2 Forwards and Futures

Change in exchange rates, interest rates and stock prices of different financial markets have increased the financial risk to the corporate world. Adverse changes in the macroeconomic factors have even threatened the very survival of business world. It is therefore necessary to develop a set of new financial instruments known as derivatives in the Indian financial markets, to manage such risk. The important derivatives for risk management are forwards, futures, options, and swaps. In this chapter we study forwards and futures.

Before discussing forwards and futures, it is desirable to explain spot contracts.

Spot Contract

A spot contract is an agreement between a buyer and a seller by which the seller of the asset agrees to deliver it immediately and the buyer agrees to pay for that asset immediately. The price at which the exchange takes place is called the spot price (cash price). The market for the spot contracts is known as spot market. The spot market involves both the transfer of ownership and delivery of instrument (asset) on the spot or immediately. Now let us explain forward contracts.

Meaning of Forwards (or Forward Contracts)

A forward contract (or simply forward) is the simplest and oldest form of derivatives. A forward is an agreement between two parties to buy or sell an asset at a future date at a price agreed today. So, in forward contracts, the date, the price and the quantity are decided at the time of entering into contract. But the contract is implemented in future on the agreed date. Suppose a shopkeeper agrees to sell you a particular model and brand of television set after one month from now at a price of, say, ₹ 1,00,000. You agree to the offer. This means that you have entered into a forward contract with the shopkeeper. You are obliged to make payment of ₹ 1,00,000 and take delivery of the television set after one month from today. Similarly the shopkeeper is obliged to deliver the particular model and brand of television set to you and receive ₹ 1,00,000. When you agree to buy an asset in future, you actually buy a forward contract. The shopkeeper sells the forward contract. Suppose after one month the

price of the television set increases to ₹ 1,10,000. But you have to pay only the agreed price (i.e., ₹ 1,00,000). Suppose the price falls to ₹ 95,000. Then you have to pay the agreed price of ₹ 1,00,000. The agreed price is called forward price. If the actual spot price is higher than the forward price, the buyer is in an advantageous position because he gets the asset at a cheaper price than the prevailing market price. The seller is in a disadvantageous position because he has to deliver the asset at a price which is lower than the prevailing market price. If the spot price is lower than the forward price, the buyer would be at a disadvantage and the seller would benefit.

Both parties to the forward (buyer and seller) have an obligation to perform the contract. That is, the seller must deliver the asset and receive payment and buyer must make payment and take delivery of the asset. In case of default by either party, the other party has a right to seek a compensation.

In the forward contracts, one party takes long position (one who agrees to buy the asset, i.e., the buyer). The other party takes short position (one who agrees to sell the asset, i.e., the seller).

A forward is a negotiated agreement between two parties. There is no third party or middleman. The transaction occurs between buyer and seller only. Thus, it is a bilateral agreement. It is not traded on organized exchanges. It does not require an initial payment when signing the contract (except for a minor administrative fee, if the other party is a financial institution).

Thus, a forward contract is an agreement made today to exchange the commodity or instrument for cash at a predetermined future date at a price agreed upon today. The transfer of ownership occurs on the spot. But delivery of the commodity or instrument does not occur until some future date. It means forward is a forward delivery contract and not ready delivery contract. No money changes hands at the time the deal is signed. For example, a wheat farmer may wish to contract to sell his harvest at a future date to eliminate the risk of a change in price by that date.

Features of Forwards

The salient features of forward contract are:

1. They are bilateral contracts. That is, the terms of the contract are negotiated directly by the buyer and seller. Hence, they are exposed to counter-party risks.
2. They are customised. The terms of the contract are individually agreed between two counter parties according to their requirements.
3. These are private contracts. They are traded over the counter (OTC).
4. On the expiration date, the contract has to be settled by delivery of the asset. It may also be settled by payment of differential prices in cash without delivery of assets.

5. A forward contract is a zero sum game. This is because the gain of one party is the loss of the other (or counter party).
6. Forward contracts are an ideal tool for hedging the risk arising from price fluctuations of underlying assets. They are largely used in foreign currencies and in agricultural products.

Example of a Forward Contact

A wheat farmer has planted a crop that is expected to yield 80 quintals. To eliminate the risk of fall in the price of wheat, before the harvest the farmer enters into a forward contract on 1st July 2019, with a trader to sell the 80 quintals of wheat at ₹ 1,300 per quintal after five months. The current price is ₹ 1,200 per quintal. No money changes hands now. Suppose the market price of wheat is ₹ 1,100 per quintal on 1st December 2019. On this date the farmer delivers the 80 quintals of wheat to the trader in exchange for ₹ 1,04,000 (i.e., 1,300 x 80). This price, i.e., ₹ 1,300 is fixed and does not depend upon the spot price of wheat at the time of delivery and payment (i.e., ₹ 1,100).

At the time of entering into contract, the farmer did not know what exactly the price of wheat would be after five months. Here the farmer gets a gain of ₹ 200 per quintal because the market price on 1st December 2019 is ₹ 1,100 per quintal. If he had not entered into forward contract, he would get only ₹ 88,000 (i.e., 1,100 x 80). The total gain is ₹ 16,000 (1,04,000 – 88,000 or 200 x 80). Thus, by entering into forward contract the farmer could eliminate the fall in the price of wheat.

Terms used in Forwards

Underlying asset: This refers to the asset on which the forward contract is made. The various underlying assets are equity shares, stock indices, commodity, currency, interest rate etc.

Long position: The party that agrees to buy an underlying asset in a future date is said to have a long position. In the above example, the trader is said to hold a long position.

Short position: The party that agrees to sell an underlying asset in future date is said to have a short position. In the above example, the farmer is said to hold a short position.

Spot price: It is the price of the underlying asset for buying and selling at the spot time or immediately. In the above example, the spot price of wheat is ₹ 1,200 per quintal.

Forward price/Contract price/Delivery price: The price at which the forward contract is settled on expiration is said to be contract price or delivery price or forward price. In the above example, the contract or delivery price is ₹ 1,300.

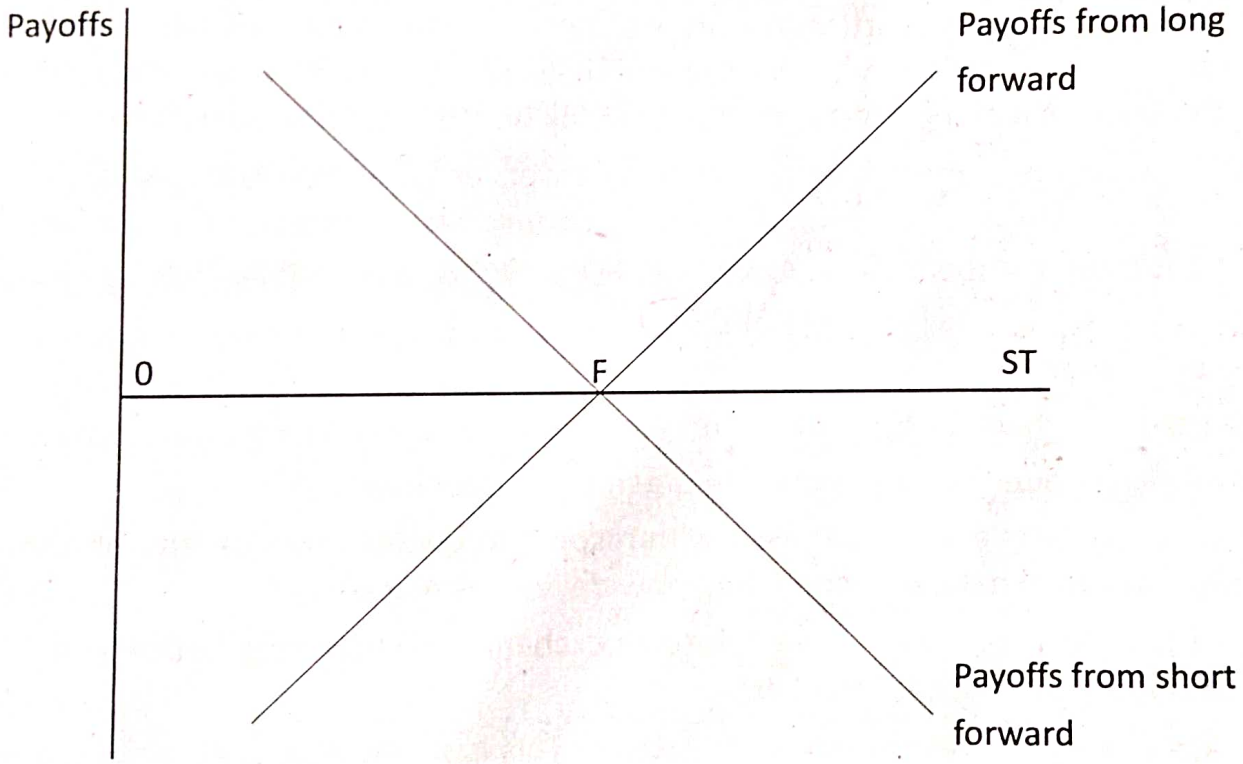
Expiration date: This is the date on which the formal contract expires. In the above example, the expiration date is 1st December 2019.

Pay-off from Forward Contracts

A payoff is the likely profit or loss that would accrue to a market participant with change in the price of the underlying asset. The payoff from a forward contract is the profit or loss

made by the two parties to the contract. Take an example. Suppose a buyer and seller enter into a forward contract on a stock with a contract or delivery price ₹ 100 (F=100). Let S_T denote the price of the stock on the expiration date T. Then on date T, payoff to the long position (buyer) is S_T-100. The long position makes a profit, if $S_T > 100$. But he loses, if $S_T < 100$. Suppose S_T is ₹ 120, then the long is buying stock worth ₹ 120 for ₹ 100. So he gains ₹ 20. But the short is selling stock worth ₹ 120 for ₹ 100. So he loses ₹ 20. If S_T is 80, the long is buying stock worth ₹ 80 for ₹ 100. So he loses ₹ 20, while the short is selling stock worth ₹ 80 for ₹ 100, so gains ₹ 20. Thus, the profit of one is the loss of the other.

The following graph shows the pay-offs to the long and short positions on the maturity date T of a forward contract with delivery price F as the time T and price S_T of the underlying asset vary.



FUTURES

We have seen that in forward contracts there are some problems such as counter party risk, illiquidity, lack of centralisation of trading etc. The futures contract has been developed to remove the disadvantages of a forward contract. A futures contract is very similar to a forward contract in all respects except the fact that it is completely a standardised one. Hence, it is rightly said that a futures contract is nothing but a standardised forward contract.

Meaning of Futures

Futures contract is standardised and exchange-traded. Futures contract is an agreement between buyer and seller to buy or sell a an asset at a certain time in future at a certain price. These are traded on recognised exchanges like NCDEX (National Commodity and Derivative

Exchanges Limited), MCX (Multi Commodity Exchange of India Limited, Mumbai), NSE, BSE etc. Asset is delivered at a future date at the price fixed today. The future date is called the delivery date or final settlement date. The agreed price is called the 'futures price'.

Thus, futures contract provides both a right and an obligation to buy or sell a standard asset or security or currency on a specified future date at a price agreed when the contract is entered into. Futures contracts are commonly known as futures.

Futures are standardised with regard to the contract size and also the maturity period of the contract. Futures contracts require deposits of margins. Hence, default risk is avoided. Although the price of the futures is negotiable between the parties, it is regulated by the futures exchange.

There are separate futures exchanges. Each exchange has a clearing house. The clearing house arranges for delivery of asset and payment of money. Clearing house becomes the counter-party to the original parties. The original parties are the buyer and the seller. Clearing house becomes a counter-party to the buyer in delivering the asset. It becomes a counter-party to the seller in making payment. Thus, clearing house is called a central counter-party.

A wide variety of commodities and financial assets are the underlying assets in futures contracts. Wheat, sugar, wool, gold, aluminium, copper, etc. are some of the commodities underlying futures contracts. Stocks, stock indices, foreign currencies, bond, etc. are the financial assets underlying futures contracts.

Features of Futures

The essential characteristics of futures are summarised as follows:

1. Futures are traded on the floor of an organised exchange.
2. Futures contracts are standardised with respect to quality and quantity of underlying asset, the expiry date and where and how delivery is made.
3. There is a clearing house for each futures exchange. The clearing house acts as a link between the buyer and the seller.
4. In case of futures, default risk is eliminated. This is so because transactions are done through clearing house and not between buyer and seller.
5. There is a margin system. The default risk is undertaken by the clearing house. In order to protect itself from this risk, the clearing house requires the parties to keep margin money (5% to 10% of the face value of the contract).
6. The delivery of the asset in question is not essential on the date of maturity of the contract in the case of a futures contract. Generally, the parties simply exchange the difference between the futures price and spot price on the date of maturity. Thus, futures contracts are mostly cash settled.

Advantages of Futures

Following are the advantages of futures :

1. There is no counter-party risk in futures.
2. Futures are more liquid as compared to forwards.
3. Futures are standardised contracts.
4. It enables a party to transfer the risk to another party who is willing to accept the risk.
5. It can be used for hedging as well as for speculative purpose (i.e., for making profit).
6. Transaction cost of trading in futures is lesser.

Disadvantages of Futures

Following are the disadvantages of futures :

1. The futures contract, just like the forward contract, is a legal obligation. Being a legal obligation, it can sometimes be a problem to the trader.
2. Futures contracts have standardised features with respect to contract size, expiry date etc. Hence, perfect hedging may be impossible.
3. A trader who wishes to take a position in the futures market must first pay an initial margin. Apart from this, he has to pay other margins also.
4. The trader sometimes has to forge favourable price movements.

Futures Terminology (Specifications of a Futures Contract)

Some of the specifications of the terms used in the futures contracts may be explained below:

1. **Underlying asset:** The underlying asset may be a commodity or a financial asset. Futures contracts are normally specified by the name of the underlying asset and month and year of the expiry of the contract. For example, a futures contract in rice at Multi-Commodity Exchange (MCX) denoted as RICE MAR19 implies that the contract in rice is due for delivery in March 2019.
2. **Contract size:** Contract size or trading unit refers to the standard contract size that will be traded on the exchange. In other words, this is the amount of asset that has to be delivered under one contract. Each futures contract for gold on NMCE is for 100 gm.
3. **Price quotation:** Quotation is the basis of price. It is not the value of futures contract. For example, the price quotation for futures contract on rice is rupees per quintal.
4. **Tick size:** This is the minimum change that will be rcognised in the price quotation. It is the minimum difference between two quotes of a similar nature.
5. **Price limit:** These are the limits on the maximum price variation permitted in a day's trading. The exchange sets a daily price movement limit of the underlying asset, which normally matched the initial margin money collected against the futures contract. When the price increases by an amount equal to the daily price limit, it is called 'limit up' and decreases by the amount equal to the daily price limit, it is called 'limit down'.

6. **Position limits:** These are the limits upon the maximum number of contracts an individual client or a member broker may hold. This is specified by the futures exchange. The purpose is to avoid any concentration of business in the market place.
7. **Spot price:** This is the price at which an asset trades in the spot or current market. It is also called cash price or current price.
8. **Futures price:** This is the price at which the futures contracts trades in the futures market. The futures price is essentially a market estimate about the price of the underlying asset in the future. It may be higher or lower than the spot price of the underlying asset.
9. **Expiry date:** This is the date specified in the futures contract. This is the last day on which the contract will be traded. At the end of this, it will expire.
10. **Basis:** This is the futures price minus the spot price. In a normal market, basis will be positive. This means that futures prices normally exceed spot prices.
11. **Long and short positions :** There are two parties to every futures contract - a buyer and a seller. The buyer is said to have a long position and the seller is said to have a short position.
12. **Open position** : A long (buy) or short (sell) position that is outstanding or unsettled in various derivative contracts is called an open position. For example, if X sells 5 contracts on Infosys futures and buys 3 contracts on TCS futures, he would be termed as having an open position. This is equivalent to short on 5 contracts on infosys and long on 3 contracts of TCS. If he then buys 2 infosys contracts with the same maturity, his open position would be short on 3 infosys contracts and long on 3 TCS contracts.

Futures Trading Mechanism (Trading in Futures Contracts)

Futures trading refers to entering into contracts to buy or sell financial assets or commodities for future delivery on standardised terms. The trading mechanisms of futures contract may be briefly explained as below:

1. **Placing an order:** The futures contracts are traded on recognised exchanges which are similar to stock exchanges. Once an investor decides to buy a certain contract, he calls his broker and instructs to buy the desired contract for him. Once the deal is struck, the information of confirmation of the conclusion of the order shall reach the investor through the broker.

The exchange determines the size of the contract, how the price is to be quoted and limits on the amount by which the futures price can move in any one day. Also, in case of a commodity, the exchange also specifies the quality of the product and the delivery location. The prices for the commodity contracts, just like other securities, are determined by the forces of demand and supply.

2. **Role of the Clearing House**: At this point the clearing house intervenes. A clearing house plays a key role in the trading of futures contracts. It acts as an intermediary for each contract. The clearing house guarantees performance on futures contracts, thereby eliminating counter-party risk. The two parties in a futures contract have no worry because of the guarantee of

the clearing house. The main function of the clearing house is to guarantee the performance of the contract.

3. **Daily settlement**: A key role of the futures exchange is to organise trading such that contract defaults are minimized or even eliminated. The clearing house uses the fees it collects on transactions to provide the necessary funds for this purpose. Besides, buyers and sellers are required to deposit a margin on the contract. Thus when a contract is entered into, both the buyer and the seller are required to deposit an initial margin. This is typically 5 to 10% of the value of the contract. The exact amount is determined by the exchange. At the end of each trading day, the margin account is adjusted to reflect the investor's gain or loss. The gains and losses are netted against the initial margin. This is called marking-to-market. In marking-to-market, day after day it is just possible that the margin may become too low or possibly even wipe out or the balance may be negative. To avoid this kind of situation, an investor is required to ensure a maintenance margin. In this process of marking to the market, if the balance in the margin account falls below the maintenance margin, the investor receives a margin call. He is required to deposit additional funds to bring the balance to the level of initial margin, in a very short period of time. The extra funds deposited are called variation margin. If the investor does not provide the variation margin, the broker closes out the position. With the liquidation of the contract, the remaining margin is given to the investor. On the other hand, if the balance in the margin account exceeds the initial margin, the excess may be withdrawn by the investor.

4. **Settlement:** All contracts eventually expire. On expiry, contacts should be settled. Some contracts are settled by physical delivery of the assets. Others are cash settled, thus, there is no delivery at all.

On cash settled contracts, such as stock index futures, the settlement price on the last trading day is fixed at the closing spot price of the underlying instrument, such as the stock index. All contracts are marked to market on that day, and the positions are deemed to be closed. It may be noted that about 99% of all futures contracts are not delivered or cash settled. Most traders close out their positions prior to expiration, through a process called offsetting (i.e., settle by difference in cash).

Role of Clearing House

In a stock purchase, a broker simply acts as an intermediary to enable the investor to buy shares from or sell to another investor through the stock exchange. On the other hand, in futures trading, the clearing house plays a more active role.

Futures trading is facilitated through clearing houses attached with each futures exchange. A clearing house is a separate body or a part of the futures exchange. For example, National Securities Clearing Corporation Limited (NSCCL) acts as the clearing house of NSE. The clearing house has a number of members, called clearing brokers. Brokers who are not members of the clearing house have to transact their futures through a member of the clearing

house. The seller has to deliver the asset to the clearing house and the clearing house deliver the same to the buyer. Similarly, the buyer has to make payment to the clearing house and the clearing house has to pay to the seller. Thus, clearing house acts as an intermediary between investors and exchange. In one way the clearing house is the counter-party to the buyer for delivery of asset and in another way, it is the counter-party to the seller for making payment against delivery. Thus, the clearing house facilitates the smooth operation of the futures trading. It guarantees performance on futures (and options) contracts, thereby eliminating counter party risk. It serves as position of buyer to every seller and seller to every buyer.

After a trade has been agreed to, it must be recorded or cleared by the clearing house. This is known as clearing. Thus, clearing is the matching of buy and sell records to ensure that there are no discrepancies in the price and / or quantity. Further, it keeps track records of all transactions during the day. It daily computes (for each clearing member) the net gain or loss on the member's position. The clearing house matches the transactions, reconciles sales and purchases and does daily settlements. It is also responsible for risk management of its members and does inspection and surveillance, besides collection of margins, capital etc. It also monitors the networth requirements of the members. Once the trade is cleared, the clearing house has to ensure performance of the contract. Actually, clearing house plays the role of a market maker in futures trading, i.e., it gives guarantee to the performance of futures contract.

Functions of the Clearing House

The main function of the clearing house is to eliminate the risk that someone at some stage would fail to honour their part of the commitment. The other functions are :

(a) It provides a quick and simple way for traders to settle their contracts.

(b) It provides uniform and continuous protection against default on contracts by guaranteeing performance of the parties to the contract.

(c) It records and settles the day-to-day trading results.

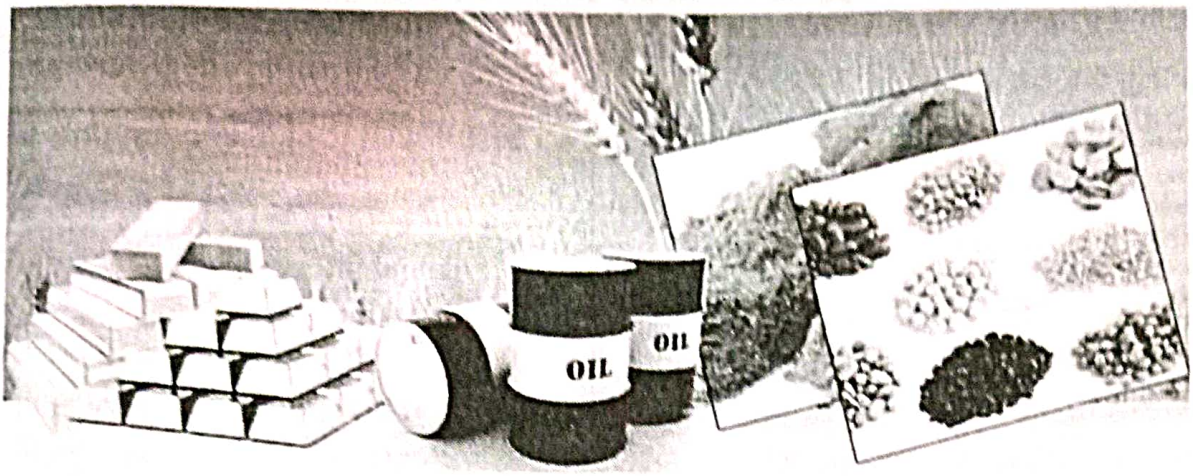
(d) It acts as a legal counter party to the buyer as well as to the seller.

Types of Futures

Futures can be classified on the basis of underlying asset. On the basis of underlying assets, futures may be broadly classified into commodity futures and financial futures.

1. Commodity Futures

A commodity futures is an exchange traded contract to buy or sell standardised physical commodities for delivery on a specified future date at an agreed price. In the case of commodity futures, the underlying asset is a commodity. Contracts are available in India on agricultural commodities such as wheat, rice, coffee, sugar, tea, pepper, cotton, coconut etc. Contracts on metals such as gold, silver, etc. are also available. Futures contracts on oil also fall under commodity futures. At present, there are 22 registered / recognised commodity exchanges in India.



Commodity futures market in India (Fig. 2)

2. Financial Futures

Although forwards and futures in commodities have existed for centuries, financial futures are a recent phenomenon. Financial futures are standardised, legally enforceable forward contracts traded on exchanges called futures exchanges. In the case of financial futures, financial assets or instruments are underlying assets. Thus, financial futures is a futures contract in foreign exchange or financial instruments like Treasury bill, commercial papers, stock market index or interest rate. Financial futures are further classified into four. They are as follows:

(a) **Currency futures:** Currency futures are those where the underlying assets are currencies. Futures contracts on various currencies are available in major centres such as Chicago, London, Singapore etc.

(b) **Stock futures:** Stock futures are those where the underlying assets are stocks. Stock futures were introduced in 1882 by Kansas City Board of Trade. Stock futures were introduced in India on June 12, 2000 for Indices and on November 9, 2001 on select individual securities at NSE.

(c) **Interest rate futures:** Interest rate futures are those where the underlying assets are interest rates. In India interest rate futures were introduced on June 24, 2003 at NSE. This attempt was not successful. They were re-launched on August 31, 2003 with modification to the underlying asset and contract features.

(d) **Index futures:** Index futures are those where the underlying assets are stock indices such as BSE Sensex or Nifty.

Among the financial futures, currency futures were first emerged in 1972 in the United States. It was only in the 1980s that the interest rate futures and stock index futures came into existence.

Difference between Forwards and Futures

Futures are similar to forwards. However, there are certain differences between the two. The following are the important points of differences between forwards and futures:

Futures	Forwards
1. Standardised contracts.	1. Customised or tailor-made contracts.
2. Valuation (or settlement) is done on a daily basis (marked to market basis).	2. Settlement is made on the pre-specified date of maturity.
3. Margins are required (requires guarantee deposits from the parties).	3. Margins are not required.
4. Transaction is done through a clearing house.	4. There is no clearing house. It is only a bilateral (between buyer and seller) agreement.
5. Traded in organized stock exchanges (futures exchanges).	5. Not traded in organized stock exchanges (traded on phone or telex).
6. Default risk is considerably reduced (there is a margin as guarantee deposit).	6. Default risk is higher.
7. More liquid.	7. Less liquid.
8. Rarely closed. Buyer and sellers normally reverse their positions to close the deals (only about 1% of the contracts are settled through delivery).	8. Contracts are generally closed (closed on actual delivery and payment) (over 90% contracts are settled by delivery).
9. Settled daily	9. Settled at the period end.

Margin System

In futures contracts, the clearing house undertakes the default risk. To protect itself from this risk, the clearing house requires the participants (both buyer and seller) to keep margin money (security deposit). Thus margins are amounts required to be paid by dealers in respect of their futures positions to ensure that both parties will perform their contract obligations. It is also known as *performance bond.* The margin normally ranges between 5% to 10% of the face value of the contract (contract price). The main objectives of margining system are: (a) to safeguard the integrity of the futures market, and (b) to ensure the performance of the futures contract.

Types of Margin

There are three types of margin. They are:

1. **Initial margin:** Initial margin is the margin to be paid at the time of entering into the contract. It is a deposit required on futures trading to be paid by both parties (long position holders and short position holders) to ensure that the terms of any future contract will be fulfilled. Thus, initial margin is the original amount to be deposited by the market participants in their margin account with the clearing house before they can place buy or sell order of a

futures contract. In other words, it is the amount of security money that must be deposited in the margin account at the time a futures contract is first entered into. It is also known as *ordinary margin. The* amount of margin varies according to the type of the contract. Minimum margin levels are set by each exchange. Initial margin is generally equal to about 2% of the contract value. Either cash or treasury bills may be used to meet the margin requirement.

2. **Maintenance margin:** Maintenance margin is the margin (minimum balance) to be maintained throughout the duration of the contract. This is the margin a futures trader must maintain once a futures position is taken. In other words, it is the minimum amount that must be remained (kept) in a margin account. It may be equal to 75% of the initial margin. If the futures prices move against the investor, margin account will fall below the maintenance margin. Then the broker will make a call, i.e., asking the client to replenish the margin account by paying the variation. The demand for additional fund is known as a *margin call.* For example, suppose that the initial margin on a futures contract is ₹ 5,000 and the maintenance margin is ₹ 3,750 (75% of the initial margin). The next day suppose that the client has suffered a loss of ₹ 1,000, then the balance in the margin account reduces to ₹ 4,000 (this is above the maintenance margin and hence margin call will not be made). Further, suppose that on the next day the price decreased and sustained loss is ₹ 500. Thus, the balance remained in the margin account is ₹ 3,500 (actual balance falls below the maintenance margin). In this situation, the broker will make a call (margin call) to replenish the margin account to ₹ 5,000 (upto the level of initial margin). The client is required to deposit ₹ 1,500 (and not ₹ 500) in the margin account. In short, maintenance margin is the additional margin required by the broker from the client.

3. **Variation margin:** It is the shortfall in margin to be remitted properly. If the investor's margin account falls (when losses occur) below the maintenance margin level, variation margin must be added to the account to bring it back to the initial margin level in order to keep the position open. Thus, variation margin refers to the additional amount that has to be deposited by the trader with the broker to bring the balance of margin account to the initial margin level. It is the difference between the initial margin and the balance in the margin account. In the above example, the variation margin is ₹ 1,500 (i.e., 5,000 - 3,500). If the investor does not pay the initial margin immediately, the broker may proceed to unilaterally close out the account by entering into an offsetting futures position.

In addition to the above three types of margin there is one more type of margin. This is *exposure margin.* This is imposed on Index futures. Currently, it is 3% of the notional value.

Example 1

Gold futures contract: Size = 100 gms.

Investor buys 1st May 2019 gold futures contract on 1st March 2019 at ₹ 600 per gm.

Findout : (a) Value of the contract, (b) Initial marging, and (c) Maintenance margin (assume 7.5 % maintenance margin).

Solution

In this case, value of contract = 600 x 100 = ₹60,000

Initial Margin (Say) 10% = 60,000 x 10 / 100 = ₹6,000

Maintenance Margin (say) 7.5% = 60,000 x 7.5 / 100 = ₹4,500

Marking-to-Market (Daily Settlement)

In case of forward contract, on the expiry date the contract is settled by delivery of the asset and payment of the money. On the other hand, in futures contract, the practice is different. Here, only rarely the contract is settled (closed) on the expiration date (delivery date). Generally, it is settled on daily basis. It is settled daily on settlement price (the price at the close of daily trading on the exchange). This is called *marking-to-market*. Thus, the system of daily settlement in the futures market is called marking-to-market. It is the process of marking profits or losses that accrues to traders on daily basis. In short, marketing-to-market involves the daily settlement of futures. The term marking simply means settlement.

The basic purpose of marking-to-market is that the futures contract should be daily settled and not at the end of its life. At the end of each trading day, the margin account is adjusted with the gains or loss. When there is any decrease in the futures price the buyer of the futures would incur a loss and the seller would gain. Therefore, margin account of the long position (buyer) is debited (or subtracted from the margin). Simultaneously, the margin account of the short position (seller) is credited by the same amount (or added to the margin). This brings the value of the contract back to zero. This makes the futures more attractive than forwards because of the holder of futures may receive cash on a daily basis.

The feature of marking-to-market is that market participants (buyer and seller) earn their profit or suffer their losses on a day-to-day basis rather than all at once at maturity as in the case of forward contract. At the end of the daily trading, a futures contract is similar to a new forward contract on the underlying asset at the new settlement price with a one-day-shorter maturity. It may be noted that marking-to-market ensures that both parties to the futures contract maintain sufficient funds in their account to guarantee the eventual pay-off when the contract matures. We shall get a clear idea about marking-to-market with help of an example.

Example 2 (on the basis of the previous example)

	Day	Price	Daily Gain/Loss	Cumulative Gain/Loss	Margin Balance	
March	1	600	—	—	6,000	
	2	595	– (500)	– (500)	5,500	(i.e., 6,000 - 500)
	3	603	800	300	6,300	(i.e., 5500 + 800 or 6000 + 300)
	4	596	– (700)	– (400)	5,600	(i.e., 6300 - 700 or 6000 - 400)
	5	591	– (500)	– (900)	5,100	(i.e., 5600 - 500 or 6000 - 900)
	6	585	– (600)	– (1,500)	4,500	(i.e., 5100 - 600 or 6000 - 1500)

7	575	–(1,000)	–(2,500)	3,500	(i.e., 4500 - 1000 or 6000 - 2500)
8	579	400	–(2,100)	3,900	(i.e., 3500 + 400 or 6000 - 2100)
9	608	2,900	800	6,800	(i.e., 3900 + 2900 or 6000 + 800)

On 7th March the balance in the margin account has fallen below the maintenance margin (the maintenance margin is ₹ 4,500). So amount to be added to bring back to the initial margin is ₹ 2,500 (i.e., 6,000 – 3,500). This is the variation margin. On this date, now the balance is ₹ 6,000 (i.e., 3,500 + 2,500). On 8th, the margin balance again falls to ₹ 3,900. So the amount to be added is ₹ 2,100. This is the variation margin. Now the balance becomes ₹ 6,000 (i.e., ₹ 3,900 + 2,100). We can say that everyday the price of gold changes. This leads to daily gains or losses. Consequently, the margin balance changes.

Suppose, the gold is sold on 9th March. Then the profit will be:

Balance of initial margin	₹ 6,800
Less: Cost (6,000 + 2,500 + 2,100)	10,600
Loss	3,800

Thus, in futures, settlement is done on daily basis.

Stock Futures

Equity shares of different companies are traded in stock exchanges. The market prices of these shares (or stocks) are determined on the basis of performance of the companies. The market prices of shares or stock depend upon the demand and supply forces in the market. Whenever there is a change in demand and supply factors, there is a corresponding change in the market prices of shares or stock. Thus, the market prices of shares or stock fluctuate on a continuous basis. The volatility in stock prices creates risk for the investor. Thus, there is possibility of incurring losses in stock trading. The volatility also provides an opportunity for speculative activity, i.e., making short term profits from fluctuations in stock prices. This has led to the emergence of stock futures as a means of hedging the risk involved in stock trading.

Meaning of Stock Futures

Stock futures are agreements to buy or sell a specified stock (i.e., equity shares of a specified company) in the future at a specified price. Thus, stock is the underlying asset in stock futures. An investor may buy shares in the stock exchange for cash. Instead of buying the shares straightaway, the investor may agree to buy it in the future at a specified price within a specified time period. This is done when the share price is expected to rise in the future. The investor is said to take a long position in the share. This enables the investor to buy the shares at a lower price later in a rising market.

The futures agreements are transacted through futures exchanges with the help of brokers. The clearing house of the exchange arranges for the delivery of the shares and the

payment of money to the transacting parties. In order to prevent default by the contracting parties, the clearing house prescribes a margining system for trading in futures contracts.

Currency Futures

There are significant changes in the exchange rates. Hence trading in currency involves greater risks. To hedge the risk, the traders enter into forwards and futures.

The market for currency futures is comparatively recent origin. It came into being in 1972 when the Chicago Mercantile Exchange (CME) had set up its International Monetary Market division for trading of currency futures. Other exchanges were established for this purpose in the subsequent period. Notable among them are Philadalphia Board of Trade, London International Financial Futures Exchange, Singapore International Monetary Exchange and Sydney Futures Exchange.

Meaning of Currency Futures

When futures are written on a currency, the futures are called currency futures. In the case of currency futures market, the underlying asset is foreign currency. Currency futures are contracts specifying a standard volume (size) of a particular currency to be exchanged on a specific settlement date. Delivery period and quantity are standard and only price is left to be determined by market. They are commonly used by MNCs to hedge their foreign currency positions. In addition, speculators who expect to make profit on exchange rate movements use currency futures. A buyer of a currency futures locks in the exchange rate to be paid for a foreign currency at a future date. Alternatively, a seller of a currency futures locks in the exchange rate at which a foreign currency can be exchanged for another foreign currency. Thus, currency futures are used for hedging foreign exchange risk.

The undertaker in a futures market can have two positions in the contract:

(a) Long position when the buyer of a futures agrees to purchase the underlying asset. In short, purchase of a futures contract is called long position or net asset position.

(b) Short position when the seller agrees to sell the asset. In short, sale of a futures contract is called short position or net liability position.

The important point to understand about currency futures is that when one has a futures contract, one does not own foreign exchange. In fact, a futures contract represents a pure bet on the direction of exchange rate (price) movement of the underlying currency. The bet can be that either the price will go up or it will go down. Thus if we buy a futures contract (go long) and the futures price goes up, we make money (gain), i.e., we need to pay only at the rate of the day on which the contract is entered into. If the futures price goes down, we lose money. If an investor's foreign exchange portfolio consisted a long position in currency futures, he would be betting that the price would go up (gain arises). If we sell a futures (go short) and the futures price goes down, we make money (price of the day of contract is higher). If the futures price goes up, we lose money. Thus, if the total foreign exchange portfolio consisted of a short position in currency futures, the investor would be betting that the prices would go down.

Features of Currency Futures

Currency futures have the following features :

1. **Size and maturity of the contract:** Currency futures involves trading of an underlying currency at a specified exchange rate and for a fixed maturity. Currency futures are traded only in a limited number of currencies. The size of the contract is standardized involving a fixed amount of different currencies. The date of delivery is also fixed normally on the 3rd Wednesday of January, March, April, June, July, September and December.

2. **Use of pits:** In case of currency futures, brokers, strike the deals sitting face to face under a trading roof known as pits. The brokers can trade for themselves as well as on behalf of their customers.

3. **Transaction through a clearing house:** In every deal, the clearing house is involved as a party (counter party). Suppose X and Y are traders. X strikes a deal with the clearing house. Y too strikes a deal with the clearing house. X, if it is a buyer of the currency, shall acquire a long position with the clearing house, while Y being the seller of the currency shall acquire a short position with the clearing house. In fact, the obligation of the buyer and the seller does not lie with each other but with the clearing house. If a buyer of a currency futures likes to close its position before the settlement date, it sells an identical futures. The difference between the price of purchasing futures and the price of selling futures will determine the gain/loss to the party. Similarly, a seller of a futures closes its position by purchasing an identical futures. This is known as *reverse trading.*

4. **Margin money:** In futures contract, a clearing house serves as the third party to all transactions. That is, the buyer of a futures effectively buys from the clearing house and the seller sells to the clearing house. Thus, the clearing house undertakes third party risk. In order to cover the risk, the contracting parties are required to deposit margin money with the clearing house.

5. **Marking-to-the market:** In case of currency futures, the rates are matched every day with the movements in spot rates. On this basis, gains and losses are settled every day. This process is called *marking to the market.*

6. **Mode of transaction:** When a trader has to enter a currency futures contract, he informs his agent who in turn informs the commission broker at the futures exchange. The commission broker executes the deal in the pit for a commission. After the deal is executed, the commission broker confirms the trade with the agent of the trader (principal). The agent furnishes details to the trader about the transaction and futures price. The trader deposits the margin money (initial) with the clearing house at the very start of the next day. Settlement takes place every working day (called marking to market). The final settlement is made on the maturity date.

7. **Costs in futures deal:** There are certain costs associated with the transaction in the market for currency futures. The first is the brokerage commission. This is charged by the commission brokers. The second is the floor trading and clearing fee. It is charged by the futures exchange

and its associated clearing house. If there is actual delivery of the currencies, one more cost will be incurred, i.e., delivery cost.

Interest Rate Futures

Interest rates in the economy change periodically. Such periodic changes are unpredictable. This uncertainty creates risk for both borrowers and lenders. When interest rates rise, borrowers suffer loss. When interest rates fall, the lenders suffer loss. The possibility of incurring losses from unexpected changes in interest rates is known as *interest rate risk*. Both borrowers and lenders are exposed to interest rate risk. Interest rate futures have been emerged to enable borrowers and lenders to hedge the risk arising from changes in interest rates. A company which is planning expansion of its business in the near future would wish to borrow funds in future for financing such expansion. If interest rate rises in the mean time, the company suffers a loss on account of the higher interest rate payable on the borrowing. The company can use interest rate futures to hedge this risk. Similarly, a decline in interest rates in future may adversely affect organisations or individuals planning to invest funds in the future. Such companies or individuals can use interest rate futures to compensate the loss. Thus, interest rate futures are useful in hedging interest rate risk.

The first interest rate futures contract was the Eurodollar futures. It was created in 1975 by the Chicago Mercantile Exchange. Since then interest rate futures on different securities have been introduced in all major derivative markets in the world. In India, interest rate futures are of fairly recent origin. They commenced trading only in June 2003.

Meaning of Interest Rate Futures

Interest rate futures are futures contracts with interest rates being the underlying. It is a standardised contract traded on an exchange to buy or sell a debt security at a certain future date at a specified price determined today. Interest rate futures may be in treasury bills, notes, bonds and so on. Interest rate futures allow the buyer of the contract to lock in a future interest rate. Those who trade in interest rate futures do not usually take possession of the financial instrument. At the expiration of the futures contract, if interest rates are higher than the rate specified in the futures contract, the buyer of the futures contract will pay the seller the difference between the market interest rate and the interest rate specified in the contract. Conversely, if interest rates decrease, the seller of the futures contract will compensate the buyer for the lower interest rate. Thus, a fall in interest rate benefits the buyer (long position), while a rise in interest rate benefits the seller (short position) of the futures contract.

Interest rate futures may be short term interest rate futures or long term interest rate futures. Interest rate futures on treasury bills and Eurodollars are examples of short-term interest rate futures. Interest rate futures on treasury bonds and treasury notes (long term securities) are examples of long term interest rate futures.

Applications of Interest Rate Futures

Futures markets provide investors, corporate enterprises, and other entities like banks, financial institutions etc., a means for hedging their spot positions against undesirable price movements. The two hedging positions that can be assumed are long hedge and short hedge. Generally in any asset market like commodity futures, stock index futures, a hedger takes a long position (buy the futures) in a futures contract to protect against an increase in the price of the underlying asset. For example, an oil refiner may buy oil futures to protect himself from oil price rises. Similarly, a short hedge involves taking a short futures position to protect against a decrease in the price of the underlying asset. For example, a cotton farmer may sell cotton futures to protect against price decreases by the time his crop comes to his hand.

The applications of interest rate futures may be examined in the following pages:

1. **Long hedge:** A long hedge involves buying futures contract. In other words, long hedge means assuming a long position in the futures market. Investors use long hedges to protect against falling interest rates by fixing interest rates on future investments. Rather than investing funds, today one can buy futures on T-bills.
2. **Short hedge:** A short hedge involves selling futures contract. If interest rates in the economy go up, issuer will pay the investors more but will be compensated by taking short position in the futures contract.

   In order to hedge against rising interest rates, we shall sell futures contract on T-bills now and buy the same futures contract on them later and lock in the cost of borrowing that is offered today in T-bill futures.
3. **Converting floating rate loan to a fixed rate loan:** A fixed rate loan carries a constant interest rate over the life of the loan. A floating interest rate involves the rate being changed at regular pre-defined intervals during the loan period. When the interest rate is likely to increase, demand from borrowers for fixed rate loans will increase. When the interest rates are expected to fall, borrowers will be interested in floating rate loans. However, using interest rate futures, one can convert an existing fixed rate loan to a floating rate loan and vice versa.
4. **Converting a fixed rate loan to floating rate loan:** We can convert a fixed rate loan to a floating rate loan by using an interest rate future to protect from risk of unfavourable changes in the interest rates.
5. **Extending the maturity of a security:** Interest rate futures can be used to extend (artificially) the maturity of a debt market security.
6. **Shortening the maturity of a security:** We can use futures (e.g., T-bill futures) for reducing the maturity of a debt market security.

7. **Hedging a commercial paper issue:** When short term interest rates are expected to increase, the issuer can hedge the futures commercial paper issue by taking a short position in T-bill futures contracts.
8. **Hedging a bond portfolio with T-bond futures**: Fixed income portfolio managers often use T-bond futures to shield the future values of their portfolios against interest rate changes.

Pricing and Valuation of Futures Contracts

Before discussing the pricing of futures contract it is desirable to understand the difference between value of an asset and price of an asset. The holder of an asset has money tied up in the asset. If the holder is willing to retain the asset, the asset must have a value at least equal to its price. If the asset's value were less than its price, the owner would sell it. The value is the present value of the future cash flows, with the discount rate reflecting the opportunity cost of money and a premium for the risk assumed. The price is an observable number. The value is less obvious. But fortunately the value of a forward or futures contract at the start is easy to determine. That value is simply zero. This is because neither party pays anything nor party receives anything of monetary value. This does not mean that neither party will pay or receive money at a later date. The values of futures and forward contracts during their lives, however, are not necessarily equal either to each other or to zero.

A futures contract is a standardised contract to buy or sell an asset on a future date at a price predetermined on the date of contract. The price at which two parties agreed to transact as on the settlement date is known as futures price. Under pricing of futures contracts we are pricing the underlying asset today to be delivered in future. The futures price is simply the figure that the two parties have agreed to be paid by the buyer to the seller at expiration in exchange for the underlying asset.

The pricing of futures contract is dependent upon the characteristics of the underlying asset. Different assets have different characteristics. They have different demand and supply patterns. Their capability may be different. This means that some are carriable and some are not. Similarly, cash flows may be different. This means that some generate returns and some don't. Futures price is based also on factors such as the spot price of the underlying asset, the risk involved in performance, the market behaviour etc. Hence there is no single way of pricing futures contracts.

Difference between Futures Price and Price in the Future Period

Before examining the pricing of futures, we should make the important distinction between futures price and price in future period. Futures price is the current price of the futures contract. But price in future period is the spot price that will prevail on a specified date later in the future.

Difference between Futures Price and Futures Value

Futures price and futures value are different. As already stated, futures price is the price at which the two parties agree to buy and sell the underlying asset on the maturity date. The

value of a futures contract is the profit that can be made by a party out of futures contract. At the time the futures contract is entered into, the value is zero. This is because there is no cash changing hands and there would be no arbitrage opportunity existing to make profit. If at maturity sport price (S_T) is not equal to futures price (F_T) an arbitrage opportunity will exist there to make profit. If S_T is more than F_T, there will be profit. Thus, profit is the difference between S_T and F_T. This profit is the value of the futures contract.

Now the problem is to determine the futures price which will be acceptable to both buyer and seller. Before pricing futures, it is desirable to study some basic concepts.

Basic Concepts in Futures Pricing

There are some basic concepts which are commonly used in futures pricing. They are : sport price, basis, spreads, arbitrage and repo rate.

Spot Price

Spot price is the price of a good if it is bought immediately. It is also known as cash price or current market price.

Basis

Basis is an important concept in futures contracts. Basis is the difference between the futures price and the cash or spot or current price. It is calculated by the following formula:

Basis = Futures price – Spot price or $F_0 - S_0$

If futures price of an asset is higher than its cash price, basis for the asset is positive. If spot price of an asset is higher than its futures price, basis for the asset is negative. For example, If the cash price of an asset is ₹ 10,000 and two months futures on the same assets is ₹ 10,500, then basis is ₹ 500 positive. If the futures price of the asset is ₹ 9,800, the basis is ₹ 200 negative. Hence a negative basis reflects the downward expectations about the market. Positive basis will show the upward expectations about the market. If the market has a negative basis, it is called a *backwardation market* (also known as *inverted market*). If it has positive basis, it is called *contango market* (contango and backwardation will be discussed later in this chapter).

It may be noted that in normal market, the basis will be positive, while in an inverted market it shall be negative. Thus, the market where the futures price exceeds the spot price, it is called normal market as the cost of carry is positive. The difference in the two prices is the cost of carry. However, sometimes futures price is less than the spot price. This happens due to changing demand and supply positions of the underlying asset. For example, spot price of wheat may be high due to short supply of wheat now. But when the crop matures in future, the supplies will be large. Hence futures price may be lower. Market where futures price is lower than the spot price is known as inverted market.

Spread

Sometimes futures contracts can be made on the same commodity for two different

maturity dates. The term 'spread' refers to the difference in price between two futures contracts on the same asset for different maturity dates.

Types of Spreads

Following are the different types of spreads :

1. **Intracommodity spread (time spread)** : This is the difference in prices between two futures of different maturity dates on the same commodity.
2. **Inter-commodity spread** : This is the spread between the futures prices of two different but related commodities.
3. **Inter-market spreads** : This is related with different markets for inter-related commodities.

Arbitrage

An arbitrage is a process of earning riskless profit without investment by taking advantage of differences in prices in different markets. It refers to buying a commodity or a financial instrument from a low price market and selling it in a high price market. Profit is the difference between high price and low price.

Repo Rate

The term 'repo' is a short form of repurchase. It is the rate at which the borrower will buy the security or asset (sold to the lender) at a later date.

Theories or Approches or Models of Futures Pricing

There are four important models for determining futures prices. They are :

1. Cost of carry model
   (a) in perfect market, and (b) in imperfect market
2. Expectation model
3. Normal backwardation model
4. Capital asset pricing model

Cost of Carry Model or Approach

Cost of carry model is the common method to value a futures contract. According to this approach, futures price depends upon two elements- (a) the current spot or cash price of the commodity or financial instrument, and (b) the cost of carrying or storing the underlying commodity or financial instrument from the present time to the delivery date (maturity date) of the futures contract. Thus, there are two determinants for futures prices, namely, the spot price and the carrying costs. Carrying costs are of several types. They are : storage costs, insurance costs, transportation costs, and financing costs. Storage costs are those expenses which are incurred for storing and maintaining the asset in safe custody. These include rent, warehouse expenses, normal wastage etc. In the case of financial instruments, storage costs include the expenses for keeping the securities in a bank vault or with custodians. Insurance

costs include the amount incurred on safety of the assets against fire, accidents etc. In some cases carrying costs include transportation costs also. Transportation costs are the costs of transportation to the place of delivery. Financing costs include the cost of financing the underlying assets. The total of storage costs, insurance costs, transportation costs and financing costs is known as gross carrying costs.

There is a possibility of earning a yield on storing the asset. Such yield is known as *convenience yield* from holding stocks. Thus, convenience yield is the benefits that arise from ownership of an asset during the life of the futures contract. This should be deducted from carrying costs (gross) to get net carrying costs.

In short, the central theme of cost of carry model is that futures is so priced as to prevent arbitrage profit. In other words, investors will be indifferent to spot and futures market to execute their buying and selling of underlying asset. This is because, the prices they obtained are the same. Expectations about market shall not influence the price directly. They influence the spot price through it, the futures price.

We shall now discuss the cost of carry model in perfect market and imperfect market separately.

Cost-of-Carry Model in Perfect Market : Cost of carry model is shown below :

Futures price = Spot price + Carrying costs

Note : If there is carry return (dividend or income from underlying asset during holding period), it should be deducted.

The cost of carry model is based on the following assumptions:

1. There are no transportation costs.
2. There are no restrictions in short selling, in borrowing and lending etc.
3. Investors can borrow and lend without any limit.
4. There is no credit risk. Hence, no margin is required.
5. There are no taxes.

The cost-of-carry model can be expressed as:

$F_{0,t} = S_0 (1 + C)$

$F_{0,t}$ = Current Futures price for delivery of the asset at time t

S_0 = Current spot price

C = Cost of carry (or carrying cost) expressed as a percentage of spot price.

Alternatively, we can use continuous compounding. Then futures price is calculated as below:

$F_{0,t} = S_0 e^{rt}$

where, e = exponential term, the value is 2.71828

t = time to maturity or expiration

Note : When calculations are done using continuous compounding, the results would be almost identical.

Example 3

Determine the futures price as per cost of carry model from the following :

Spot price of the commodity	₹ 50,000
Storage costs	5% p.a.
Insurance costs	3% p.a
Transportation costs	5 (fixed)
Financing costs	5% p.a
Carry period (time to expiration)	6 months

Solution

$F_0 = S_0 (1 + C)$

S_0 = ₹ 50,000

Cost of carry from today till time t

= Storage cost + insurance cost + transportation cost + financing cost

= (5% + 3% + 10%) x 6 / 12 + 5%

= 9% + 5% = 14% or 0.14

F_0 = 50,000 (1 + 0.14) = ₹ 57,000 or 50,000 + 14% = ₹ 57,000

Note : (a) If negotiated or contracted futures price is greater than the calculated futures price, arbitrage will take place. Such arbitrage is known as *cash and carry arbitrage.*

(b) If negotiated or contracted futures price is less than the calculated futures price, arbitrage will take place. Such arbitrage is known as *reverse cash and carry arbitrage.*

Cash and Carry Arbitrage

When contracted futures price is higher than the calculated futures price, cash-and-carry arbitrage occurs. In such situation, a market participant borrows money, buys the goods or asset today for cash, sells futures contract, carries the goods to the expiration of the futures contract. On expiration, he delivers the commodity or asset against a futures contract and pays off the loan. The profit of such strategy is called cash and carry arbitrage profit. Cash and carry model is also known as *non-arbitrage model.*

The cash and carry model of futures pricing is subject to the following assumptions:

1. The underlying asset is available in abundance in cash market.
2. There is no seasonal demand and supply in the underlying asset.
3. The storability of the underlying asset is not a problem, i.e., the asset is carriable.
4. The underlying asset can be sold short.

5. There are no transaction costs.
6. No taxes are applicable.
7. There are no margin requirements.

The model assumes that whenever there is an opportunity to make profit due to mispricing of an asset, and its replicas, arbitrageurs will start trading in order to eliminate these opportunities. This trading will continue until the prices will become equal across the products/ markets.

Example

Consider a situation in the bullion market where gold is available in the cash market at ₹ 20,000 per 10 grams and cost of financing, storage and insurance for carrying the gold for 3 months is ₹ 500 per 10 gram. Thus one may say that the value of gold (fair price of futures) at the end of 3 months will be ₹ 20,500 per 10 gram. It is further assumed that a 3 months futures contract on gold is trading at ₹ 20,800 per 10 gram. One must attempt to exploit the arbitrage opportunity that exists in the gold market by buying gold in the cash market and selling it in the futures market, simultaneously. It is therefore necessary to borrow money in order to take delivery of gold in the cash market, hold the gold for 3 months and then deliver it in the futures market to honour the futures contract. The money received on the performance of futures contract will be used to repay the money borrowed for buying gold in the cash market. This will result in a profit of ₹ 300 per 10 gram gold, assuming that there is no other cost involved in the transaction.

If many people purchase gold in the cash market and sell it in the futures market, price of gold will rise in the cash market. In the meantime, the price will fall in the futures market. This arbitrage on gold between the cash and futures market will continue until the prices between the cash market and futures market become equal.

Therefore, if the futures price is more than the future fair price (spot price plus interest) of asset, it will provide cash and carry arbitrage, (i.e., borrowing money to buy asset and to incur storage cost, and selling a futures contract) until the prices in both markets become equal. The current price of the gold increases due to buying pressure and the future price falls due to selling pressure. This process stops only when the arbitrage opportunity disappears. This happens when the futures price is equal to the spot price plus interest. Cash and carry arbitrage involves buying the asset immediately in the cash market and carrying it till maturity. It ensures that the futures price of an asset cannot exceed the spot price plus interest. Suppose crude oil is trading at ₹ 3500 a barrel when the interest rate is 6% and monthly storage costs amount to ₹ 30. Assuming that the storage cost is paid at the end of the month, the total cost of cash and carry would be ₹ 3500 + 30 + one month interest cost ₹ 17.50 = ₹ 3547.5. If one month crude oil futures price is ₹ 3600, it would be profitable to implement cash and carry arbitrage. The arbitrage profit would be ₹ 52.50 per barrel.

Thus, the trader takes the following steps in case of cash-and carry arbitrage (when the contracted futures price is higher than the calculated futures price).

A. At date of contract:

1. Borrow money
2. Buy asset or commodity
3. Sell futures contract

B. At maturity:

4. Deliver the asset or commodity against the futures contract
5. Receive the amount (price) and pay off the loan.

Reverse Cash-and-Carry Arbitrage

When contracted futures prices is lower than the calculated futures price, the reverse cash-and-carry arbitrage occurs. In such situation, a market participant sells the commodity today for cash. Then he purchases a futures contract. This contract will be used to honour the short sale commitment. Further, he lends the sale proceeds of the commodity upto the date of expiration of futures contract. On the expiration date, he accepts delivery against the futures contract and settles the payment. The profit of such strategy is reverse cash-and-carry arbitrage profit.

In this situation, the market participant will sell the asset, save storage cost and invest the proceeds to earn a return and buy a futures contract. This reverse arbitrage will result in reduction of the cash price of the asset and an increase of its price of futures, until these prices become equal in both markets.

Example

Continuing the above example, reverse cash and carry would produce the following cash flows at the end of a one month period (continuing the example given in the earlier paragraph):

Sale proceeds of one barrel at spot price = ₹ 3,500

Add one month interest earned at 6% on ₹ 3,500 = ₹ 17.50

Add one month storage cost saved = ₹ 30

Thus total cash flow at the end of one month from reverse cash and carry would be ₹ 3,547.50. If the futures price is ₹ 3,535, then there is an arbitrage profit of ₹ 12.50 from this transaction because it costs only ₹ 3,535 to buy back the barrel of crude oil. In the meantime the spot sale, together with interest and storage costs saved, amount to ₹ 3,547.50. Hence, it would be profitable to implement reverse cash and carry arbitrage.

Reverse cash and carry arbitrage can also be implemented by people who do not own the asset. Such arbitrageurs must borrow the asset from someone else before they can sell it. In many cases large institutions are able to borrow and sell securities that they do not own. This

process is known as *short selling* or simply *shorting*. When reverse cash and carry arbitrage is implemented through shorting, the process is as follows:

1. Borrow the asset and sell in spot.
2. Lend the proceeds at risk free interest rate.
3. Buy the asset at futures price.
4. At maturity reverse all of the above. Settle the futures contract using the loan repayment, take delivery of the asset and use it to repay the borrowed asset.

Thus, shorting refers to selling the assets which are not owned by the seller and buying them back at a later date. This is done with the hope that the price of an asset would go down.

Comparison between Cash-and-Carry and Reverse Cash-and-Carry Arbitrage Strategies

Cash-and-Carry Strategy	Reverse Cash-and-Carry Strategy
1. Borrow funds equal to spot price	1. Lend funds out of sale proceeds
2. Buy asset and store	2. Sell asset and lend the sale proceeds
3. Sell futures	3. Buy futures
4. Delivery against futures	4. Accept delivery set at expiration.

Cost-of-Carry Model in Imperfect Market

The assumptions of cost-of-carry model in perfect market have no practical implication. There are five important imperfections noticed in the market. These are as follows :

1. There are transaction costs.
2. Unequal borrowing and lending rates.
3. Restrictions on short selling.
4. Sell-buy profit (Bid-ask spread).
5. Limitations to storage (most of the commodities cannot be stored well).

Equations are :

Cash-and carry arbitrage

$$F_{0,t} \leq S_0 (1 + T) (1 + C)$$

Reverse cash-and-carry arbitrage

$$F_{0,t} \geq S_0 (1 - T) (1 + C)$$

No arbitrage

$$S_0 (1 - T) (1 + C) \leq F_{0,t} \leq S_0 (1 + T) (1 + C)$$

When transaction cost (e.g., commission, brokerage etc.) is taken into consideration, the cost of carry model gives the no-arbitrage bounds (bounds mean the upper and lower boundary) for futures price to prevent arbitrage. In view of the transaction costs, we can

only define a range for futures price rather than lock it up in an exact equation. If the futures price goes beyond these bounds, arbitrage opportunity arises. The futures price may vary within these bounds without attracting arbitrage activity. The no-arbitrage bounds are calculated as follows:

Upper no-arbitrage bound:

$$F_{0,t} \leq S_0 (1 + T)(1 + C)$$

Lower no-arbitrage bound:

$$F_{0,t} \geq S_0 (1 - T)(1 + C)$$

Combining the two equations, the no-arbitrage bounds may be expressed as:

$$S_0 (1 - T) (1 + C) \leq F_{0,t} \leq S_0 (1 + T) (1 + C)$$

Note : In the lower bound, transaction cost is deducted and in the upper bound, transaction cost is added.

Example 4

The spot price of gold per gram is ₹ 4,500. The annual interest rate for borrowing and lending is 10%. Transaction cost is generally 2% of the transaction amount. For a futures contract, maturing in six months, calculate the following:

No-arbitrage futures price in perfect market environment

No-arbitrage bounds for futures price when transaction cost is taken into consideration

Solution

(a) ***No-arbitrage futures price in perfect market environment***

$F_{0,t} = S_0 (1 + C)$

$= 4,500 (1 + 0.05) = ₹ 4,725$

(b) (i) ***Upper no-arbitrage bound***

$F_{0,t} \leq S_0 (1 + T) (1 + C)$

$= 4,500 (1 + 0.02)(1 + 0.05) = ₹ 4,819.50$

(b) (ii) ***Lower no-arbitrage bound***

$F_{0,t} \geq S_0 (1 - T) (1 + C)$

$= 4,500 (1 - 0.02)(1 + 0.05) = ₹ 4,630.50$

Note : Carrying cost (interest) is 10% for 1 year. For 6 months, it is 5% or 0.05.

Expectancy Model (Expectation Approach)

This approach is advocated by J.M.Keynes, J.R. Hicks and N. Kalidor. They argued that the futures price is the market expectation of the price at the future date.

In case of consumption assets or non-carry assets, the cost of carry model cannot work properly. According to cost of carry model, the futures price must exceed the spot price by

the amount of cost of carry for the period remaining for maturity of the contract. This is called full cost of carry. In case futures are not at full cost of carry to the spot, then the process of arbitrage sets in. In some cases we can find that futures price is not only at full cost of carry but at discount to the spot price. Clearly, the process for arbitrage appears to be failing here. In such cases either the arbitrage cannot be executed or gains are too little to offset the transaction and delivery costs.

Expectancy theory of futures pricing states that futures price is a reflection of expected spot price in the future. In other words, the futures price is nothing other than the expected spot price of an asset in future. Therefore, market participants will price the futures based upon their estimates of the future spot prices of the underlying assets. According to this theory, first point is that futures can either be at a premium or at a discount to the cash price (current or spot price) of the underlying asset. Secondly, futures prices give market participants an indication of the direction in which the cash prices are likely to move in the future. Thus, if futures are trading lower than the spot or cash price, it indicates that the cash price is expected to be lower in the future. This is easily justifiable in case of agricultural commodities. For example, before harvest the supply of wheat would be low and current prices may be higher today. But in future, wheat may be available at a lower price. Naturally futures price in this case would be lower than the current spot price.

The expectancy model is based on the philosophy that relationship is between the futures price and expected spot price in the future and not between the futures price and cash price or current spot price. Thus, the expectation model states that the current futures price must be equal to the expected spot price.

This approach is expressed as follows :

$F_{0,t} = E_0 (S_t)$

where, $F_{0,t}$ = Futures price at t = 0

E_0 = Expectation at t = 0

S_t = Spot price at time t

$E_0 (S_t)$ = Expectation at t = 0 of the spot price to prevail at time t

The above equation states that the futures price approximately equals the spot price currently expected to prevail at the delivery date and if this relationship does not hold, there would be attractive speculative opportunities. In simple terms, the futures prices are influenced to some extent by expectations prevailing at the current time. If market participants are operating properly, then Current futures price = Expected futures spot price.

In short, according to expectation model, the current futures price must be equal to the expected future spot price. The difference between expected future price and initial futures price is the expected futures profit.

Example 5

Suppose there is general expectation that the price of gold next April 1 will be ₹ 2,500 per gram. The futures price today for July 1 must somewhat reflects this expectation. If today's futures price is ₹ 2,475, going long futures will yield an expected profit. What is the expected profit.

Solution

Expected futures profit = Expected futures price - Initial futures price

= 2,500 - 2,475 = ₹ 25

Note: (a) If the above model $F_{0,t} = E_0 (S_t)$ is considered as correct, then a speculator cannot expect any profit or loss from a position in the futures market. Then expected profit = $E_0 (S_t) = F_{0,t} = 0$.

(b) If $F_{0,t} \neq E_0 (S_t)$, speculative opportunities emerge and speculators would exploit the opportunities and ultimately there would be parity between these prices.

Normal Backwardation Model

Backwardation, in general, refers to a market in which the futures price is less than the cash price (or spot price). In such cases, the basis is negative (basis = futures price - cash price). This situation can occur only if futures prices are determined by considerations other than, or in addition, to cost-of-carry factors. Further, if the futures prices are higher than the cash prices, this condition is usually referred to as a 'contango' market; and the basis is positive. Normal backwardation is used to refer to a market where futures prices are below expected spot prices.

The normal backwardation model is expressed as :

$$F = E + rp$$

where F = Futures Price

E = Expected spot price at maturity

rp = Risk premium

Capital Asset Pricing Model

In general, the higher the risk of an investment, the higher the expected return demanded by an investor. The expected return demanded by the holders of futures positions is reflected in the difference between futures prices and expected spot prices. This risk return model can be used for other assets like stocks and bonds. The CAPM leads to the conclusion that there are two types of risk in the economy, systematic and unsystematic. Unsystematic risk is not so important because it can be almost completely eliminated by holding a well-diversified portfolio. Systematic risk or market risk cannot be diversified away. So as per this model, the investors should be compensated only for systematic risk. Systematic risk is represented by β_j. Generally, an investor requires a higher expected return than the risk-free interest rate for bearing the systematic risk.

In brief, according to CAPM, the expected return on a long futures position depends on the beta of the futures contract. If $\beta_j > 0$, the futures price should rise overtime; if $\beta_j = 0$, the futures price should not change, and if $\beta_j < 0$, the futures price should fall over time and vice-versa in the case of short futures.

Assumptions of CAPM

1. Perfectly competitive market.
2. No tax and no transaction cost.
3. Investors are risk-averse. They prefer highest expected returns for a given level of risk. They will take the risk only if they are compensated for the risk.
4. Investors have homogeneous expectations about the expected return and risks of securities.
5. All investors have same holding period.
6. Risk-free rate at which all investors can lend and borrow.

Methodology of CAPM

The risk averse investors expect higher return than the risk-free return. The Capital Market Line (CML) defines this relationship by the following equation:

$$E(R_P) = R_j + \left\{\frac{E(R_m) - R_j}{\sigma_m}\right\}\sigma_p$$

where, $E(R_P)$ = Expected portfolio return

R_j = Risk-free return

$E(R_m)$ = Expected return on market portfolio

s_m = Standard deviation of the market portfolio

s_p = Standard deviation of the portfolio

As mentioned above, beta (β) represents the systematic risk. It cannot be minimised. A beta of 1 indicates average level of risk. A beta more than 1 signifies that the security's return more than that of the market portfolio. However, a zero beta means no risk.

Expected Return on Security

The following model is used to measure the expected return on a security :

$$E(R_j) = R_j + (R_m - R_j)\,\beta_j$$

where, $E(R_j)$ = Expected return on security

R_j = Risk-free rate

R_m = The market return

β_j = The measure of the security's systematic risk

Pricing of Commodity Futures

For the purpose of pricing the commodity futures, commodities should be classified into two – commodities which are of 'carry type' and those which are of 'non-carry' type. Carry type commodities are used for investment purposes and non-carry type commodities are meant primarily for consumption. Thus, there are two types of commodities – investment commodities (carry) and consumption commodities (non carry). Examples of investment assets are gold, silver etc. Rice is an example of consumption commodity or asset.

Pricing of Futures on Investment Assets

For pricing a forward contract we can apply the principle of arbitrage. For pricing futures, the principle of arbitrage may or may not be applicable.

For pricing futures on investment assets, we can use cost of carry model. According to cost of carry approach, futures prices depend on the cash price of an asset (commodity) and cost of storing the commodity from the date of cash price to the delivery date of the futures contract. The cash price is also known as spot price or current price.

Under cost of carry model, the futures price is equal to the sum of the spot price of the asset or commodity and the carrying costs incurred by buying and holding on to the asset, less the carry return, if any. Thus,

Futures Price = Spot Price + Cost of Carry – Carry Return

Here, spot price is the current price of the deliverable asset in the market. Carrying costs or costs of carry refer to the holding costs, including the interest charges on borrowing the cash to buy (or the opportunity cost of using one's own funds) the asset. In case of financial assets, the carry cost typically includes interest cost. In the case of commodities, there are also insurance costs and storage costs in addition to interest cost. Carry return refers to the income, such as dividend on share or interest on debt which may accrue to the investor during the holding period.

The benefits due to ownership do not accrue to the buyer of futures contract. For example, if the underlying asset is stock, the dividend on it will accrue to the owner of the asset and not to the owner of the futures contract. That is why this benefit is deducted from the futures price.

Pricing Futures on Non-carry or Consumption Commodities

For pricing futures on consumption assets, the cost of carry model cannot be applied as above. In respect of such commodities, this model helps to determine the *upper bound* only. In other words, for the agricultural and other non-carry commodities, we may say that the futures price will not exceed the sum of the spot price and the carrying costs less carry return, if any. For pricing futures on consumption assets, the principle of arbitrage may not be applicable. This is because of the utility of consumption (called convenience yield). Investors keep such a commodity in inventory because of its consumption value and not because of

value as investment. Thus they are reluctant to sell the commodity and buy futures contracts because futures contracts cannot be consumed. Similarly, pure arbitrageurs will not always be able to find supplies of cash goods to borrow and sell short. Producers need to maintain supplies of these goods in order to use them in their production process. For example, cereal manufacturers need to keep wheat and corn in inventory. Therefore, it is possible that the spot prices of such commodities are higher than the futures prices. It is possible that no one might be able to arbitrage by selling the commodity in the spot market and buying futures contracts.

Thus, the pricing of the non-carry or consumption commodity requires introducing another concept called *convenience return* or *convenience yield*. It is the return that an investor (the holder) realises for carrying inventory of the commodity over his/her immediate short term needs. Convenience yield simply refers to the benefits enjoyed by the owner of the asset due to its possession and consumption value. In short, consumption assets have consumption value. This consumption value is called convenience yield. People hold consumption assets to satisfy consumption needs. Wheat, rice, pulses, edible oils are consumed by one and all. Similarly, crude oil, jute, copper etc. are raw materials for manufacturing concerns. These are held for deriving consumption value and not for obtaining returns by trading in them. In some situations, people essentially derive convenience yield merely by holding the asset. Convenience yield is expressed in monetary terms or in percentage terms.

It may be noted that the physical holding of asset and futures on the same are not equivalent due to consumption value attached to the commodity. For an oil producer buying oil futures and selling in physical market leaves no stock of oil required for production. Due to consumption value of the asset we only have an upper bound to the futures price.

Agricultural commodities generally have convenience yield (financial assets have no convenience yield). It may be noted that the convenience yield for a commodity is likely to be different for different investors and may vary over time. It is a subjective issue. Hence, the convenience yield cannot be measured and expressed easily.

Example 6

Spot price of gold ₹4,000/g

Annual interest rate 12%

Assuming that carrying cost comprises only the financing cost, calculate the futures price of the gold to be delivered in 6 months. Use cost of carry model.

Solution

$F_{0,t} = S_0 (1 + C)$

$= 4,000 (1 + 0.06) = ₹4,240$

When continuous compounding is used in the calculation, futures price will be :

$F_{0,t} = S_0 e^{rt} = 4,000 \times e^{0.12 \times 6/12} = ₹4,247$

Pricing of Financial Futures

So far we have seen how the commodity futures are priced. Now let us turn our attention to pricing of financial futures. Financial futures include stock futures, stock index futures, interest rate futures, currency futures etc.

Pricing of Stock and Stock Index Futures

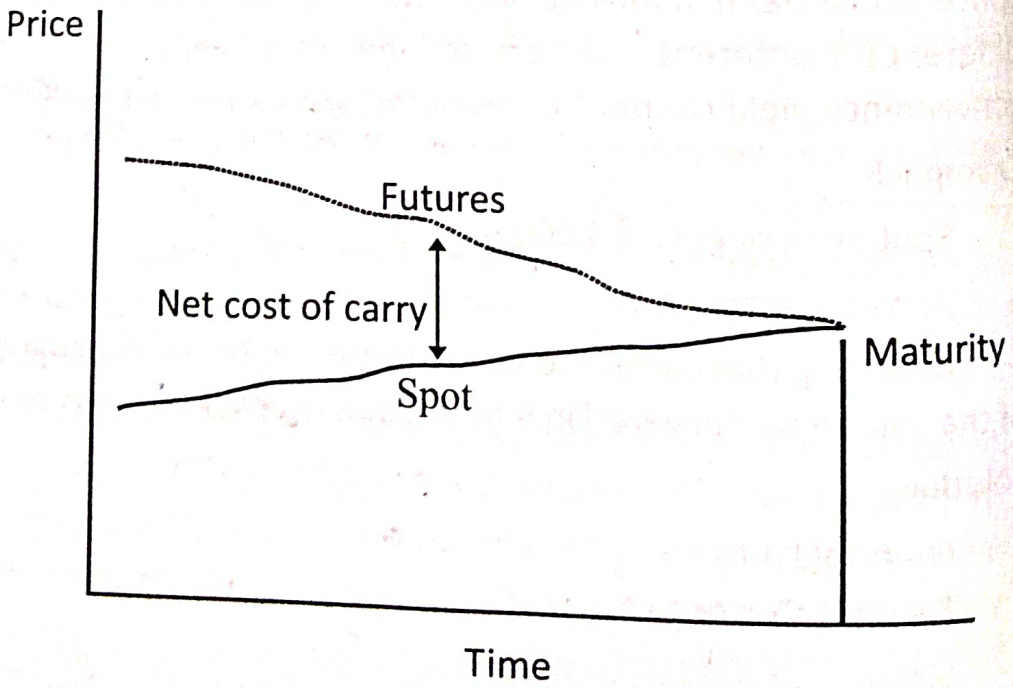
Pricing of stock or stock index futures can be done by using cost of carry model. For pricing of financial assets, cost of carry model is better. In the case of financial assets, there is no convenience yield. This further simplifies the determination of price. The cost of carry model is based on the arbitrage argument. For stock or stock index futures, the spot price is the "spot index value", the "carry cost" means the interest on the value of stock underlying the index, and "carry return" is the value of the dividends receivable between the day of pricing and the date of maturity. Accordingly, stock indices or stock indexes can be treated as securities (stock) that pay dividends and futures value. Therefore,

Futures price = Spot price + Cost of carry r – benefits (i.e., dividends) of ownership d

Cost of carry = Interest cost in case of stock index futures / financial assets

Principle of Convergence

As per the cost of carry model, the difference in the futures price and spot price represents the cost of carry (storage cost, insurance, interest etc.) or basis. These costs are incurred to keep the commodity in inventory until its delivery date. Generally, the longer the time to maturity, the greater the carrying costs or basis. In other words, the futures contract with longer maturity will be priced higher than the futures contract with shorter maturity. As maturity nears or delivery month approaches, the difference between the futures price and spot price (i.e., basis) declines. That is, on maturity the futures price and spot price are approximately the same. This means that the two prices (spot and futures prices) become identical or equal on the day of maturity. This phenomenon is known as *convergence.* Thus, convergence refers to the tendency of spot and futures prices to come together (both prices converge), i.e., the basis shrinks as a futures contract approaches expiration. This is shown in the given graph:



Convergence of Spot and Futures Prices (Fig. 3)

The difference of the futures price and the spot price represents cost of carry for the remaining period of the futures contract. As time elapses, the cost of carry would reduce being directly proportional to the time remaining. Thus on the day of maturity the cost of carry would be zero. It is also possible for the commodity futures contracts to have negative basis. For example, a particular commodity may be in short supply now. Therefore, its spot price may be high. If the supply is likely to improve in the course of time, say, due to good monsoons, then the futures price may be lower. In case of other commodities as well, the basis may be found to be negative or positive. In both cases, however, the convergence to the spot price occurs. It is easy to understand why the futures price equals or is very close to the spot price, when the delivery period is reached. If the two are unequal, then the arbitrage opportunities exist for traders. For instance, if the futures price is higher than the spot price, an investor would (a) short sell a futures contract, (b) buy the asset, and (c) make the delivery. If he does so, he will get a profit equal to the excess of the futures price over the spot price. As traders exploit this opportunity, the futures price will tend to decrease and the spot price will tend to increase. Similarly, if the futures price is lower than the spot price, one who is interested in buying an asset would be tempted to buy a futures contract and take the delivery. When he does so, after sometimes, the futures price will tend to increase and the spot price will tend to fall. This process of change will continue till the date of expiration when both prices will converge (due to arbritrage process). In other words, when the futures price is different from spot price, the arbitrage opportunities will exist and this will drive them to a common value. This is called convergence. On the date of expiration, the basis becomes zero.

Relationship between Futures Price and Expected Spot Price

As already stated, the basis is primarily attributable to the carrying cost of a commodity. If there were no carrying costs involved and if there were no uncertainty, then the futures price would be equal to the expected spot price in the future (i.e., the date of maturity). In conditions of certainty, then the expected basis would be equal to zero in a market where there are no carrying costs and other inefficiencies.

As we have seen, on the date of maturity the futures price and spot price will converge. This means that both prices become the same irrespective of whether the market is normal or inverted. Does this mean that we can take today's futures price to be the expected spot price on the date of maturity? There are three theories that attempt to establish the relationship between the futures price and expected spot price. These are explained as below:

1. **Normal backwardation approach or hypothesis:** This hypothesis was propounded by J.M. Keynes. This hypothesis states that the expected basis is negative because the futures price tends to be a downward estimate of its spot price in the cash market at the maturity date. J.M. Keynes argued that the futures market is dominated by short hedgers. They attempt to avoid the risk associated with a decrease in the price of a commodity. They depend on the speculators

who are willing to assume this risk by taking a long position in the contract. Therefore, the speculators are expected to write contracts below the expected spot price in order to get compensation for the risk they take. The theory is thus based on the assumption that speculators usually buy the contracts while hedgers usually sell the contracts.

2. **Contango:** Contango assumes the opposite of Keynes hypothesis. This approach assumes that the hedgers buy the futures contracts and the speculators sell the futures contracts. Because of their knowledge and expertise about the futures market and the inefficiencies of the market, speculators are largely willing to assume the price risk in anticipation of earning profits. In anticipation of profits, they pull up (or bid up) the prices of the futures contracts. Hence the futures price is an overestimate of expected spot price. This results in a positive basis. The speculators can make profit only if they sell the contracts and the futures price declines. With the price of a futures contract above the spot price initially and then declining over time, this phenomenon is called contango.

3. **Expectation hypothesis:** This approach assumes that the expected basis would be equal to zero. This is based on the argument that futures prices are an unbiased estimate of expected spot price in the future. This happens when markets are efficient and hedgers and speculators correctly read the minds of each other. One group cannot outsmart the other group. Under efficient market conditions all the factors determining the futures price such as the cost of storage, insurance, carrying costs, convenience yield etc. are well-known. Hence the futures price must genuinely reflect the expected spot price in the future. There is no opportunity for any excess returns either for the hedgers or for the speculators.

Relationship between Futures Price and Forward Price

In efficient and perfect markets the forward price and futures price would be the same. In a perfect market where the interest rates remain unchanged, the futures price would equal the forward price, with the marking to market having no impact on the prices. However, when interest rates are variable, the two may be different. Broadly speaking, if movements in the futures prices are positively correlated to the interest rates, then the futures prices are likely to be higher than the forward prices. As futures prices increase, long positions (buying futures contracts) are profitable. If the interest rates also rise simultaneously (a positive correlation) then the marking to market cash inflows can be reinvested at higher rates (because interest rates increase). Similarly, if interest rates fall when futures prices fall (still a positive correlation) then long position holders incur losses. However, such loss can be offset by borrowing at lower interest rates. Consequently, the futures prices tend to be bid higher in relation to the forward prices. The reverse happens when the futures prices and interest rates are negatively correlated. That is, when interest rates tend to fall with an increase in the futures prices, then the cash inflows resulting from marking to market can be reinvested at lower rates of interest. Similarly, increased interest rates associated with falling futures prices would imply that profits to long position on futures have to be offset by borrowing at higher rates of interest. This has the effect of bidding lower futures prices than those of forward contracts.

However, in the imperfect real markets, this does not work so well. The presence of transaction costs, indivisibilities and taxes tend to weaken these propositions. Accordingly, the futures price may be reasonably taken to be the same as the forward prices derived from the cost of carry model. Even in the real markets, it is observed that the futures and forward prices run very close to each other and the process of daily settlement (marking to market) has only an insignificant impact on prices.

Hedging Strategies using Futures

As already discussed, hedging means eliminating the risk in an asset or a liability. It is the process of reducing exposure to risk. Thus, a hedge is any act that reduces the price risk of a certain position in the cash market.

Risk is not a loss. It is uncertainty about the expectation of a future event. The uncertainty may turn out to be favourable (resulting in a profit) or unfavourable (resulting in a loss). Risk is thus a neutral concept. Profit and loss are merely two sides of the same coin called risk. Since hedging eliminates risk it follows that hedging does not aim at maximising profit or minimising loss. Instead, it locks the investment to a current value.

Futures contracts are the primary tools of effective hedging. They enable the market participants to change their risk exposure from unexpected unfavourable price fluctuations.

In the context of futures trading, hedging is regarded as the use of futures transactions to avoid or reduce price risk in the spot market. In short, hedging is a strategy to reduce risk by taking opposite of what one already has.

Need for Hedging

Stock prices fluctuate because of two sets of factors. These factors are systematic and non-systematic. Systematic factors are those that influence the market as a whole. They include such things as interest rates, taxation policies, political conditions, fiscal and monetary policies etc. Non-systematic factors are company specific factors. They are peculiar to a particular company. They may relate to technological developments, labour relations, takeover situations etc. When an investor takes a long position (buying) in a stock, he believes that it is undervalued and hopes to gain when its price increases. Any increase in its value will yield him profits. But his assessment need not be correct. Thus, while taking the long position, he carries the risk of his basic thinking about the stock being wrong. There is another risk he carries. That is, the market might move in the unfavourable direction. Therefore, the particular stock he bought declines in value. In the first case, he will suffer losses, when his judgement about the stock proves incorrect. He is also prone to suffer losses when the whole market moves in the downward direction for whatever reasons, although his analysis of stock was correct. Similarly, when an investor takes a short position in a stock (selling stock) in the belief that the stock is overvalued, any decline in the stock price would earn him profits. Here again, the investor runs two risks. First, his analysis and conclusion about the stock may

Example 11

The present value of Nifty Index is 3,150. The three month interest rate is 12 % p.a. The dividend yield on this index is estimated to be 6 %. Calculate the fair value of futures with 90 days remaining for maturity.

Solution

Fair value of the index futures = Value of index (or S) + Cost of carry for 90 days - Dividend benefit for 90 days

$= 3,150 + (3,150 \times 12\ \% \times 90/360) - (3,150 \times 6\ \% \times 90/360)$

$= 3,150 + 94.50 - 47.25 = ₹\ 3,197.25$

or

$= 3,150\ (1 + 0.03)\ (1 - 0.015) = 3,150\ (1.03)\ (0.985) = ₹\ 3,195.83$

or

$= 3,150\ (1 + 0.03 - 0.015) = 3,150\ (1.03 - 0.015)$

$= 3,150\ (1.015) = ₹\ 3,197.25$

or

$F = Se^{(r - d)\ t} = 3,150 \times e^{(0.12 - 0.06) \times 90/360}$

$= 3,150 \times 2.71828^{0.015} = 3150 \times 1.015 = 3,197.25$

Note : (a) Cost of carry or interest rate for 90 days = 12 % x 90/360 = 3 % or 0.03. Similarly, dividend yield for 90 days = 6 % x 90/360 = 1.5 % or 0.015.

(b) It is better to use continuous compounding rather than discrete compounding.

Hedging with Stock Index Futures

Investors can use stock index futures for hedging their risk. Suppose a portfolio manager who has a portfolio of ₹ 100 crores held primarily in equity shares. Suppose, he anticipates a decline in the market price in the near future. To avoid writing a low portfolio value, he might decide to sell the securities of the portfolio now and buy back later when the prices fall, thereby protecting his gains. However, it would be very expensive because he has to incur commissions, taxes and other costs involved in such a big deal. The best strategy is to use stock index futures. In India, futures contracts are available on two stock indices - the S & P, CNX Nifty and the S & P Sensex.

In stock index futures, there is no delivery and receipt of stock. Stock index futures are cash settled.

Trading in Index futures has many advantages. Some of them are :

i) An investor is able to buy or sell the 'entire stock market' instead of individual securities.

ii) Index based futures satisfy the hedging requirements of investors having reasonable sized portfolio irrespective of the composition of the individual securities in portfolio.

iii) Index based futures are settled in cash. Therefore, all problems related to bad delivery, forged, fake certificates, etc. can be avoided.

iv) Since the index consists of many securities, it is very difficult to manipulate the index. This adds to the attractiveness of index as a base for introducing futures trading.

v) Investors are required to pay a small fraction of the value of the total contract as margins.

An investor who holds a portfolio of securities may be anxious about the possibility that the prices of his shares might fall. He thus faces a risk of reduction in the value of his portfolio on account of an adverse movement of share prices in the stock market. He can effectively hedge this risk by taking a position in the stock index futures that will provide him a gain in the event of a fall in share prices. The hedging strategies using stock index futures may be discussed as follows:

1. **Short Hedging:** If the investor anticipates a fall in share prices, he should take a short position (or sell) in the required number of stock index futures. He would thus be guaranteeing a selling price for sale of the stock index for a specific period in the future. If there is a fall in share prices in the future as anticipated, the stock index would also fall correspondingly. The investor can then close out his position in the index futures by taking a long position (or buying) in the same number of contracts. The buying price would be lower than his predetermined selling price. The excess of the selling price over the buying price would be received by the investor. This represents his gain in the futures transaction. The reduction in the value of his portfolio would be compensated by the gain in the index futures transaction without making any change in his original portfolio of shares. If, against his expectations, the share prices were to rise, the investor would suffer a loss in his futures transaction but the value of his portfolio of shares would rise proportionately to compensate the loss.

Example

Let us consider an investor who holds a portfolio of shares valued at ₹ 60,000. He anticipates a fall in equity prices and would like to avoid a reduction in the value of his portfolio. The NSE index Nifty on which futures contracts are available now stands at 2,000.

In order to hedge the risk in this case, the investor needs to sell Nifty futures contracts. As the monetary value assigned to Nifty futures is ₹ 1 per index point, the value of one Nifty future at the current index value would be ₹ 2,000. As the value of the investor's portfolio is ₹ 60,000, he needs to sell 30 Nifty futures to hedge his portfolio. Let us assume that the investor sells 30 Nifty futures at ₹ 2,000 per contract. If there is a fall in equity prices in the stock market as anticipated, there would be a reduction in the value of the investor's portfolio and also a fall in the value of the stock market index. Let us assume that there has been a general decline in share prices to the extent of 10 per cent over a period of one month. This means that the value of the investor's portfolio would have declined by ₹ 6,000 and the stock index would be at 1,800 by the month end.

The investor can now close out his position in the index futures by buying 30 Nifty futures at the current price of ₹ 1,800. The selling price being higher than the buying price by ₹ 200, the investor would receive ₹ 6,000 (₹ 200 x 30 contracts) on buying 30 Nifty futures. The gain of ₹ 6,000 from the index futures trading would thus compensate the reduction in the value of his portfolio. Thus trading in the index futures has helped the investor to hedge his risk.

2. **Long Hedging:** A long position in index futures can also be used as a hedging tool. An example would illustrate this strategy. Let us consider a mutual fund company which has announced an investment scheme and is expecting to receive ₹ 50,00,000 within a month for investment in the stock market. The research wing of the company has estimated that the prices of equity shares in the market would rise in the meantime. The mutual fund thus faces a risk of having to buy the shares from the market at higher prices. By taking a long position for buying in index futures, the mutual fund can hedge this risk.

Example

Let us assume that Nifty currently stands at 2000. The fund needs 2500 Nifty futures to cover its expected receipt of ₹ 50,00,000. The mutual fund can buy 2500 Nifty futures at ₹ 2,000 per contract. If, by the end of the month, Nifty rises to 2200 on account of a general increase of 10 per cent in equity prices, the fund can now close out its long position in Nifty futures by selling 2500 Nifty futures at the current price of ₹ 2200 per contract. The fund would receive ₹ 5,00,000 being the excess of the selling price over the buying price on 2500 Nifty futures. These additional funds can be used to compensate the 10 per cent increase in the price of shares in the stock market. The mutual fund can practically buy the same quantity of shares that it could have bought one month earlier.

3. **Adjusting the Beta of Portfolio using stock index futures:** The beta (beta is the statistical measure of the sensitivity of the movement of an equity price to the movement of the market as a whole) of the portfolio can readily be adjusted by using stock index futures. When portfolio managers believe that the stock market offers a relatively high expected return, for a given level of risk, they would increase the beta values of their portfolio. On the other hand, when they feel that the market risk has increased, they would tend to lower their portfolio betas. The desired beta can be achieved by trading in futures on the stock index by using the following strategy:

(a) Sell futures to reduce beta

(b) Buy futures to increase beta

If the value of portfolio is P having a beta of β_p and investor goes short on futures of the value of F, then the beta of his combined position, β_n, is

$P \times \beta_n = P \times \beta_p - F \times 1$

Value of future to be sold (+) / bought (-) = $\pm P \times (\beta_p - \beta_n)$

The advantages of the strategy to adjust beta through futures are: (a) avoid frequent buying or selling of equity portfolio, (b) save transaction costs and yet adjust beta on regular basis to the desired level of risk, (c) avoid sending unnecessary signals to the market by constant buy and sell orders, (d) avoid impact cost if the volumes of trade are large (the effect on price due to actions of selling and buying and vice versa is called impact cost).

Open Interest

Open interest refers to the total number of futures and / or option contracts outstanding at the close of the previous day's trading. In other words, it is the total number of futures and / or options contracts that are not closed on a particular day. It is the sum of all long positions or all short positions. In short, open interest is the number of contracts that have been bought or sold, but not yet settled. Open interest is important in futures trading because it is an indication of the trading in the contract as well as the liquidity of the contract. An increase in the open interest indicates an increase in the number of contracts available for delivery. A decrease in the open interest indicates a decrease in the number of contracts available for delivery. This is an indication of the liquidity of the contract.

Calculation of Open Interest

The calculation of the open interest involves the following :

1. When two traders conclude a trade for the first time in a particular futures contract the open interest will increase by the number of contracts entered into by these traders.
2. If one of the parties to the trade is closing out a position taken earlier and the other party is a trader who is not closing the position, there will be no change in open interest, because this transaction just shifts the obligation from the party that is closing the position to the other party.
3. If both the parties are closing their positions because they had opposite positions in the futures before the trade, the open interest will decrease by the number of contracts these two parties had entered into.

Typically, whenever trading in a new contract is started, the open interest will be initially low. As time passes, more and more new traders will enter, and the number of contracts traded by them will be more than the number of contracts that are closed out and hence the open interest would increase. However, near the maturity of the contract, most traders would close out their position - both long and short - and these offsetting trades among the traders who already had positions will cause the open interest to decrease. At the time of maturity, the open interest will be very small, because the number of contracts held for delivery will be very small.

Example 12

Consider the following transactions in ICICI single-stock futures that took place in one of the exchanges. Megafunds took a long position in 10 contracts, Minifund took a long position in 12 contracts, Ram took a short position in 7 contracts, and Interfund took a short position in 15 contracts.

On January 3, Megafund took a short position in 5 contracts, Minifund took a long position in 8 contracts, Ram took a long position in 3 contracts, and Interfund took a short position in 6 contracts.

On January 4, Megafund took a short position in 10 contracts, Minifund took a short position in 5 contracts, Ram took a long position in 8 contracts, and Interfund took a long position in 7 contracts.

Calculate the open interest

Solution

The open interest is calculated as follows :

January 2 :

Total number of long positions : Megafund's 10 + Minifund's 12 = 22 contracts

Total number of short positions : Ram's 7 + Interfund's 15 = 22 contracts

Thus, 22 contracts are available for delivery and hence the open interest is equal to 22 contracts.

January 3 :

Total number of long positions : Minifund's 8 + Ram's 3 = 11 contracts

Total number of short positions : Megafund's 5 + Interfund's 6 = 11 contracts

Although there were 11 contracts, the open interest does not increase by 11 contracts, as some of these contracts were used to close the position taken on January 1.

To calculate the open interest on January 3, let us look at the position of each trader on *January 3 :*

Megafund - January 2 : 10 long : January 3 : 5 short: net position = 5 long contracts

Minifund - January 2 : 12 long; January 3 : 8 long: net position = 20 long contracts

Ram - January 2 : 7 short: January 3 : 3 long: net position = 4 short contracts

Interfund - January 2 : 15 short: January 3 : 6 short : Net position = 21 short contracts

Thus, the number of contracts available for delivery is 25 and the open interest on January 2 is 25 contracts.

Settlement of Futures

Settlement is the act of closing the contract. It relates to the manner in which the obligation in a contract is honoured. Futures can be settled in one of the following three ways:

1. **Physical delivery:** The underlying asset of the contract is delivered by the seller to the futures exchange and by the futures exchange to the buyer and payment by the buyer. Physical delivery is common with commodities and bonds. Physical delivery occurs very rarely.
2. **Cash settlement:** All futures contracts are cash settled, i.e., through exchange of cash. This is mostly used for settling stock indices futures (stock indices cannot be delivered physically).

On the expiry of the settlement period, the futures exchange sets the final settlement price equal to the spot price of the asset on that day. Thus, cash settlement futures contracts are settled at the spot price. As per the recent rule, the stock futures will be cash settled.

In practice there are two types of cash settlement for futures. They are daily marketing-to-market settlement and final settlement. Daily marking-to-market settlement has already been discussed. In final settlement, on the expiry day of the futures contract, after the close of the hours, the clearing house marks all positions of a clearing member to the final settlement price and the resulting profit or loss is settled in cash.

3. **Offsetting position:** This is the most common and popular method of settling or closing futures. Offsetting is a process of carrying forward the transaction by changing sides (i.e., entering into a reverse contract). To be more clearly, the initial buyer (holding long position) liquidates his position by selling (going short) a similar (same commodity and same delivery terms) futures contract, and initial seller (holding short position) goes for buying (going long) an identical (same commodity and same delivery terms) contract. Thus, offsetting is done through reversing trade which reverses the existing open position. After these trades are executed and reported to the clearing house, both traders' obligations are extinguished on the books of the clearing house and on the exchange members.

Types of Members on Futures Exchange

Members on futures exchange fall in the following four categories :

(i) **Trading Member :** He trades on his own behalf and on behalf of his own clients. The exchange assigns a trading member ID to each trading member. There may be more than one user for each trading member. The exchange notifies the number of users allowed for each trading member. Each user of a trading member must be registered with the exchange. Accordingly, the Exchange assigns an unique user ID to each user. The unique trading member ID functions as a reference for all orders/trades of different users. This ID is common for all users of a particular trading member. In short, trading members are those who are allowed to trade in the exchange.

(ii) **Clearing Members :** The clearing house will have a number of members. When a trader wants to buy or sell futures contracts, the deal will have to be cleared through a member of the clearing house. This member of the clearing house is known as the clearing member. Generally, a clearing member performs the settlement obligations of his own trading claims as well as the trading claims of other non-clearing members. Clearing members are members of clearing corporations under the exchange.

(iii) **Self-clearing Members :** When a member trades, clears and settles his own trade only, he is called a self-clearing member.

(iv) **Professional Clearing Member :** He performs only clearing functions. He does not trade on his own account or on behalf of his client.

Futures Trading on BSE and NSE for Risk Management

In India derivative trading is being done on National Stock Exchange and Bombay Stock Exchange. The National Stock Exchange or the NSE has much more volume of derivatives as compared to the Bombay Stock Exchange or the BSE. For F&O trading, NSE is where you should trade.

The Bombay Stock Exchange (BSE) is finally taking steps to re-energise its almost-dormant derivatives segment by allowing trading of futures in Sensex and stocks on BSE Online Trading (BOLT) terminals.

BOLT terminals are now used for trading in the cash segment of the exchange. The move is aimed at simplifying the process for doing derivative trades as cash and futures trades. The idea is to make futures trading easier and cheaper.

There are 40,000 BOLT terminals in 400 cities with 700 BSE members. BSE had started BOLT terminals after the entry of NSE.

At present, the derivatives trading at BSE takes place through a fully automated screen-based trading platform called DTSS (Derivatives Trading and Settlement System) which is designed to allow trading on a real time basis. In addition to generating trades by matching opposite orders, DTSS also generates various reports for the members.

There are 280 BSE members registered for derivatives, but the problem is that many of them don't have DTSS at all the branches. This is one of the factors why derivative trading has remained dormant so far on BSE, allowing NSE to steal a march over it in the derivatives market.

Sources close to BSE said that offering derivative trading on BOLT in early May is just the first step and some more measures to reactivate the segment would follow. Initially, only futures in index and stocks will be allowed as the exchange has to introduce some changes on the technology front.

Facility to trade in futures on BOLT will help brokers to trade with one terminal and single login. BSE sources said the facility was expected to increase volumes in derivatives and with the cross margining facilities available now, brokers would find it easy. This will also give some arbitrage opportunities to traders on BSE's cash and futures segment.

The National Stock Exchange of India Limited (NSE) commenced trading in derivatives with the launch of index futures on June 12, 2000. The futures contracts are based on the popular benchmark S&P CNX Nifty Index.

The Exchange has also introduced trading in Futures and Options contracts based on CNX-IT, BANK NIFTY, and NIFTY MIDCAP 50 indices.

Equity Futures in India

Equity futures are of two types - Stock index futures and futures on individual securities. Both the types of equity futures are available in India.

Stock Index Futures : The National Stock Exchange and the Bombay Stock Exchange have introduced stock index futures. The National Stock Exchange has a stock index futures contract

based on S & P CNX Nifty Index; the Bombay Stock Exchange has a stock index futures contract based on Sensex.

The features of the S & P CNX Nifty futures contracts are as follows :

1. The Nifty Futures (FUTDIX) is traded on the NSE F & O segments.
2. National Securities Clearing Corporation (NSCCL) is the clearing and settling agency for all deals done on NSE F & O segment. NSCCL guarantees all F & O settlements.
3. S & P CNX Nifty futures contracts have a maximum of 3 months trading cycle- the near month (one), the next month (two), and the far month (three). A new contract will be introduced on the trading day following the expiry of the near month contract.
4. S & P CNX Nifty futures contracts expire on the last Thursday of the expiry month. If the lst Thursday is a trading holiday, the contracts shall expire on the previous trading day.
5. The permitted lot size of S & P CNX NIFTY contracts is 200 and multiples thereof.

Futures on Individual Securities : Futures on individual securities were introduced in India in 2001. The list of securities in which futures contracts are permitted is specified by Securities Exchange Board of India. The National Stock Exchange and the Bombay Stock Exchange have introduced futures on individual securities.

The salient features of futures on individual securities on the National Stock Exchange are as follows :

1. The underlying for the futures on individual securities contracts shall be the underlying security available for trading in the capital market segment of the Exchange.
2. Futures contracts on individual securities will have a maximum of three-month trading cycle. New contracts will be introduced on the trading day following the expiry of the near month contract.
3. Futures contracts on individual securities shall expire on the last Thursday of the expiry month. If the last Thursday is a trading holiday, the contracts shall expire on the previous day.
4. The permitted size of the futures contracts on individual securities shall be the same as the same lot size of options contract for a given underlying security or such lot size as may be stipulated by the Exchange from the time to time.
5. The price steps in respect of all futures contracts admitted to the dealings of the Exchange shall be ₹ 0.05.
6. The base price of the futures contracts on introduction of new contracts shall be the previous day's closing price of the underlying security. The base price of the contracts on subsequent trading days will be the daily settlement price of the futures contracts.
7. Futures contracts on individual securities shall be initially cash settled and would be settled in the following manner : (i) Daily mark-to-market settlement and, (ii) Final mark-to-market settlement on expiry of a futures contract
8. The pay-in and pay-out of the mark-to-market settlement is on T + 1 day (T= Trade day)

Trading Mechanism : The futures and options trading system of NSE is called NEATF & O. It is a nation-wide fully automated screen-based trading arrangement for Nifty futures and options and stock futures and options, with an online monitoring and surveillance mechanism. Similar to the trading of equities in the cash market system, NEAT-F & O trading system is an anonymous and transparent order driven market that operates on a strict price-time priority basis. The NEAT-F & O trading system can be accessed by two types of users, the Trading Members (TMs) and the Cleaning Members (CMs). Users have tremendous flexibility in terms of the kind of orders that they can place on the system. They can impose various conditions like Good-till-Day, Good-till-Cancelled, Immediate or Cancel, Limit / Market Price, Stop Loss, and so on.

Clearing and Settlement : The NSCCL (the National Stock Exchange Clearing Corporation Limited) clears and settles all the deals executed on the NSE's F & O segment. It acts as a legal counterparty to all deals on the F & O segment and guarantees settlement. It works out the open positions or obligations of members. ATM's open position is the sum of proprietary open position, client open long position, and client open short position. While F & O contracts on individual securities can be delivered as in the spot market, currently F & O contracts in India are cash - settled.

Commodity Futures in India

Organised trading in commodity futures started in India in 1875 in Mumbai. By early 1970s most of the registered associations conducting such trading became inactive owing to government restrictions caused mainly by inflation concerns. A period of ban on commodity futures trading followed which lasted for nearly thirty years and was lifted only in 2003. Generally futures prices have strong influence on the spot commodity prices. Since a sharp rise or fall in spot prices affects consumers in general, the government retains summary intervention powers in commodity futures market. Forward / futures trading is now allowed in most commodities. Trading in commodity options is still prohibited.

Commodity Futures Exchanges : The three national level multi commodity exchanges offering on-line futures trading in commodities are National Commodity & Derivatives Exchange Limited (NCDEX), Multi Commodities Exchange of India Limited (MCX), and National Multi Commodity Exchange (NMCE). Out of these NCDEX and MCX are the most popular ones. Both are Mumbai based public limited companies promoted by leading banks and other financial intermediaries in 2003.

Though many commodities are listed in both the exchanges, NCDEX mainly attracts trading in agricultural commodities and MCX in metals like gold and silver and crude oil. At present MCX is the largest commodity exchange in the country. It has already become the third largest bullion exchange and the fourth largest energy exchange in the world. The exchanges conduct settlement of trades and all related functions through a clearing house / clearing corporation, the members of which are called clearing members. A person allowed to trade in the exchange is called a trading member who could also happen to be a clearing member. For effecting physical delivery of commodities, the exchanges tie up with warehouses in different locations.

Interest Rate Futures in India

Interest rate futures were introduced in India at NSE and BSE in June 2003. NSE has three contracts with following underlying assets:

(a) Three-month T-bill

(b) Ten-year zero coupon

(c) Ten-year govt. security 6% semi-annual

Exchange traded interest rate derivatives are supposed to provide the much needed depth in the market eliminating the counterparty risk. Trading in these instruments left much to be desired and did not attract active participation for several reasons including the methodology settlement price of futures. The trading in interest rate derivatives has not taken off at desired level. There are certain reasons for this. Some of them are: (a) insufficient volume and instruments available in the government securities debt market, (b) concentrated holding amongst few financial institutions and banks etc.

On 31st August 2009, NSE has introduced interest rate futures on GOI security with a notional bond of maturity of 10 years with 7% coupon payable semi-annually. A price of the bond equal to ₹ 100 would denote that the market yield is 7%. The inverse relationship of bond prices with the yield, a price greater than ₹ 100 indicates yield lesser than 4% and price of the notional bond less than ₹ 100 indicates market yields greater than 7%.

Value at Risk (VaR)

There are various measures of risks involved in derivatives. These measures are delta, gamma, vega and theta. These measure the sensitiveness of derivative to various risk factors. A financial institution usually calculates each of these measures each day for every market variable to which it is exposed. Often there are hundreds, or even thousands of these market variables. Therefore, a delta-gamma-vega analysis leads to a very large number of different risk measures being produced each day. These risk measures provide valuable information to derivative traders. However, these do not provide a way of measuring the total risk to which the financial institution is exposed. Moreover, these risk measures have disadvantages as measures of enterprise-wide risk. Some of the disadvantages are: (a) finance theory requires that enterprise wide risk be measured at the portfolio level and not at the level of individual positions or individual underlying assets, (b) a large number of these measures is too detailed and too-enterprise-specific to be communicated to regulators or to investors at large, (c) these measures are too complex even for senior management within the institution to monitor on a regular basis. It is therefore necessary to develop a summary measure of risk which addresses all the above shortcomings. Value at risk is one such summary measure that has become immensely popular over the last couple of decades. It was initially popularized by J.P. Morgan and later on advocated by regulators globally.

Meaning of VaR

VaR attempts to measure the loss that may be incurred on the entire portfolio of derivatives. Since loss is measured in money terms, losses in various different positions and

underlying assets can all be aggregated to arrive at a loss on the entire portfolio. The probability distribution of this aggregate loss is a complete description of the risk faced by the financial institution at the total portfolio level. But this is too complex for internal management or external stakeholders. VaR summarises this distribution in terms of a single number. In order to do this, it is first necessary to choose a particular level of significance (95% or 99%). For example, a financial institution reports that the daily VaR of its portfolio is 1 million at 99% confidence level. This means that under normal market conditions, only 1% of the time, the daily loss will exceed ₹ 1 million. This can be interpreted in an alternative way : There is 99% probability that the loss will not exceed ₹ 1 Million. Thus, VaR is a measure of the minimum loss (or maximum loss) that would be expected over a period of time with a given probability. It is a statistical computation which will enable the corporate manager to know the maximum extent to which the portfolio value can deteriorate over a given period with probability of 95% or 99%. This figure (always in absolute amount) gives a farely a good indication of the maximum risk exposure that the company has. Thus, value at risk is a technique used to estimate the probability of portfolio losses based on statistical analysis of historical price trends and volatility.

In short, VaR is the potentianal loss of the asset(s) over a specified time horizon

VaR may be computed annually or daily. An annual VaR number is based on possible losses over a one year time horizon. A daily VaR number is based on possible losses over a one day time horizon. Thus every VaR number is based on VaR level (95% or 99%) and a time horizon (year or day). In practice, VaR is most usually computed at the 1-day horizon.

Importance of VaR

The utility of the VaR lies in distilling complex statistical and probability concepts into a single number that is comprehensible to everyone. This risk measure is easy to understand. It captures the enterprise risk in a few key numbers. It is comparable across institutions. Thus the external stakeholders like regulators and investors can interpret the measure easily.

VaR is a volatility based measure containing information on losses during normal market conditions and the probability in a single number. The institution's overall exposure across various products and currencies can also be expressed in the same number. It has become widely used by corporate treasurers and fund managers as well as by financial institutions. Bank regulators also use VaR in determining the capital a bank is required to keep for the risks it is bearing. In short, VaR is very popular among financial institutions and their regulators. In short, on the basis of value at risk, a suitable risk management policy can be formulated.

Methods of Computation of VaR

VaR computation is easy if we have the probability distribution of the likely values that may be assumed by the portfolio. VaR computation methods can be classified into two categories – variance based models and non-variance based models.

Variance based Models

As the name indicates here the methodology centres around estimation of variance or volatility. Assuming that the distribution of the rate of returns is normal and linear asset pay-off profile, the VaR statistic can be expressed in the simple form as follows:

$$VaR = \alpha \sqrt{T}\ \sigma p$$

where α is the critical value from the standard normal distribution.

$\sqrt{T}$ reflects the statistical result that the VaR will increase with the square root of the number of time periods if the returns series is serially uncorrelated.

σ represents the standard deviation of the series as a measure of the return volatility.

p is an estimate of the initial value of the portfolio.

Non-variance based Models or Simulation Models

The various non-variance based methods or simulation methods are briefly explained as below:

1. **Historical method :** Historical method is a popular method of estimating VaR. It involves using past data in a very direct way as a guide to what might happen in the future. In this method, the actual historical fluctuation in market prices during some sample period is applied to the current market prices to arrive at different price scenarios for the future. Suppose VaR is to be calculated for a portfolio using a 1-day time horizon, a 99% confidence level and 501days of data. The first step is to identify the market variables affecting the portfolio. The market variables may be interest rate, exchange rate, equity prices, and so on. Then data are collected on the movements in these market variables over the most recent 501 days. This provides 500 alternative scenarios for what can happen between today and tomorrow. Scenario 1 is where the percentage change in the values of all variables are the same as were between Day 0 and Day 1. Scenario 2 is where they are the same as they were between Day 1 and Day 2 and so on. For each scenario, the rupee change in the value of the portfolio between today and tomorrow is calculated. This defines a probability distribution for daily changes in the value of the portfolio. The fifth-worst daily change is the first percentile of the distribution. The estimate of VaR is the loss at this first percentile point. Assuming that the last 501 days are a good guide to what could happen during the next day, the company is 99% certain that it will not take a loss greater than the VaR estimate.

Thus, the historical method estimates the distribution of the portfolio's performance by collecting data on the past performance of the portfolio and the using it to estimate the future probability distribution. Obviously it assumes that the past distribution is a good estimate of the future distribution. There are certain limitations for historical method. First, this method need not be accurate. Second, it requires the choice of a sample period. Third, the historical period may be badly representative of the future.

2. **Monte Carlo Simulation:** This method is based on the idea that portfolio returns can be fairly easily simulated. Simulation requires inputs on the expected returns, standard deviations,

and correlations for each financial instrument. It is based on the ability of computer software to generate random numbers. These random numbers can be used to generate samples from any given distribution. For example, if the distribution is normal and the means and variances are given, the software can generate a sample of thousands of scenarios consistent with these means and variances. From this sample, a single VaR number is arrived at.

3. **Delta normal method:** This is based on the normal distribution. If the loss distribution (or equivalently the portfolio value) is assumed to be a normal distribution, then the VaR at any level (95% or 99%) can be read of the normal distribution tables.

Back Testing

Whatever method is used to estimate VaR, the validity of the estimates must be checked by back testing. In back testing, the chosen estimation model is run for several hundred days in the past and portfolio loss each day is compared with the VaR estimate at the beginning of the day (or equivalently at the end of the previous day). If the VaR model is correct, then the actual loss would exceed the 99% VaR on approximately 1% of the days.

Stress Testing

After calculating, VaR, many companies carry out stress testing. This involves estimating how a company's portfolio would have performed under some of the most extreme market moves (abnormal business conditions) seen in the last 10 to 20 years. Thus, the purpose of stress testing is to assess the valuation impact of worst-case scenarios, regardless of whether these outcomes were realised during the recent past.

PRACTICAL PROBLEMS

Illustration 1

An investor enters into futures (short) contract to sell January cotton for ₹ 50 per kg on the commodity exchange. The size of the contract is 5,000 kg. Initial margin is ₹ 40,000 and maintenance margin is ₹ 30,000. What price change will lead to margin call to investor ? If investor does not deposit margin call what will happen ?

Solution

Margin call to investor will occur when ₹ 10,000 lost from margin account. It will happen when price of cotton increased by ₹ 2 per kg. So price of cotton must rise to ₹ 52 per bundle for margin call. And in case investor does not make a payment of margin call, broker will close out investor's position.

Illustration 2

On Bombay Stock Exchange (BSE), Stock Index Contract is traded. One stock index consists of 30 shares of 30 companies. One tick size is ₹ ¼ per share. What is the amount of tick size per contract ?

Solution

Since one contract consists of 30 shares of different companies and tick size is ¼ per share. So total amount of tick size per contract will be 30 x ¼ = ₹ 7.5 per contract of BSE Stock Index.