

## TOPIC 5 - OVERVIEW

<b>1. CURRENCY DERIVATIVE PRODUCTS</b>	5.3
1.1 Currency Forwards	5.3
1.2 Foreign Exchange Swaps	5.3
1.3 Currency Swaps	5.3
1.4 Currency Options	5.4
1.5 Non-deliverable Forwards	5.4
1.6 Exchange-traded Currency Derivative Products in Hong Kong	5.5
<b>2. PRICING CURRENCY DERIVATIVES</b>	5.5
2.1 Pricing Currency Forwards	5.5
2.2 Pricing Foreign Exchange Swaps	5.6
2.3 Pricing Currency Options	5.6
2.4 Valuing Foreign Exchange Options	5.7
2.5 Pricing Non-deliverable Forwards	5.7
<b>3. HEDGING USING CURRENCY DERIVATIVES</b>	5.7
<b>4. TRADING STRATEGIES FOR CURRENCY DERIVATIVES</b>	5.9
<b>5. COMMODITY DERIVATIVE PRODUCTS</b>	5.10
5.1 Commodity Groups	5.10
5.2 Types of Commodity Derivatives	5.11
5.3 Exchange-traded Commodity Derivative Products in Hong Kong	5.13
<b>6. PRICING COMMODITY DERIVATIVES</b>	5.15
6.1 Pricing Fundamentals	5.15

<b>7. HEDGING USING COMMODITY DERIVATIVES</b>	5.15
7.1 Hedging using a Gold Swap	5.15
7.2 Hedging using WTI Crude Oil Futures	5.16
<b>8. TRADING STRATEGIES FOR COMMODITY DERIVATIVES</b>	5.17

## 1. CURRENCY DERIVATIVE PRODUCTS

- Currency derivatives are one of the **most popular derivative investment classes** traded
- Currency derivatives are **traded on exchanges and OTC** – the majority are traded OTC
- Currency derivatives to be considered are:
  1. Currency forwards
  2. Foreign exchange (FX) swaps
  3. Currency swaps
  4. Currency options
  5. Non-deliverable forwards (NDFs)
  6. Exchange-traded currency derivatives

### 1.1 Currency Forwards

- 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
- By locking in an agreed exchange rate in advance of the transaction, the risk of an adverse move in exchange rates is mitigated

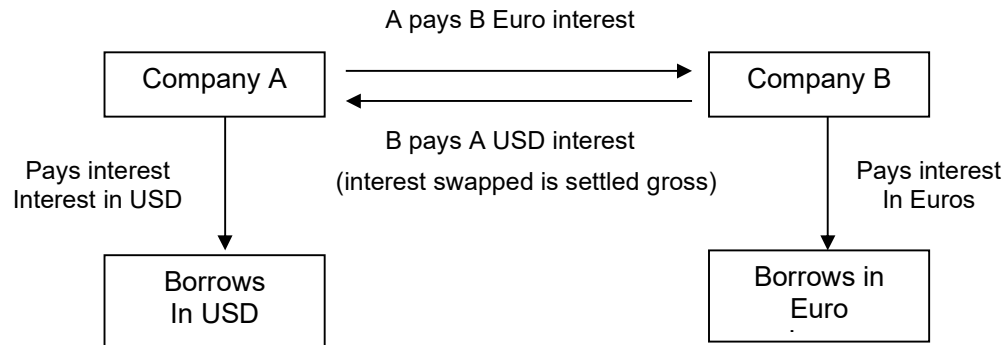
### 1.2 Foreign Exchange Swaps

- Agreements to buy or sell a quantity of currency on one date and reverse the transaction at a later date – in effect, swapping currencies for a period of time
- FX swaps are the most popular FX transaction type in Hong Kong
- They are used in the interbank funds market by financial institutions to buy and sell currencies among themselves
- An FX swap is made up of a spot FX transaction followed by a forward transaction, known as a “spot to forward date” swap
- FX swaps can occur where both the first and second halves (legs) happen in the future, known as “forward against forward” swaps

### 1.3 Currency Swaps

- In principle, the same as an interest-rate swap, except that it involves two currencies
- A currency swap is an agreement between two parties to exchange their financial obligations (interest payments) for a portfolio of liabilities that are denominated in different currencies
- Currency swaps usually involve an exchange of principals at the beginning and end of the swap period, such that the common stages of a currency swap are:
  - Exchange of principal amounts
  - Exchange of interest-rate payments
  - Reversing exchange of principal amounts

### Currency Swap



- In the above diagram, Company A borrows in US dollars (USD), while Company B borrows in Euros
- The companies then exchange the amounts borrowed and make repayments on each other's borrowing
- At the end of the swap period, the two companies reverse the exchange of principals
- As with interest-rate swaps, currency swaps allow parties to access borrowings at a cheaper rate of interest

## 1.4 Currency Options

- A currency option gives the buyer the right, but not the obligation, to buy or sell a certain amount of foreign currency, on or before a fixed future date at a specified exchange rate
- They can be used to hedge against adverse movements in FX rates
- Currency options have the specified exchange rate as their strike prices
- The premiums for currency options are expressed either as a percentage of the currency amount or as a number of exchange-rate points

## 1.5 Non-deliverable Forwards (NDFs)

- Similar to currency forwards, NDFs are used where countries impose FX restrictions
- Rather than settling an FX forward trade with the exchange of principal for the two currencies concerned, NDFs settle on a net basis – the settlement currency is usually US\$
- Renminbi (RMB) is an important example in Hong Kong
- NDFs allow market participants to hedge currency risks associated with their activities in developing economies, despite not being able to directly access the market for the currency in question

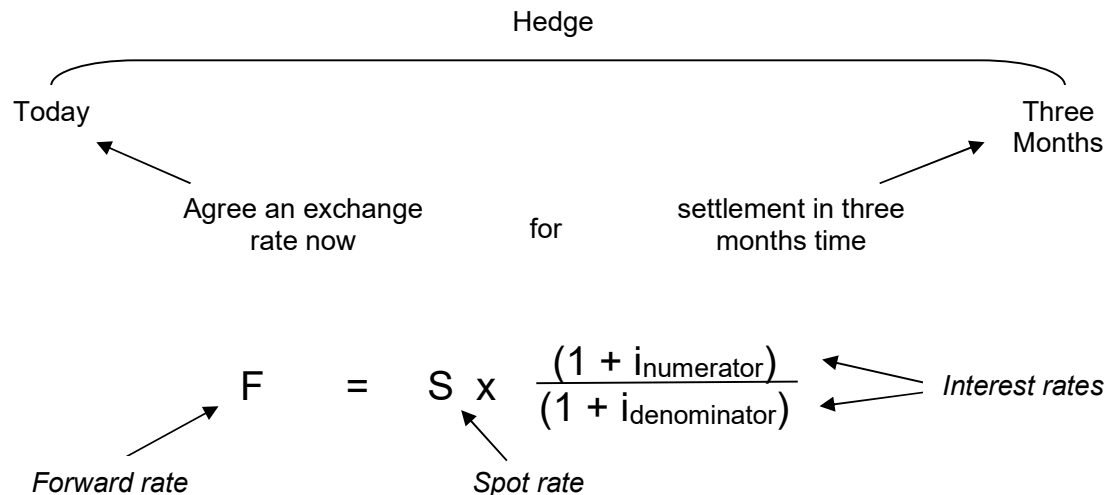
## 1.6 Exchange-traded Currency Derivative Products in Hong Kong

- HKEX has introduced the world's first deliverable RMB currency futures, which allows investors to hedge or take on RMB exposure
- The futures contracts are traded on a margin basis and settled at expiration with delivery of US\$ by the seller and payment of RMB by the buyer – USD/CNH futures
- The underlying asset is US\$100,000 of CNH
- The contract is quoted in standard interbank FX terms: RMB to USD (eg RMB6.5 per USD)
- In March 2017, HKEX launched its first RMB currency options to help market participants hedge currency risk more efficiently against the backdrop of increased volatility of the CNH

## 2. PRICING CURRENCY DERIVATIVES

### 2.1 Pricing Currency Forwards

- 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



#### Currency Forward Exchange Rate Example

Calculate the 1-year 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

$$\begin{aligned}
 F &= 1.35 \times \frac{(1 + 0.0075)}{(1 + 0.03)} \\
 &= 1.32
 \end{aligned}$$

## 2.2 Pricing Foreign Exchange Swaps

- With a **spot against forward date swap**, the swap involves a spot transaction for the first date and a forward transaction for the second
- The convention for pricing the spot transaction is to take the spot mid-rate, ie the mid-rate between the buy and sell quotes
- The second date is calculated as a forward transaction and this forward margin reflects the price of the swap
- With a **forward against forward swap**, the two dates can be calculated as parallel forward transactions. We then subtract the forward margin for the first date from the forward margin for the second to obtain the swap quote

## 2.3 Pricing Currency Options

- As was seen in Topic 2, an option's value can be divided into **two components**:
  - Intrinsic value
  - Time (or extrinsic) value
- The **time value** can be further broken down into:
  - Implied (or market) volatility
  - Time to expiry
  - Interest rate differential
  - Current price vs exercise price
- With currency options, two of the above factors require further attention:

### Implied Volatility

- One of the most important variables in calculating the fair value/price of an option, implied volatility is the expected degree of spot price movement during the life of the option
- Implied volatility is partly based on the historical volatility of the relevant exchange rate, is affected by the supply and demand for options from time to time and is sometimes considered to be a market consensus of the volatility forecast
- It is possible to input the market price of an option into an option-pricing model to arrive at a value for implied volatility
- Implied volatility will certainly differ from historical volatility due to a number of factors including supply/demand and market sentiment
- Trading options is effectively trading volatility, given that the other option pricing inputs are known

### Interest-rate Differential

- Movements in the interest rates of the relevant currencies involved in pricing an option will alter the interest-rate differential and accordingly, affect the price of an option

## 2.4 Valuing Foreign Exchange Options

- **Garman and Kohlhagen** extended the Black-Scholes-Merton (BSM) model in 1983 to cope with different risk-free rates in two currencies
- The Garman and Kohlhagen model is very similar to the BSM model, with the introduction of the foreign risk-free rate

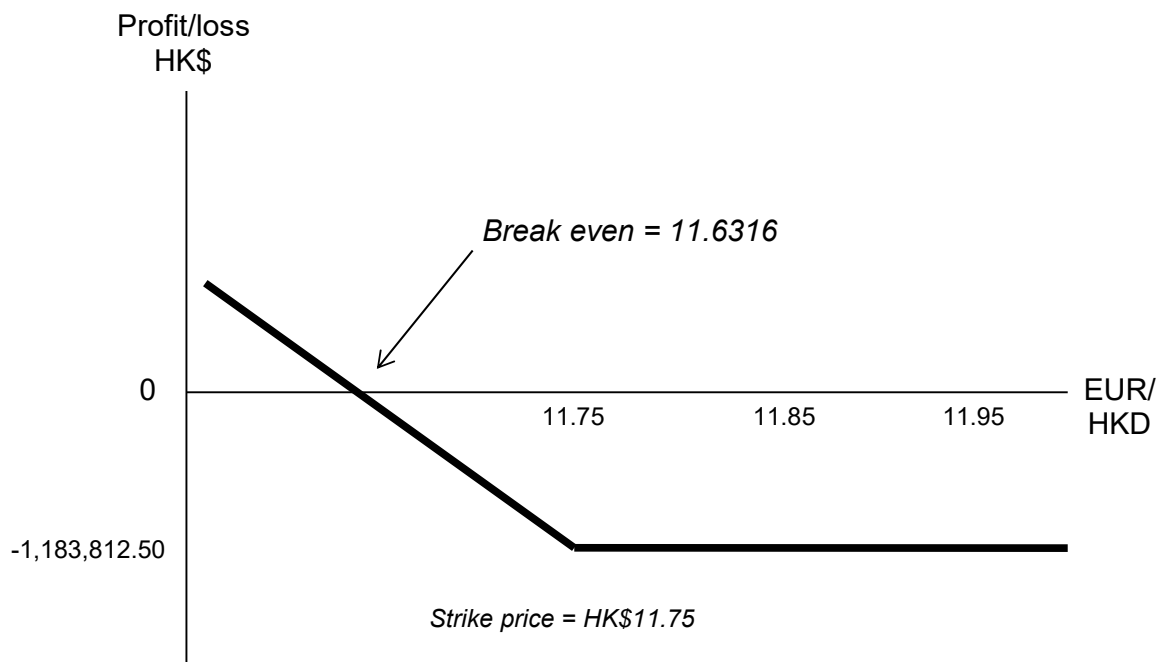
## 2.5 Pricing Non-deliverable Forwards

- Follows the same process and calculation as standard deliverable FX forwards, as outlined in section 2.1
- By convention, the valuation of an NDF is quoted in the deliverable currency, with the non-deliverable leg converted back to the deliverable currency, based on the prevailing interest rate

## 3. HEDGING USING CURRENCY DERIVATIVES

- We will look at an example where an exporting company hedges its foreign currency exposure using an **OTC put option**
- The company is scheduled to receive EUR10m in three months' time and is **exposed to the possibility of the Euro weakening against the HKD** in that period
- The following **market information** is available:
  - Spot EUR/HKD: 11.75 (ie HK\$11.75 per Euro)
  - HK interest rate: 3% pa
  - A 90-day (3 months) EUR put/HKD call with a strike of 11.75 costs 1% of HKD
- **What is the option contract?**
  - To sell EUR10m at HK\$11.75/EUR = HKD117.5m
- **What is the premium cost?**
  - HKD117.5m x 1% = HKD1,175,000
- **What is the funding cost?**
  - It is the cost of borrowing the premium for 90 days
  - $(\text{HKD}1,175,000 \times 3.00\%) \times 90/360 = \text{HKD}8,812.50$
- **What is the total cost?**
  - It is the premium cost + funding cost
  - $\text{HKD}1,175,000 + \text{HKD}8,812.50 = \text{HKD}1,183,812.50$

### Pay-off Diagram for Long Put



#### First Possible Outcome – in three months, the EUR/HKD rate is 11.60

- The company **exercises the put option** and sells EUR10m for HKD117.5m
- HKD received: HKD117.5m – HKD1,183,812.50 = HKD116,316,187.50
- Effective rate: HKD116,316,187.50/EUR10m = 11.6316
- The effective rate of 11.6316 is better than the current spot rate of 11.60

#### Second Possible Outcome – in three months, the EUR/HKD rate is 12.00

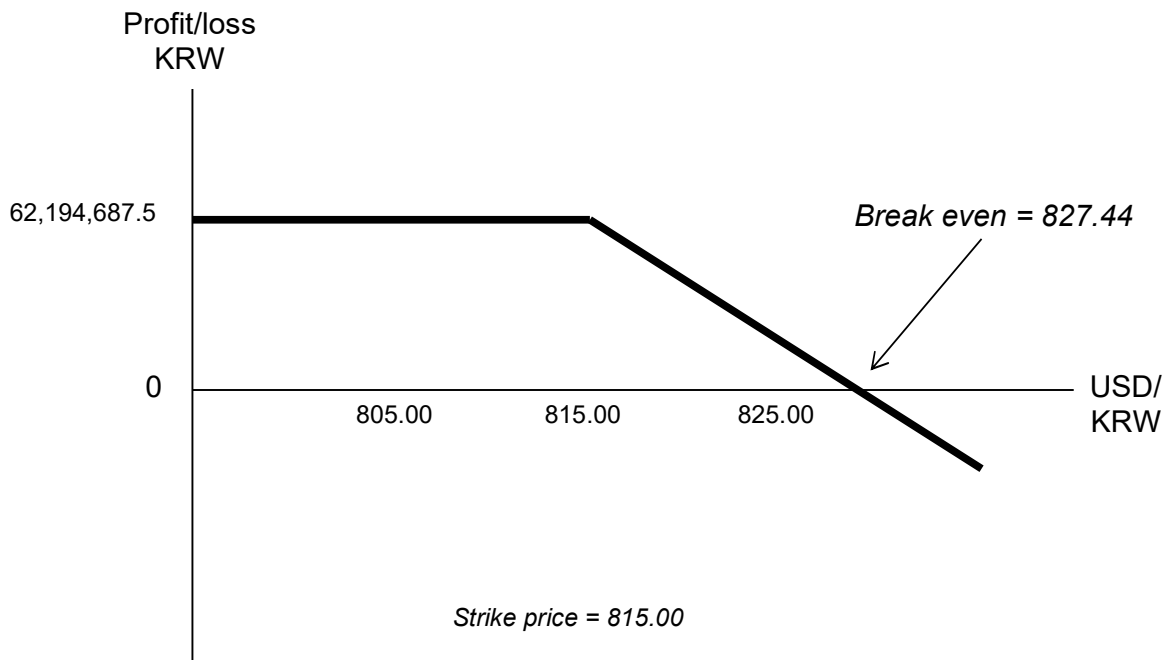
- The company **allows option to lapse** and sells EUR10m for HKD120.0m
- HKD received: HKD120.0m – HKD1,183,812.50 = HKD118,816,187.50
- Effective rate: HKD118,816,187.50/EUR10m = 11.8816
- The effective rate of 11.8816 is not as good as the current spot rate of 12.00



#### 4. TRADING STRATEGIES FOR CURRENCY DERIVATIVES

- We will look at an example where a **Korean investment bank decides to sell an option to receive premium income**. The bank believes that the Korean won (KRW) will not depreciate significantly over the next 3 months
- The bank sells USD5m USD call/KRW put. If the buyer of the option exercises the option, the bank would have to sell USD and buy KRW
- The following **market information** is available:
  - Spot USD/KRW: 815.00 (ie KRW\$815.00 per USD)
  - KRW interest rate: 7% pa
  - A 90-day (3 months) USD call/KRW put with a strike of 815 sells for 1.50% of USD
- **What is the break-even point for the bank?**
  - Premium received:  $\text{USD}5\text{m} \times 1.5\% = \text{USD}75,000$
  - Converted into KRW:  $75,000 \times 815 = \text{KRW}61,125,000$
  - Interest received:  $\text{KRW}61,125,000 \times 7\% \times (90/360) = \text{KRW}1,069,687.50$
  - Total received:  $\text{KRW}61,125,000 + \text{KRW}1,069,687.50 = 62,194,687.50$
  - **Break-even** =  $[\text{KRW}62,194,687.50 + (\text{USD}5\text{m} \times 815)]/\text{USD}5\text{m}$   
= 827.44

#### Pay-off Diagram for Short Call



### First Possible Outcome – in three months, the USD/KRW rate is 805.25

- As the USD has depreciated against the KRW, the option holder will not exercise
- **The bank will realise a profit** of KRW62,194,687.50 on the trade

### Second Possible Outcome – in three months, the USD/KRW rate is 830.00

- As the KRW has depreciated against the USD, the option holder will exercise
- The bank will be required to sell USD and buy KRW
- Therefore, the bank will deliver USD5m and will receive KRW4,075,000,000 (USD5m x 815 = KRW4,075,000,000)
- At the prevailing rate of 830.00, the bank would have received KRW4,150,000,000 (USD5m x 830 = KRW4,150,000,000)
- **The bank will therefore, suffer a loss** of KRW75,000,000 on option exercise
- As the bank has received the option premium plus interest earned, the overall loss is KRW12,805,312.50 (KRW75,000,000 – KRW62,194,687.50)

## 5. COMMODITY DERIVATIVE PRODUCTS

- The underlying assets for commodity derivatives include such items as: gold, oil, corn and soybeans
- Commodity derivatives are some of the oldest derivative products traded
- Commodity derivatives figure prominently in exchange-traded markets, sometimes with dedicated commodity exchanges they are also traded on the OTC market

### 5.1 Commodity Groups

- Commodities can be broken into three main groups:
  - Agricultural
  - Metals-based
  - Energy

#### 5.1.1 Agricultural Instruments

- Agricultural instruments can be further broken down into:
  - **Grains:** corn and soybean
  - **Softs:** coffee, sugar, cocoa and orange juice
  - **Meats:** live cattle and pork bellies
- While primarily used as hedging instruments, speculators often trade particular futures, such as orange juice and coffee
- Some of the major agricultural derivatives exchanges are: the Chicago Board of Trade, Dalian Commodity Exchange, the Intercontinental Exchange (ICE) and the Tokyo Commodity Exchange

## 5.1.2 Metal-Based Instruments

- Metal-based instruments can be further broken down into:
  - **Base:** nickel, aluminium, copper and tin (used by heavy industries)
  - **Precious:** gold, silver and platinum
- They are traded OTC and on exchanges, such as the Commodity Exchange Inc, the London Metals Exchange (LME) and Shanghai Futures Exchange

## 5.1.3 Energy Instruments

- Energy instruments can be further broken down into:
  - **Crude oil:** West Texas Intermediate (WTI) and Brent Crude oil
  - **Refined products:** heating and gasoline oil, natural gas and electricity
- Market analysts watch crude oil instruments closely, since they are seen as important economic growth leading indicators
- They are traded OTC and on exchanges, such as the New York Mercantile Exchange and the ICE

## 5.2 Types of Commodity Derivatives

- We will look at four different types of commodity derivatives traded in the market:
  - Commodity futures
  - Commodity forwards
  - Commodity swaps
  - Commodity options

### 5.2.1 Commodity Futures

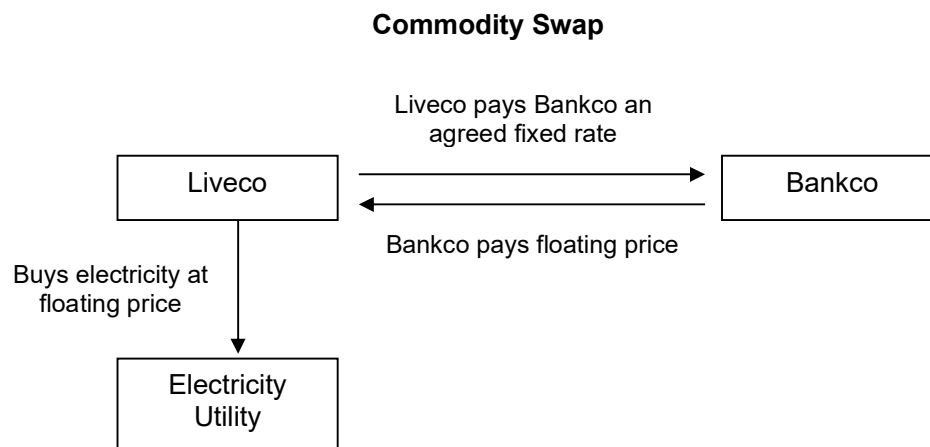
- The majority of commodity futures traded have physical settlement – the seller delivers the quantity of the underlying asset to the buyer
- However, there are many commodity futures that are cash settled
- Popular futures trades are in WTI crude oil futures and corn and soybean contracts

### 5.2.2 Commodity Forwards

- Commodity forwards are particularly popular in metals trading
- Most commodity forwards involve physical delivery
- It is common for producers and purchasers of gold to enter into forward agreements

### 5.2.3 Commodity Swaps

- A commodity swap is closer to an interest-rate swap than a currency swap, as it does not involve an exchange of underlying assets, and payments between counterparties are netted
- A simple commodity swap involves a fixed-for-floating exchange of risk, where a commodity producer or consumer swaps its floating risk for a fixed payment with a counterparty
- An example of a commodity swap would be where a larger electricity consumer (Liveco) enters into a swap with an investment bank (Bankco) to lock in a buy price against the floating price of electricity. In return for the fixed price, the counterparty (Bankco) agrees to pay the floating pool price. See below for diagram:



### 5.2.4 Commodity Options

- Commodity options are traded on a variety of underlying instruments in both the exchange-traded and OTC markets and include:
  - Options on base and precious metals
  - Options on agricultural, grains and meat products
  - Options on energy products
- Energy instruments can be further broken down into:
  - **Options on a physical commodity:** these include options to take delivery of or sell a quantity of an underlying commodity
  - **Options on commodity futures:** Traded on an exchange, these options provide the right to buy or sell an underlying futures contract and are popular with commodity speculators as they are cheaper to fund than outright futures

## 5.3 Exchange-traded Commodity Derivative Products in Hong Kong

- We will look at four different commodity derivative products traded in Hong Kong:
  - London Metal Mini Futures
  - Gold Futures
  - Silver Futures
  - Iron Ore Futures

### 5.3.1 London Metal Mini Futures

- The following **RMB-trade commodities contracts** are traded on HKFE and cleared through HKCC:
  - CNH London **Aluminium** Mini Futures
  - CNH London **Zinc** Mini Futures
  - CNH London **Copper** Mini Futures
  - CNH London **Nickel** Mini Futures
  - CNH London **Tin** Mini Futures
  - CNH London **Lead** Mini Futures
- As well as providing arbitrage opportunities, the contracts are designed to:
  - Match Chinese physical players' exposure to commodities contracts priced in RMB
  - Ease margin financing needs for entities holding RMB
  - Establish RMB pricing of metals in Asian trading hours
  - Meet the various needs of producers and investors, particularly those based in Asia
- Contracts are monthly cash-settled
- HKEX launched USD London Metal Mini Futures in August 2019 for users who have exposure in USD-denominated metal in the Asian time zone

### 5.3.2 Gold futures

- HKFE launched CNH and USD Gold futures in July 2017
- The underlying asset is one kilogram of gold and contracts can be physically settled

### 5.3.3 Silver Futures

- HKFE launched CNH and USD Silver futures in June 2020
- The underlying asset is 30 kilograms of silver and contracts can be physically settled
- It is common for producers and purchasers of gold to enter into forward agreements

### 5.3.4 Iron Ore Futures

- Introduced by HKFE in November 2017
- Provides a transparent and efficient risk management tool for physical and financial users, offering investors a highly China-relevant underlying for investment

## 6. PRICING COMMODITY DERIVATIVES

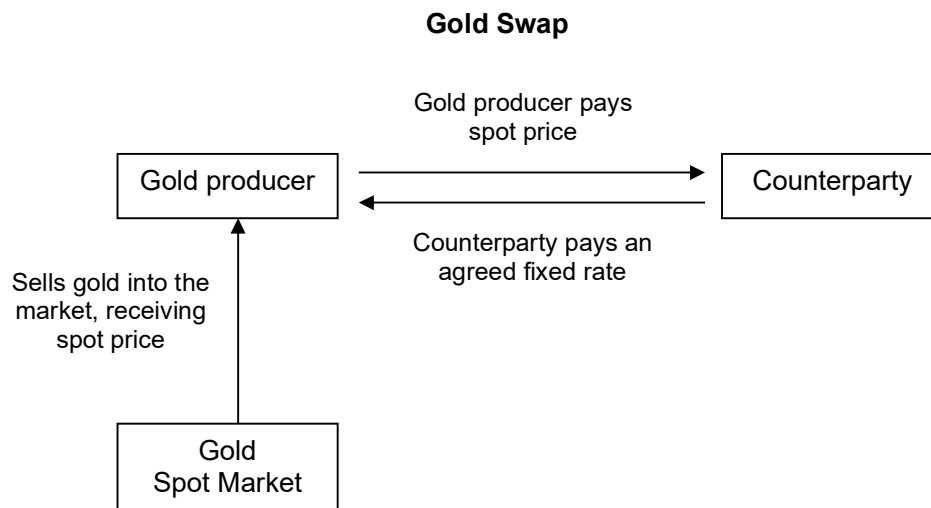
### 6.1 Pricing Fundamentals

- Expectations of supply and demand play a part in determining prices, but the most significant determinant of a commodity futures price is the cost of carry
- Fair value = cash price + cost of carry
- Cost of carry reduces the closer the contract gets to expiry. At expiry, cost of carry becomes zero

## 7. HEDGING USING COMMODITY DERIVATIVES

### 7.1 Hedging Using a Gold Swap

- A miner and producer of gold, who is concerned about a fall in the price of gold, could hedge price risk in any of the following ways:
  - Enter into a gold forward contract for the sale of its production
  - Sell gold futures
  - Enter into a gold swap
  - Purchase gold put options
- In reality, the miner/producer would probably enter into a swap for the following reasons:
  - A swap agreement is longer term than the other instruments
  - A swap agreement requires less on-going management than options and shorter-dated forwards
  - Compared to futures, a swap agreement does not involve the tying-up of capital in initial and variation margins
- See below for diagram:



## 7.2 Hedging Using WTI Crude Oil Futures

- DD Airways wants to hedge against rising oil prices
- The jet fuel monthly expense is estimated to be USD100m
- There are two actively traded crude oil futures:
  1. WTI crude oil futures trading on the New York Mercantile Exchange
  2. Brent crude oil futures trading on the ICE

Both contracts involve 1,000 barrels
- DD Airways decides to use WTI futures, the December contract for which is trading at USD135.9 per barrel and decides to hedge for half of the jet fuel

**Question:** What are the cost savings and increase in expenses if WTI crude oil settles at USD70, USD120 and USD170?

- **How many contracts?**
  - Contract size of WTI crude oil futures:  $\text{USD}135.9 \times 1,000 = \text{USD}135,900$
  - No. of contracts to hedge full exposure:  $\text{USD}1\text{m}/\text{USD}135,900 = 736$
  - No. of contracts to hedge half of exposure:  $736/2 = 368$
  - So, DD Airways buys 368 contracts at USD135.9 to hedge half the exposure to a rise in fuel costs

### Outcome 1: WTI crude oil futures settle at USD70

- **Unhedged situation:**
  - Fuel cost saving =  $(\text{USD}70.0 - \text{USD}135.9) \times 1,000 \times 736 = \text{USD}48,502,400$
- **Hedged for half of exposure:**
  - Oil futures loss =  $(\text{USD}70.0 - \text{USD}135.9) \times 1,000 \times 368 = \text{USD}24,251,200$
  - Fuel cost saving =  $(\text{USD}70.0 - \text{USD}135.9) \times 1,000 \times 736 = \text{USD}48,502,400$
  - Overall cost saving =  $\text{USD}48,502,400 - \text{USD}24,251,200 = \text{USD}24,251,200$

### Outcome 2: WTI crude oil futures settle at USD120

- **Unhedged situation:**
  - Fuel cost saving =  $(\text{USD}120.0 - \text{USD}135.9) \times 1,000 \times 736 = \text{USD}11,702,400$
- **Hedged for half of exposure:**
  - Oil futures loss =  $(\text{USD}120.0 - \text{USD}135.9) \times 1,000 \times 368 = \text{USD}5,851,200$
  - Fuel cost saving =  $(\text{USD}120.0 - \text{USD}135.9) \times 1,000 \times 736 = \text{USD}11,702,400$
  - Overall cost saving =  $\text{USD}11,702,400 - \text{USD}5,851,200 = \text{USD}5,851,200$



**Outcome 3: WTI crude oil futures settle at USD170**

- **Unhedged situation:**
  - Fuel expense increase =  $(\text{USD}170.0 - \text{USD}135.9) \times 1,000 \times 736 = \text{USD}25,097,600$
- **Hedged for half of exposure:**
  - Oil futures gain =  $(\text{USD}170.0 - \text{USD}135.9) \times 1,000 \times 368 = \text{USD}12,548,800$
  - Fuel cost increase =  $(\text{USD}170.0 - \text{USD}135.9) \times 1,000 \times 736 = \text{USD}25,097,600$
  - Overall cost increase =  $\text{USD}25,097,600 - \text{USD}12,548,800 = \text{USD}12,548,800$

**Unhedged vs Hedged**

Oil Futures Price	Unhedged	Half-hedged
USD70.0	Saving of USD48,502,400	Saving of USD24,251,200
USD120.0	Saving of USD11,702,400	Saving of USD5,851,200
USD170.0	Extra cost of USD25,097,600	Extra cost of USD12,548,800

- By hedging half of the exposure, volatility in corporate earnings can be reduced:

**8. TRADING STRATEGIES FOR COMMODITY DERIVATIVES**

- A speculator believes that the price of silver will soon increase sharply
- Rather than risk capital being tied up in a futures trade, she decides to purchase options on silver futures – the current futures price is USD25.25
- She buys a call option with a USD25.25 strike price for USD2.85

**Pay-off Diagram for Long Call on Silver Futures**