  - Price of the underlying asset (stock price)
  - Time to expiry
  - Exercise price
  - Annualised volatility of underlying asset
  - Risk-free rate of interest



Where:

$d_1 = [\ln(S_0/X) + (r + \sigma^2/2)T]/(\sigma T^{-2})$

$d_2 = d_1 - \sigma T^{-2}$

T = time to expiry

σ = annualised volatility of underlying asset

r = risk-free interest rate

4.6.2 Effect of Variables in the BSM Model

- There are 5 variables that affect the price of an option (option premium):
  1. Effect of stock price
  2. Effect of time to expiry
  3. Exercise price
  4. Annualised volatility of underlying asset
  5. Interest rate

1. Effect of Spot Price

- The higher the spot price, the more in-the-money a call option will be, assuming the spot price is above the strike price
- The lower the spot price, the more in-the-money a put option will be, assuming the spot price is below the strike price
- Although dividend payment is not a variable in the BSM model, it will affect the stock price as the dividend payment will cause a drop in the stock price

2. Effect of Time to Expiry

- With **American-style options** (as with all SEHK traded stock options), the longer the time to expiration, the higher the value of the option (both call and put)
- With **European-style options** that have long times to expiration, the effect of the time to maturity is less certain than with American-style options

3. Exercise Price

- The higher the exercise price, the less in-the-money a call option will be, assuming the spot price is above the exercise price
- The lower the exercise price, the less in-the-money a put option will be, assuming the spot price is below the exercise price

4. Annualised Volatility of Underlying Asset

- As the volatility of a stock price increases:
  - The probability of a call option increasing in value is higher
  - The probability of a put option increasing in value is higher
- So, **as the price volatility of an underlying security increases, so does the value of both call and put options**
- Volatility is the most critical variable in the BSM model as the option price is very sensitive to changes in volatility – it is the only unobservable variable
- There are two measures of volatility:
  - ***Historical volatility***: observed over a recent period and measured by standard deviation
  - Implied volatility: using the BSM model with current option price

5. Interest Rate

- Instead of buying a security now, an investor can choose to buy a call option and then exercise, thereby buying the stock. In the interim, funds to buy the stock can be put on deposit, earning interest. The higher the interest rate, the more popular this strategy and the higher the call option price
- So, **call options increase in price when interest rates rise**
- Instead of selling a security now, an investor can choose to buy a put option and then exercise, thereby selling the stock. In the interim, funds required now would need to be borrowed, incurring interest. The higher the interest rate, the less popular this strategy and the lower the put option price
- So, **put options fall in price when interest rates rise**
- In reality, there needs to be a large change in the interest rate to cause a significant change in the option price

4.6.3 Risk Measurement for Options

- To describe the sensitivity of the option price relative to certain variables, the names of Greek letters are used, known as "the Greeks"

Delta (Δ)

- The delta of an option measures the **sensitivity of the option price to changes in the price of the underlying stock**

$$\Delta = \frac{\text{Dollar change in option price}}{\text{Dollar change in underlying stock price}}$$

- The delta value of a long call/short put is always between 0 and 1
- The delta value of a long put/short call is always between -1 and 0

Option	Delta Value		
	In-the-money	At-the-money	Out-of-the-money
Long call/short put	Up to 1	0.5	Down to 0
Long put/short call	Down to -1	-0.5	Up to 0

Delta Hedging Example
Charlie buys 1,000 shares of Pumping Limited at $200 per share. Charlie is interested in hedging his downside risk by using a put option. Currently, the put option has a delta of -0.5. If the put option contract has a lot size of 200 shares, how should Charlie hedge his risk?

Answer
Charlie's risk is that of making a loss if the stock price falls.

Using put options, Charlie should buy the options to hedge against downside risk. How many put option contracts should he buy?

$$\text{No. of put options needed} = \frac{\text{Total shares held}}{\text{Delta x option lot size}}$$

$$= \frac{1{,}000}{-0.5 \times 200}$$

$$= -10$$

If the share price drops by $1 to $199, Charlie will lose $1,000 on his investment. However a $1 fall in the share price will result in a $0.50 rise in the put option price (-$1 x- 0.5).

Therefore, Charlie will make the following gain on his put position:

$0.50 x 200 x 10 options = $1,000

The loss on shares is covered by the gain on put option contracts

Gamma (Γ)

- Gamma measures the rate of change in the option delta:

$$\Gamma = \frac{\text{Change in delta}}{\text{Dollar change in underlying stock price}}$$

- Gamma represents the **sensitivity of delta to underlying stock price changes**
- If gamma is low, delta changes slowly and little adjustment is required to keep the delta of a portfolio at the required level
- If gamma is large, delta is very sensitive to changes in the underlying stock price and frequent changes will be required to maintain a portfolio delta

Vega (v)

- Vega measures the change in option price for a 1% **change in volatility of the underlying stock price**

$$\mathbf{v} = \frac{\text{Dollar change in option price}}{\text{1\% change in volatility of underlying stock price}}$$

Theta (θ)

- Theta measures the effect of the **passage of time** on the option price

$$\boldsymbol{\theta} = \frac{\text{Dollar change in option price}}{\text{Decrease in time to expiration}}$$

- Theta is always negative, as option values always decrease as time passes

Rho (ρ)

- The Rho of an option measures the rate of change in the value of an option with respect to **changes in the risk-free interest rate**

4.6.4 The Binomial Option Pricing Model

- Proposed in the late 1970s, it is more of a computational procedure than a formula
- Its major advantage is its ability to handle American style options
- Inputs to the binomial model are similar to the BSM model:
  - Price of underlying asset (stock price)
  - Exercise price
  - Risk-free rate
  - Up-factor, down-factor
  - Number of binomial periods

  } Reflects price volatility

- Most useful in valuing options that are complex in structure

5. OPTION TRADING STRATEGIES

- There are many option trading strategies, however this material will focus on three:
  1. Straddles
  2. Strangles
  3. Spreads

- To explain the different strategies, HSI options are used with the following details:

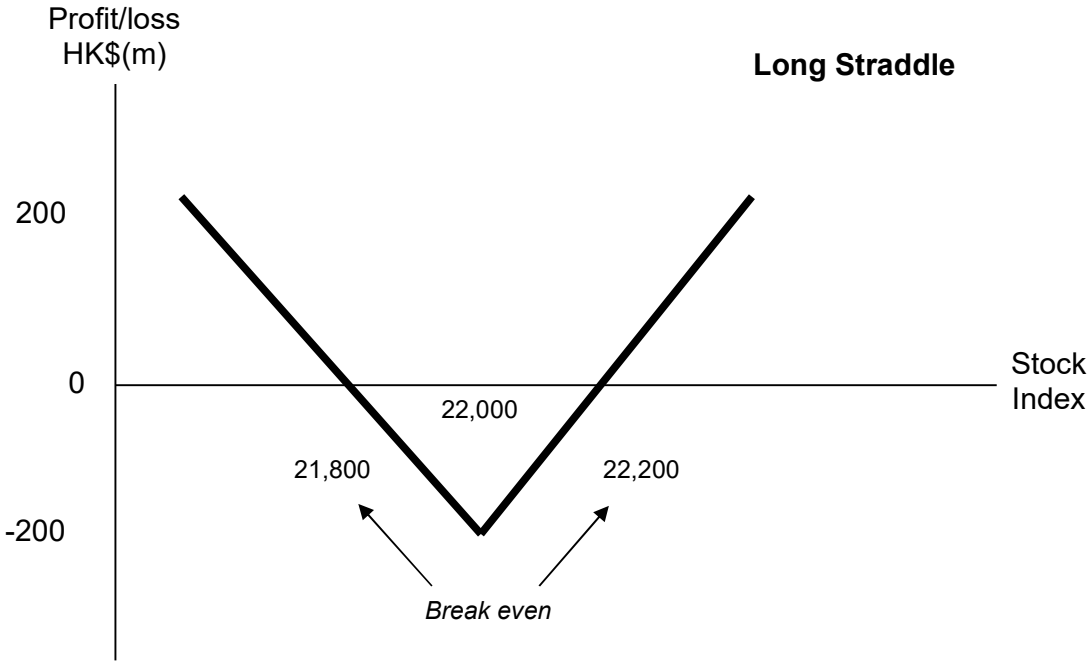
HSI strike prices	**22,000**	**22,400**
Calls	150	30
Puts	50	330

The current HSI level is 22,100

5.1 Straddles

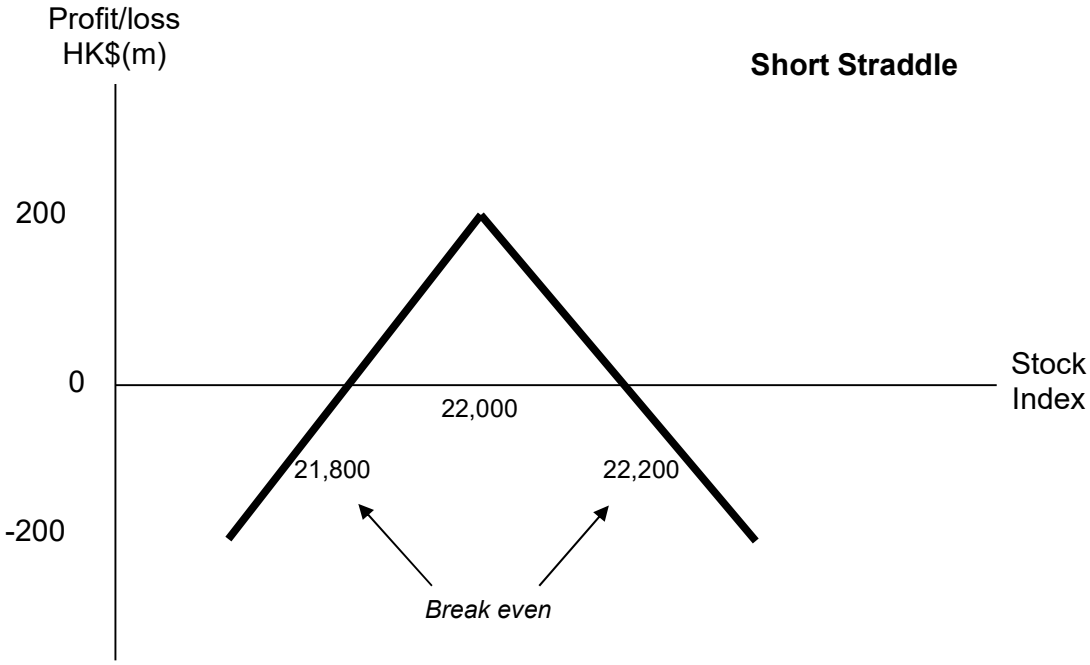
<u>Long Straddle</u> – buy call and put at same strike

- **Expectation**: HSI will move out of its current range of around the 22,100 level
- **Strategy**:
  - Buy the 22,000 call for 150 points
  - Buy the 22,000 put for 50 points
  - Cost of straddle (premiums): 150 + 50 = 200 points
  - Breakeven at 21,800 and 22,200 (22,000 +/- 200)



Short Straddle – sell call and put at same strike

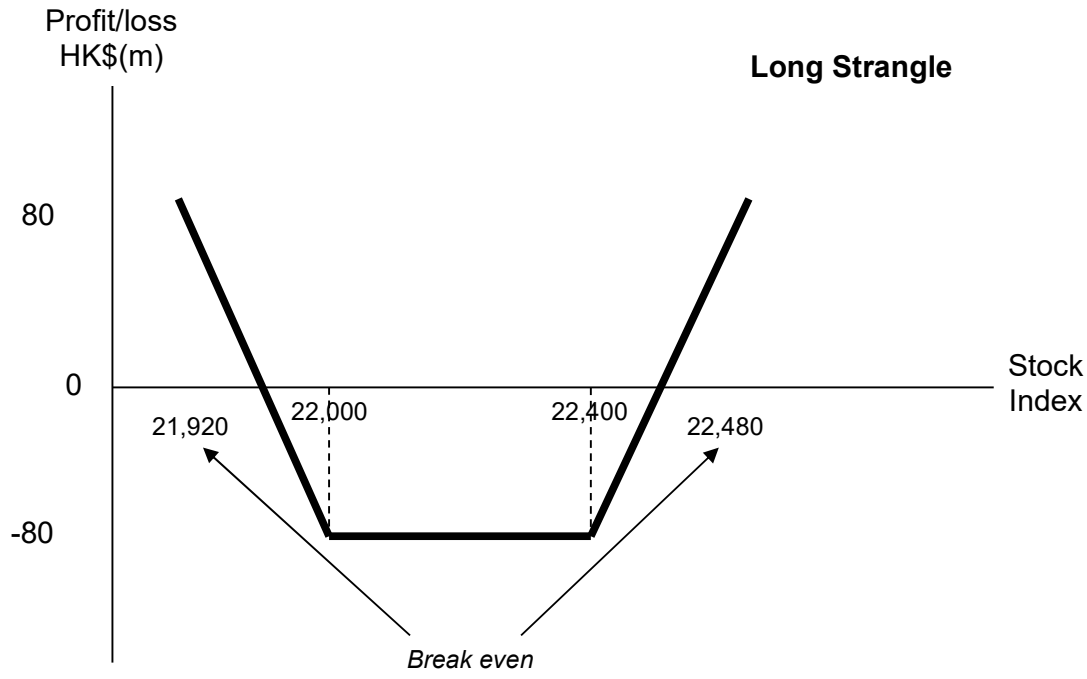
- **Expectation**: HSI will not move out of its current range of around the 22,100 level
- **Strategy**:
  - Sell the 22,000 call for 150 points
  - Sell the 22,000 put for 50 points
  - Premiums received: 150 + 50 = 200 points
  - Breakeven at 21,800 and 22,200 (22,000 +/- 200)



5.2 Strangles

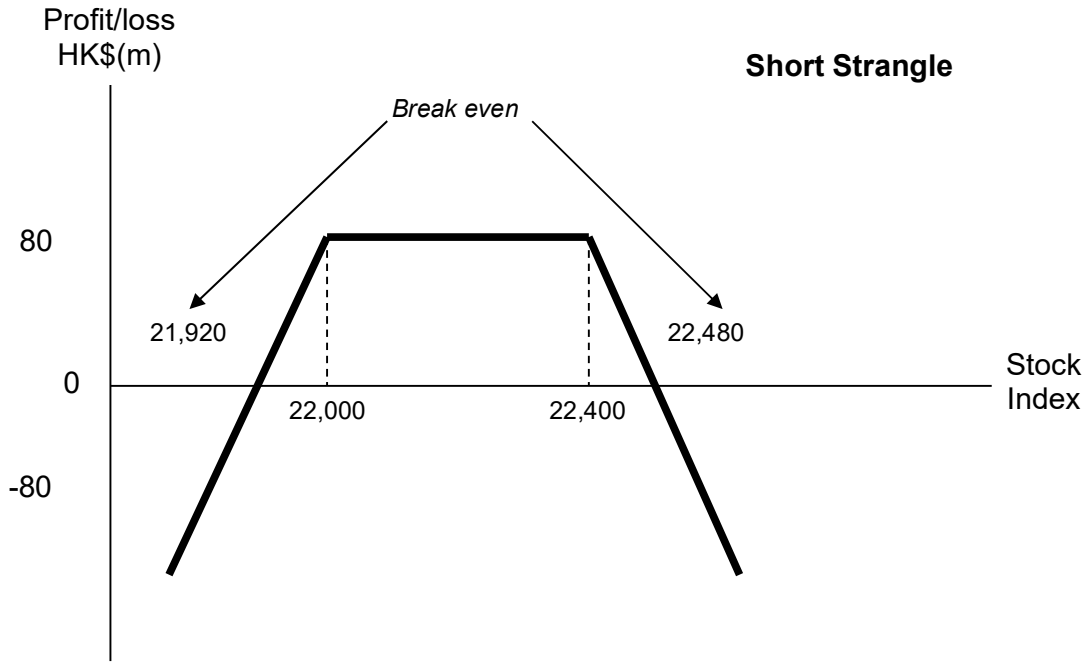
Long Strangle – buy call and put at different strike prices

- **Expectation**: HSI will move out of its current range of around the 22,100 level, but you want to reduce the option premium paid (or received)
- **Strategy**:
  - Buy the 22,400 call for 30 points
  - Buy the 22,000 put for 50 points
  - Cost of strangle (premiums): 30 + 50 = 80 points
  - Breakeven at 21,920 and 22,480 (strikes +/- 80)



Short Strangle – sell call and put at different strike prices

- **Expectation**: HSI will not move out of its current range of around the 22,100 but wider than that of the straddle – less option will be received as a result
- **Strategy**:
  - Sell the 22,400 call for 30 points
  - Sell the 22,000 put for 50 points
  - Premiums received: 30 + 50 = 80 points
  - Breakeven at 21,920 and 22,480 (strike +/- 200)

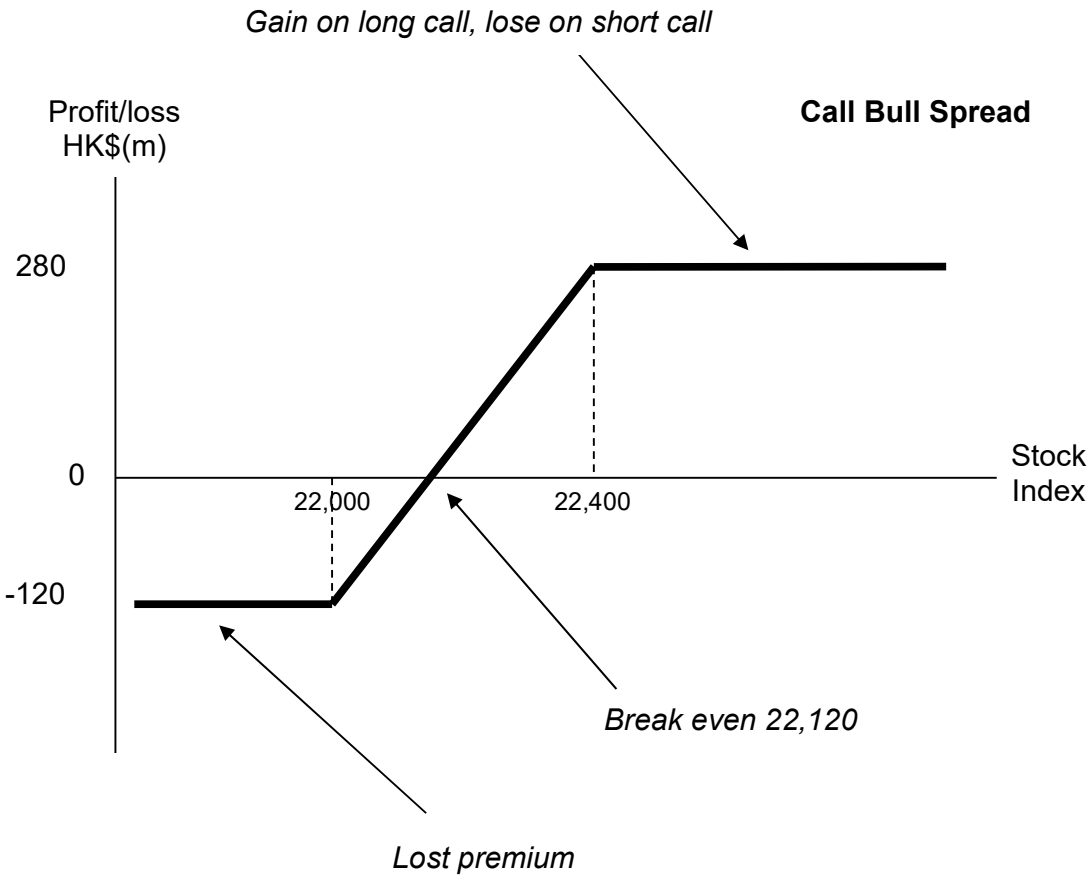


5.3 Spreads

- A spread strategy involves.
  - Having **a view on the direction of the market**
  - Being **happy to cap your profit** in return for a reduced premium
  - Both **buying and selling options**

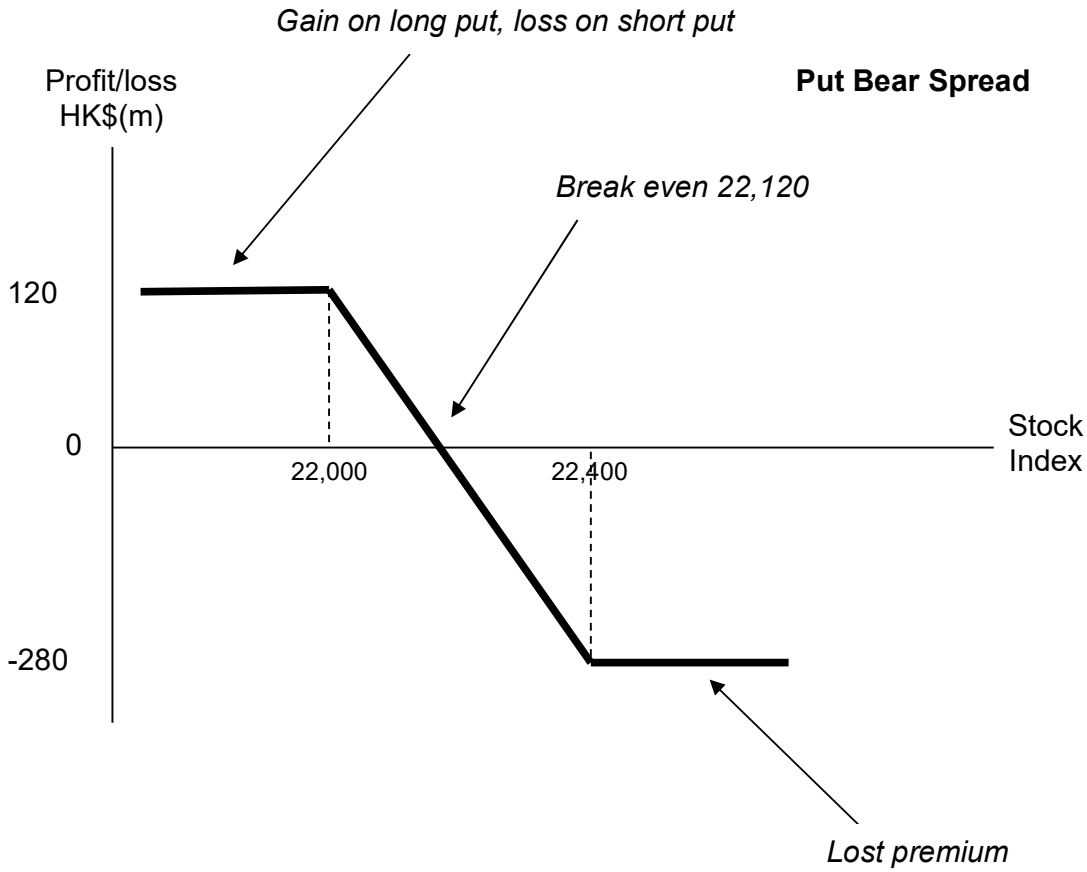
5.3.1 Call Bull Spread

- **Expectation**: HSI will go up rather than down
- **Strategy**:
  - Buy the 22,000 call for 150 points
  - Sell the 22,400 call for 30 points
  - Net cost of spread: 150 - 30 = 120 points
  - Breakeven at 22,120 (22,000 + net cost of spread)



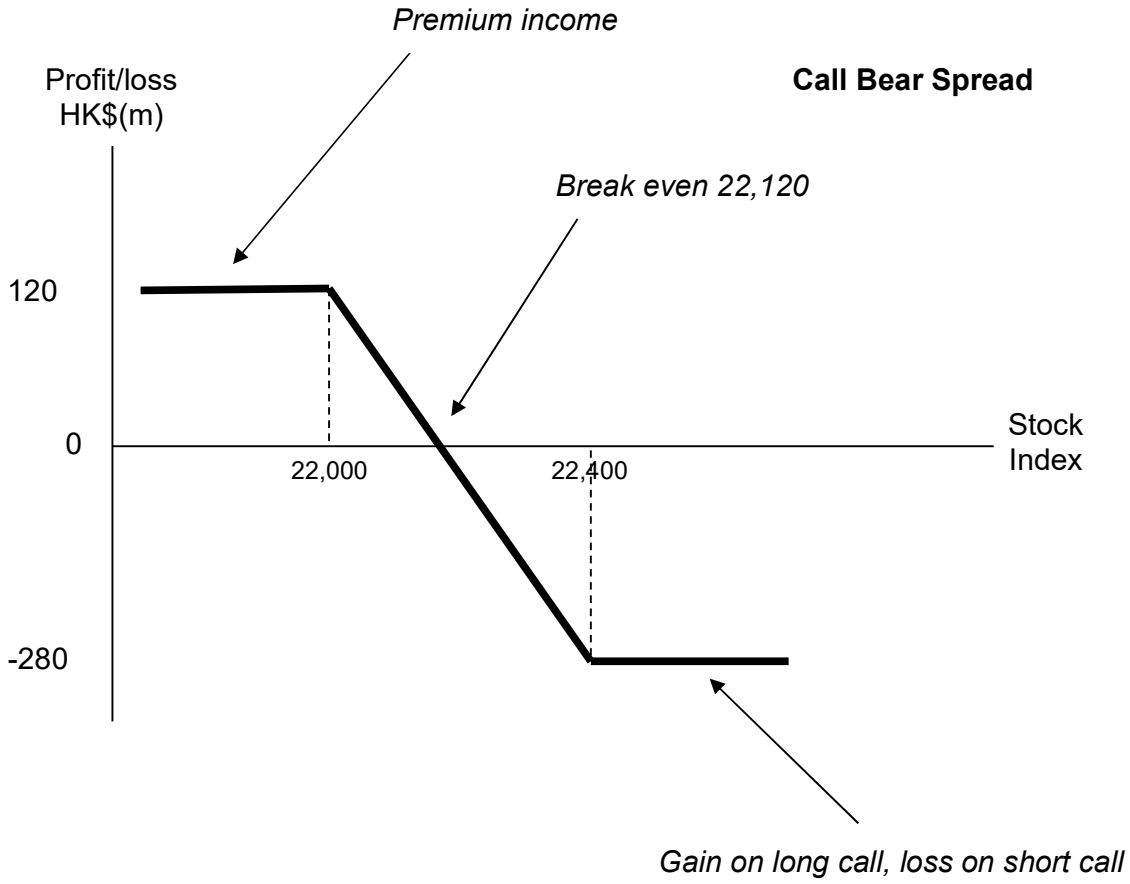
5.3.2 Put Bear Spread

- **Expectation**: HSI will go down rather than up
- **Strategy**:
  - Sell the 22,000 put for 50 points
  - Buy the 22,400 put for 330 points
  - Net cost of spread: 330 - 50 = 280 points
  - Breakeven at 22,420 (22,000 - net cost of spread)



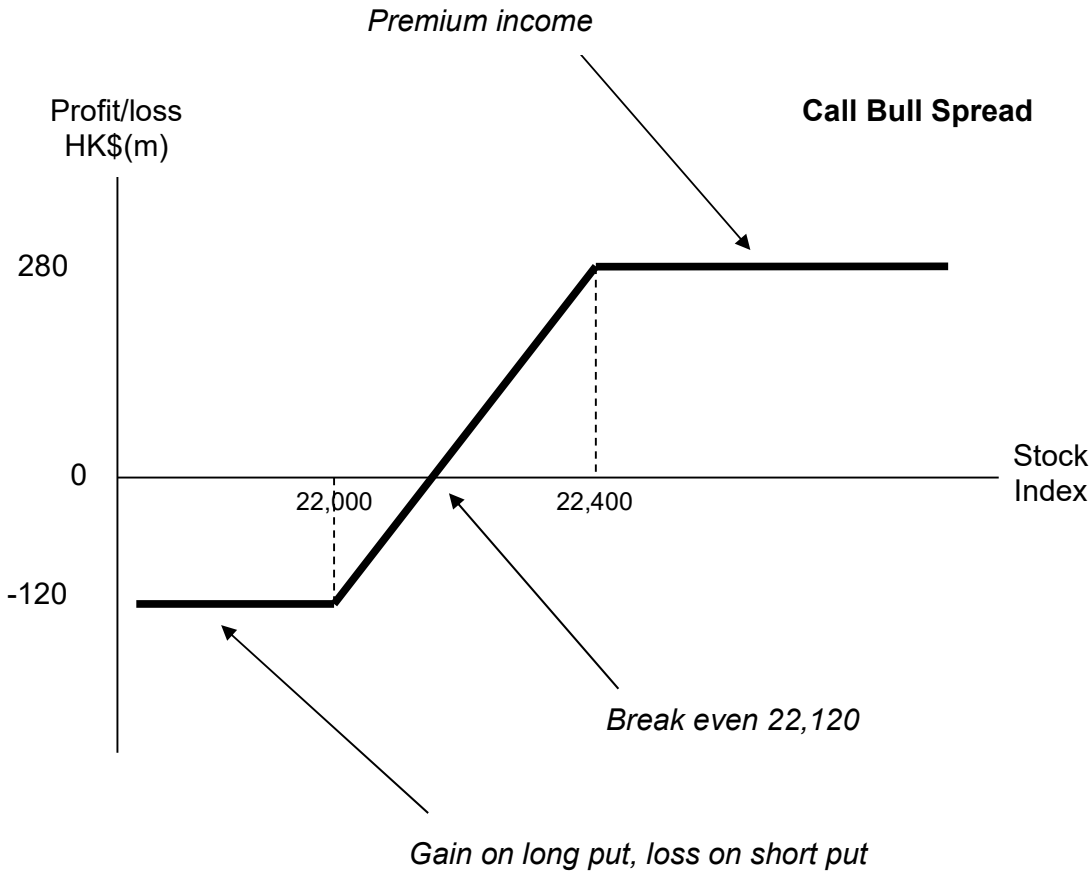
5.3.3 Call Bear Spread

- **Expectation**: HSI will go down rather than up (as with the put bear spread)
- **Strategy**:
  - Sell the 22,000 call for 150 points
  - Buy the 22,400 call for 30 points
  - Net gain of spread: 150 - 30 = 120 points
  - Breakeven at 22,120 (22,000 + net cost of spread)



5.3.4 Put Bull Spread

- **Expectation**: HSI will go up rather than down (as with the call bull spread)
- **Strategy**:
  - Buy the 22,000 put for 50 points
  - Sell the 22,400 put for 330 points
  - Net gain of spread: 280 - 50 = 120 points
  - Breakeven at 22,120 (22,400 - net cost of spread)



5.3.5 Box Spread

- A combination of call bull spread and put bear spread
- Designed as a riskless strategy
- The idea is to capture an arbitrage profit if there is any mispricing between the two pairs of call and put options

5.3.6 Long Butterfly Spread

- For investors who believe that the market will consolidate, with lower volatility for a period of time
- The strategy is to buy calls with an exercise price below the current market price and also calls with an exercise price above the current market price
- You should also sell double the amount of ATM calls with a strike price close to the current market price

5.3.7 Short Butterfly Spread

- For investors who believe that the market will undergo a dramatic change, with significantly higher volatility for a period of time
- The strategy is to sell calls with an exercise price below the current market price and also calls with an exercise price above the current market price
- You should also buy double the amount of ATM calls with a strike price close to the current market price

5.3.8 Calendar Spread

- **Long calendar spread**:
  - An investor expects the volatility of the underlying asset to reduce and the stock price to trade within a narrow range
  - Strategy is to buy options with a longer time to expiration and sell options with a shorter time to expiration at the same strike price
  - The profitability of the calendar spread depends on a decline in volatilities and a time value decay
- **Reverse calendar spread**:
  - An investor expects the stock price to move significantly
  - Strategy is to buy options with a shorter time to expiration and sell options with a longer time to expiration at the same strike price

- **Advantages of spread trading**:
  - Lower cost of trade – the cost of buying an option is offset by the income from selling an option
  - Lower overall risk
  - Lower break-even points
  - Fluctuation in profit/loss of the position is reduced
  - Can be used to trade volatility in underlying asset price
- **Disadvantages of spread trading**:
  - Higher commission cost as more transactions are involved
  - Limited profit potential

5.4 Options with Underlying Assets

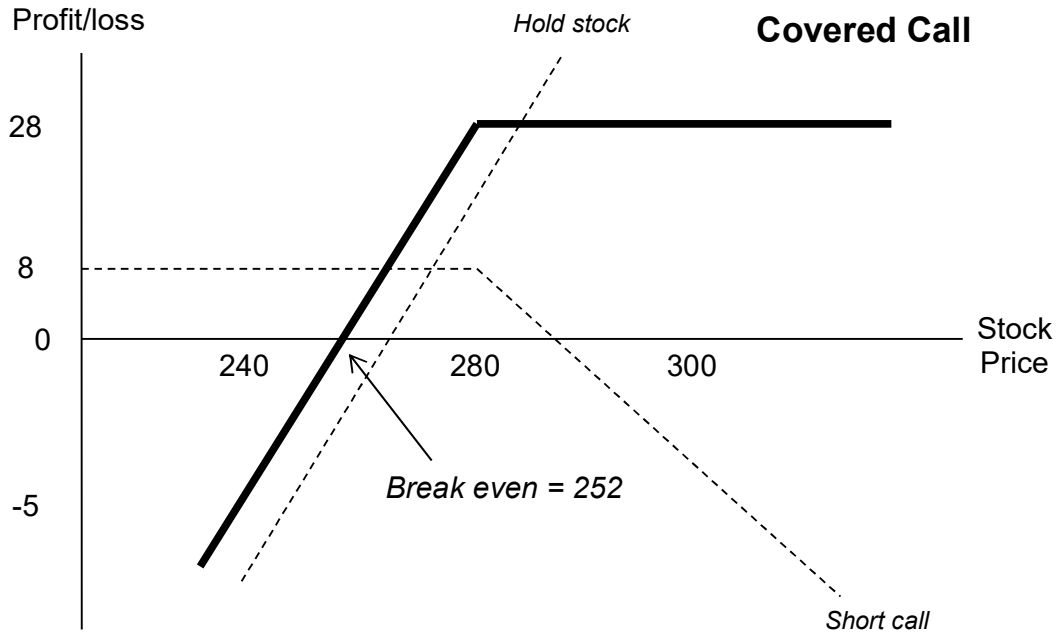
- Fund managers can combine option strategies with holding the underlying assets to modify portfolio payoffs
- We will look at three such strategies:
  - Covered call
  - Protective put
  - Collar

5.4.1 Covered Call

- A strategy used by fund managers to enhance portfolio income by selling call options with the underlying being stock held by the fund manager
- Used when the fund manager expects the price of the stock in question to trade within a narrow range with low price volatility
- The written call option is "covered" as the fund manager can deliver the stock if the option is exercised

Advantages	**Disadvantages**
➢ Income enhancement ➢ A lower break-even price ➢ Any fall in the stock price will be cushioned by the option income	➢ Limited profit potential – the stock will need to be sold if the call option is exercised

Example: A fund manager buys a stock for $260 and sells a call option on that stock, with a strike price of $280, for $8

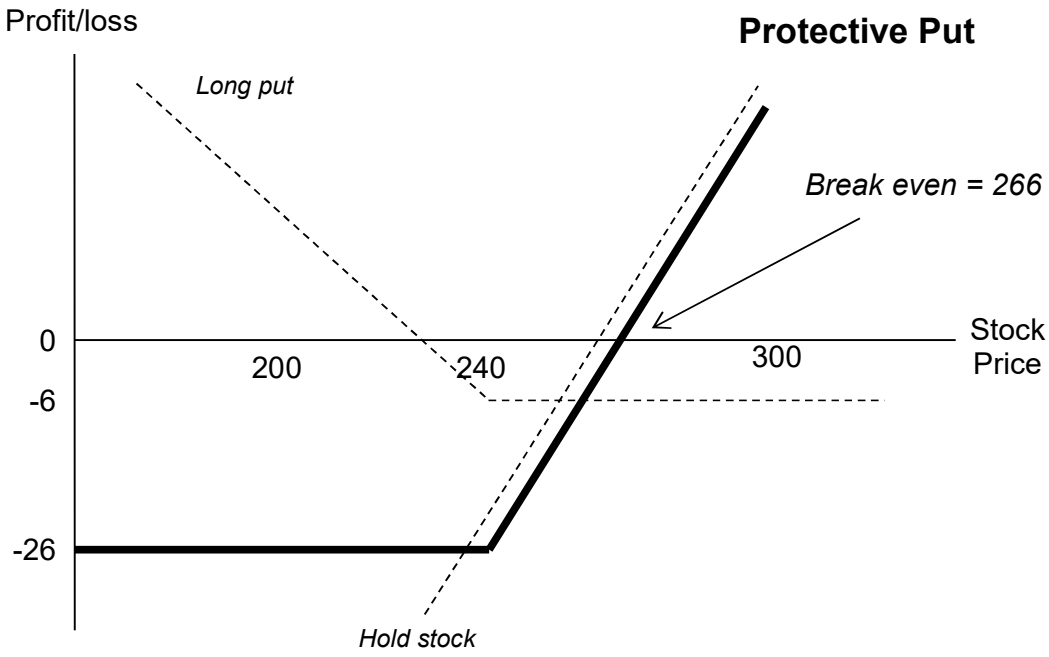


5.4.2 Protective Put

- A strategy used by fund managers to protect portfolios from downward price movements
- If the price of the underlying asset drops significantly, the fund manager can sell the stock at the exercise price

Advantages	Disadvantages
➢ Upside profit potential is retained ➢ If the stock price falls, the fund manager will only suffer a limited loss	➢ An increase in the break-even price

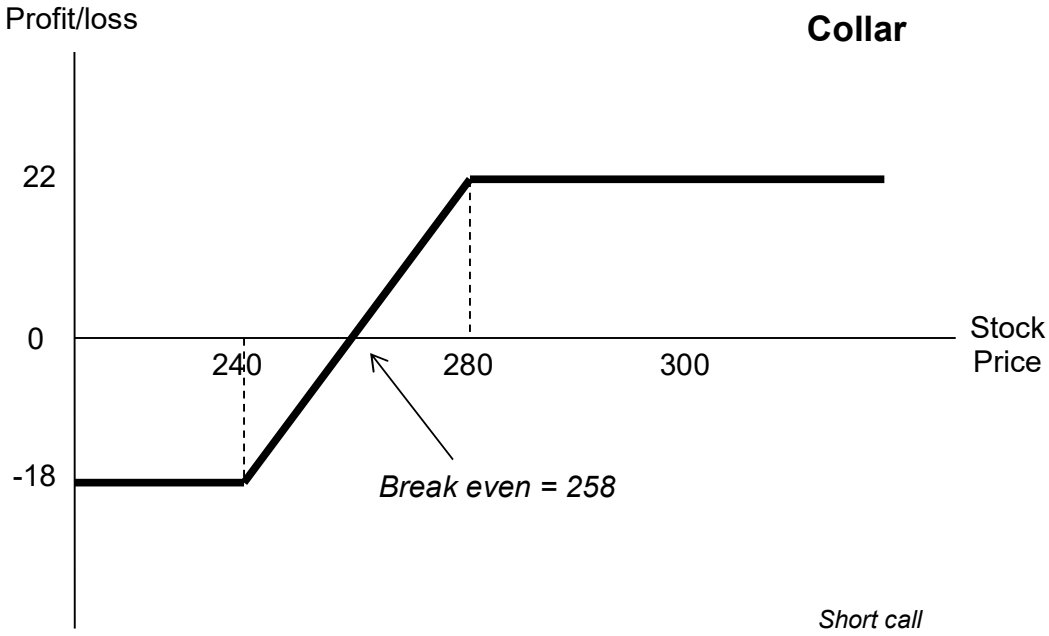
Example: A fund manager buys a stock for $260 and buys a put option on that stock, with a strike price of $240, for $6



5.4.3 Collar

- A strategy used by fund managers to protect portfolios from downward price movements. The cost of buying puts is financed by selling calls
- The put option has a lower exercise price than the current stock price and the call option has a higher exercise price than the current stock price

Example: A fund manager buys a stock for $260, buys a put option on that stock, with a strike price of $240, for $6 and sells a call option, with a strike price of $280 for $8



- The payoff diagram of the collar is similar to that of the call bull spread