Derivatives

INTRODUCTION

Meaning of Derivative

- The term ‘Derivative’ stands for a contract whose price or value is derived from or is dependent upon an underlying asset

Or

- A derivative is a financial instrument whose value depends on (or derives from) the value (price) of basic underlying variables

- Derivatives generally involve an agreement between two parties (known as counterparties) to exchange a standard quantity of an asset or cash flow at a predetermined price at a specified date in future

Meaning of Derivative (contd…)

- The underlying asset could be a financial asset such as currency, stock and market index, an interest bearing security (bond, T-bills, notes) or a physical commodity
- Derivative contracts are even traded on electricity, weather, temperature, and volatility
- Derivatives derive their names from their respective underlying asset
- If a derivative's underlying asset is equity, it is called equity derivative and so on

Types of Derivative Contracts

- Forwards (OTC)
- Futures (Exchange Traded)
- Options (OTC and Exchange Traded)
- Swaps (OTC)
- Credit Derivatives (OTC)

Over-the-Counter (OTC) v/s Regulated Exchange

- Derivatives that trade on an exchange are called exchange traded derivatives, whereas privately negotiated derivative contracts are called OTC contracts.
- **Exchange Traded:**
  - Contracts are standardized;
  - Once two traders have agreed on a trade, it is handled by the exchange CLEARINGHOUSE and there is virtually no **credit risk**;
  - Traditionally, derivatives exchanges have used the open-outcry system, but exchanges have largely replaced the open outcry system by electronic trading
- **Over-the-Counter (OTC):**
  - Traditionally, participants in the OTC derivatives markets have contacted each other directly by phone and email, or have found counterparties for their trades using an interdealer broker;
  - Banks often act as market makers for the more commonly traded instruments;
  - Contracts are non-standardized (customized) and there used to exist small amount of **credit risk**

OTC Market: Some New Regulations

- Prior to the credit crisis, which started in 2007 OTC derivatives markets were largely unregulated. Following the credit crisis and the failure of Lehman Brothers OTC derivatives markets saw development of many new regulations affecting the operation of OTC markets
- Particularly, introducing Central Counterparties (CCPs) and Collateralization in OTC Markets
- The purpose of the regulations is to improve the transparency of OTC markets, improve market efficiency, and reduce systemic risk.

OTC Market: Central Counterparty (CCP)/Central Clearing Party (CCP) and Bilateral Trades

– Once an OTC trade has been agreed, the two parties can either present it to a central counterparty (CCP) or clear the trade bilaterally

CCP Trades: A CCP is like an exchange clearing house. It stands between the two parties to the derivatives transaction (through margin requirements) so that one party does not have to bear the risk that the other party will default

Bilateral Trades: When trades are cleared bilaterally, the two parties have usually signed an agreement (known as master agreement) covering all their transactions with each other. This agreement often includes an annex, referred to as the credit support annex (CSA), requiring the counterparties to provide collateral (similar to the margin required by exchange clearing houses or CCPs)

OTC Market and Central Counterparty/ Central Clearing Party (CCP)

Example

If the transaction is a forward contract where A has agreed to buy an asset from B in one year for a certain price, the clearing house agrees to:

1. Buy the asset from B in one year for the agreed price;
2. Sell the asset to A in one year for the agreed price

It takes on the credit risk of both A and B. All members of the CCP are required to provide initial margin to the CCP. Transactions are valued daily and there are daily variation margin payments to or from the member

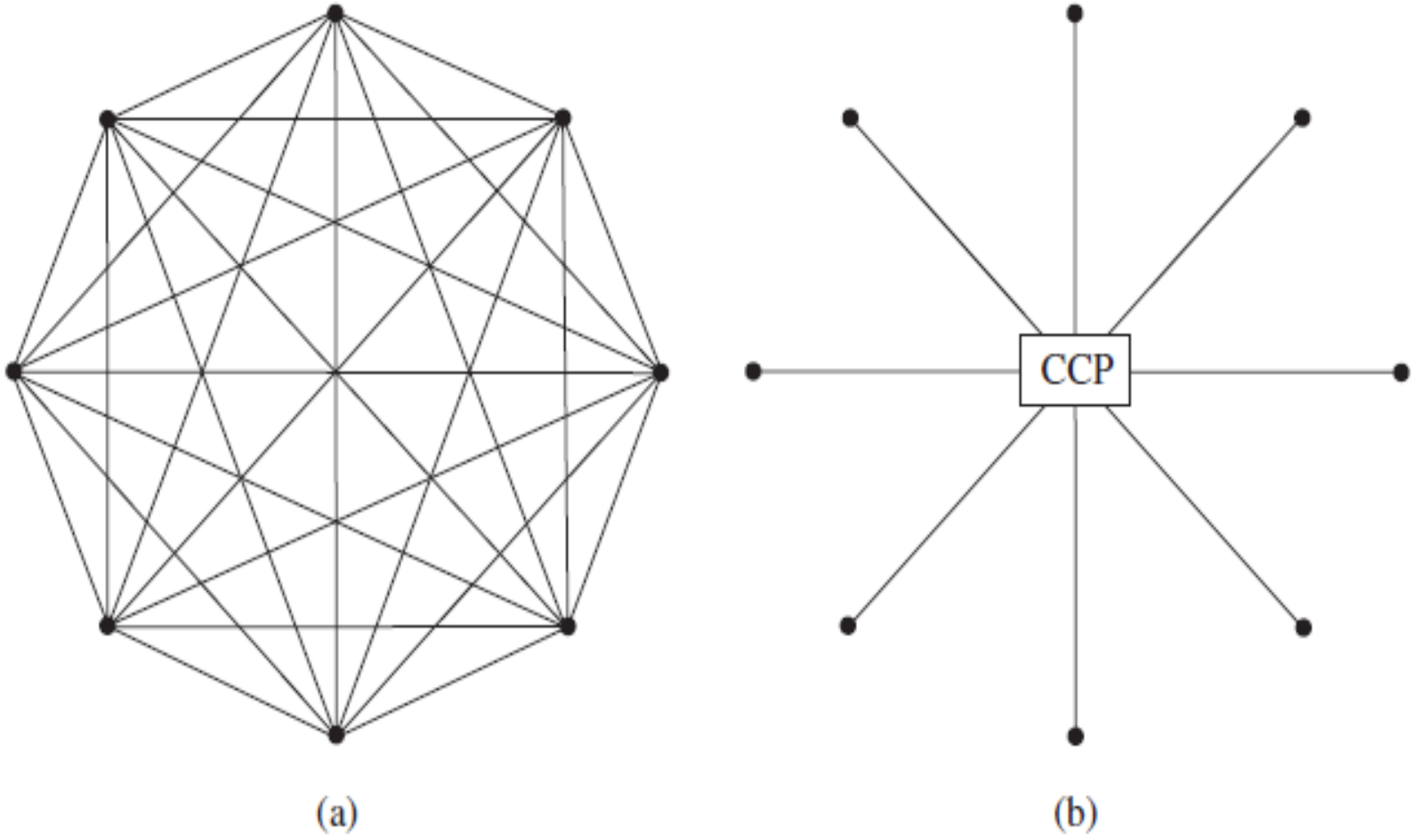
OTC Markets: Collateralization in OTC Markets

Example:

Consider two companies, A and B. The collateralization agreement applying to the transactions might involve the transaction being valued each day. If from one day to the next, the value of the transaction to company A increases by a positive amount say X, company B is required to pay X to company A and vice-versa

Note: The contract is not settled daily. The payments are a security deposit designed to ensure that obligations will be honored.

(a) The traditional way in which OTC markets have operated: a series of bilateral agreements between market participants; b) how OTC markets would operate with a single central counterparty (CCP) acting as a clearing house.



Participants in the Derivatives Market

1. Hedgers: Market participants who seek to reduce or minimize their risk are called hedgers. Hedgers participate in the derivatives market to lock the prices at which they will be able to transact in the future. Hedging in derivatives market can be done through two positions, viz. SHORT HEDGE and LONG HEDGE:

- **Short Hedge:** A short hedge involves taking a short position in the derivatives market. Short hedge position is taken by someone who already owns or may own the underlying asset and is BEARISH about the price of the underlying asset in the market
- A Short position holder agrees to SELL the underlying asset at the expiry date by receiving the agreed upon or predetermined price

- **Long Hedge:** A long hedge involves holding a long position in the derivatives market. This strategy is used by those who will need to acquire the underlying asset in the future
- Long hedge position is taken by someone who will need to acquire/buy the underlying asset in the future and is BULLISH about the price of the underlying asset in the market.
- A Long position holder agrees to BUY the underlying asset at the expiry date by paying the agreed upon or predetermined price.

EXAMPLE

Strategy: Long Hedge and Short Hedge

Counterparties: A chocolate manufacturer and a Sugar manufacturer

Price Risk: Chocolate manufacturer needs sugar in future and is BULLISH about the prices of sugar. Sugar manufacturer wants to sell sugar in future and is BEARISH about the prices of the sugar

Hedging: To hedge against this price risk, the chocolate manufacturer can hold a **long position** in sugar where as the sugar manufacturer can hold a **short position** in sugar

Gain: Long Hedge = Spot Price > Predetermined Price

Gain: Short Hedge = Spot Price < Predetermined Price

WHY HEDGING?

WHY HEDGING?: TO MITIGIATE FINANCIAL RISK (PRICE RISK and CREDIT RISK)

- Multinational Corporations (MNCs) operate in more than one country and their operations involve multiple foreign currencies, interest rates and different levels of prices;
- MNCs lend and borrow foreign currencies at different interest rates on a short-term and long-term basis;
- MNCs also invest in foreign financial instruments whose cash flows are denominated in foreign currency;
- MNCs import and export to different countries and their cash flows are denominated in different foreign currencies;

Participants in the Derivatives Market

2. Speculators: Market participants who seek to increase their risk are called speculators. Speculators generally bet on the derivatives market based on their perception on the potential movement of the price of the underlying

A speculator will take a long position if he is BULLISH about the market and takes a short position if he is BEARISH about the market for a given underlying

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Participants in the Derivatives Market

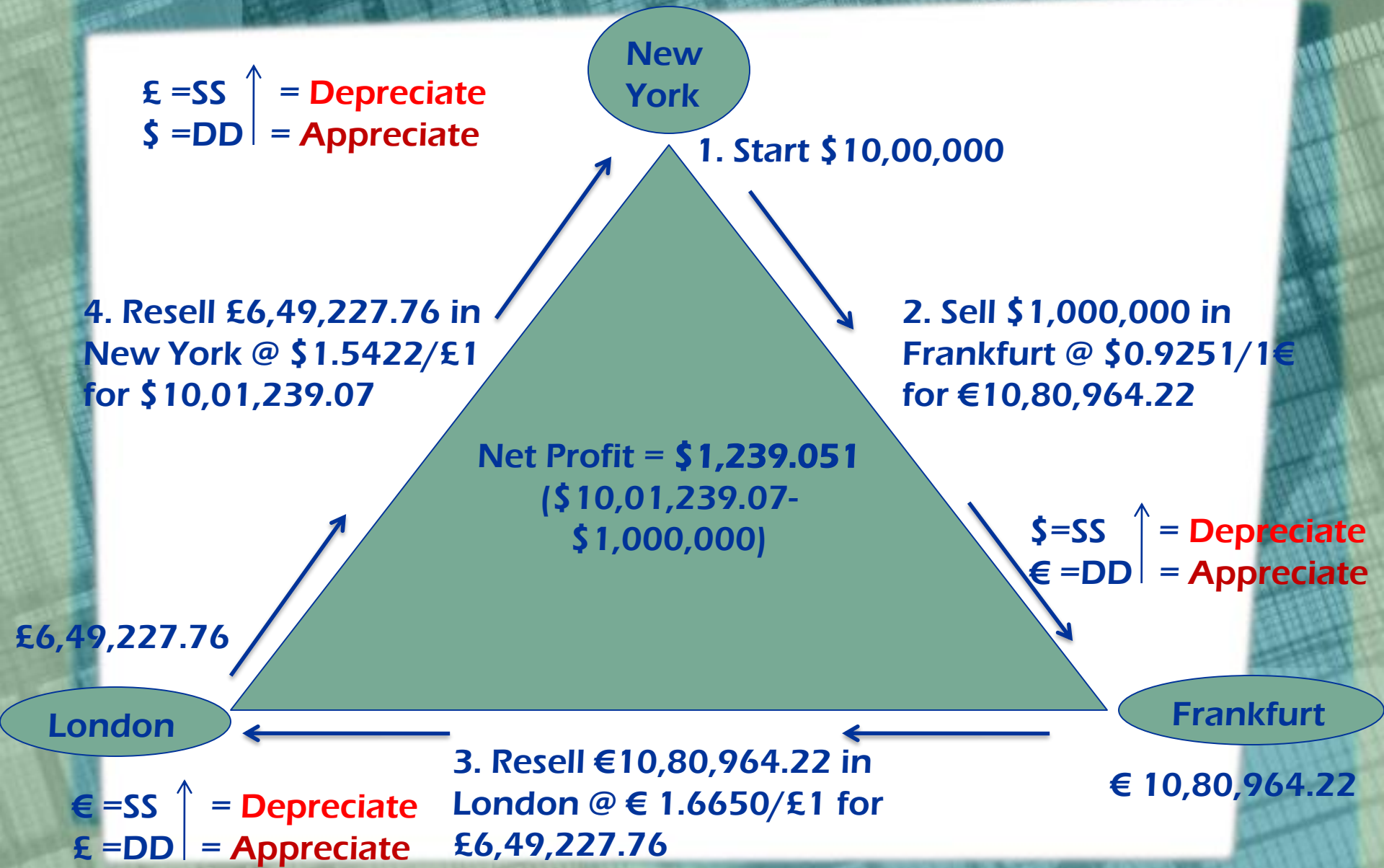
3. Arbitrageurs: Arbitrageurs attempt to profit from pricing inefficiencies in the market by making simultaneous trades that offset each other and capture a risk-free profit

TRINGULAR CURRECNY ARBITRATION

1. New York: $1.5422/£1
2. Frankfurt: $0.9251/1€
3. London: €1.6650/£1

Assume that the arbitrageur has $10,00,000.

TRINGULAR CURRECNY ARBITRATION



Forward Contracts

- A forward contract is an agreement to buy or sell an asset at a certain time/period/date in the future for a certain price (the delivery/forward price)
- One of the parties to the contract assumes a **long position** and agrees to **buy** the underlying asset on a certain specified future date for a certain specified price
- The other party assumes a short position and agrees to sell the asset on the same date for the same price

Important Features of Forward Contracts

- It is traded only in the OTC market
- Each contract is custom designed, and hence is unique in terms of contract size, delivery date and the asset type and quality

Payoffs from Forward Contracts

The payoff from a **long position** in a forward contract on one unit of an asset is:

$$\mathbf{S_T - K}$$

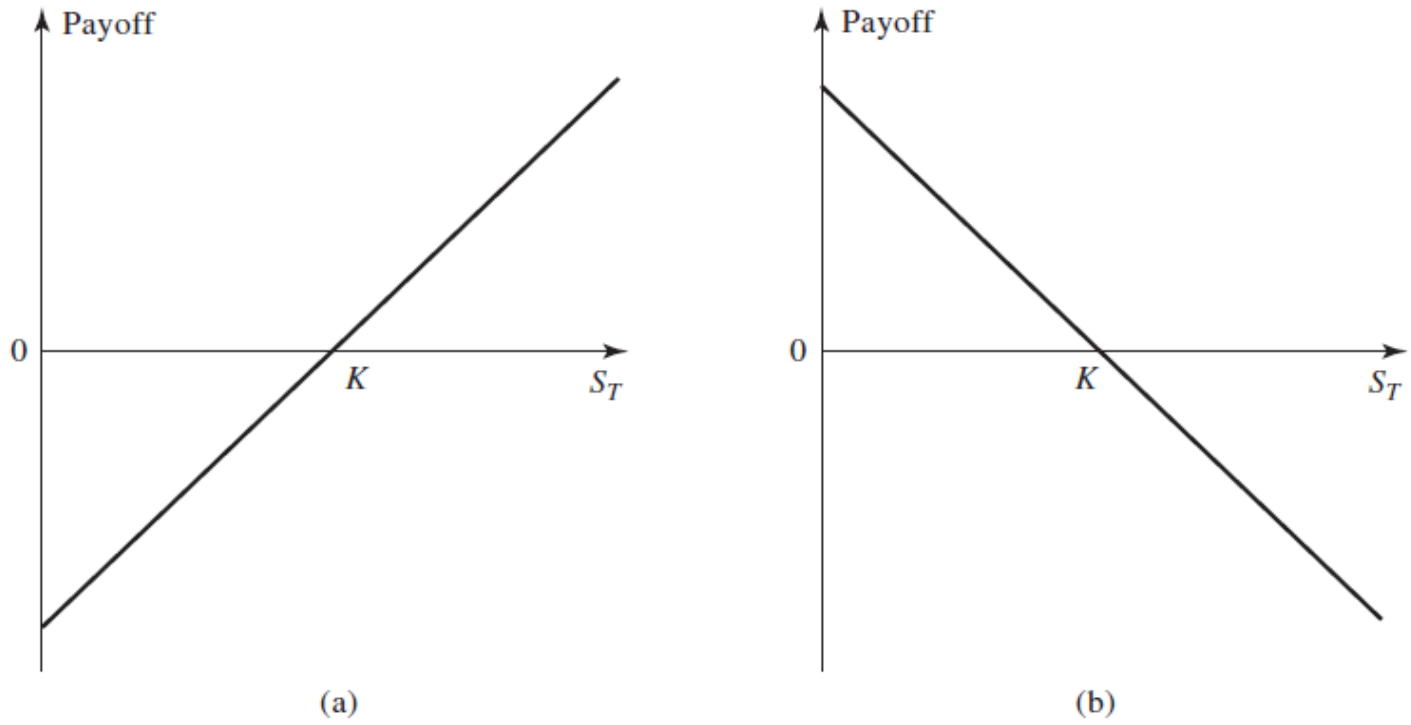
where K is the delivery price and S_T is the spot price of the asset at maturity of the contract

The payoff from a **short position** in a forward contract on one unit of an asset is:

$$\mathbf{K - S_T}$$

Payoffs from Forward Contracts

Payoffs from forward contracts: (a) long position, (b) short position.
Delivery price = K; price of asset at contract maturity = S_T



Hedging through Forwards

Suppose that on August 12, 2016, the treasurer of US Corporation knows that the corporation will pay £1million in six-months on February 12, 2017 and believes that the US$ will depreciate at the time of payment. What should the treasurer of US company do?

Table 1: Foreign Exchange Quotes for GBP on Aug 12, 2016 (No. of US$ per GBP)

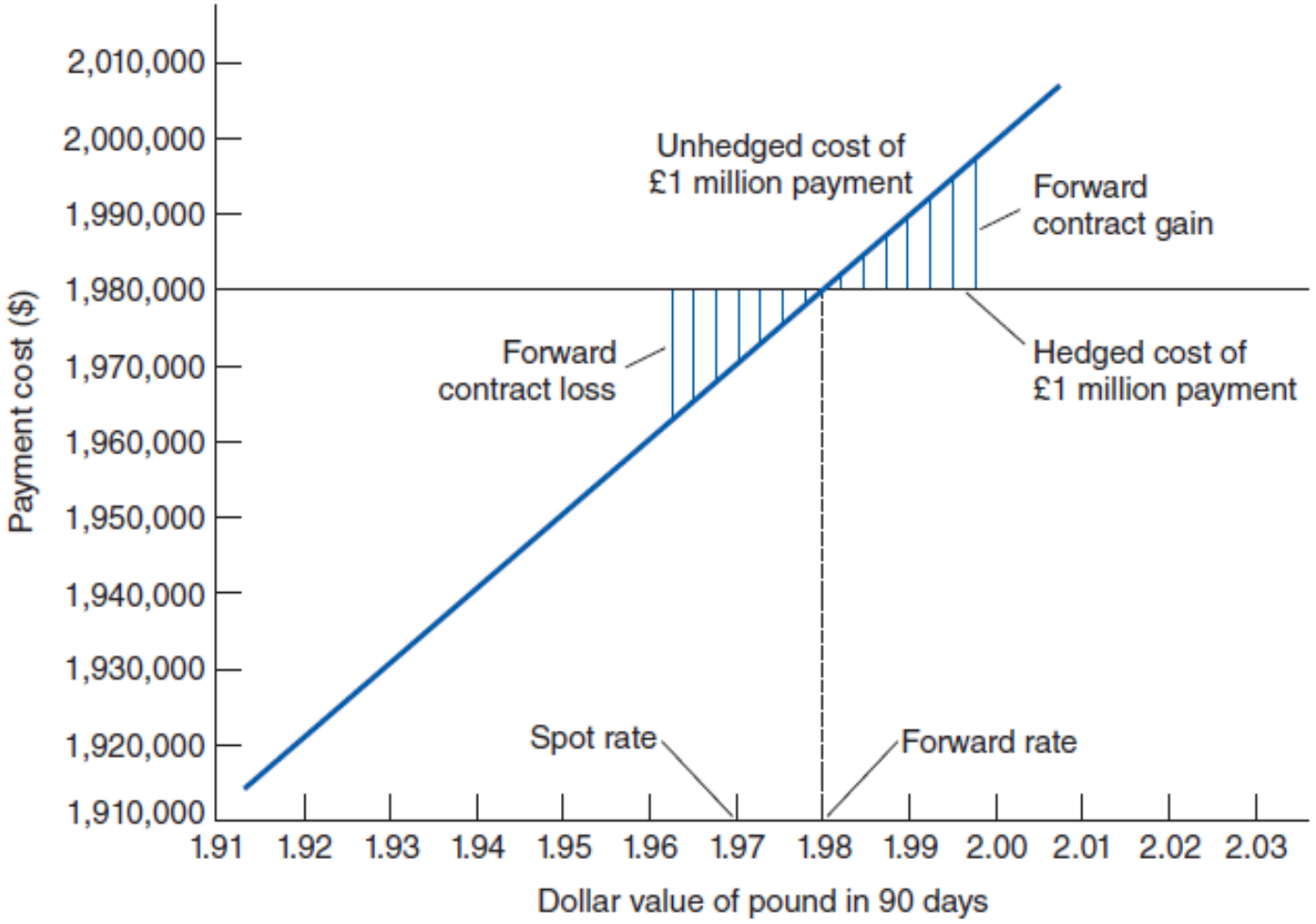
	Bid	Offer
Spot	1.5541	1.5545
1-month forward	1.5538	1.5543
3-month forward	1.5533	1.5538
6-month forward	1.5526	1.5532
12-month forward	1.5528	1.5530

Hedging through Forwards

Using the quotes given in Table by the dealer, the US Treasurer can agree to BUY £1million six-months forward at a forward exchange rate of $1.5532/1£.

US CORPORATION	BANK
Long Position (£): BUY £1million from bank @ $1.5532/1£ for (SELL) $15,53,200 ($1.5532 million) on Feb, 12, 2017.	Short Position (£): SELL £1million to US CO @ $1.5532/1£ for (BUY) $15,53,200 ($1.5532 million) on Feb, 12, 2017.

Hedging a Future Payment with a Forward Contract



Hedging through Forwards

An Indian Company has ordered machinery from USA. The price of $5,00,000 is payable after six months. The current exchange rate is Rs.67.75/1US$. The CEO of the company anticipates that the Indian rupee will depreciate in the next six months. To hedge its currency risk the company enters into a 6-month currency forwards contract a per the quotes given in Table 2. Calculate the payoff of the company if the spot rate is (a) Rs.69.95/1US$ and (b) Rs.65.95/1US$ on delivery date.

Table 2: Foreign Exchange Quotes for US$

(No. of rupees per US$)

	Bid	Offer
Spot	67.72	67.75
1-month forward	67.69	67.71
3-month forward	67.67	67.70
6-month forward	67.91	67.95
12-month forward	67.97	67.99

Hedging through Forwards

Using the quotes given in Table, the CEO can lock in the exchange rate by entering into a six-month forward contract at a forward exchange rate of Rs.67.95/$ and forget about any fluctuations in the exchange rate.

INDIAN CORPORATION	BANK
Long Position ($): BUY $5,00,000 from bank @ Rs.67.95/$ for (SELL) Rs.33,975,000 on maturity or delivery date.	**Short Position ($): SELL $5,00,000 to INDIAN CO @ Rs.67.95/$ for (BUY) Rs.33,975,000 on maturity or delivery date.**

Payoffs from Forward Contract

Case I: S_T = 69.95/$; K= 67.95/$

INDIAN CORPORATION	BANK
Long Position ($): S_T -K = (69.95-67.95) **= Rs. 2 (500000)** **= Rs.10,000,00**	**Short Position ($):** K-$S_T$ =(67.95-69.95) **= Rs. -2 (500000)** **= Rs. -10,000,00**

Case II: S_T = 65.95/$; K= 67.95/$

INDIAN CORPORATION	BANK
Long Position ($): S_T -K = (65.95-67.95) **= Rs. -2 (500000)** **= Rs. -10,000,00**	**Short Position ($):**K-$S_T$ =(67.95-65.95) **= Rs. 2 (500000)** **= Rs.10,000,00**

Settlement of Contracts:

Physical Settlement and Cash Settlement

Physical Settlement

A forward contract can be settled by the physical delivery of the underlying asset by a short investor (i.e. the seller) to the long investor (i.e. the buyer) and the payment of the agreed forward price by the buyer to the seller on the agreed settlement date.

Cash Settlement

Cash settlement does not involve actual delivery or receipt of the security. Each party either pays (receives) cash equal to the net loss (profit) arising out of their respective position in the contract.

Futures Contracts

- Agreement to buy or sell an asset for a certain price at a certain future time
- Similar to forward contract
- Whereas a forward contract is traded on OTC, a futures contract is traded on an exchange where the contract terms are standardized by that exchange
- The number of futures contracts outstanding at any one time is called the **open interest**

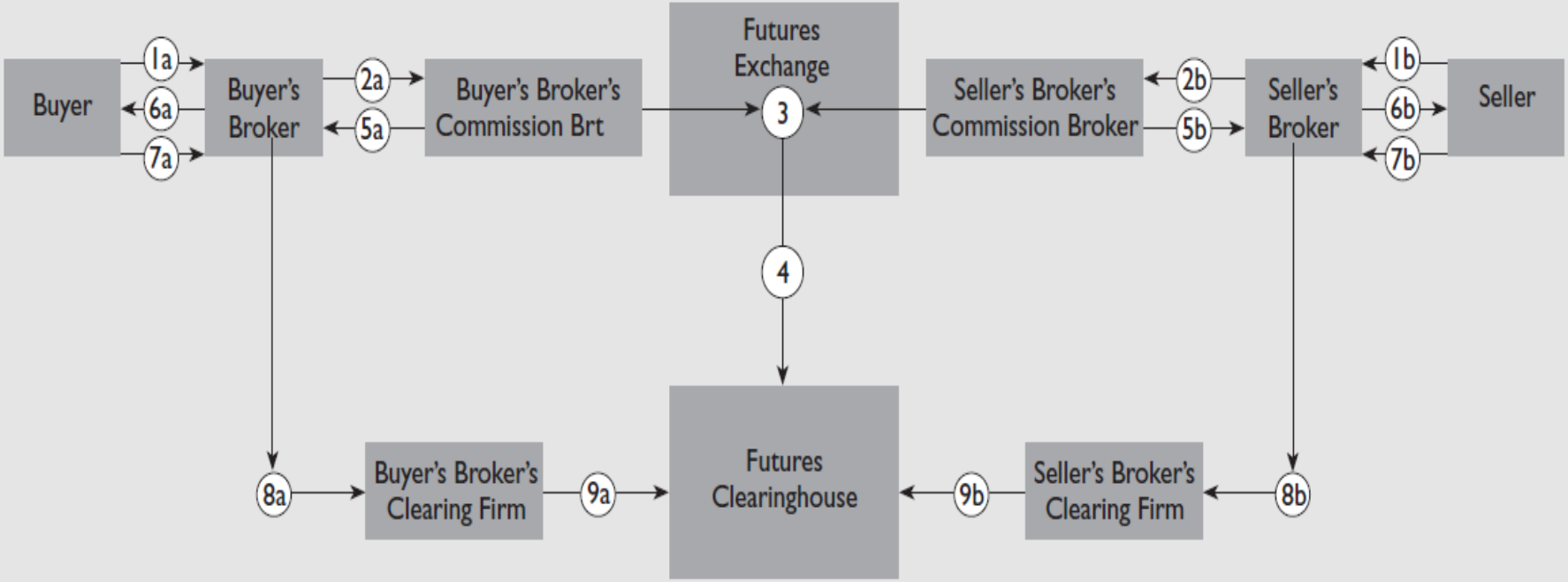
Forwards v/s Futures

Forwards	Futures
OTC in nature	Traded on organized exchanges
Customized contract terms	Standardized contract terms
Mostly was self-regulatory but swiftly shifting to regulation	Regulated through the respective exchanges
Some element of counterparty risk or default risk if CCP is not involved	No counterparty risk or default risk
Can be delivered on any date as agreed by the parties	Available for delivery only on a few specified dates in year

Forwards v/s Futures

Forwards	Futures
More than 90 percent of forward contracts are settled by actual delivery of the assets	Most of the futures contracts (about 95% to 99%) are settled without delivery
The cost of forward contracts is based on bid-ask spread	The cost of futures contracts is based on brokerage fee which is charged based on purchase and sale orders
Forward Contracts are usually quoted in European Terms (Units of local currency per US$)	Futures Contracts are usually quoted in American Terms (US$ per Unit of local currency)

A Transaction on the Futures Exchange: Under a Pit Trading System



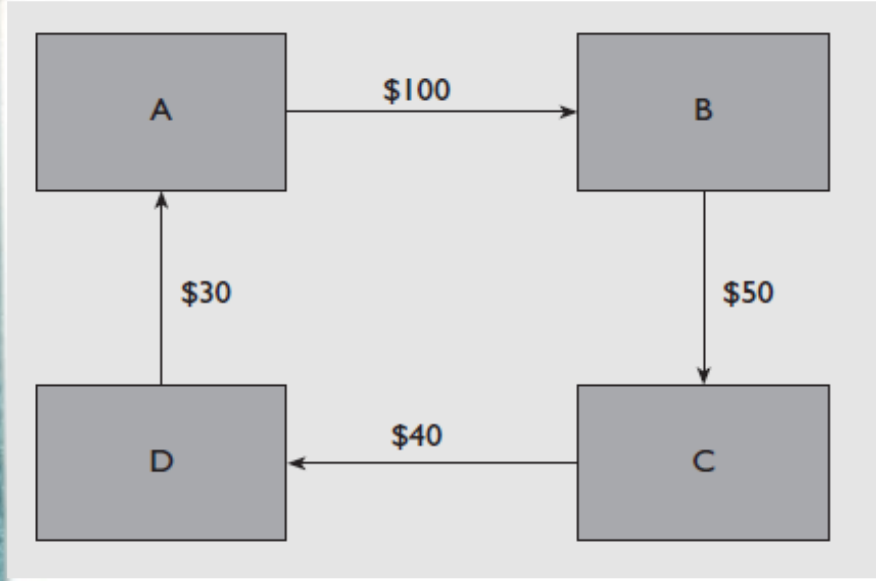
(1a)(1b) Buyer and seller instruct their respective brokers to conduct a futures transaction.
(2a)(2b) Buyer's and seller's brokers request that their firms' commission brokers execute the transaction.
(3) Both commission brokers meet in the pit on the floor of the futures exchange and agree on a price.
(4)Information on the trade is reported to the clearinghouse.
(5a)(5b) Both commission brokers report the price obtained to the buyer's and seller's brokers.
(6a)(6b) Buyer's and seller's brokers report the price obtained to the buyer and seller.
(7a)(7b) Buyer and seller deposit margin with their brokers.
(8a)(8b) Buyer's and seller's brokers deposit margin with their clearing firms.
(9a)(9b) Buyer's and seller's brokers' clearing firms deposit margin with clearinghouse.

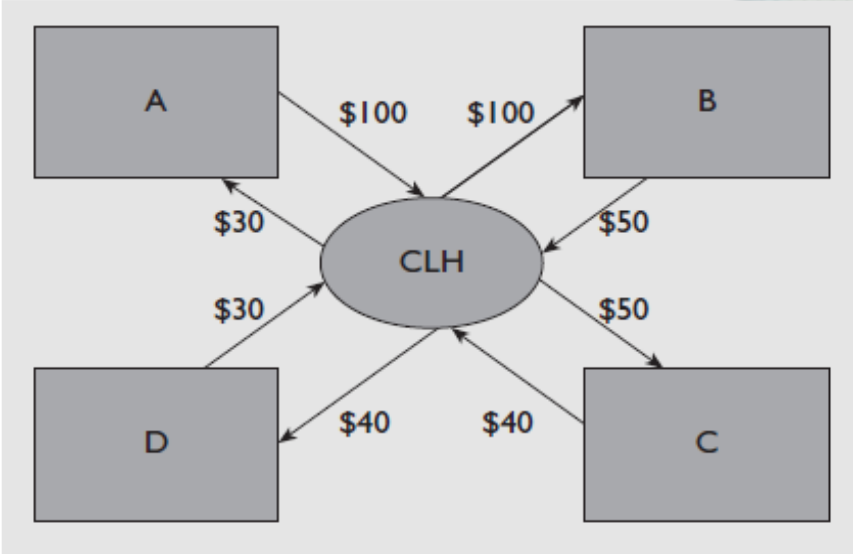
Note: Either buyer or seller (or both) could be a floor trader, eliminating the broker and the commission broker.

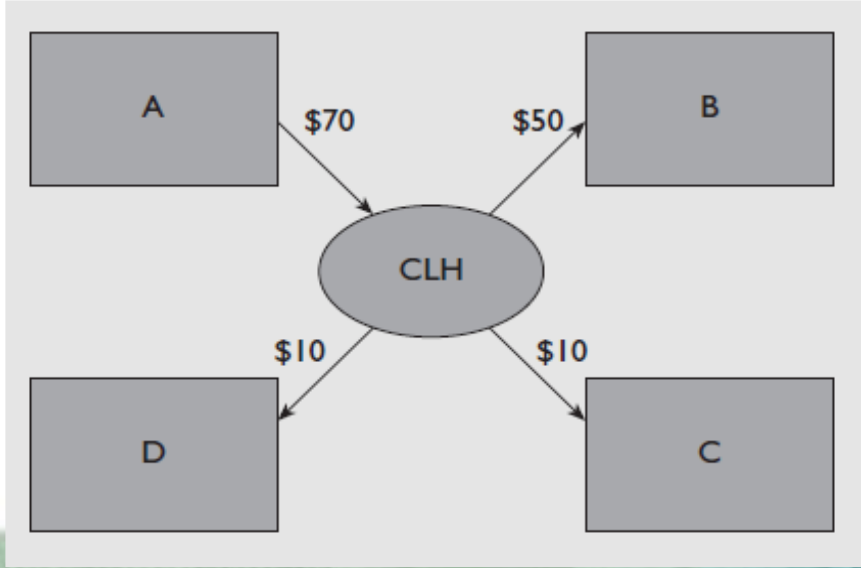
Role: Futures Clearinghouse or Clearing Exchange

- Each futures exchange operates its own independent **clearinghouse** or clearing exchange which is an independent corporation that has a number of **members** who are known (act) as **clearing firms**;
- The clearinghouse acts as an intermediary and guarantor to ensure that the buyer and the seller of a futures contract does not suffer as a result of the counterparty defaulting on its obligation;
- One of the main task of the clearinghouse is to keep track of all the transactions that take place during a day so that it can calculate the net position of each of its members;
- It guarantees the performance of the parties to each transaction by collecting some amount known as *Clearing Margin*.

How Clearinghouses Reduce Credit Risk



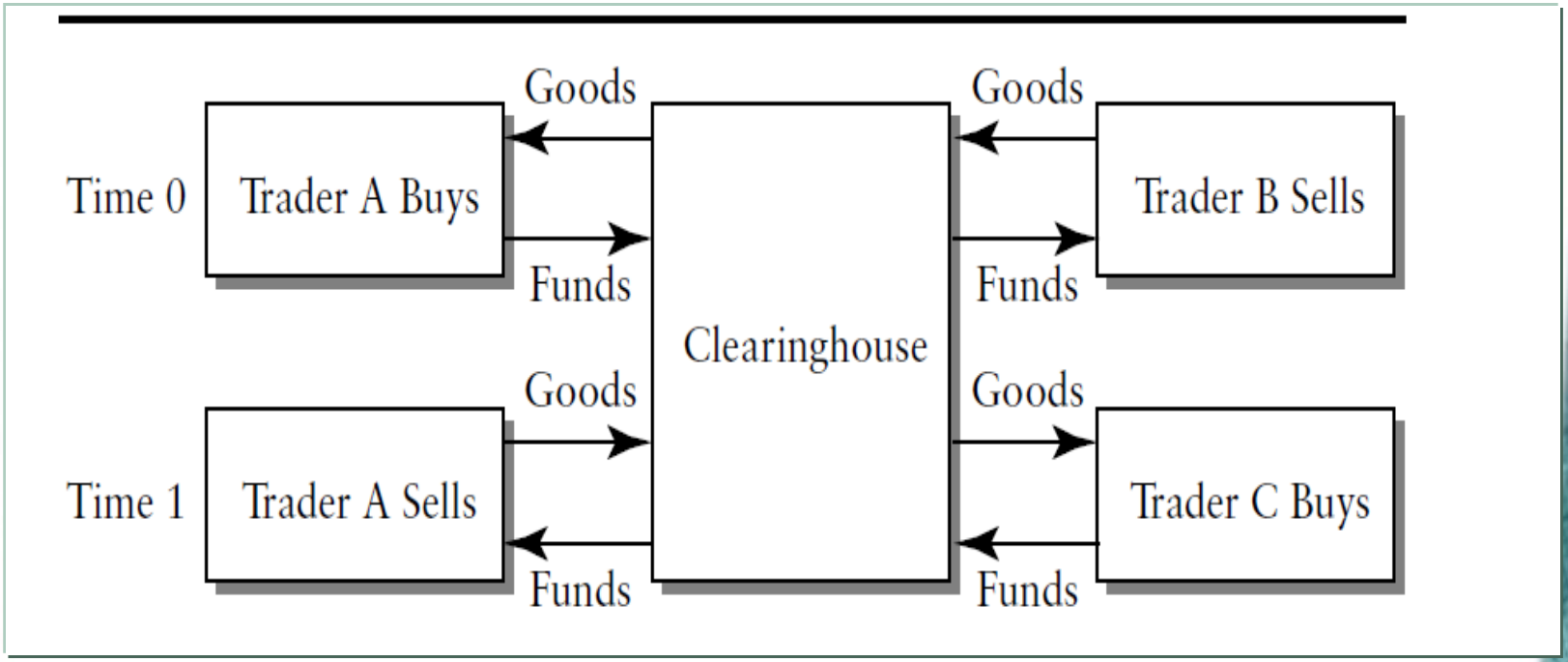




Futures: Closing Out Positions

- The vast majority of futures contracts do not lead to delivery. The reason is that most traders choose to close out their positions prior to the delivery period specified in the contract. Closing out a position means entering into the opposite trade to the original one;
- For example, the New York trader who bought a September corn futures contract on June 5 can close out the position by selling (i.e., shorting) one September corn futures contract on, say, July 20. The Kansas trader who sold (i.e., shorted) a September contract on June 5 can close out the position by buying one September contract on, say, August 25;
- In each case, the trader's total gain or loss is determined by the change in the futures price between June 5 and the day when the contract is closed out.

Mechanism of Reversing Trades



SPECIFICATION OF A FUTURES CONTRACT

- When developing a new contract, the exchange must specify in some detail the exact nature of the agreement between the two parties. In particular, it must specify the asset, the contract size (exactly how much of the asset will be delivered under one contract), where delivery can be made, and when delivery can be made and so on. The following are important:
- **Asset;**
- **Contract Size;**
- **Delivery Months;**
- **Delivery Arrangements;**
- **Price Limits and Position Limits;**

Delivery

The period during which delivery can be made is defined by the exchange and varies from contract to contract. The decision on when to deliver is made by the party with the short position, whom we shall refer to as investor A

Delivery Process: 1. Issuance of Notice of Intention*:* When investor A decides to deliver, investor A's broker issues a ***notice of intention*** to deliver to the exchange clearing house. This notice states how many contracts will be delivered and, in the case of commodities, also specifies where delivery will be made and what grade will be delivered;

2. Counterparty with long position chosen: The exchange then chooses a party with a long position to accept delivery. Suppose that the party on the other side of investor A's futures contract when it was entered into was investor B. It is important to realize that there is no reason to expect that it will be investor B who takes delivery. Investor B may well have closed out his or her position by trading with investor C, investor C may have closed out his or her position by trading with investor D, and so on.

The usual rule chosen by the exchange is to pass the notice of intention to deliver on to the party with the ***oldest*** outstanding long position. Parties with long positions must accept delivery notices. However, if the notices are transferable, long investors have a short period of time, usually half an hour, to find another party with a long position that is prepared to take delivery in place of them. In the case of a commodity, taking delivery usually means accepting a warehouse receipt in return for immediate payment. The party taking delivery is then responsible for all warehousing costs.

Delivery

For all contracts, the price paid is usually the most recent settlement price. If specified by the exchange, this price is adjusted for grade, location of delivery, and so on. The whole delivery procedure from the issuance of the notice of intention to deliver to the delivery itself generally takes about two to three days

Three critical days for a contract: These are the ***first notice day***, ***the last notice day***, and ***the last trading day***.

The first notice day is the first day on which a ***notice of intention*** to make delivery can be submitted to the exchange;

The last notice day is the last such day;

The last trading day is generally a few days before the last notice day.

To avoid the risk of having to take delivery, an investor with a long position should close out his or her contracts prior to the first notice day.

CONVERGENCE OF FUTURES PRICE TO SPOT PRICE

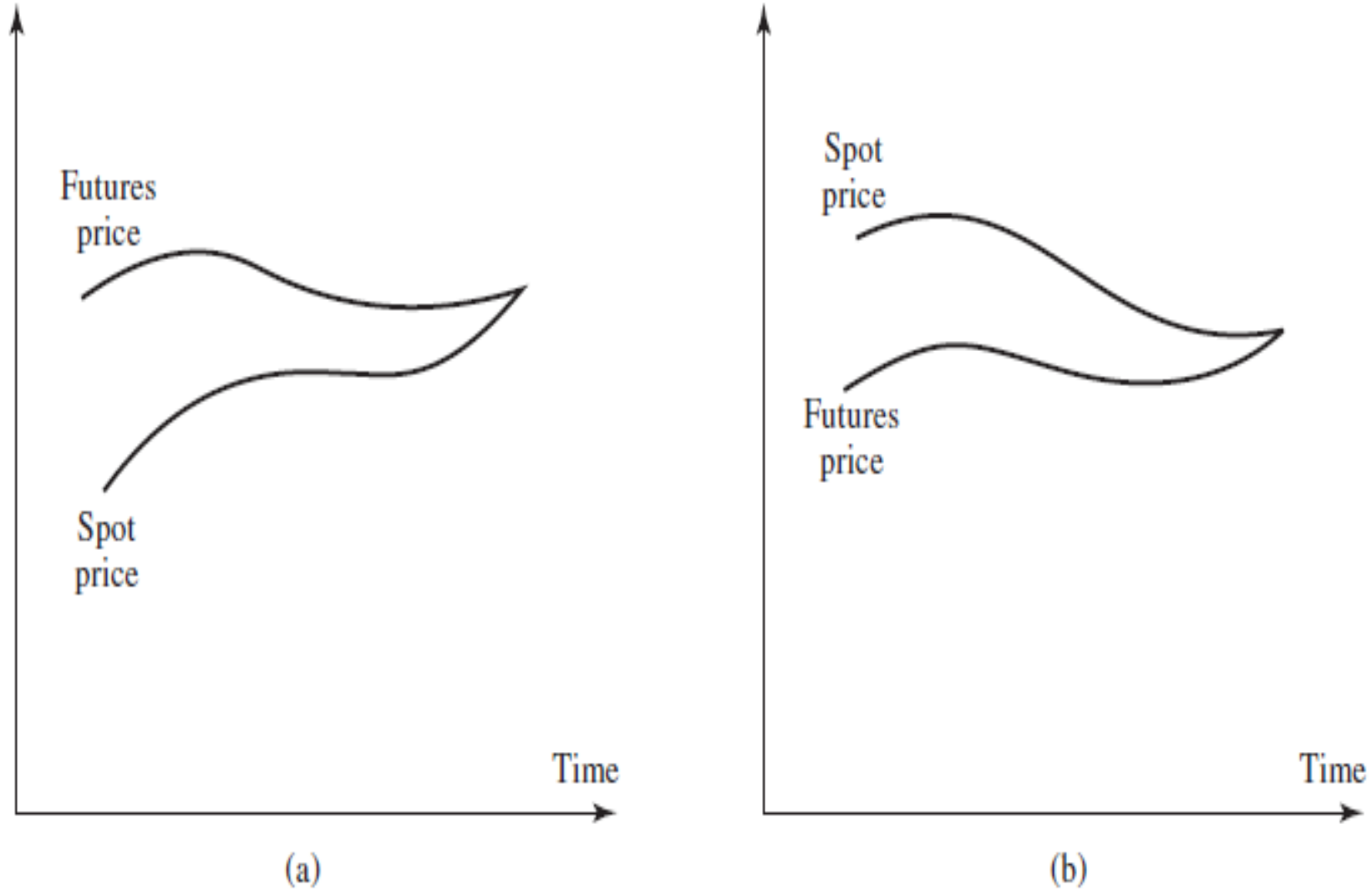
As the delivery period for a futures contract is approached, the futures price converges to the spot price of the underlying asset. When the delivery period is reached, the futures price equals—or is very close to—the spot price.

To see why this is so, we first suppose that the futures price is above the spot price during the delivery period. Traders then have a clear arbitrage opportunity:

1. Sell (i.e., short) a futures contract
2. Buy the asset
3. Make delivery.

These steps are certain to lead to a profit equal to the amount by which the futures price exceeds the spot price. As traders exploit this arbitrage opportunity, the futures price will fall. Suppose next that the futures price is below the spot price during the delivery period. Companies interested in acquiring the asset will find it attractive to enter into a long futures contract and then wait for delivery to be made. As they do so, the futures price will tend to rise.

Figure 2.1 Relationship between futures price and spot price as the delivery period is approached: (a) Futures price above spot price; (b) futures price below spot price.



TYPES OF TRADERS

TRADERS: There are mainly two types of traders executing trades:

- **Futures Commission Merchants (FCMs):** FCMs follow the instructions of their clients and charge a commission for doing so
- **Locals:** Locals are trading on their own account.

Note: Individuals taking positions, whether locals or the clients of FCMs, can be categorized as hedgers, speculators, or arbitrageurs

Speculators can be classified:

Scalpers: Scalpers are watching for very short-term trends and attempt to profit from small changes in the contract price. *They usually hold their positions for only a few minutes*

Day Traders: *Day traders hold their positions for less than one trading day*. They are unwilling to take the risk that adverse news will occur overnight

Position Traders: *Position traders hold their positions for much longer periods of time*. They hope to make significant profits from major movements in the markets

TYPES OF TRADERS

1. MARKET ORDER: Instructing your broker to buy or sell immediately at best available price (this is the prevailing market price). Some amount of risk and uncertainty is associated with the price.

Buy Market Order: If it was buy order it can be very well the case that the price which at which it gets executed is greater that the price investor expected

Sell Market Order: If it was sell order it can be very well the case that the price which at which it gets executed is lower that the price investor expected

Note: Guarantee of execution but no control of price.

2. LIMIT ORDER:

Buy Limit Order: A buy limit order is an instruction by the investor instructing the broker to enter into a buy transaction in futures market at a prices which is less than or equal to a pre-specified price say S_{LIMIT} ("no more" than S_{LIMIT}). This means the broker cannot execute the order if the price is more than S_{LIMIT} price

Sell Limit Order: A sell limit order is an instruction by the investor instructing the broker to enter into a sell transaction in futures market at a prices which is greater than or equal to a pre-specified price say S_{LIMIT} ("no less" than S_{LIMIT}). This means the broker cannot execute the order if the price is less than S_{LIMIT} price

Note: No guarantee of execution but control of price.

3. STOP LOSS ORDER/STOP ORDER:

Sitting on an existing long position: If the investor is sitting on a long position starts making losses if the price goes down. This order is used to close out position to limit loss/protect a profit. Investor will be instructing the broker to enter into an offsetting short position as soon as the price falls below say S^* (stop price). In a stop loss order, investor will be specifying the stop price (S*), instructing the broker to enter into an offsetting short position as soon as the price falls below S*. If the price related condition gets satisfied than a stop loss order automatically becomes a market order. If the spot price (S^0) any point in time touches or crosses S*, the broker has to treat the order as market order

Sitting on an existing short position: If the investor is sitting on a short position starts making losses if the price goes up. This order is used to close out position to limit loss/protect a profit. Investor will be instructing the broker to enter into an offsetting long position as soon as the price rises above say S^* (stop price). In a stop loss order, investor will be specifying the stop price (S*), instructing the broker to enter into an offsetting long position as soon as the price rises above S*. If the price related condition gets satisfied than a stop loss order automatically becomes a market order. If the spot price (S^0) any point in time touches or crosses S*, the broker has to treat the order as market order.

Note: Price uncertainty, no control of price- **investor may suffer a greater loss than the calculated loss at S***, no uncertainty with closing out the position.

4. STOP LIMIT ORDER: To control about the uncertainty of final loss realised by the investor, the investor can use STOP LIMIT ORDER, a combination of LIMIT order and STOP order. Therefore, investor has to specify two different prices. The investor has to specify S* for STOP order and S_{LIMIT} for the LIMIT order. Thus, this is an order which converts into a LIMIT order as soon as the price related condition w.r.t S* is satisfied. Investor has more control over final realised loss because you will only allow your broker to enter into an offsetting position if an only if the price is better than the LIMIT price.

Note: There is no guarantee of executing the order at the end. It might happen that the condition w.r.t. S* is satisfied, the order becomes a LIMIT Order, but because the price never went into the favourable region determined by S_{LIMIT} , the broker may not able to enter into offsetting transaction.

4. MARKET IF TOUCHED ORDER (BOARD ORDER): It is essentially a market order provided the price touches **"if touched"** level. So in **"market if touched"** order investor will be specifying a price say S* treating this price to be some kind of boundary where favourable prices start.

Sell order: In a market if touched order if its a SELL order, essentially what will happen is that if price is S_0 and the prices rise overtime and touches or crosses S*, the order becomes a market order.

Buy order: In a market if touched order if its a BUY order, essentially what will happen is that if price is S_0 and the prices goes down overtime and touches or crosses S*, the order becomes a market order.

5. DISCREATIONARY ORDER/MARKET-NOT-HELD: Order in which the investor leaves it to the broker's discretion as to when the broker wants to fill the order

6. TIME-OF-DAY ORDER: Investor tells the broker the time of the day (window of time) within which the order has to be executed.

7. OPEN ORDER/GOOD-TILL-CANCELLED: This order stays alive or open till it is finally executed or let say we arrive at the last trading day in futures market

8. KILL ORDER: Kill is an order not to be executed at all.

Mechanics of Futures Trading

(The Marking-to-Market Practice)

- The futures contract requires certain margins called Margin Requirements (now called as **Performance Bonds** by CME);
- Before placing an order to trade futures contracts, an investor must open an account known as **Margin Account** with his broker;
- The amount that must be deposited at the time the contract is entered into is known as the **Initial Margin** (now called as **Initial Performance Bond** by CME) and is usually about 2% of contract value;
- To ensure that the balance in the margin account never becomes negative a **Maintenance Margin** (now called as **Maintenance Performance Bond** by CME) which is somewhat lower (about 75% of IPB) than the initial margin is set

Mechanics of Futures Trading

(The Marking-to-Market Practice)

- If the balance in the **margin account** falls below the maintenance margin, the investor receives a **Margin Cal**l (now called as **Performance Bond Call** by CME) and is expected to top up the margin account to the **initial margin level** the next day;
- The extra funds deposited is known as **Variation Margin**;
- At the end of each trading day, the margin account is adjusted to reflect the investor's gain or loss (**Marking- to-Market or Mark-to-Market);**

Note: A forward contract is settled at the end of its life, a futures contract is settled daily. At the end of each day, the investor's gain (loss) is added to (subtracted from) the margin account, bringing the value of the contract back to zero. A futures contract is in effect closed out and rewritten at a new price each day

The Clearinghouse and Clearing Margins

Just as an investor is required to maintain a margin account with a broker, the broker is required to maintain a margin account with a *clearinghouse member* (known as clearing firms) and the clearinghouse member is required to maintain a margin account with clearinghouse (which is sometimes referred to as ***clearing margin);***

The margin accounts for clearinghouse members are adjusted for gains and losses at the end of each trading day in the same way as are the margin accounts of investors. For clearinghouse members, there is an original margin but no maintenance;

The Clearinghouse and Clearing Margins

Every day the account balance for each contract must be maintained at an amount equal to the original margin times the number of contracts outstanding;

In determining initial margin, the number of contracts outstanding is usually calculated on a net basis. This means that short positions the clearing house member is handling for clients are offset against long positions

Suppose, for example, that the clearing house member has two clients: one with a long position in 20 contracts, the other with a short position in 15 contracts. The initial margin would be calculated on the basis of 5 contracts.

Example of Futures Trading

(The Marking-to-Market Practice)

1. Consider an investor who contacts his broker on Thursday, June 5 to buy two December Gold futures contracts on the CME and closes out on June 26. The current futures price is $600 per ounce and the contract size is 100 ounces. The broker requires the investor to deposit $2000 per contract as initial margin and the maintenance margin is $1500 per contract. The settlement prices (futures prices) at the close of everyday trading for June 5 through June 26 are given below:

Settlement Prices (futures price) at the close of everyday trading for June 5 through June 26

Day Close	Futures Price ($)
5-Jun	$600.00
5-Jun	$597.00
6-Jun	$596.10
9-Jun	$598.20
10-Jun	$597.10
11-Jun	$596.70
12-Jun	$595.40
13-Jun	$593.30
16-Jun	$593.60
17-Jun	$591.80
18-Jun	$592.70
19-Jun	$587.00
20-Jun	$587.00
23-Jun	$588.10
24-Jun	$588.70
25-Jun	$591.00
26-Jun	$592.30

The daily cash flows and performance bond calls on Long investor's account

Day	*Futures price* ($)	*Daily gain (loss)* ($)	*Cumulative gain (loss)* ($)	*Margin account balance* ($)	*Margin call* ($)
	600.00			4,000	
June 5	597.00	(600)	(600)	3,400	
June 6	596.10	(180)	(780)	3,220	
June 9	598.20	420	(360)	3,640	
June 10	597.10	(220)	(580)	3,420	
June 11	596.70	(80)	(660)	3,340	
June 12	595.40	(260)	(920)	3,080	
June 13	593.30	(420)	(1,340)	2,660	1,340
June 16	593.60	60	(1,280)	4,060	
June 17	591.80	(360)	(1,640)	3,700	
June 18	592.70	180	(1,460)	3,880	
June 19	587.00	(1,140)	(2,600)	2,740	1,260
June 20	587.00	0	(2,600)	4,000	
June 23	588.10	220	(2,380)	4,220	
June 24	588.70	120	(2,260)	4,340	
June 25	591.00	460	(1,800)	4,800	
June 26	592.30	260	(1,540)	5,060	

Example of Futures Trading

(The Marking-to-Market Practice)

2. Consider an investor who contacts his or her broker to buy two December gold futures contracts on the New York Mercantile Exchange (NYMEX), which is part of the CME Group. Suppose that the current futures price is $1,450 per ounce. One contract size is 100 ounces. The initial margin is $6,000 per contract and the maintenance margin is $4500 per contract. The contract is entered into on Day 1 at $1,450 and closed out on Day 16 at $1,426.90. The settlement prices (futures prices) at the close of everyday trading for day 1 through day 16 are given below:

Settlement Prices (futures price) at the close of everyday trading for day 1 through day 16

Day Close	Futures Price ($)
1	1,450.00
1	1,441.00
2	1,438.30
3	1,444.60
4	1,441.30
5	1,440.10
6	1,436.20
7	1,429.90
8	1,430.80
9	1,425.40
10	1,428.10
11	1,411.00
12	1,411.00
13	1,414.30
14	1,416.10
15	1,423.00
16	1,426.90

The daily cash flows and performance bond calls on Long investor's account

Day	*Trade price ($)*	*Settlement price ($)*	*Daily gain ($)*	*Cumulative gain ($)*	*Margin account balance ($)*	*Margin call ($)*
1	1,450.00				12,000	
1		1,441.00	−1,800	−1,800	10,200	
2		1,438.30	−540	−2,340	9,660	
3		1,444.60	1,260	−1,080	10,920	
4		1,441.30	−660	−1,740	10,260	
5		1,440.10	−240	−1,980	10,020	
6		1,436.20	−780	−2,760	9,240	
7		1,429.90	−1,260	−4,020	7,980	4,020
8		1,430.80	180	−3,840	12,180	
9		1,425.40	−1,080	−4,920	11,100	
10		1,428.10	540	−4,380	11,640	
11		1,411.00	−3,420	−7,800	8,220	3,780
12		1,411.00	0	−7,800	12,000	
13		1,414.30	660	−7,140	12,660	
14		1,416.10	360	−6,780	13,020	
15		1,423.00	1,380	−5,400	14,400	
16	1,426.90		780	−4,620	15,180	

Currency Futures

On Tuesday morning, an investor takes a long position in a Swiss franc currency futures contract containing SFr1,25,000 at a price of $0.75 that matures on Thursday afternoon. The broker requires a performance bond of $1,890 and a maintenance performance bond of $1,400. The settlement prices for Tuesday through Thursday are $0.755, $0.743, $0.74 respectively. Calculate the daily cash flows on investor's account and show the performance bond calls on investor's account.

The daily cash flows and performance bond calls on long investor's account (Contract Size= SFr1,25,000, IM=$1,890 & MM=$1,400)					
Day	Futures Price ($)	Daily gains (loss) ($) (Mark-to-market)	Cumulative gain (loss) ($)	Margin account balance ($)	Margin call ($)
TUE	$0.750			1890	
TUE	$0.755	625	625	2515	
WED	$0.743	(1500)	(875)	1015	+875
THU	$0.740	(375)	(1250)	1515	Trade Closes

The Daily Cash Flows on long investor's account:

TIME	ACTION	CASH FLOWS ON SFr Futures
TUE (MORNING) Futures price =$0.750	Investor buys SFr futures contract that matures on Thursday @ $0.750/1SFr	NONE
TUE (CLOSE) Futures price =$0.755	Futures price rises to $0.755/1SFr ($-Depreciated, SFr-Appreciated) (1) Position mark-to-market	(1) Investor Receives 125000X(0.755-0.750) =+$625 (profit)
WED (CLOSE) Futures price =$0.743	Futures price drops to $0.743/1SFr ($-Appreciated, SFr-Depreciated) (1) Position mark-to-market	(1) Investor Pays 125000X(0.743-0.755) = -$1500 (loss)
THU (CLOSE) Futures price =$0.740	Futures price drops to $0.740/1SFr ($-Appreciated, SFr-Depreciated) (1) Position mark-to-market (2) Investor takes the delivery of SFr 125000	(1) Investor Pays 125000X(0.740-0.743) = -$375 (loss) (2) Investor pays 125000X0.740 =$92,500

Net Profit/Loss to the Long Investor = +$625-($1500+$375) = -$1250 Loss

Currency Futures

On Monday morning, you short one CME yen futures contract containing ¥12,500,000 at a price of $0.009433. Suppose the broker requires an initial performance bond of $4,000 and a maintenance performance bond of $3,400. The settlement prices for Monday through Thursday are $0.009542, $0.009581, $0.009375, and $0.009369, respectively. On Friday, you close out the contract at a price of $0.009394. Calculate the daily cash flows on your account. Describe any performance bond calls on your account. What is your cash balance with your broker as of the close of business on Friday? Assume that you begin with an initial balance of $4,590 and that your round-trip commission was $27.

The daily cash flows and performance bond calls on short investor's account (Contract Size= ¥12,500,000 , IM=$4000 & MM=$3400) Investor begins with an initial balance of $4,590

Day	Futures Price ($)	Daily gains (loss) ($) (Mark-to-market)	Cumulative gain (loss) ($)	Margin account balance ($)	Margin call ($)
MON	$0.009433			$4590.00	
MON	$0.009542	($1,362.50)	($1,362.50)	$3227.50	+$772.50
TUE	$0.009581	($487.50)	($1850.00)	$3512.50	
WED	$0.009375	+ $2575.00	$725.00	$6087.50	
THU	$0.009369	+$75.00	$800.00	$6162.50	
FRI	$0.009394	−$312.50	487.50	$5850.00	Trade Closes
FRI	You pay out a round-trip commission $-27		$460.50	$5823.00	

The Daily Cash Flows on short investor's account:

TIME	ACTION	CASH FLOWS ON FUTURES CONTRACT
MON (MORNING) Futures price =$0.009433	Investor sells one CME yen futures @ $0.009433/1¥	NONE
MON (CLOSE) Futures price = $0.009542	Futures price rises to $0.009542/1¥ ($-Depreciated, ¥-Appreciated) (1) Position mark-to-market	(1) Investor Pays 12500000X(0.009433 − 0.009542)= -$1,362.50 (Loss)
TUE (CLOSE) Futures price = $0.009581	Futures price rises to $0.009581/1¥ ($-Depreciated, ¥-Appreciated) (1) Position mark-to-market	(1) Investor Pays 12500000X(0.009542 − 0.009581) = -$487.500 (Loss)
WED (CLOSE) Futures price = $0.009375	Futures price drops to $0.009375/1¥ ($-Appreciated, ¥-Depreciated) (1) Position mark-to-market	(1) Investor Receives 12500000X($0.009581-$0.009375) = **+ $2575 (Profit)**
THU (CLOSE) Futures price = $0.009369	Futures price drops to $0.009369/1¥ ($-Appreciated, ¥-Depreciated) (1) Position mark-to-market	(1) Investor Receives 12,500,000 × (0.009375 − 0.009369)= **+$75.00 (Profit)**
FRI (CLOSE) Futures price = $0.009394 Investor closes out the contract at a futures price of $0.009394	Futures price rises to $0.009394/1¥ ($-Depreciated, ¥-Appreciated) (1) Position mark-to-market	(1) Investor Pays 12500000 × (0.009369 − 0.009394)= **−$312.50 (Loss)** You pay out a round-trip commission= **−$27.00** Net gain on the futures contract $460.50

Treasury Bond Futures

Assume that on Friday August 1, you sell one CBOT September Treasury bond futures contract at the opening price of $97843.75. One such contract is for a face value of $100,000. The initial margin requirement is $2,500 and the maintenance margin requirement is $2000. You maintain your position every day through Friday, August 15, and then buy back the contract at the opening price of Monday August 18. The settlement prices (futures prices) at the close of everyday trading for August 1 through August 18 are given below. Show the daily cash flows and performance bond calls on short investor's account for the September Treasury bond futures contract.

Settlement Prices (futures price) at the close of everyday trading for August 1 through August 18	
Day	**Futures Price ($)**
	97843.75
Aug 1	**97406.25**
Aug 4	**97781.25**
Aug 5	**96562.50**
Aug 6	**96218.75**
Aug 7	**97156.25**
Aug 8	**99093.75**
Aug 11	**101031.25**
Aug 12	**99781.25**
Aug 13	**101031.25**
Aug 14	**100781.25**
Aug 15	**100781.25**
Aug 18	**100500.00**

The daily cash flows and performance bond calls on short investor's account (IM=$2500 & MM=$2000)

Day	Futures Price ($)	Daily gains (loss) ($) (Mark-to-market)	Cumulative gain (loss) ($)	Margin account balance ($)	Margin call ($)
	97843.75			2500	
Aug 1	97406.25				
Aug 4	97781.25				
Aug 5	96562.50				
Aug 6	96218.75				
Aug 7	97156.25				
Aug 8	99093.75				
Aug 11	101031.25				
Aug 12	99781.25				
Aug 13	101031.25				
Aug 14	100781.25				
Aug 15	100781.25				
Aug 18	100500.00				

The daily cash flows and performance bond calls on short investor's account (IM=$2500 & MM=$2000)

Day	Futures Price ($)	Daily gains (loss) ($) (Mark-to-market)	Cumulative gain (loss) ($)	Margin account balance ($)	Margin call ($)
	97843.75			2500	
Aug 1	97406.25	437.50	437.50	2937.50	
Aug 4	97781.25	(375.00)	62.50	2562.50	
Aug 5	96562.50	1218.75	1281.25	3781.25	
Aug 6	96218.75	343.75	1625.00	4125.00	
Aug 7	97156.25	(937.50)	687.50	3187.50	
Aug 8	99093.75	(1937.50)	(1250.00)	1250.00	+1250.00
Aug 11	101031.25	(1937.50)	(3187.50)	562.50	+1937.50
Aug 12	99781.25	1250.00	(1937.50)	3750.00	
Aug 13	101031.25	(1250.00)	(3187.50)	2500.00	
Aug 14	100781.25	250.00	(2937.50)	2750.00	
Aug 15	100781.25	0.00	(2937.50)	2750.00	
Aug 18	100500.00	281.25	(2656.25)	3031.25	

Treasury Bond Futures

August 1: The short investor has a profit because September Treasury Bond Futures which the investor contracted to sell at $97843.75, can now be sold for only $97406.25 (treasury bond price decreased) in the spot market. So he makes a profit of ($97843.75- $97406.25=$437.50).

August 4: The investor has a loss because September Treasury Bond Futures which the investor contracted to sell at $97406.25, can now however be sold for $97781.25 (treasury bond price increased) in the spot market. So he makes a loss of ($97406.25-$97781.25=-$375.00)

Speculation using Futures

Consider a US speculator who in February thinks that the British pound will strengthen relative to the US dollar over the next 2 months and is prepared to back that hunch to the tune of £250,000. The current exchange rate in February is $1.5470/1£ and the April futures price is $1.5410/1£

Two alternate investment opportunities are available:

1. Speculation in the Spot Market: Purchase £250,000 in the spot market at the spot rate of $1.5470/1£ in the hope that the sterling can be sold later at a higher price. (The sterling once purchased would be kept in an interest-bearing account);

2. Speculation in the Futures Market: Take a long position in four CME April futures contracts on sterling at a futures price $1.5410/1£. (One futures contract is for the purchase of £62,500).

Payoff: Speculation using Spot and Futures Contracts

Speculation using spot and futures contracts. One futures contract is on £62,500. Initial margin on four futures contracts = $20,000 @ $5000 per contract:

	Possible trades	
	Buy £250,000 *Spot price = 1.5470*	*Buy 4 futures contracts* *Futures price = 1.5410*
Investment	$386,750	$20,000
Profit if April spot = 1.6000	$13,250	$14,750
Profit if April spot = 1.5000	–$11,750	–$10,250

HEDGING STRATEGIES USING FUTURES

Hedging Strategies using Futures

General Issues: When is a short futures position appropriate? When is a long futures position appropriate? Which futures contract should be used? What is the optimal size of the futures position for reducing risk?

Hedge-and-forget strategies:

Hedge-and-forget strategies: We assume that no attempt is made to adjust the hedge once it has been put in place. The hedger simply takes a futures position at the beginning of the life of the hedge and closes out the position at the end of the life of the hedge. We initially treat futures contracts as forward contracts (that is, ignoring daily settlement). Later, we will learn an adjustment known as ‘‘tailing the hedge’’ that takes account of the difference between futures and forwards.

Hedging Strategies using Futures

1. **Long Hedge and**
2. **Short Hedge**

Long Hedges: The purchase of a futures contract to protect against the possibility of rise in the price of assets/securities or commodities that will be bought in the near future;

Short Hedges: The sale of a futures contract to protect against the possibility of decline/fall in the price of assets/securities or commodities that will be sold in the near future

Perfect Hedge: A perfect hedge is one that completely eliminates the risk involved

- Hedging
  - **Long Hedges**: When you need to buy a product (asset) in the future and are concerned about an increase in price and would like to protect against a rise in price. E.g, An oil company try to secure oil in the future. An importer needs to secure home currency to make a foreign payment in the future. (Importer makes payment in foreign currency and is concerned about the depreciation of home currency);
  - **Short Hedges:** When you need to sell a product (asset) and are worried about a decrease in price and would like to protect against a fall in price. E.g, A farmer would like to fix the future selling price of his crop today. An exporter would like to fix today the selling price of foreign currency he expects to receive in the future (Exporter receives payment in foreign currency and is concerned about the depreciation of foreign currency).
- Speculation
  - Go Long if you believe price will rise (Bullish) …
  - Go Short if you believe price will fall (Bearish)…

Summary of Futures Hedging Strategies

Situation Today	Risk	Appropriate Hedge
Hold Asset/ May Hold Asset	Asset Price May Fall	Short Hedge (Short (sell) Futures)
Plan/Need to Buy Asset	Asset Price May Rise	Long Hedge (Long (buy) Futures)

Closing out positions on Maturity:

1. **Short Hedge: Short Hedge means Short Futures and Long Spot**
2. **Long Hedge: Long Hedge means Long Futures and Short Spot**

(Because futures price and spot price are expected to converge on maturity)

Example 1A: Hedging in the Futures Market (Short Hedge)

On May 15 an Oil producer has just negotiated a contract to sell 1 million barrels of crude oil. The spot price on May 15 is $80 per barrel and the August crude oil futures price on the New York Mercantile Exchange (NYMEX) is $79 per barrel. It has been agreed that the price that will apply in the contract is the market price on August 15. Each futures contract on NYMEX is for the delivery of 1000 barrels. The spot price on August 15 proves to be $75 per barrel.

Selling 1000 crude oil futures contracts on May 15

	Spot Market	Futures Market for Aug 15 delivery
Price per barrel	$80	$79
Cost of 1 million barrels of crude oil	$80 million	$79 million
Action Taken	None	Sell 1000 Aug 15 crude oil futures contract

Reversing the earlier futures contracts on Aug 15

	Spot Market	Futures Market for Aug 15 delivery
Price per barrel	$75	$75
Cost of 1 million barrels of crude oil	$75 million	$75 million
Action Taken	Sell 1 million barrels and realize $75 million	Buy 1000 Aug 15 crude oil futures contract

Payoff from Spot Market

	Aug 15	May 15
	Sell 1000 barrels of crude oil @$75 =$75 million	He would have sold 1000 barrels of crude oil @$80 =$80 million
Gain/Loss in Spot Market	Loss of $5 million ($75 million-$80 million)	

Payoff from Futures Market

	Aug 15	May 15
	Buy 1000 crude oil futures contract @$75 =$75 million	Sold 1000 crude oil futures contract @$79 =$79 million
Gain/Loss in Futures Market	Gain of $4 million ($79 million-$75 million)	

Net Payoff from Spot and Futures Market

Net Payoff from Spot and Futures Market:

Loss $1 million ($5m - $4m). The total amount realized from both the futures position and the sales contract is therefore approximately $79 per barrel or $79 million in total.

Basis: Difference between the spot rate/price and the futures rate/price prevailing on the day the futures contract is liquidated is known as Basis. It narrows toward zero as the contract moves toward maturity

Example 1B: Hedging in the Futures Market (Short Hedge)

On May 15 an Oil producer has just negotiated a contract to sell 1 million barrels of crude oil. The spot price on May 15 is $80 per barrel and the August crude oil futures price on the New York Mercantile Exchange (NYMEX) is $79 per barrel. It has been agreed that the price that will apply in the contract is the market price on August 15. Each futures contract on NYMEX is for the delivery of 1000 barrels. The spot price on August 15 proves to be $85 per barrel.

Selling 1000 crude oil futures contracts on May 15

	Spot Market	Futures Market for Aug 15 delivery
Price per barrel	$80	$79
Cost of 1 million barrels of crude oil	$80 million	$79 million
Action Taken	None	Sell 1000 Aug 15 crude oil futures contract

Reversing the earlier futures contracts on Aug 15

	Spot Market	Futures Market for Aug 15 delivery
Price per barrel	$85	$85
Cost of 1 million barrels of crude oil	$85 million	$85 million
Action Taken	Sell 1 million barrels and realize $85 million	Buy 1000 Aug 15 crude oil futures contract

Payoff from Spot Market

	Aug 15	May 15
	Sell 1000 barrels of crude oil @$85 =$85 million	He would have sold 1000 barrels of crude oil @$80 =$80 million
Gain/Loss in Spot Market	Gain of $5 million ($85 million-$80 million)	

Payoff from Futures Market

	Aug 15	May 15
	Buy 1000 crude oil futures contract @$85 =$85 million	Sold 1000 crude oil futures contract @$79 =$79 million
Gain/Loss in Futures Market	Loss of $6 million ($79 million-$85 million)	

Net Payoff from Spot and Futures Market

Net Payoff from Spot and Futures Market:

Loss $1 million ($5m - $6m). The total amount realized from both the futures position and the sales contract is therefore approximately $79 per barrel or $79 million in total.

Basis: Difference between the spot rate/price and the futures rate/price prevailing on the day the futures contract is liquidated is known as Basis. It narrows toward zero as the contract moves toward maturity

Example 2: Hedging in the Futures Market (Long Hedge)

On February 1, an American firm imports 5,000 Swiss watches at a cost of SFr250,000 with payment and delivery due on March 1. The Swiss firm, being a tough negotiator, has demanded that the payment be made in Swiss francs upon the delivery of the watches. On February 1, the exchange rates are $0.6667 per franc in the spot market and $0.6655 per franc in the futures market for delivery on March 15. The exchange rates are $0.7658 per franc in the spot market and $0.7650 per franc in the futures market on March 1 respectively. Each futures contract is for the delivery of SFr1,25,000.

Buying Two Franc Futures Contracts on February 1		
	Spot Market	Futures Market for Mar 1 delivery
Exchange Rate	$0.6667/SFr	$0.6655/SFr
Cost of SFr 2,50,000	$1,66,675	$1,66,375
Action Taken	None	Buy two March 15 Swiss francs futures contract

Reversing the Earlier Futures Contracts on March 1		
	Spot Market	Futures Market for Mar 1 delivery
Exchange Rate	$0.7658	$0.7650
Cost of SFr 2,50,000	$1,91,450	$1,91,250
Action Taken	Buy SFr 2,50,000	Sell two March 15 Swiss francs futures contract

Payoff from Spot Market

	Mar 1	Feb 1
	Buy SFr 2,50,000 @$0.7658 for $1,91,450	He would have bought SFr 2,50,000 @$0.6667/SFr for $1,66,675
Gain/Loss in Spot Market	Loss of $ 24,775 ($166675-$191450)	

Payoff from Futures Market

	Mar 1	Feb 1
	Sell two Swiss Franc futures contract @$0.7650/SFr for $1,91,250	Buy two Swiss Franc futures contract @$0.6655/SFr for $1,66,375
Gain/Loss in Futures Market	Gain of $24,875 ($1,91,250-$1,66,375)	

Net Payoff from Spot and Futures Market

Net Payoff from Spot and Futures Market: Gain $100 ($24,875 - $24,775).

Basis: Difference between the spot rate/price and the futures rate/price prevailing on the day the futures contract is liquidated is known as Basis. It narrows toward zero as the contract moves toward maturity

Basis and Basis Risk

In practice, hedging is often not straightforward due to the following reasons:

1. The hedge may require the futures contract to be closed out before its delivery month;
2. The asset whose price is to be hedged may not be exactly the same as the asset underlying the futures contract;
3. The hedger may be uncertain as to the exact date when the asset will be bought or sold

These problems give rise to what is termed **BASIS RISK**

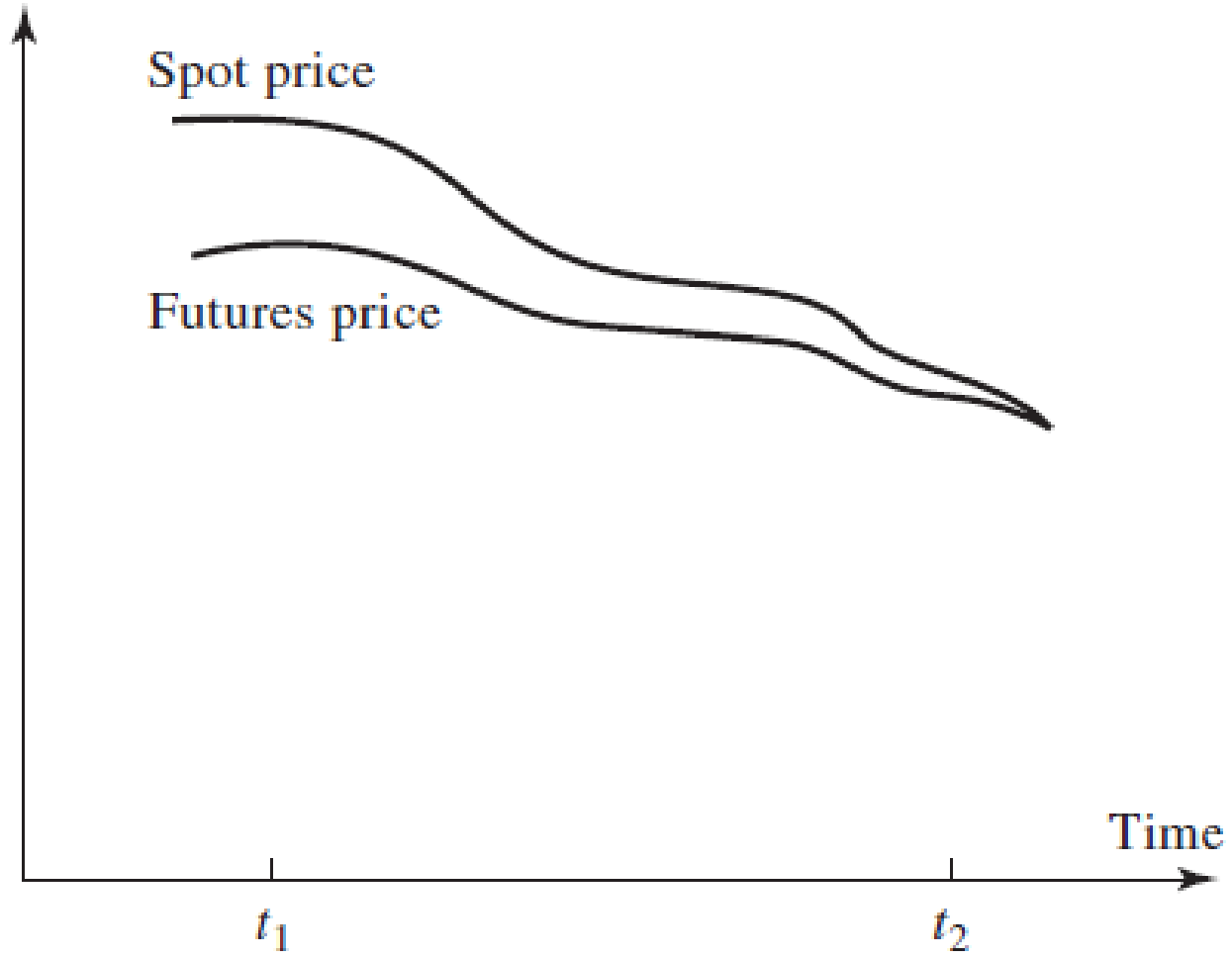
Basis and Basis Risk

- **Basis** is the difference between the spot price and futures price when the futures contract is liquidated. The basis in a hedging situation is as follows:

Basis = Spot price of asset to be hedged-Futures price of contract used

- Basis risk arises because of the *uncertainty* about the basis when the hedge is closed out;
- If the asset to be hedged and the asset underlying the futures contract are the same, the basis should be ZERO at the expiration of the futures contract;
- However, ***prior to expiration***, the basis may be positive or negative. As time passes, the spot price and the futures price for a particular month do not necessarily change by the same amount. As a result, the basis changes;
- An increase in the basis is referred to as a ***strengthening of the basis*****;** a decrease in the basis is referred to as a ***weakening of the basis***

Figure below illustrates how a basis might change over time in a situation where the basis is positive prior to expiration of the futures contract:



Nature of Basis Risk

To examine the nature of basis risk, we will use the following notation:

S_1: Spot price at time t_1

S_2: Spot price at time t_2

F_1: Futures price at time t_1

F_2: Futures price at time t_2

b_1: Basis at time t_1

b_2: Basis at time t_2.

We will assume that a hedge is put in place at time t_1 and closed out at time t_2. From the definition of the basis, we have:

$$b_1 = S_1 - F_1 \quad \text{and} \quad b_2 = S_2 - F_2$$

Short Hedge

- Consider first a situation of a hedger who knows that the asset will be sold at time t_2 and takes a short futures position at time t_1:
- We define:

  F_1 : Initial Futures Price

  F_2 : Final Futures Price

  S_2 : Final Asset Price

<u>If you hedge the future sale of an asset by entering into a short futures contract then:</u>

Effective Price Realized=S_2+($F_1 - F_2$) = F_1 + b_2

(The price realised for the asset is S_2 and the profit on the futures position F_1-F_2)

Note: The company uses a short hedge because it plans to sell the asset. If the basis STRENGTHENS (i.e., increases) unexpectedly, the company's position IMPROVES because it will get (obtain/realize) a higher price for the asset after futures gains or losses are considered; if the basis WEAKENS (i.e., decreases) unexpectedly, the company's position WORSENS after futures gains or losses are considered.

Long Hedge

- Consider a situation of a hedger who knows that the asset will be bought at time t_2 and takes a long futures position at time t_1:
- We define

F_1 : Initial Futures Price

F_2 : Final Futures Price

S_2 : Final Asset Price

If you hedge the future purchase of an asset by entering into a long futures contract then:

Effective Price Paid=$S_2 - (F_2 - F_1) = F_1 + b_2$

(The price paid for the asset is S_2 and the profit on the futures position F_2-F_1)

Note: The company uses a long hedge because it plans to buy the asset. If the basis STRENGTHENS unexpectedly, the company's position WORSENS because it will pay a higher price for the asset after futures gains or losses are considered; if the basis WEAKENS unexpectedly, the company's position IMPROVES after futures gains or losses are considered.

Hedging Profitability and Basis

Type of Hedge	Benefits from	Which Occurs if
Short hedge	Strengthening basis	Spot price rises more than futures price rises or Spot price falls less than futures price falls or Spot price rises and futures price falls
Long hedge	Weakening basis	Spot price rises less than futures price rises or Spot price falls more than futures price falls or Spot price falls and futures price rises

Note: Short hedge means long spot, short futures; long hedge means short spot, long futures.

Key Factor affecting Basis Risk

One key factor affecting basis risk is the **CHOICE** of the futures contract to be used for hedging. This choice has two components:

1. The choice of the asset underlying the futures contract: Cross hedging

2. The choice of the delivery month: When the expiration of the hedge corresponds to a delivery month, the contract with that delivery month is expected to be chosen. But, a contract with a later delivery month is usually chosen

Reasons: 1. The reason is that futures prices are in some instances quite erratic during the delivery month. 2. A long hedger runs the risk of having to take delivery of the physical asset if the contract is held during the delivery month. Taking delivery can be expensive and inconvenient. (Long hedgers normally prefer to close out the futures contract and buy the asset from their usual suppliers.)

Rule of Thumb: Since, in general, *basis risk increases as the time difference between the hedge expiration and the delivery month increases*, a good rule of thumb is therefore to choose a delivery month that is as close as possible to, but later than, the expiration of the hedge.

Example: Suppose delivery months are **March, June, September, and December** for a futures contract on a particular asset. For hedge expirations in December, January, and February, the March contract will be chosen; for hedge expirations in March, April, and May, the June contract will be chosen; and so on.

Example 1: Short Hedge

1. It is March 1. A US company expects to receive 50 million Japanese yen at the end of July. Yen futures contracts on the CME Group have delivery months of March, June, September, and December. One contract is for the delivery of 12.5 million yen. The company accordingly shorts four September yen futures contracts on March 1. When the yen are received at the end of July, the company closes out its position. We suppose that the futures price on March 1 in cents per yen is 0.9800 and that the spot and futures prices when the contract is closed out are 0.9200 and 0.9250, respectively

Solution: **Effective Price Realized =S_2+($F_1 - F_2$) = F_1 + b_2**

The gain in futures contract is 0.9800-0.9250 (F_1-F_2) = 0.0550 cents per yen. The basis (b_2) is 0.9200-0.9250 = -0.0050 cents per yen when the contract is closed out

The effective price obtained in cents per yen is the final spot price plus the gain on the futures:=S_2+($F_1 - F_2$) = 0.9800-0.0050= **0.9750**. This can also be written as the initial futures price plus the final basis F_1 + b_2 = 0.9800 + (-0.0050) = **0.9750**.

The total amount received by the company for the 50 million yen is 50X 0.00975 million dollars, or $487,500.

Example 2: Long Hedge

2. It is June 8 and a company knows that it will need to purchase 20,000 barrels of crude oil at some time in October or November. Oil futures contracts are currently traded for delivery every month on the NYMEX division of the CME Group and the contract size is 1,000 barrels. The company therefore decides to use the December contract for hedging and takes a long position in 20 December contracts. The futures price on June 8 is $88.00 per barrel. The company finds that it is ready to purchase the crude oil on November 10. It therefore closes out its futures contract on that date. The spot price and futures price on November 10 are $90.00 per barrel and $89.10 per barrel.

Solution: **Effective Price Paid=$S_2 - (F_2 - F_1) = F_1 + b_2$**

The gain in futures contract is $89.10-$88.00 $(F_2 - F_1)$ = $1.10 per barrel. The basis (b_2) is $90.00-$89.10 = $0.90 per barrel when the contract is closed out.

The effective price paid (in dollars per barrel) is the final spot price less the gain on the futures: $S_2 - (F_2 - F_1)$ = $90.00-$1.10 = **$88.90.** This can also be written as the initial futures price plus the final basis $F_1 + b_2$ = $88.00+$0.90 = **$88.90.** The total price paid is $88.90X20,000 = $1,778,000.

Example 1: Short Hedge

It is March 1. A US company expects to receive 50 million Japanese yen at the end of July. Yen futures contracts on the CME Group have delivery months of March, June, September, and December. One contract is for the delivery of 12.5 million yen. The company therefore shorts four ***September*** yen futures contracts on March 1. When the yen are received at the end of July, the company closes out its position. We suppose that the futures price on March 1 is \$0.0098 per yen and that the spot and futures prices when the contract is closed out are 0.0092 and 0.009250, respectively.

F_1 : Initial Futures Price = \$0.0098 per yen

F_2 : Final Futures Price = \$0.009250 per yen

S_2 : Final Asset Price = \$0.0092 per yen

Effective Price Realized=S_2+($F_1 - F_2$) = F_1 + $\mathbf{b_2}$

= \$0.0092+(0.0098- \$0.009250)=\$0.00975

This can also be written as the initial futures price plus the final basis:

The basis ($\mathbf{b_2}$) = S_2-F_2 = \$0.0092- \$0.009250= -0.00005

Effective Price Realized = \$0.0098 + (-0.00005) = \$0.00975

The total amount received by the company for the 50 million yen is 50000000*0.00975= \$4,87,500.

Example 2: Long Hedge

It is June 8 and a company knows that it will need to purchase 20,000 barrels of crude oil at some time in October or November. Oil futures contracts are currently traded for delivery every month on the NYMEX division of the CME Group and the contract size is 1,000 barrels. The company therefore decides to use the ***December*** contract for hedging and takes a long position in 20 December contracts. The futures price on June 8 is $88.00 per barrel. The company finds that it is ready to purchase the crude oil on November 10. It therefore closes out its futures contract on that date. The spot price and futures price on November 10 are $90.00 per barrel and $89.10 per barrel.

F_1 : Initial Futures Price = $88 per barrel

F_2 : Final Futures Price = $89.10 per barrel

S_2 : Final Asset Price = $90 per barrel

Effective Price Paid=S_2+($F_1 - F_2$) = F_1 + b_2

= $90+($88-$89.10)=$88.90

This can also be written as the initial futures price plus the final basis:

The basis (**b_2**) = S_2-F_2 = $90-$89.10= 0.90

Effective Price Paid = $88 + (0.90) = $88.90

The total price paid is $88.90 per barrel* 20,000 = $17,78,000

Cross Hedging, Optimal Hedge Ratio and Optimal Number of Contracts

Cross Hedging: Cross hedging occurs when the two assets are different. The asset that gives rise to the hedger's exposure (asset at risk) is sometimes different from the asset underlying the futures contract that is used for hedging. For example, an airline that is concerned about the future price of jet fuel. Because ***jet fuel*** futures are not actively traded, it might choose to use ***heating oil*** futures contracts to hedge its exposure.

Hedge Ratio: The *hedge ratio is the ratio of the size of the position taken in futures contracts to the size of the exposure* (Technically, the hedge ratio is the dollar value of the futures position relative to the dollar value of the spot position). It is then used to determine the number of futures contracts necessary. Therefore, the hedge ratio helps in determining the number of futures contracts one should use to hedge a particular exposure in the spot market

The hedge ratio should be the one in which the futures profit or loss matches the spot profit or loss. Unfortunately, there is no exact method of determining the hedge ratio before performing the hedge. There are, however, several ways to estimate it.

Cross Hedging, Optimal Hedge Ratio and Optimal Number of Contracts

When the asset underlying the futures contract is the same as the asset being hedged, it is natural to use a hedge ratio of 1.0.

- For instance, if the hedger's exposure was on 20,000 barrels of oil, and futures contracts were entered into for the delivery of exactly this amount of oil. When cross hedging is used, setting the hedge ratio equal to 1.0 is not always optimal.
- The hedger should choose a VALUE for the hedge ratio that ***minimizes the variance of the value of the hedged position.*** The minimum variance hedge ratio gives the optimal number of futures contracts when the objective is to minimize risk

Calculating the Minimum Variance Hedge Ratio

- The minimum variance hedge ratio (h^*) (*Optimal Hedge Ratio)* depends on the relationship between changes in the spot price, ΔS (commodity/asset at risk) and changes in the futures price, ΔF (underlying asset/commodity used for hedging). Define:

ΔS: Change in spot price, S, during a period of time equal to the life of the hedge;

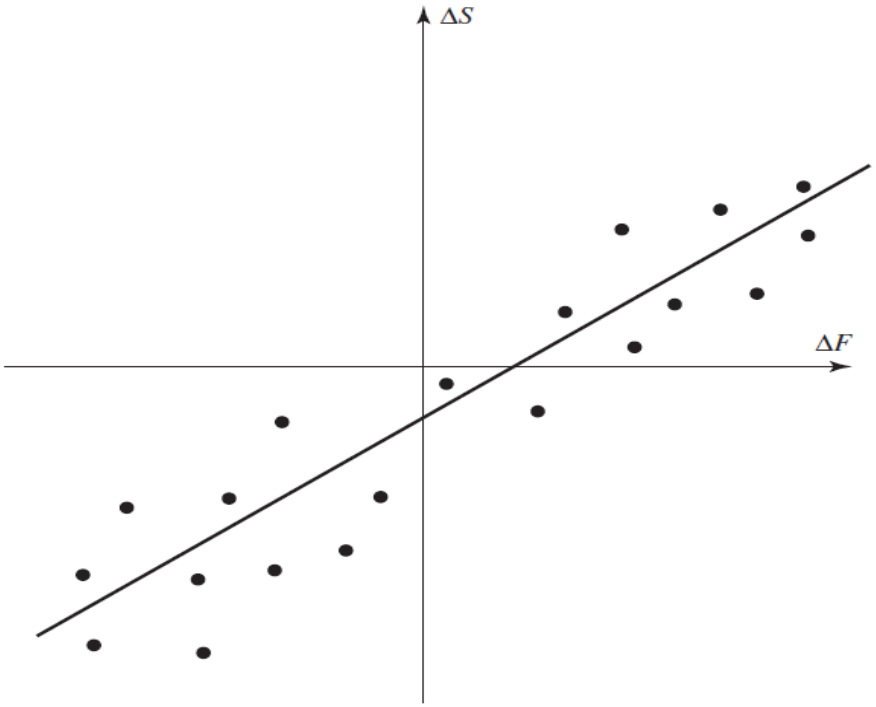
ΔF: Change in futures price, F, during a period of time equal to the life of the hedge.

$$h^* = \rho \frac{\sigma_S}{\sigma_F}$$

where h^* is the minimum variance hedge ratio; σ_S is the standard deviation of ΔS, the change in the spot price during the hedging period; σ_F is the standard deviation of ΔF, the change in the futures price during the hedging period and ρ is the coefficient of correlation between ΔS and ΔF

The hedge ratio equation shows that the optimal hedge ratio (h^*) is the product of the coefficient of correlation between ΔS and ΔF and the ratio of the standard deviation of ΔS to the standard deviation of ΔF.

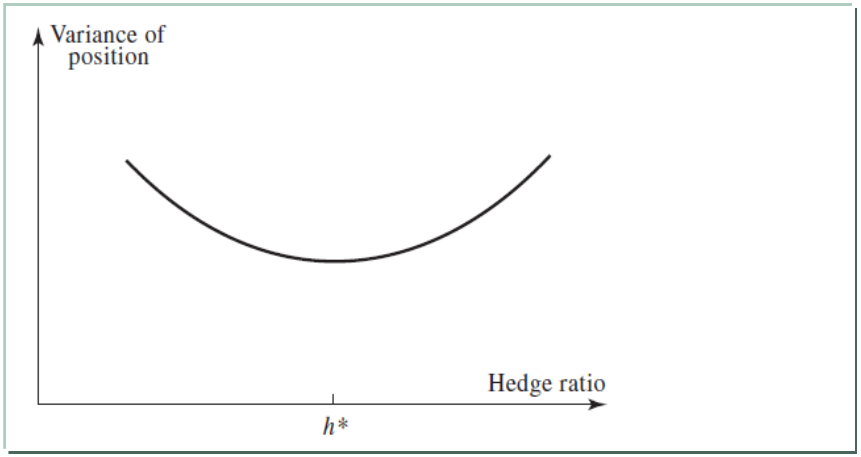
- It can be shown that the optimal hedge ratio h^* is the slope of the best-fit line from a linear regression when ΔS is regressed against ΔF.



Regression of change in spot price against change in futures price.

- The following figure shows how the variance of the value of the hedger's position depends on the hedge ratio chosen:

Dependence of variance of hedger's position on hedge ratio



- If $\rho=1$ and $\sigma_S = \sigma_F$, the hedge ratio, $h^* = 1.0$. This result is expected, because in this case the futures price mirrors the spot price perfectly;
- If $\rho=1$ and $\sigma_F = 2\sigma_S$, the hedge ratio, $h^* = 0.5$. This result is also expected, because in this case the futures price always changes by twice as much as the spot price;
- The hedge effectiveness can be defined as ***the proportion of the variance that is eliminated by hedging***. This is the R^2 from the regression of ΔS against ΔF and equals ρ^2

Cross Hedging and Optimal Hedge Ratio
Example 1

The following table gives data on monthly changes in the spot price and the futures price for a certain commodity. Use the data to calculate a minimum variance hedge ratio.

Spot price change	+0.50	+0.61	−0.22	−0.35	+0.79
Futures price change	+0.56	+0.63	−0.12	−0.44	+0.60
Spot price change	+0.04	+0.15	+0.70	−0.51	−0.41
Futures price change	−0.06	+0.01	+0.80	−0.56	−0.46

Optimal Number of Contracts

To calculate the optimal number of contracts that should be used in hedging, define:

Q_A: Size of position being hedged (units)

Q_F : Size of one futures contract (units)

N^*: Optimal number of futures contracts for hedging.

- The futures contracts should be on h^*Q_A units of the asset (h^* is the minimum variance hedge ratio). The number of futures contracts required is therefore given by:

$$N^* = \frac{h^* Q_A}{Q_F}$$

Hedge Ratio and Optimal Number of Contracts

Example 2

- An airline expects to purchase 2 million gallons of *jet fuel* in 1 month and decides to use *heating oil* futures for hedging. Suppose that Table 1 gives, for 15 successive months, data on the change, ΔS, in the jet fuel price per gallon and the corresponding change, ΔF, in the futures price for the contract on heating oil that would be used for hedging price changes during the month. Each heating oil contract traded on NYMEX is on 42,000 gallons of heating oil. Calculate the optimal number of contracts to be used by the company.

Table 1: Monthly Changes in the Spot Price and the Futures Price of Jet Fuel and Heating Oil

Month i	*Change in heating oil futures price per gallon* $(= \Delta F)$	*Change in jet fuel price per gallon* $(= \Delta S)$
1	0.021	0.029
2	0.035	0.020
3	−0.046	−0.044
4	0.001	0.008
5	0.044	0.026
6	−0.029	−0.019
7	−0.026	−0.010
8	−0.029	−0.007
9	0.048	0.043
10	−0.006	0.011
11	−0.036	−0.036
12	−0.011	−0.018
13	0.019	0.009
14	−0.027	−0.032
15	0.029	0.023

Proof of the Minimum Variance Hedge Ratio Formula

Suppose we expect to sell N_A units of an asset at time t_2 and choose to hedge at time t_1 by shorting futures contracts on N_F units of a similar asset. The hedge ratio, which we will denote by h, is

$$h = \frac{N_F}{N_A} \tag{3A.1}$$

We will denote the total amount realized for the asset when the profit or loss on the hedge is taken into account by Y, so that

$$Y = S_2 N_A - (F_2 - F_1) N_F$$

or

$$Y = S_1 N_A + (S_2 - S_1) N_A - (F_2 - F_1) N_F \tag{3A.2}$$

where S_1 and S_2 are the asset prices at times t_1 and t_2, and F_1 and F_2 are the futures prices at times t_1 and t_2. From equation (3A.1), the expression for Y in equation (3A.2) can be written

$$Y = S_1 N_A + N_A(\Delta S - h\,\Delta F) \tag{3A.3}$$

where

$$\Delta S = S_2 - S_1 \quad \text{and} \quad \Delta F = F_2 - F_1$$

Because S_1 and N_A are known at time t_1, the variance of Y in equation (3A.3) is minimized when the variance of $\Delta S - h\,\Delta F$ is minimized. The variance of $\Delta S - h\,\Delta F$ is

$$v = \sigma_S^2 + h^2\sigma_F^2 - 2h\rho\sigma_S\sigma_F$$

where σ_S, σ_F, and ρ are as defined in Section 3.4, so that

$$\frac{dv}{dh} = 2h\sigma_F^2 - 2\rho\sigma_S\sigma_F$$

Setting this equal to zero, and noting that d^2v/dh^2 is positive, we see that the value of h that minimizes the variance is $h = \rho\sigma_S/\sigma_F$.

Tailing the Hedge

- When futures contracts are used for hedging, there is daily settlement of futures contracts which means that when futures contracts are used, there is a series of one-day hedges, not a single hedge. To allow for the impact of daily settlement, a small adjustment known as ***tailing the hedge*** is made using the following equation:

$$N^* = \frac{h^* V_A}{V_F}$$

where: V_A (=SxQ_A) is the *dollar value of the position being hedged* and V_F (=FxQ_F) is the *dollar value of one futures contract*. The effect of tailing the hedge is to *multiply the hedge ratio by the ratio of the spot price to the futures price*

Assume,

Spot Price (S) (jet fuel) = $1.94 per gallon;

Futures Price (F) (heating oil) = $1.99 per gallon.