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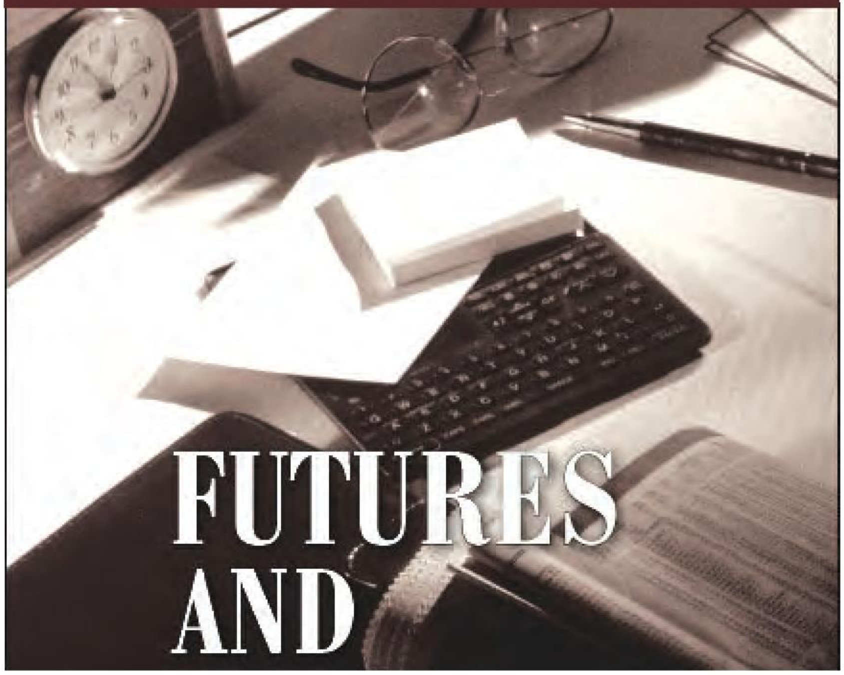

FUTURES AND FORWARDS

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McGraw-Hill Education: *Securities Markets Series*

FUTURES AND FORWARDS

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To
my parents
Savitri Parameswaran
and
Late A.S. Parameswaran

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PREFACE

This book covers the fundamentals of two important types of derivative securities, namely futures and forward contracts. Other types of derivatives, such as options and swaps, will be covered in subsequent books.

The first chapter covers the fundamental features of these instruments, along with their similarities and differences.

The second chapter focuses on the valuation of forward and futures contracts. The techniques of cash and carry arbitrage and reverse cash and carry arbitrage are demonstrated. The difference between an investment asset and a consumption asset is highlighted. The chapter concludes with a discussion of markets in Backwardation and Contango respectively.

Hedging and speculation is the focus of attention of the third chapter. The conditions required to achieve a perfect hedge are studied. The concept of basis risk is introduced, and calculation of the minimum variance hedge ratio is demonstrated.

The last chapter covers trading strategies. The issues that we look at include:

- Hedging with stock index futures
- Changing the beta of a stock portfolio
- Program trading
- Stock picking
- Portfolio insurance

- Covered interest arbitrage
- Hedging import and export transactions

Each volume in this series is self contained and the series should serve as valuable study material for a course on Securities Markets. The manuscripts have been used at business schools as well as for corporate training programmes, and consequently are a blend of academic rigour and practical insights. Students of finance, and market professionals, in particular those in the BFSI space of information technology, should find these books to be a lucid and concise resource, for developing a strong foundation in the field.

SUNIL K. PARAMESWARAN

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Sunil K. Parameswaran

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Series on Securities Markets

Volume–5

Futures and Forwards

by

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1 CHAPTER

FUNDAMENTALS

Introduction

In order to understand the nature of *forward* and *futures* contracts, we first need to look at typical cash or spot transactions. In a cash or a spot transaction, as soon as a deal is struck between the buyer and the seller, the buyer has to hand over the payment for the asset to the seller. He in turn has to transfer the rights to the asset to the buyer.

In the case of a forward or a futures contract, however, the actual transaction does not take place when an agreement is reached between a buyer and a seller. At the time of negotiating the deal, the two parties merely agree on the terms on which they will transact at a future point in time, including the price to be paid per unit of the underlying asset. Thus the transaction per se occurs only at a future date that is decided at the outset. Consequently (and unlike a cash transaction) no money changes hands when two parties enter into a forward or a futures contract. However, both of them do have an obligation to go ahead with the transaction on the scheduled date.

Example 1.1

Mitoken Solutions has entered into a forward contract with Wachovia Bank to acquire £ 100,000 after 90 days at an exchange rate of $ 1.75 per pound. 90 days from today, the company will be required to pay $ 175,000 to the bank and accept the pounds in lieu of it. The bank as per the contract, will have to accept the equivalent amount in US dollars, and deliver the British pounds.

In both forward and futures contracts, there obviously have to be buyers and sellers. The person who agrees to buy the underlying asset in such a contract is known as the *long* and he is said to assume a *long position*. The counter party who agrees to sell the underlying asset as per the contract is known as the *short* and he is said to assume a *short position*. Thus, the long agrees to take delivery of the underlying asset on a future date, while the short agrees to make delivery on that date.

Comparisons and Contrasts

Although forward as well as futures contracts have certain similarities, they differ in some crucial aspects. They are similar in the sense that both require the long to acquire the asset on a future date, and the short to deliver the asset on that date. Thus, there is an obligation on the long as well as on the short in both. However, there is one major difference between the two types of contracts. Futures contracts are *standardised*, whereas forward contracts are *customised*.

Let us clarify the meaning of standardisation and customisation. In any contract of this nature, certain terms and conditions need to be clearly defined. The major terms which should be explicit are:

1. How many units of the underlying asset is the long supposed to acquire, or (put differently) how many units of the asset does the short have to deliver?
2. What is the acceptable grade or grades (in certain cases) of the underlying asset that is/are allowable for delivery?
3. Where should delivery be made? Is it possible only at a particular location, or do one or both parties have a choice of locations?
4. When can delivery be made? Is it possible only on a particular day, or is there a specified period during which it can occur?

In a customised contract, these terms and conditions have to be negotiated between the buyer and the seller. Consequently, the two parties are free to incorporate any features if they can mutually agree upon the same. In a standardised contract, however, there is a third party which will specify the allowable terms and conditions. The long and the short have the freedom to design a contract within the boundaries specified. However, they cannot incorporate features other than those that are specifically allowed. The third party in the case of futures contracts is the *futures exchange.* A futures exchange is essentially similar to a stock exchange. It is an arena where trading in futures contracts takes place.

Example 1.2

Consider the wheat futures contract that is listed for trading on the Kansas City Board of Trade. According to the terms specified by the exchange, each futures contract requires the delivery of 5,000 bushels of wheat.[1] The allowable grades are No. 1, No. 2, and No. 3. The allowable locations for delivery are Kansas City and Hutchinson. The specifications state that delivery can be made at any time during the expiration month.

Now take the case of Jacob Paret, a wholesale dealer, who wants to acquire 5,000 bushels of No. 1 wheat in Kansas City during the last week of the month. Assume that there is another party, Victor Kolb, a farmer who is interested in delivering 5,000 bushels of No. 1 wheat in Kansas City during the last week of the month. In this case, the futures contracts that are listed on the exchange are obviously suitable for both the parties. So if they were to meet on the floor of the exchange, a trade could be executed for one futures contract, at a price of say $ 3.60 per bushel. Notice that the price agreed upon for the underlying asset is one feature that is not specified by the exchange. This has to be negotiated between the two parties who are entering into the contract. It is a function of demand and supply conditions.

Let us now consider a slightly different scenario. Assume that Jacob wants to acquire 4,750 bushels of No. 1 quality wheat in Topeka during the last week of the month, and that Victor is looking to sell the same quality of wheat in Topeka during that period. The terms of the contract sought by the two parties are not within the framework that has been specified by the futures exchange in Kansas City. Consequently, neither party can enter into a futures contract to fulfil its objectives. However, nothing prevents the two men from getting together to negotiate an agreement which incorporates the features that they desire. Such an agreement would be a customised agreement that is tailor made to suit their needs. This kind of an agreement is called a forward contract. Thus, futures contracts are exchange traded products just like common stocks and bonds, while forward contracts are private contracts.

One of the key issues in the case of futures contracts which permit delivery of more than one specified grade, and/or at multiple locations, is who gets to decide as to what to deliver and where. Traditionally, the right to choose the location and the grade, has always been given to the short. Also, the right to initiate the process of delivery is given to the short. A person with a long position, therefore, cannot demand delivery. What this also means is that, in practice, investors with a long position who have no desire to take delivery will exit the market prior to the commencement of the delivery period. They can do so by taking an opposite or offsetting position. This is because once the delivery period commences, they are liable to be called upon to take delivery without having the right to refuse.

Role of the Clearinghouse

A clearinghouse is an entity that is associated with a futures exchange. It may be a wing of the exchange or a separate corporation. The clearinghouse essentially guarantees both the long and the short that they need not worry about the possibility of the other party defaulting. It does so by positioning itself as the effective counterparty for each of the two original parties once a futures deal is struck. In other words, the clearinghouse becomes the effective buyer for every seller, and the effective seller for every buyer. Thus, each party to a transaction needs to worry only about the financial strength and integrity of the clearinghouse and not of the other party with whom it has traded. It must be remembered that neither the long nor the short trades with the clearinghouse. The clearinghouse enters the picture only after an agreement is reached between them.

A futures contract imposes an obligation on both the parties. On the expiration date of the contract (depending on the movement of prices in the interim), it will be in the interest of one of the two parties to the agreement to go through with the transaction. However, a price move in favour of one party would clearly translate into a loss for the other. Consequently, given the opportunity, one of the two parties would like to default on the expiration date. Therefore, a clearinghouse is needed as a surety for both.

Example 1.3

Consider two people, Peter and Keith. Assume that Peter has gone long in a futures contract to buy an asset five days hence at a price of $ 40, and that Keith has taken the other side of the transaction. Let us first take the case where the spot price of the asset five days later is $ 42.50.

If Keith already has the asset, he is obliged to deliver it for $ 40, thereby foregoing an opportunity to sell it in the spot market at $ 42.50. If he does not have the asset, he has to acquire it by paying $ 42.50, and then subsequently deliver it to Peter for $ 40. Quite obviously, Keith will choose to default unless he has an impeccable conscience and character.

Now let us consider a second situation, where the price of the asset five days hence is $ 37.50. If Keith already has the asset, he would be delighted to deliver it for $ 40, for the alternative is to sell it in the spot market for $ 37.50. Even if he does not have the asset, he will be more than happy to acquire it for \$ 37.50, and then deliver it to Peter for \$ 40.

The problem here is that Peter will refuse to pay \$ 40 for the asset if he can get away with it. There are two ways of looking at this: If he does not want the asset, taking delivery at \$ 40 would entail a subsequent sale at \$ 37.50, (and therefore a loss of \$ 2.50); on the other hand, even if he needed the asset, he would be better off buying it in the spot market for \$ 37.50.

The purpose of having a clearinghouse is to ensure that such defaults do not occur. It ensures protection for both parties by requiring them to post a performance bond or collateral called a margin. The amount of collateral is adjusted daily to reflect any profit or loss for each party, based on the price movement during the day. By doing so, the clearinghouse effectively takes away the incentive for a party to default.

Margins

As we have just seen, whenever two parties enter into an agreement to trade at a future date, there is an element of default risk. In other words, there is always a possibility that one of the parties may not carry out his part of the deal as required by the contract.

In futures contracts, compliance is ensured by requiring both the long and the short to deposit collateral with their broker in an account known as the *margin account.* This margin deposit is therefore a performance guarantee.

The amount of collateral is related to the potential loss that each party is likely to incur. Since both the parties have an obligation in a futures contract, it is necessary to collect collateral from both the parties. Once such potential losses are collected, the incentive to default is effectively taken away. Even if the party that ends up on the losing side were to fail to perform its obligation, the collateral collected from it would be adequate to take care of the interests of the other party.

Since the clearinghouse stands guarantee for both parties, it too requires margin money to be deposited with it. This margin is known as clearing margin. In practice, the long as well as the short deposit margins with their respective brokers, who in turn deposit margins with the clearinghouse.

Offsetting

Futures contracts are easier to offset than forward contracts. Offsetting means taking a counterposition. It means that if a party has originally gone long, it should subsequently go short and vice versa. The effect of offsetting is to cancel an existing long or short position in a contract.

Remember that a forward contract is a customised private contract between two parties. Thus, if a party to a forward contract wants to cancel the original agreement, he must seek out the counterparty and have the agreement cancelled.

However, cancelling a futures contract is a lot simpler. This is because a futures contract between two parties, say Jacob and Victor, to transact in wheat at the end of a particular month, will be identical to a contract between two other parties, say Kimberly and Patricia. This is because both the contracts would have been designed according to the features specified by the exchange. In addition, once Jacob enters into a contract with Victor, he effectively enters into a contract with the clearinghouse. The link between him and Victor is broken. So if Jacob, who had entered into a long position wants to get out of his position, he need not seek out Victor. All he has to do is go back to the floor of the exchange and offer to take a short position in a similar contract. This time the opposite position may be taken by a new party, say Robert. Thus, by taking a long position initially with Victor, and a short position subsequently with Robert, Jacob can ensure that he is effectively out of the market, and that he has no further obligations. As far as the clearinghouse is concerned, its records will show that Jacob has bought and sold an identical contract, and that his net position is zero. This is what is meant by offsetting.

The profit or loss for an investor who takes a position in a futures contract and subsequently offsets it will be equal to the difference between the futures price that was prevailing at the time the original position was taken, and the price at the time the position is offset.

Marking to Market

The reason for collecting margins is to protect both parties against default.

This loss however will not arise all of a sudden at the time of expiration of the futures contract. As the futures price fluctuates in the market from trade to trade, one of the two parties to an existing futures position will experience a gain, while the other experiences a loss. Thus, the total loss or gain from the time of getting into a futures position till the time the contract expires or is offset by taking a counter-position, whichever happens first, is the sum of these small losses/profits corresponding to each observed price in the interim.

The term *marking to market* refers to the process of calculating the loss for one party or the corresponding gain for the other at specified points in time, with reference to the futures price that was prevailing at the time the contract was previously marked to market. In practice, when a futures contract is entered into, it will be marked to market for the first time at the end of the day. Subsequently, it will be marked to market every day until the position is either offset or else the contract itself expires. The party who has incurred a profit will have the amount credited to his margin account, while the other party, who would have incurred an identical loss, will have his margin account debited.

Example 1.4

Let us take the case of Peter who has gone long in a futures contract expiring five days hence with Keith, at a futures price of $ 40. Assume that the price at the end of five days is $ 42.50, and that the prices at the end of each day prior to expiration are as follows:

Table 1.1

END OF THE DAY FUTURES PRICES

Day	*Futures Price*
0	40.00
1	40.50
2	39.50
3	38.50
4	40.50
5	42.50

Day ‘0’ denotes the time the contract was entered into, and the corresponding price is the futures price at which the deal was struck. Day ‘*t*’ represents the end of that particular day, and the corresponding price is the prevailing futures price at that instant.

Let us assume that as per the contract, Peter is committed to buying 100 units of the asset, and that at the time of entering into the contract, both the parties had to deposit $ 500 as collateral in their margin accounts. The amount of collateral deposited when a contract is first entered into is called the *initial margin.*

At the end of the first day, the futures price is $ 40.50. This means that the price per unit of the underlying asset for a futures contract being entered into at the end of the day is $ 40.50. If Peter were to offset the position that he had entered into in the morning, he would have to do so by agreeing to sell 100 units at $ 40.50 per unit. If so, he would earn a profit of $ 0.50 per unit, or $ 50 in all. While marking Peter’s position to market, the broker will behave as though he were offsetting. He would calculate his profit as $ 50, and credit it to his margin account. However, since Peter has not expressed a desire to actually offset, the broker would act as if he were reentering into a long position at the prevailing futures price of $ 40.50.

At the end of the second day, the prevailing futures price is $ 39.50. When the contract is marked to market, Peter will make a loss of $ 100. Remember, that his contract was reestablished the previous evening at a price of $ 40.50, and if the broker were to now behave as if he were offsetting at $ 39.50, the loss is $ 1 per unit, or $ 100 in all. Once again a new long position would be automatically established, this time at a price of $ 39.50.

This process will continue either until the delivery date, when Peter will actually take possession of the asset, or until the day that he chooses to offset his position, whichever is earlier. As you can see, rising futures prices lead to profits for the long, whereas falling futures prices lead to losses.

Now let us consider the situation from Keith's perspective. At the end of the first day, when the futures price is $ 40.50, marking to market would mean a loss of $ 50 for him. That is, his earlier contract to sell at $ 40 will be effectively offset by making him buy at $ 40.50, and a new short position would be established for him at $ 40.50. Similarly, by the same logic, at the end of the second day, his margin account will be credited with a profit of $ 100. As you can see, shorts lose when futures prices rise, and gain when the prices fall.

Thus, the profit/loss for the long is identical to the loss/profit for the short. It is for this reason that futures contracts are called *zero sum games*. One man's gain is another man's loss.

Thus, by the time the contract expires, the loss incurred by one of the two parties (in this case the short) has been totally recovered. In Example 1.4, Peter's account would have been credited with $ 250 by the time the contract expires. This amount represents the difference between the terminal and the initial futures price, multiplied by the number of units of the underlying asset. These funds will have come from Keith's account, which would have been debited. Now, if Keith were to refuse to deliver the asset at expiration, Peter would not be at a disadvantage. For, since he has already realised a profit of $ 250, he can take delivery in the spot market at the terminal spot price of $ 42.50 per unit, in lieu of taking delivery under the futures contract.[2] Thus, effectively, he will get the asset at a price of $ 40 per unit, which is what he had contracted for in the first place.

Forward contracts unlike futures contracts are not marked to market. Consequently, both the parties to the contract are exposed to credit risk. Thus, in practice, the parties to a forward contract tend to be large and well known, such as banks, financial institutions, corporate houses and brokerage firms. Such parties find it easier to enter into forward contracts (as compared to individuals) because their credit worthiness is easier to appraise.

Both longs and shorts have to therefore deposit a performance bond with their brokers known as the initial margin on entering into a futures contract. If the markets were to subsequently move in favour of one party, the balance in his margin account will increase, and the opposite would happen if the market were to move against him.

The broker has to ensure that a client always has adequate funds in his margin account. Otherwise the entire purpose of requiring clients to maintain margins would be defeated. Consequently, he will specify a threshold balance called the *maintenance margin*, which will be less than the initial margin. If due to adverse price movements the balance in the margin account were to decline below the level of the maintenance margin, the client will be immediately asked to deposit additional funds to take the balance back to the level of the initial margin. In futures market parlance, we would say that the broker has issued a *margin call* to the client. A margin call is always bad news, for it is an indication that a client has suffered major losses since he opened the margin account. The additional funds deposited by a client when a margin call is complied with are referred to as *variation margin*.

Example 1.5

Let us reconsider the case of Peter, who went long in a contract for 100 units of the asset at a price of $ 40 per bushel, and deposited $ 500 as collateral for the same. Assume that the broker fixes a maintenance margin of $ 400. If the contract lasts for a period of five days, and the futures prices on the subsequent days are as in Table 1.1, then the impact on the margin account will be as summarised in Table 1.2.

Table 1.2

CHANGES IN THE MARGIN ACCOUNT OVER THE COURSE OF TIME

Day	*Futures Price*	*Daily Gain/(Loss)*	*Cumulative Gain/(Loss)*	*Account Balance*	*Margin Call*
0	40.00			500	
1	40.50	50	50	550	
2	39.50	(100)	(50)	450	
3	38.00	(150)	(200)	300	200
4	40.50	250	50	750	
5	42.50	200	250	950	

Numbers in parentheses denote losses

Let us analyse a few of the entries in Table 1.2. Consider the second row. As compared to the time the contract was entered into, the price has increased by $ .50 per unit or $ 50 for 100 units. Consequently, Peter, who has entered into a long position, has gained $ 50, which is to be credited to his margin account. Thus, the balance in the margin account has increased to $ 550 at the end of the first day.

The futures price at the end of the second day is \$ 39.50. Thus, Peter has suffered a loss of \$ 1 per unit or \$ 100 for 100 units. When this loss is debited to his margin account, the balance in the account becomes \$ 450. The price at the end of the next day is \$ 38.00, which implies that Peter has suffered a further loss of \$ 150. When this loss is debited to his margin account, the balance in the account becomes \$ 300, which is less than the maintenance margin of \$ 400. Hence a margin call is issued for \$ 200, which is the amount required to take the balance back to the initial margin level. So, Peter has to pay a variation margin of \$ 200.

The price that is used to compute the daily gains and losses for the longs and the shorts when the futures contracts are marked to market at the end of each day is called the *settlement price*. In many cases, futures exchanges adopt the practice of setting the settlement price equal to the observed closing price for the day. Sometimes, if there is heavy trading towards the close of the day, the exchange may set the settlement price equal to the average of the observed futures prices, in the last half hour or hour of trading. At the other extreme, if there were to be no trades at the end of the day, the exchange may set the settlement price equal to the average of the observed bid and ask quotes.

Default

Default can occur at two points, either before the maturity of the futures contract or at the time of maturity. Let us first consider the case where a client defaults before maturity. We will illustrate it using the data in Table 1.2.

Example 1.6

At the end of Day 2, when the balance in the margin account falls to \$ 300, a margin call will be issued for \$ 200. If the client fails to pay the variation margin, the broker will actually offset his position. In this case, since the client has originally gone long, the broker will offset his contract by going short at the market price. In our case, the price at the time the margin call was issued was \$ 38.00. Assume, that by the time the broker is able to offset the contract, the price has fallen further to \$ 37.70. If so, the investor would have incurred a further loss of \$ 0.30 per unit or \$ 30 per 100 units. This loss, along with the transactions costs incurred by the broker, will be deducted from the balance of \$ 300 that is available in the margin account. The remaining amount will be refunded to the client. Similarly, if a broker fails to respond to a margin call from the clearinghouse, the futures exchange will close his account at the prevailing market price.

In the second case, default at the time of expiration, the broker will act at follows. If the default is on the part of a short 'that is, the short fails to deliver the asset' then the broker will acquire the good in the spot market and deliver it to the long. If a long were to default, then the broker will acquire the good from the short and sell it in the cash market. In either case, he will deduct his costs and losses from the balance in the defaulting party's margin account.

Role of Futures Commission Merchants

A Futures Commission Merchant (FCM) is a broker who is authorised to open an account on behalf of a client who wishes to trade. This entails the collection of margin money, the maintenance of balances in the margin accounts, and the recording and reporting of all trading activities. It must be remembered that all brokers are not FCMs. There is a category of brokers called *introducing brokers*, who as the name suggests, acquaint a client with an FCM. In other words, they will accept an order and route it through an FCM. It is important to note that introducing brokers cannot maintain margin accounts.

Every FCM is not a member of the clearinghouse or in other words is not a *clearing member*. Only clearing members are authorised to maintain clearing margins with the clearinghouse and clear transactions through it. Consequently, if your FCM is not a clearing member, he must route the order through a clearing member.

Spot—Futures Convergence

At the time of expiration of the futures contract, the futures price must be the same as the cash or spot market price. A futures contract is a contract to transact at a future point in time. At the expiration date of the contract, any futures contract that is entered into, must lead to an immediate transaction because the contract is scheduled to expire immediately. At this point, it is valid only for an instant. Thus a person who enters into a futures contract at the time of expiration is effectively entering into a spot market transaction. Consequently, if the futures price at expiration were to be different from the spot price, there will be arbitrage opportunities.

Let us denote the futures price at expiration by F_T and the spot price at that point in time by S_T. It has to be that

$F_T = S_T$. We will examine the consequences if F_T were to be greater than or less than S_T.

1. $F_T > S_T$

   This situation can be exploited by an arbitrageur. He can acquire the asset in the spot market at a price of S_T and simultaneously go short in a futures contract. Since the contract is scheduled to expire immediately, he can at once deliver for a price of F_T. Thus $F_T - S_T$, which by assumption is positive, represents an arbitrage profit for such an individual.

Example 1.7

Assume that the futures price of an asset at the time of expiration is $ 425, whereas the spot price is $ 422. An arbitrageur will immediately acquire the asset in the spot market at $ 422 per unit, and simultaneously go short in a futures contract. Since the contract is expiring he will immediately deliver at $ 425, thereby making a costless risk-less profit of $ 3 per unit.

2. $F_T < S_T$

   An arbitrageur will exploit this condition by going long in a futures contract. Since it is about to expire, he can take immediate delivery by paying F_T, and can then sell the asset in the spot market for S_T. In this case, $S_T - F_T$, which by assumption is positive, represents an arbitrage profit.

Example 1.8

Assume that the futures price of an asset at the time of expiration is $ 422, whereas the spot price is $ 425. An arbitrageur will immediately take a long position in a futures contract, which will entail taking immediate delivery at $ 422 per unit. The asset can then be immediately sold in the spot market for $ 425 per unit. Thus, once again, the arbitrageur will be able to lock in a costless, risk-free profit.

Delivery

Although both forward and futures contracts call for delivery at the time of expiration, there are fundamental differences between them. Firstly, in practice most forward contracts are settled by delivery. However, only a small fraction of the futures contracts that are entered into (in some markets the figure is as low as 2%), result in actual delivery. The remainder are offset prior to expiration by taking a counter-position.

Secondly, since a forward contract is a customised agreement between two parties, unless the contract is cancelled subsequently, it will result in the short delivering to the original party who had gone long. In the case of futures, however, the link between the long and the short is broken by the clearinghouse once a contract is entered into. Subsequently, one or both parties may offset and exit the market. Hence, when a short expresses his desire to deliver, it is not necessary that the person with whom he had originally traded be in a position to take delivery of the asset. This person may not still have an open long position. Thus, in the case of futures contracts, the exchange will decide as to who the short should deliver to. In practice, the person with the oldest outstanding long position, is usually called upon to take delivery.

Finally, the price that is paid by the long at the time of taking delivery under a forward contract, would be different from what he would have to pay to take delivery under a futures contract with the same features and on the same underlying asset. A forward contract is not marked to market at intermediate points in time. Consequently at expiration, the long has to pay the price that was agreed upon at the outset in order to take delivery. However, in a futures contract, the contract would have been marked to market on every business day during its lifetime. Hence, in order to ensure that the long gets to acquire the asset at the price that was agreed upon at the outset, he has to be asked to pay the prevailing futures price at expiration, which as you have seen earlier, will be the same as the prevailing spot price at expiration.

Consider a futures contract that was entered into on day 0 at a price F_0, and which expires on day T. We will denote the price at expiration by F_T. Such a contract will be marked to market on days 1, 2, 3 .... up to day T. The cumulative profit for the long due to marking to market is:

$$(F_T - F_{T-1}) + (F_{T-1} - F_{T-2}) + (F_{T-2} - F_{T-3}) + \ldots + (F_2 - F_1) + (F_1 - F_0) = (F_T - F_0)$$

In order to ensure that the long is able to acquire the asset at the original price of F_0, he must be asked to pay a price P at the time of delivery, such that:

$$P - (F_T - F_0) = F_0$$

$$\Rightarrow \quad P = F_T = S_T$$

Thus the price paid by the long at the time of delivery must equal the prevailing futures price at expiration, or equivalently the prevailing spot price at expiration. In the case of a forward contract, however, there will be no marking to market, and hence, there will be no intermediate cash flows. Consequently, at the time of delivery, the price paid by the long, P, must be the same as the price that was agreed upon originally. That is:

$$P = F_0$$

Example 1.9

Consider a futures contract on wheat, that was entered into at a price of \$ 3.50 per bushel. We will assume that the contract lasts for a period of five days, and that the movement in the futures price on subsequent days is as depicted in Table 1.3.

Table 1.3

MARKING A CONTRACT TO MARKET

Day	*Futures Price*	*Profit from Marking to Market*
0	3.5	
1	3.4	(0.10)
2	3.2	(0.20)
3	3.5	0.30
4	3.8	0.30
5	4.0	0.20
	Total	0.50

In this case, $F_0 = 3.5$ and $F_T = 4.0$. A person who had gone long in a futures contract at a time when the futures price was \$ 3.5, would have to pay \$ 4.0 at the time of delivery. Taking into account the profit of \$ 0.50 due to marking to market, he will effectively get the asset for

$ 3.5, which is nothing but the initial futures price. At the same time, a person who had gone long in a forward contract at a price of $ 3.5, would have to pay $ 3.5 at the time of taking delivery.

Trading need not stop as soon as delivery commences. In the case of most assets, the first day on which a short can declare his intention to deliver (the Notice Day), is before the last day of trading, whereas the last Notice Day is after the day on which trading ceases. Here are the details for the corn futures contract on the Chicago Board of Trade.

Table 1.4

DELIVERY SCHEDULE FOR CORN FUTURES ON THE CBOT

First Notice Day	*Last Notice Day*	*Last Trading Day*
Last Business Day Prior to the Delivery Month	Second to Last Business Day of the Delivery Month	Eighth to Last Business day of the Delivery Month

Cash Settlement

There are certain futures contracts which do not allow for physical delivery of the underlying asset. In such cases, the contract is marked to market till the last day, and subsequently all positions are declared closed. Both the long and the short will exit the market, with his or her cumulative profit (which could also be a loss) since the inception of the contract. However, the short will not deliver the underlying asset at the end.

Cash settlement is the prescribed mode of settlement for Stock Index Futures, which as the name suggests, are contracts on stock indices like the Dow Jones and the S&P

500. In order to form a portfolio that mimics an index, one is required to buy all the stocks that are included in the index, and in exactly the same proportions as they are present in it. Quite obviously, physical delivery under such circumstances will be extremely cumbersome.[3] Cash settlement can also be specified as a mechanism to control manipulation of prices by traders by creating artificial shortages in the underlying asset.

Trading Volume versus Open Interest

The trading volume in a futures contract on a given day is the number of contracts that were traded on that particular underlying asset in the course of the day. The open interest at any point in time, is the total number of outstanding contracts at that point in time. The open interest is a measure of the number of open positions at any instant of time. Since every long position must be matched by a corresponding short position, open interest may be measured either as the number of open long positions at a point in time, or equivalently as the number of open short positions at the same point.

The relationship between the trading volume for a day and the change in the open interest from the close of trading on the previous day depends on the nature of the transaction, and can best be illustrated with the help of an example.

Example 1.10

Let us assume that a new contract in silver futures has just opened for trading and that three trades have taken place on the first day as depicted in Table 1.5.

Table 1.5

TRADE DETAILS FOR THE FIRST DAY

Time	*Trade*	*No. of Contracts*
10 a.m.	Maureen goes long and Anthony goes short	50
1 p.m.	Rachel goes long and Victor goes short	100
4 p.m.	Peter goes long and Robert goes short	50

The trading volume for the day is 200 contracts. Since nobody has offset any contracts after entering into a trade, the number of open positions or the open interest is also 200 contracts.

Now consider these scenarios for the next day.

Case A

Maureen goes long and Anthony goes short in 50 contracts.

Both these parties are entering into a trade that increases their open positions. The trading volume for the second day is obviously 50 contracts. The number of open positions at the end of the day is 250 contracts. Hence, the change in the open interest as compared to the previous day is 50 contracts. Thus if a trade involves two parties who are establishing new positions by entering into a contract with each other, the open interest will rise.

Case B

Maureen goes long and Rachel goes short in 50 contracts. The trading volume for the day is once again 50 contracts.

But what about the open interest? In this case, no new positions have been opened. All that has happened, is that Rachel who had a long position in 100 contracts has partially offset by taking a counter-position in 50 contracts, and her place has been taken by Maureen. The number of open positions at the end of the day continues to remain at 200 contracts. Here the change in the open interest as compared to the previous day is zero. Hence, if a trade involves one party taking a counter-position by trading with another party who is opening a position, then the open interest will remain unchanged.

Case C

Anthony goes long and Rachel goes short in 50 contracts. As before, the trading volume for the day is 50 contracts. The change in the open interest can be analysed as follows. Rachel has partially offset her long position by going short, and at the same time the trade has also resulted in Anthony offsetting his short position by going long. Thus, the overall result is that the number of open contracts has reduced by 50 and the change in the open interest as compared to the previous day is therefore –50 contracts. Thus the open interest at the end of the second day is only 150 contracts. Therefore, if a trade involves one party taking a counter-position by trading with another party who is also taking a counter-position, then the open interest will fall.

If the trading volume is high on a given day, then it signifies greater liquidity. On the other hand, high open interest at the end of a day indicates more scope for counter-positions on subsequent days. It is consequently a signal that future volumes are likely to be high.

Endnotes

1. A bushel is a unit of measure. A bushel of wheat is equivalent to 60 pounds or 27.216 kilograms.
2. You will see shortly that at the time of expiration of the contract, the spot and futures prices must be equal.
3. If you think it is difficult for an index like the Dow Jones which contains 30 stocks, contemplate delivery in the case of the Standard and Poor's 500, which includes 500 companies!

2

CHAPTER

Valuation

Introduction

A forward contract entails an obligation on the part of the short to make delivery of the asset on a future date, and an equivalent obligation on the part of the long to take delivery.

From the perspective of the short, if the difference between the forward price and the prevailing spot price were to exceed the cost of carrying the asset until delivery, then clearly there would exist an arbitrage opportunity. For instance, in the case of an asset that pays no income before the maturity of the forward contract, the cost of carrying the asset will be rS, where r is the risk-free rate of interest and S is the prevailing spot price. Consequently, if:

$$F - S > rS,$$

then a person could exploit the situation by borrowing and buying the asset, and simultaneously going short in a forward contract to deliver on a future date.

Such a strategy is called *cash and carry arbitrage*. To rule it out, we require that:

$$F - S \leq rS \Rightarrow F \leq S(1 + r)$$

Example 2.1

Assume that IBM is currently selling for \$ 100 per share, and is not expected to pay any dividends for the next six months. The price of a forward contract for one share of IBM to be delivered after six months is \$ 106.

Consider an investor who can borrow funds at the rate of 5% per six monthly period. Such an individual can borrow \$ 100 and acquire one share of IBM, and simultaneously go short in a forward contract to deliver the share after six months for \$ 106. Thus the rate of return on his investment is:

$$\frac{(106 - 100)}{100} = 0.06 \equiv 6\%,$$

whereas his borrowing cost is only 5%.

Consequently, cash and carry arbitrage is a profitable proposition under such circumstances. This is because:

$$F > S(1 + r)$$

or, in other words, the forward contract is overpriced.

The rate of return obtained from a cash and carry strategy is called the *implied repo rate*. A cash and carry strategy is profitable if the implied repo rate exceeds the borrowing rate.

By engaging in this strategy, the investor has ensured a payoff of \$ 106 after six months for an initial investment of \$ 100. Thus, it is as if he has bought a *zero coupon* or *deep discount* debt instrument with a face value of \$ 106, for a price of \$ 100. Hence, a combination of a long position in the stock and a short position in a forward contract is equivalent to a long position in a zero coupon instrument. Such a deep discount instrument is referred to as a *Synthetic T-bill*. We can express the relationship as:

$$\text{Spot} - \text{Forward} = \text{Synthetic T-bill}$$

A negative sign indicates a short position in that particular asset. Thus, if we own any two of the three assets, we can artificially create the third.

Cash and carry arbitrage requires a short position in a forward contract and arises if the contract is overpriced. However, if F were to be less than $S(1 + r)$, then such a situation too would represent an arbitrage opportunity, this time for the long. Under such circumstances, an investor could short sell the asset and invest the proceeds at the risk-less rate, and simultaneously go long in a forward contract to reacquire the asset at a future date.

This is called *reverse cash and carry arbitrage*. In order to rule out such profit opportunities, we require that:

$$F \geq S(1 + r)$$

Example 2.2

Assume once again that IBM is selling for \$ 100 per share, and that the company is not expected to pay any dividends for the next six months. Let the price of a forward contract for one share of IBM to be delivered after six months be \$ 104.

Consider the case of an arbitrageur who can lend money at the rate of 5% per six monthly period. Such an individual can short sell a share of IBM and invest the proceeds at 5% interest for six months,[1] and simultaneously go long in a forward contract to acquire the share after six months for \$ 104.

His effective borrowing cost is:

$$\frac{(104-100)}{100} = 0.04 \equiv 4\%,$$

which is less than the lending rate of 5%.

Consequently there is a profit to be made by employing a reverse cash and carry strategy under such circumstances. This is because:

$$F < S(1 + r)$$

or, in other words, the forward contract is underpriced.

The cost of borrowing funds under a reverse cash and carry strategy is called the *implied reverse repo rate.* Reverse cash and carry arbitrage is profitable only if the implied reverse repo rate is less than the lending rate.

By engaging in a reverse cash and carry strategy, the investor has ensured the sale of a zero coupon instrument with a face value of \$ 104 for a price of \$ 100. Hence, a combination of a short position in the stock and a long position in a forward contract is equivalent to a short position in a zero coupon instrument. We can express this relationship as:

$$-\text{Spot} + \text{Forward} = -\text{Synthetic T-bill}$$

Cash and carry arbitrage is ruled out if $F < S(1 + r)$, while reverse cash and carry arbitrage is ruled out if $F \geq S(1 + r)$.

Thus, in order to rule out both forms of arbitrage, we require that $F = S(1 + r)$.

Assets Making Payouts

If a person who is holding an asset in his inventory were to receive income from it, such an inflow would obviously reduce the carrying cost. The carrying cost can now be defined as $rS - I$ where I is the future value of the income as calculated at the time of expiration of the forward contract. In order to rule out cash and carry arbitrage we require that:

$$F - S \leq rS - I \Rightarrow F \leq S(1 + r) - I$$

Similarly, from a short seller's perspective, the effective income obtained by investing the proceeds from the short sale will be reduced by the amount of payouts from the asset, since the short seller is required to compensate the lender of the asset for the payouts.

Thus to rule out reverse cash and carry arbitrage:

$$F - S \geq rS - I \Rightarrow F \geq S(1 + r) - I$$

Therefore, to preclude both forms of arbitrage it must be that:

$$F = S(1 + r) - I$$

We will illustrate cash and carry arbitrage in the case of assets making payouts. The extension to reverse cash and carry arbitrage is straightforward.

Example 2.3

Assume that the IBM share of previous Examples is selling for \$ 100, and that the stock is expected to pay a dividend of \$ 5 after three months and another \$ 5 after six months. Forward contracts with a time to expiration of six months are available at a price of \$ 96 per share. We will assume that the second dividend payment will occur just an instant before the forward contract matures.

Consider the case of an investor who can borrow at the rate of 10% per annum. Such an individual can borrow \$ 100 and buy a share of IBM, and simultaneously go short in a forward contract to sell the share after six months for \$ 96. After three months, he will get a dividend of \$ 5 which can be invested for the remaining three months at a rate of 10% per annum. And finally, just prior to delivering the share under the forward contract, he will receive a second dividend of \$ 5.

Thus, at the time of delivery of the share, the total cash inflow for the investor will be:

$$96 + 5 \times \left[1 + \frac{0.10}{4}\right] + 5 = 106.125$$

The rate of return on the synthetic T-bill is:

$$\frac{(106.125 - 100)}{100} = .06125 \equiv 6.125\% ,$$

which is greater than the borrowing rate of 5% for six months.

Consequently cash and carry arbitrage is profitable. This is because:

$$F + I > S(1 + r)$$

where I is the future value of the payouts from the asset as calculated at the point of expiration of the forward contract.

Pricing Forward Contracts on Physical Assets

While financial assets generate cash inflows for the investor, physical assets require the payment of storage costs and related expenses like insurance premia. A cost is nothing but a negative income. Hence, if the future value of all storage related costs were to be Z (as calculated at the time of expiration of the forward contract), then $I = -Z$. Thus the no-arbitrage pricing relationship can be expressed as:

$$F = S(1 + r) - (-Z) = S(1 + r) + Z$$

If this relationship were to be violated, then arbitrage profits can be made. We will demonstrate this in the case of an overpriced gold forward contract.

Example 2.4

Assume that the spot price of gold is \$ 500 per ounce and that storage costs are \$ 5 per ounce for a period of six months, payable at the end of the period. Forward contracts are available with a time to expiration of six months and the price per ounce of gold is \$ 535.

Consider the case of an investor who can borrow at the rate of 10% per annum. Such a person can borrow \$ 500 and buy one ounce of gold, and simultaneously go short in one forward contract. At the end of six months, he will get \$ 535 when he delivers the asset. His interest cost for six months is \$ 25 and the storage cost of gold is \$ 5. Thus the effective carrying cost is \$ 30.

In this case, the rate of return on the investment, which is:

$$\frac{(535-500)}{500} = 0.07 \equiv 7\%$$

is greater than the effective carrying cost, which is:

$$\frac{(530-500)}{500} = 0.06 \equiv 6\%$$

Hence cash and carry arbitrage is profitable. Such a strategy yields a profit because:

$$F > S(1 + r) + Z$$

where Z is the storage cost. In order to rule out both cash and carry as well as reverse cash and carry arbitrage, we therefore require that:

$$F = S(1 + r) + Z$$

Pure Assets versus Convenience Assets

Short selling need not always be feasible for an asset. Consequently, assets can be divided into two categories, *pure* or *investment assets*, and *convenience* or *consumption assets*.

An investment asset as the name suggests, is one that is held as an investment. As long as the owner receives the asset intact at the end of the period for which he wishes to hold it as an investment, and is compensated for any payments that he would have received in the interim, had he not parted with the asset, he will not mind parting with it. In other words, he will be amenable to lending the asset to facilitate short selling on the part of another investor. All financial assets fall in this category. A precious metal like gold is also an investment asset.

However, an agricultural commodity like wheat is often held for reasons other than potential returns. Consider the situation from the perspective of a person who chooses to hoard wheat before a harvest. Prices of commodities normally rise before the harvesting is completed, and fall thereafter. Consequently, such an investor not only has to incur storage costs, but also faces the spectre of a capital loss. Therefore, from an investment angle, it makes little sense to hoard wheat prior to a harvest. The fact that the investor chooses to do so nevertheless, implies that he is getting some intangible benefits from hoarding the commodity. For instance, he may wish to ensure that he does not have to close his wheat mill during an unanticipated shortage due to a cyclone or a rainfall failure. The value of such intangible benefits is called the *convenience value*. If the holder of an asset is getting a convenience value from it, he will not part with it to facilitate short sales.

The question that one may ask is, isn't the convenience value a form of implicit dividend? Therefore, can we not compensate the holder of the convenience asset and induce him to part with it. There are however two key differences between implicit dividends and explicit payouts like dividends from shares. Firstly, the convenience value cannot be quantified. Secondly, the perception of such value will differ from holder to holder.

Therefore in the case of those assets which are being held for consumption purposes, we can only state that:

$$F \leq S(1 + r) + Z$$

The possibility of earning profits through a cash and carry strategy will help ensure that:

$$F \ngtr S(1 + r) + Z$$

However, F may be less than $S(1 + r) + Z$ without giving rise to arbitrage, because facilities for short sales may not exist.

Quasi-Arbitrage

In reverse cash and carry arbitrage involving financial assets, the arbitrageur, (who is also the short seller), has to compensate the lender for any income which he foregoes by parting with the asset. In the case of physical assets held for investment purposes, the lender would not have received any payouts had he chosen to hold on to the asset. On the contrary, he would have incurred storage costs. Under such circumstances, it turns out that reverse cash and carry arbitrage is often profitable only if the arbitrageur receives the cost savings experienced by the lender of the asset.

Example 2.5

Assume that gold is currently selling for \$ 500 per ounce, and that the price of a six month forward contract is \$ 525. The cost of storage is \$ 5 per ounce per six months, payable at the end of the period, and the borrowing/lending rate is 10% per annum.

$$F = 525 < S(1 + r) + Z = 500(1 + 0.05) + 5 = 530$$

An investor engaging in reverse cash and carry arbitrage will short sell the asset and will receive \$ 500. This amount will be lent at the rate of 10% per annum. Simultaneously, he will go long in a forward contract to acquire the asset after six months for \$ 525. Thus, at the end of six months his cash inflow will be \$ 525, which will be the same as his cash outflow. Therefore, in order for him to make a profit on this strategy, he ought to be compensated by the lender of the asset with an amount equal to the storage cost saved by him, which in this case is $ 5.

In practice such an arrangement may not be feasible. However, this does not mean that such a mispriced contract cannot be exploited.

Consider the situation from the perspective of an investor who owns one ounce of gold. He can sell the gold in the spot market and lend the proceeds for six months. Simultaneously, he can go long in a forward contract to reacquire the gold six months later at $ 525. Six months hence, he will receive a cash inflow of $ 525, which will be just adequate to repurchase the gold. On top of it, he will have $ 5 cash in his possession, which represents the storage cost saved.

Such an individual is not an arbitrageur in the conventional sense, although he has clearly exploited an arbitrage opportunity. Consequently, such activities are referred to as *quasi-arbitrage*. In derivatives parlance, we say that the investor has replaced an actual spot position in gold with a synthetic spot position. Quasi-arbitrage will help ensure that:

$$F = S(1 + r) + Z$$

for a physical commodity that is perceived as an investment asset.

For consumption assets, however, even a quasi-arbitrage strategy may not be able to ensure that $F = S(1 + r) + Z$. This is because an asset holder who is receiving a convenience value may not be willing to substitute his natural spot position with a synthetic spot position.

The Value of a Contract

When a forward contract is first entered into, its value to both the parties is zero. Neither the long nor the short has to pay any money to take a position in a forward contract. It may be argued that both of them need to post margins. But a margin, remember, is a performance bond and not a cost.

Before we proceed to discuss the evolution of a forward contract's value over time, let us first understand the difference between the *forward price* and the *delivery price.*

The delivery price is the price specified in the forward contract. It is the price at which the short agrees to deliver, and the long agrees to accept delivery as per the contract.

What then is the forward price? At any point, the forward price is the delivery price of a contract that is being negotiated at that particular instant. Once a contract is entered into, its delivery price will remain unchanged. However, the forward price will keep changing as new trades are negotiated.

To put things in perspective, if one were to come and say that he had entered into a forward contract a week ago, we would ask "What was the delivery price?" and not "What was the forward price then?", although both would mean the same thing. However if we were to negotiate a contract at the current point in time, we would ask "What is the forward price?". If the contract were to be sealed, the prevailing forward price would become the delivery price of the contract.

At the time a contract is entered into, its value will be zero. However as time passes, a pre-existing contract will acquire value. Let us consider a long forward position that was taken at some point of time in the past and which has a delivery price of K. In order to offset this position, the investor will have to take a short position, which will obviously be executed at the prevailing forward price, F. Thus, after taking a counterposition, the investor will have a payoff of $(F - K)$ awaiting him at the time of expiration of the contract. The value of the contract is nothing but the present value of this payoff.

Assume that a forward contract exists that expires at time T and has a delivery price of K. Let F be the forward price that is currently prevailing for a contract expiring at T, and let r be the risk-less rate of interest for the period between now and T. Then the value of the long forward position is:

$$\frac{F-K}{1+r}$$

Quite obviously, the value of a short forward position with a delivery price of K will be:

$$-\frac{F-K}{1+r}=\frac{K-F}{1+r}$$

Example 2.6

Assume that a forward contract with nine months to expiration was entered into three months ago at a delivery price of \$ 100. Let today's forward price for a six month contract be 120. The risk-less rate of interest for six months is 10%. The value of a long forward position with a delivery price of 100 will therefore be:

$$\frac{120-100}{1.10}=18.18$$

The value of a short forward position with a delivery price of \$ 100 will be –18.18. Once a forward contract is sealed, a subsequent increase in the forward price will lead to an increase in value for holders of a long position, while a decrease would lead to an increase in value for holders of a short position.

Now let us turn to futures contracts. When a trade is executed, neither the long nor the short have to pay to get into a position. However, as the futures price changes subsequently, an open futures position will acquire value. But the difference, as compared to a forward contract, is that at the end of every day, the profit/loss is calculated and credit/debited to the margin account. The position is then re-initialised at the settlement price. This process of marking to market is nothing but a settlement of built up value. Once the contract is re-initialised, the value will once again revert back to zero. Thus futures contracts accumulate value in the period between two successive settlement price calculations. Once the marking to market procedure is undertaken, the value of both long and short positions will be zero.

Relationship between Forward and Futures Prices

Under certain conditions, the price of a forward contract on an asset will be the same as the price of a futures contract with the same expiration date. More specifically, if the risk-less rate of interest is a constant and the same for all maturities, then forward and futures prices will be identical. Thus all the no arbitrage conditions that we have derived for forward contracts will be equally valid for futures contracts. In real life, however, interest rates are random. This will have an impact on the relationship between forward and futures prices for contracts with the same time to expiration.

The fundamental difference between forward and futures contracts is that the latter are marked to market, and consequently lead to cash flows on a daily basis. The former are not marked to market, and hence give rise to a cash flow only at the time of expiration.

Consider a situation where interest rates and futures prices are positively correlated. If the futures price rises, then the interest rate will also be high. Rising futures prices lead to cash inflows for investors with long futures positions. Thus, the longs will be able to invest their profits at high rates of interest. At the same time, rising futures prices will lead to cash outflows for investors with short futures positions, who will consequently have to finance these losses at high rates of interest. On the contrary, if futures prices were to decline, the corresponding interest rates will be low. Declining futures prices will lead to losses for the longs and profits for the shorts. Thus the longs can finance their losses at low rates of interest while the shorts will have to invest their profits at low rates.

An investor with a long position in a forward contract will not be affected by interest rate movements in the interim. In comparison, an investor with a long futures position will be better off. By the same logic, a person with a short futures position will be worse off as compared to an investor with a short forward position. Therefore (compared to a forward contract) a person taking a long futures position should be required to pay a higher price for this relative advantage. As viewed by the short a person taking a short futures position should receive a higher price for this relative disadvantage. Hence if interest rates and futures prices are positively correlated, futures prices will exceed forward prices.

Similarly, if interest rates and futures prices are negatively correlated, then futures prices will be less than the corresponding forward prices.

Net Carry

Let us first define *net carry*. It refers to the net carrying cost of the underlying asset expressed as a fraction of its current spot price. Therefore, if the risk-less rate of interest is r, and the future value of payouts from the asset is I, then:

$$\text{Net Carry} = \frac{rS - I}{S} = r - \frac{I}{S}$$

For physical assets which entail the payment of storage costs:

$$\text{Net Carry} = r + \frac{Z}{S}$$

We know that for investment assets:

$$F = S(1 + r) - I \text{ or}$$
$$F = S(1 + r) + Z,$$

as the case may be. Therefore, in either case:

$$F = S + (\text{Net Carry})\ S$$

In the case of convenience assets:

$$F \leq S(1 + r) + Z$$
$$\Rightarrow \quad F = S(1 + r) + Z - Y = S + (\text{Net Carry})\ S - Y$$

where the variable Y, which equates the two sides of the relationship, is the *marginal convenience value.*

If $Y = 0$, then we say that the market is at *full carry*. Investment asset markets will always be at full carry, whereas convenience asset markets will not.

Backwardation and Contango

If the futures price for an asset exceeds its spot price or if the price of a near month contract is less than the price of a far month contract, then we say that there is a *Contango* market.

However, if the futures price is less than the spot price or if the price of the near month contract is more than the price of a far month contract, then the market is said to be in *Backwardation*.

Example 2.7

Consider the following spot and futures prices for wheat. Table 2.1 depicts a Backwardation market, whereas Table 2.2 depicts a Contango market.

Table 2.1

BACKWARDATION MARKET

Contract	*Price*
Spot	4.50
March futures	4.42
May futures	4.35
July futures	4.30
September futures	4.20

Table 2.2

CONTANGO MARKET

Contract	*Price*
Spot	4.50
March futures	4.55
May futures	4.62
July futures	4.70
September futures	4.80

For financial assets, the net carry can either be positive or negative, depending on the relationship between the financing cost, rS, and the future value of the payouts from the asset, I. A positive net carry will manifest itself as a Contango market, whereas a negative net carry will reveal itself as a market in backwardation.

In the case of physical commodities, if the market is at full carry, then we will have a Contango market. However, if the market is not at full carry, then we may either have a Backwardation or a Contango market, depending on the relative magnitudes of the net carry and the convenience yield.

ENDNOTE

1. We are assuming that the arbitrageur can lend the proceeds from the short sale. In practice, the amount has to be deposited with the broker (who of course, can invest it to earn interest). In a competitive market, brokers will pass on a part of the interest income to the client who is short selling. This is called a *short interest rebate.* However, the effective rate of return earned by the short seller will be lower than the prevailing market rate.

3

CHAPTER

Hedging and Speculation

Hedging

A HEDGER BY DEFINITION is a person who wants to protect himself against an unfavourable price movement in the price of the underlying asset. Quite obviously, a person who seeks to hedge has already assumed a position in the underlying asset. If he already owns the asset (in other words, if he has a long position) his worry will be that the price of the asset may fall subsequently. On the other hand, if he has made a commitment to buy or in other words has taken (a short position), his worry will be that the price of the asset may rise subsequently. In either case, his desire to hedge is a manifestation of his wish to avoid risk.

Notice that we have defined a short position in a broader sense than for a short sale involving an asset. In the case of a short sale, the short seller borrows an asset from a broker in order to sell, and therefore has a commitment to buy it back and return it at a future date. Now take the case of a company which has imported goods from the US and has been given 90 days credit by the American supplier. The company therefore has a commitment to buy dollars after 90 days. Just like the short seller, this company too would be worried that the price of the asset (in this case the US dollar) may go up by the time it is procured. Thus in a more general sense, a short position connotes a commitment to buy an asset at a future date. An example in physical commodities would be the case of a wheat mill which knows that it will have to procure wheat after the harvest. Assume this is one month away at present. Its worry consequently would be that the harvest may be less plentiful than anticipated, and that therefore the price of the wheat in the spot market may turn out to be higher than what is currently expected. Such an entity may exhibit a desire to hedge.

Futures contracts can help people to hedge, irrespective of whether they have a long or a short position in the underlying asset. A person who owns an asset can hedge by taking a short position in a futures contract. If the price of the underlying asset were to fall subsequently, he can still sell it at the original futures price, since the other party is under an obligation to buy at this price.

Example 3.1

Greg owns 500,000 bushels of wheat. His worry is that the spot price of the wheat may decline substantially during the next three months.

Futures contracts on wheat are available with a time to maturity of three months, and each contract is for 5,000 bushels. If the current futures price is $ 4 per bushel, then by going short in 100 futures contracts, Greg can ensure that he can sell the wheat three months hence for $ 2,000,000.

This amount of $ 2,000,000 is guaranteed, irrespective of what the actual spot price at the end of three months turns out to be. Thus, by locking in this amount, Greg can protect himself against a decline in the price below the contracted value of $ 4 per bushel. However, the flip side is that he will be unable to benefit if the spot price at expiration were to be greater than $ 4, for he is obliged to deliver at this price.

Now consider the issue from the perspective of a person who has a short position in the underlying asset. His worry is that the price may rise by the time he acquires it in the cash market. Such a person can hedge by taking a long position in the futures market. For, if the spot price were to rise subsequently, he can still buy at the original futures price since the other party is under an obligation to sell at this price.

Example 3.2

Vincent has imported goods worth £ 312,500 from London and is required to pay after one month. He is worried the dollar may depreciate by then, or that the dollar price of the pound may go up by then. A futures contract expiring after one month is available, and the contract size is £ 62,500. Let the futures price be $ 1.75 per pound.

So if Vincent takes a long position in five futures contracts, he can lock in a dollar value of $ 546,875 for the pounds. This would be true irrespective of the spot exchange rate one month later. So while Vincent can protect himself against a depreciating dollar (i.e. an exchange rate greater than $ 1.75 per pound) he is precluded from taking advantage of an appreciating dollar, which would manifest itself as an exchange rate below $ 1.75 per pound.

Selling and Buying Hedges

A *selling hedge* also known as a *short hedge*, requires the hedger to take a short position in the futures market to mitigate the risk faced by him in the spot market.

On the other hand, a *buying hedge* or *long hedge* requires the hedger to take a long position in the futures market, in order to offset his exposure in the spot market.

Inventory and anticipatory hedges

A person initiates a selling hedge because he expects to sell the asset at some point of time. However at the time of initiating the hedge, he may or may not have the asset in his possession.

For instance, a farmer who harvests wheat and plans to sell after three months may go in for a selling hedge. Such a hedger already has the asset in his inventory and can therefore be said to be hedging his inventory. This is an example of an *inventory hedge.*

On the other hand, consider a company which has exported goods to Germany and knows that it will be paid in euros after 90 days. It knows that it will have the euros in its possession after three months, and may therefore go short in futures contracts to hedge the amount that it will effectively receive in dollars. This kind of a selling hedge is in anticipation of a future event, since the euros are not currently in stock but are expected to arrive later. This is an example of an *anticipatory hedge.*

Buying hedges used by investors who have a prior commitment to buy on a future date, are obviously always anticipatory hedges.

Hedging and ex-post regret

A hedger who uses futures contracts may end up regretting his decision ex-post.

Example 3.3

Vincent went long in futures to acquire £ 312,500 at $ 1.75 per pound. If the spot exchange rate at the end turns out to be greater than $ 1.75 per pound, or in other words if the dollar depreciates, then his decision to hedge would certainly be perceived as wise and sound.

But if the spot exchange rate at expiration were less than $ 1.75 per pound, or in other words if the dollar appreciates, Vincent would end up looking a little foolish. If he had not hedged, he could have bought the pounds at a lower cost.

The problem is that a priori, Vincent cannot be expected to be certain as to whether the dollar would depreciate or appreciate. So if he is a risk averse individual then he may very well decide to hedge his risk, notwithstanding the possibility that he may end up regretting it ex-post.

Thus an investor will hedge if he feels uncomfortable leaving his exposure to price risk open. Price risk here refers to the risk that the spot price of the asset may end up moving in an adverse direction from his perspective. He cannot, however guarantee that his decision will be vindicated ex-post. Hindsight as they say is a *perfect science*.

A normal individual cannot be prescient, and if he were he certainly would not need derivatives in order to hedge.

Hedging and Cash Settled Contracts

The effective price at which a hedger is able to sell (if he takes a short futures position), or buy (if he takes a long futures position) will be equal to the futures price prevailing at the time of initiation of the futures position, irrespective of whether the contract is delivery settled or cash settled.

Let us first take the case of a hedger who goes short in futures contracts. If the contract is cash settled, his total profit from marking to market would be $F_0 - F_T$. He will have to sell the asset in the spot market at a price of S_T. His overall cash inflow will be:

$$S_T + (F_0 - F_T) = F_0$$

because by the no-arbitrage condition, $F_T = S_T$. Notice that the profit from the futures position has to be added to determine the effective inflow. If it is a positive number, that is, it actually is a profit, then it will lead to a higher effective inflow. If it is a negative number or a loss, then it will lead to a lower effective inflow.

Example 3.4

Take the case of Greg who went short in 100 futures contracts at a price of \$ 4 per bushel. Assume that the futures price or equivalently the spot price at expiration is \$ 4.50 per bushel.

Greg's cumulative profit from marking to market will be:

$$5{,}000 \times 100 \times (4.00 - 4.50) = -\$\ 250{,}000$$

He can sell the wheat in the spot market for $ 4.50 per bushel or $ 2,250,000 in all. The effective amount received for 500,000 bushels is:

$$\$\ 2{,}250{,}000 - \$\ 250{,}000 = \$\ 2{,}000{,}000,$$

which amounts to $ 4 per bushel.

The same is true for a hedger who goes long in futures. If the contract is cash settled, his cumulative profit from marking to market will be $F_T - F_0$. He will have to then buy the asset in the spot market by paying S_T. His overall cash outflow will be:

$$-S_T + (F_T - F_0) = -F_0$$

Notice that the profit from the futures position is added to the outflow in the spot market to determine the effective outflow. Thus a profit (or inflow from the futures market) will reduce the effective outflow, whereas a loss (or outflow from the futures market) will increase the effective outflow.

Example 3.5

Take the case of Vincent, who went long in a futures contract at a price of $ 1.75 per pound. Assume that the terminal spot or equivalently futures price is $ 1.72 per dollar. His cumulative profit from marking to market will be:

$$312{,}500 \times (1.72 - 1.75) = -\$\ 9{,}375$$

He can acquire £ 312,500 in the spot market by paying $ 537,500. His effective outflow is therefore $ 546,875 which translates into an exchange rate of $ 1.75 per pound. This is nothing but the initial futures price.

Perfect Hedges

A hedge using futures contracts which can lock in a selling price for an investor with a long position or a buying price for an investor with a short position with absolute certainty is called a *perfect hedge*. Both Examples 3.1 and 3.2 are illustrations of a perfect hedge. In Example 3.1, Greg was assured of a selling price of $ 4 per bushel, while in Example 3.2 Vincent was assured of a buying price of $ 1.75 per pound.

If we are to ensure that the hedge is perfect, then the following conditions must hold.

1. The date on which the hedger wishes to buy or sell the underlying asset must coincide with the date on which the futures contract being used is scheduled to expire
2. The number of units of the underlying asset to be bought or sold by the hedger, must be an integer multiple of the size of the futures contract
3. Futures contracts must be available on the commodity which the hedger is seeking to buy or to sell

Importance of terminating the hedge on the expiration date

It is important that the date on which the asset is bought or sold be the same as the expiration date of the futures contract in order to ensure that the hedge is perfect.

For ease of exposition, let us assume that the futures contract specifies a single delivery date rather than a delivery period.

Take the case of a hedger who has gone short in futures contracts. We will denote the initial futures price by F_0 and the terminal spot and futures prices by S_T and F_T respectively. Now assume that the hedger wishes to sell the goods in his possession on day t^*, where $0 < t^* < T$. That is, he wishes to sell the goods prior to the date of expiration of the futures contract. If he does so, he will have to offset the futures position on that day by taking a counter-position.

The cumulative profit from the futures market due to marking to market will be $F_0 - F_{t^*}$. The proceeds from the sale of the good in the spot market will be S_{t^*}. Thus the effective sale proceeds will be:

$$S_{t^*} + (F_0 - F_{t^*}) = F_0 + (S_{t^*} - F_{t^*})$$

Now if t^* were the same as T, then S_{t^*} would be equal to F_{t^*}. So the effective price received would be F_0. In other words, the hedge would be perfect, for the initial futures price would have been locked in. But in general, when t^* is a date prior to the expiration of the futures contract, F_{t^*} will not be equal to S_{t^*}. Thus, the effective price received ultimately would depend on both F_{t^*} and S_{t^*}. Since these are unknown variables until the end, there will always be uncertainty regarding the effective price ultimately received by the hedger.

A similar argument can be advanced where the hedger takes a long position in the futures contract. If the asset is bought on day t^* and the futures position offset, the effective outflow on account of the asset will be:

$$-S_{t^*} + (F_{t^*} - F_0) = -F_0 - (S_{t^*} - F_{t^*})$$

Once again, there will be uncertainty about the effective price at which the asset will be bought.

Thus, since spot-futures convergence is assured only at the time of expiration of the futures contract, it is necessary that the date on which the transaction in the underlying asset takes place be the same as the expiration date of the futures contract, if we are to ensure that the hedge is perfect.

Importance of hedging an integer multiple of the contract size

The number of units to be bought or sold should be an integer multiple of the size of the futures contract, if we are to ensure that the hedge is perfect.

Example 3.6

Assume that a farmer has 1,050 units of a commodity that he wishes to sell after one month. Futures contracts on the commodity expiring after one month are available, and each contract is for 100 units. So this farmer theoretically needs to go short in 10.5 futures contracts. In practice, he can either go short in ten or in 11 contracts. In either case, the effective price received per unit will be uncertain.

Case A: The farmer uses ten contracts

The profit from marking to market will be:

$$10 \times 100 \times (F_0 - F_T)$$

The proceeds when the goods are sold in the spot market will be $1050S_T$. The effective price received per unit of the good will be:

$$\frac{1050S_T + 1000(F_0 - F_T)}{1050}$$

$$= \frac{50S_T + 1000F_0}{1050}$$

Since S_T is a random variable whose value will be known only at the end, the effective price that will be received per unit will be uncertain.

Case B: The farmer uses 11 contracts

The profit from marking to market will be:

$$11 \times 100 \times (F_0 - F_T)$$

The proceeds from the sale of goods will be $1050S_T$. The effective price received per unit of the good will be:

$$\frac{1050S_T + 1100(F_0 - F_T)}{1050}$$

$$= \frac{1100F_0 - 50S_T}{1050}$$

Once again, there will be uncertainty regarding the effective price received.

Cross Hedging

If a contract is not available on the commodity whose price one wishes to hedge, there is no option but to use a contract on a related commodity, if available. The use of a contract on a closely related commodity is called *cross hedging*. When we say closely related, we mean that the prices of the two commodities should move together. The higher the degree of positive correlation, the greater will be the effectiveness of the hedge.

We will now show why a cross hedge can be imperfect, by considering a short hedge. Let S_T be the spot price of the asset that the hedger is selling on day T, where day T is the expiration date of a futures contract on a related commodity used for hedging. Let F_0^* be the initial futures price of this contract and F_T^* the terminal futures price. $S_T^* = F_T^*$ is the terminal spot price of the asset underlying the futures contract.

On day T, the hedger will sell his asset at its prevailing spot price and collect his profit/loss from the futures market. The effective price received per unit will be:

$$S_T + (F_0^* - F_T^*) = F_0^* + (S_T - F_T^*)$$

In this case, S_T will in general not equal F_T^* because they represent two different commodities. Consequently, there will be uncertainty regarding the effective price.

Choosing an expiration month

Let us assume that futures contracts are available on the commodity whose price we wish to hedge, and that the transaction size is an integer multiple of the size of the futures contract. However, rarely will the scheduled transaction date coincide with the expiration date of the futures contract. The only option under such circumstances would be to choose a futures contract that expires after the date on which we wish to transact. If we use a futures contract that expires earlier, subsequently we will have an open or uncovered position. This means that we would not be hedged or protected till the transaction date.

If we use a contract that expires after the transaction date, then such a contract would have to be offset on the transaction date. For a short hedger, the effective price received under such circumstances will be:

$$F_0 + (S_{t^*} - F_{t^*})$$

The uncertainty in this case arises because S_{t^*} need not equal F_{t^*}. The same holds true for a hedger who takes a long position in futures contracts.

At any point in time, t, $S_t - F_t$ is called the basis, and is denoted by b_t. At the time of expiration of the futures contract, S_T is guaranteed to equal F_T. We can be sure that the basis will be zero then. However, prior to expiration we cannot make such an assertion. Consequently, a hedger who is forced to offset the futures contract prior to expiration will face uncertainty regarding the basis, or what is called *basis risk*.

We have defined the basis as $S_t - F_t$[1]. In a Contango market the basis by this definition will be negative. If it becomes more negative over time, it is said to widen. Whereas, if it becomes less negative, it is said to narrow. In a Backwardation market, the basis will be positive. If it were to become more positive over time, we would say that it has widened. However, if it were to become less positive, it would be said to have narrowed. Thus the terms *widening* and *narrowing* connote changes in the absolute value of the basis.

For a short hedger, the effective price received is $F_0 + b_t$. Thus the higher the value of the basis the better it is for him. Thus he will benefit from a rising basis.

However, for a long hedger, the effective outflow is $F_0 + b_t$. The lower the value of the basis, the smaller is the outflow.

Therefore short hedgers benefit from an increasing value of the basis while long hedgers benefit from a declining value. We know that longs benefit from rising prices while shorts benefit from declining prices. Hence if we were to treat the basis itself as a price (for after all it is nothing but a difference of two prices), we can say that a short hedger is *long the basis*, while a long hedger is *short the basis.*

Basis risk

The basis is defined as $S_t - F_t$. In finance theory we measure risk by the variance of the random variable. So, using this yardstick:

$$\sigma^2(b) = \sigma^2(S) + \sigma^2(F) - 2\rho(S, F)\,\sigma(S)\,\sigma(F)$$

where $\sigma(S)$ is the standard deviation of the spot price, $\sigma(F)$ is the standard deviation of the futures price, and $\rho(S, F)$ is the correlation coefficient between the two variables.

Consider a person who is planning to sell an asset at time t^*. He is exposed to uncertainty regarding the price at t^*, namely S_{t^*}. This risk, as measured by the variance of the spot price, is called price risk.

If the investor were to choose to hedge, he would be exposed to uncertainty regarding the basis at time t^*, as measured by the variance of the basis. Thus hedging replaces price risk with basis risk.

An investor would therefore choose to hedge only if he were of the opinion that the basis risk is less than the price risk to which he would otherwise be exposed. As you can see from the expression for the variance of the basis, the higher the correlation between the spot and the futures price, the lower will be the variance of the basis or the basis risk.

Choosing an expiration month: Additional issues

In general, we would not use a futures contract that expires in the same month as the month in which we wish to terminate the hedge.

Example 3.7

Take the case of an investor who has a long position in a commodity that he wishes to unwind on 15 September. Assume that futures contracts expiring on 21 September are available.

If the investor takes a short position in such a contract, he would have to offset by going long on 15 September. The problem is that futures prices often behave erratically during the delivery month, and the hedger would not like to be exposed to such erratic price movements.

In the case of a long hedger who is planning to acquire the asset on 15 September, besides the desire to avoid erratic price movements, there is another reason why the hedger may not like to use the September contract.

Assume that the long hedger is based in St. Louis. His intention is to procure the asset in the local market on 15 September. However, there are no futures contracts being traded in St. Louis and the nearest futures exchange offering contracts on the commodity is in Chicago, and the contracts specify that delivery ought to take place in Chicago.

If such a hedger were to take a long position on the Chicago exchange, it will be solely because he wants to mitigate price risk. He obviously will have no intention of taking delivery in Chicago. The problem is that, being the holder of a long position, he may be called upon to take delivery on or before 15 September, assuming that the delivery period commences before that date. This is because the delivery process is initiated by the shorts, and if a particular long happens to have the oldest outstanding long position, he cannot refuse to accept delivery. For this reason, a long will generally avoid a contract that expires in the month in which he wishes to terminate the hedge.

So if the September contract is ruled out, then we clearly need a contract expiring after that. Assume that contracts expiring in October, November, and December are available. Which one should the hedger select?

It turns out that the further away the expiration month, the greater will be the basis risk. At any point in time, the spot and futures prices are being influenced by virtually the same economic factors. The difference is that the spot market is discovering the price for a trade at that particular instant, whereas the futures market is discovering the price for a trade at a point of time in the future. If the expiration date of the futures contract is very near, then both the spot as well as the futures markets will be discovering the price for a trade at virtually the same point in time. Thus, the difference between the two prices (which is nothing but the basis) may be expected to converge to a fairly predictable value. However, if the expiration date of the futures contract is far away, then the spot and futures prices are likely to be influenced by different supply and demand factors reflecting different sets of information. As a consequence, we could expect to observe much greater variability in the basis.

So in our case, the hedger will prefer the October contract. Thus the principle to be followed while choosing a futures contract is to *choose an expiration month after the month in which the hedge is to be terminated, but as close as possible to it.*

Minimum Variance Hedge Ratio

Let Q be the number of units of the underlying asset in which the investor has a long position in the spot market. Assume that each futures contract is for N units, and that C contracts are being used. So the total number of units of the underlying asset being represented by the futures contracts is $Q_f = NC$.

The question is, is it always optimal to set $Q_f = Q$? In other words should we use a hedge ratio of 1:1?

Let us look at the effective revenue for the hedger. It can be represented as:

$$R = QS_{t^*} + (F_0 - F_{t^*})\ Q_f$$

If $t^* = T$ that is, the hedge is terminated on the expiration date of the futures contract, then it would obviously make sense to have $Q_f = Q$, so that $R = QF_0$, an amount about which there would be no uncertainty.

However, when $t^* < T$, that is, the futures position is offset prior to expiration, it turns out that a hedge ratio of 1:1 need not be optimal.

If we define the hedge ratio as $h = \dfrac{Q_f}{Q}$ then $Q_f = hQ$. We can then write:

$$R = QS_{t^*} + (F_0 - F_{t^*})\ hQ$$

The issue is to find out that value of h, which will minimise the variance of the revenue. We can determine this optimal hedge ratio by differentiating the variance of the revenue with respect to h, and setting it equal to zero, in order to calculate the minima.

The optimal hedge ratio is given by:

$$h^* = \frac{\rho\sigma_s}{\sigma_f}$$

where σ_s is a measure of the variance of $\Delta S = (S_{t^*} - S_0)$ and σ_f is a measure of the variance of $\Delta F = (F_{t^*} - F_0)$ and ρ is a measure of the correlation between the two. In general, the minimum variance hedge ratio will not be equal to 1.0.

We can estimate the optimal hedge ratio using historical data, by running a linear regression of the form:

$$\Delta S = \alpha + \beta \Delta F + \varepsilon$$

The slope coefficient is a measure of the minimum variance hedge ratio.

Measuring Hedging Effectiveness

We can define the hedging effectiveness as:

$$1 - \frac{\sigma^2(b)}{\sigma^2(S)}$$

If the basis risk is equal to the price risk, then the risk reduction is nil, and the hedging effectiveness will be zero. However, if the basis risk is zero, it would mean that we have a perfect hedge, and the hedging effectiveness will be 1.0.

In practice, when we run a linear regression of the form:

$$\Delta S = \alpha + \beta \Delta F + \varepsilon$$

The R^2 of the regression is a measure of the hedging effectiveness.

Speculation

Unlike a hedger, whose objective is to avoid risk, a speculator is a person who consciously seeks to take risk, hoping to profit from subsequent price movements. Such a person is either betting that the price will rise, 'in which case he is said to be bullish, or else he is hoping that it will fall', in which case he is said to be bearish.

From the standpoint of finance theory, speculation and gambling are two different phenomena. A speculator is a person who evaluates the risk of an investment and the anticipated return from it before committing. Such a trader will therefore take a position only if he feels that the anticipated return is adequate in light of the risk he is taking. In other words, he may be said to be taking a calculated risk.

A gambler on the other hand is someone who takes a risk purely for the thrill of taking it. The expected return from the strategy is of no consequence for such a person while he is taking a decision to gamble.

Active speculation adds depth to a market and makes it more liquid. A market characterised solely by hedgers will not have the kind of volume required to make it efficient. In practice, when a hedger seeks to take a position, very often the opposite side of the transaction will be taken by a speculator. Divergence of views, and a desire to take positions based on those views is a sine qua non for making the free market system a success. Thus speculators, along with hedgers and arbitrageurs, play a pivotal role in financial markets.

Using Futures Contracts for Speculation

Consider an investor who feels that the price of an asset is going to rise. One way that he could take a speculative position is by buying the asset in the spot market and holding on to it, in the hope of offloading it subsequently at a higher price.

However, buying the asset in the spot market would entail incurring substantial costs. In addition, if it is a physical asset, the investor has to face the hassle of storing and insuring it.

All this can be avoided if futures contracts are used for speculation. If the investor takes a long futures position, then he can lock in a price to acquire the asset subsequently. If his hunch comes true and the spot price at the time of expiration of the futures contract is higher, he can take delivery at the initial futures price as per the contract. He can then sell it at the prevailing spot price, thereby making a profit.

The advantage of using futures is that the entire value of the asset need not be paid at the outset. All that is required is a small margin. In other words, futures contracts provide leverage.

Example 3.8

Futures contracts on IBM with three months to expiration are available at a price of $ 75 per share. Alex is of the opinion that the spot price of IBM three months later will be at least $ 78 per share. Therefore, he chooses to speculate by going long in 100 futures contracts, each of which is for 100 shares.

If his hunch is right and the spot price after three months is \$ 80 per share, then Alex will make a profit of:

$$100 \times 100 \times (80 - 75) = \$\ 50{,}000$$

However, there is always a possibility that Alex could be wrong. Let us assume that he read the market incorrectly and the price at expiration turns out to be \$ 72 per share. If so, he would have to acquire the shares at \$ 75 per share and sell them in the spot market at \$ 72 per share, thereby incurring a loss of:

$$100 \times 100 \times (72 - 75) = \$\ (30{,}000)$$

Now let us take the case of a bear, who is of the opinion that the market is going to fall. He too can speculate, but by going short in a futures contract. If he is right, and the market price at the time of expiration of the futures contract is indeed lower than what the futures price was at the outset, he can buy at the prevailing market price and sell it at the contract price, thereby making a profit.

Example 3.9

Nina, like Alex, observes that the futures price for a three-month contract on IBM is \$ 75 per share. However, unlike Alex, she is of the opinion that in three months time, IBM will be selling for \$ 72 or less per share in the spot market. Assume that she takes a short position in 100 futures contracts.

If her hunch is right and the price of IBM after three months is \$ 70 per share, Nina will make a profit of:

$$100 \times 100 \times (75 - 70) = \$\ 50{,}000$$

However, if the market were to rise to, say \$ 78 after three months, Nina would incur a loss of:

$$100 \times 100 \times (75 - 78) = \$\ (30{,}000)$$

Both bears and bulls can use futures to speculate. However, in their quest for substantial gains there is always a risk of incurring substantial losses.

ENDNOTE

1. Some authors prefer to define it as the futures price minus the spot price.

4 CHAPTER

TRADING STRATEGIES

Hedging with Stock Index Futures

THE NUMBER OF FUTURES CONTRACTS required to set up a minimum variance hedge for a stock portfolio is given by:

$$h = \beta_P \frac{P_t}{I_t}$$

where β_P is the beta of the portfolio whose value is sought to be hedged, P_t is the current value of the portfolio, and I_t is the current value of the index on which the futures contract is based in dollars.

Example 4.1

Take the case of a portfolio manager who is handling a portfolio currently worth 10 MM dollars. He is worried that the market is going to fall. If he decides to hedge, he needs to hedge in such a way that he will make a profit on the futures contract if the market were to fall. So he needs to go short in index futures.

Assume that the current value of the index is 250 and that each index point[1] is worth $ 250. The value of the index in dollar terms is therefore:

$$250 \times 250 = \$\ 62500$$

As per the no-arbitrage condition, the futures price is given by:

$$F_t = I_t \left[1 + r \times \frac{(T-t)}{360}\right] - D_T$$

where I_t is the current index level, $(T - t)$ is the time till expiration of the futures contract, and D_T is the future value of the dividends paid by the component stocks between t and T, as calculated at T. D_T is measured in terms of index units.

Consider a futures contract with 72 days to expiration, which we will assume coincides with the hedging horizon of the manager. If the future value of dividends in index units is assumed to be ten, and the risk-less rate of interest is taken as 10%, then the current no-arbitrage futures price is given by:

$$250 \left[1 + .10 \times \frac{72}{360}\right] - 10 = 245$$

We will assume that the beta of the portfolio relative to the index is 1.25. The number of futures contracts required for a risk minimising hedge is therefore:

$$1.25 \times \frac{10{,}000{,}000}{62{,}500} = 200 \text{ contracts}$$

We will examine the performance of the hedge in two different terminal scenarios.

Case A: The index rises in value

Let the index value at expiration be 260. The value of our portfolio can be calculated as follows:

The return on the index $= \frac{260-250}{250} \equiv 4\%$

The dividend yield $= \frac{10 \times 250}{250 \times 250} \equiv 4\%$

Thus, the total return on the market $= 4\% + 4\% = 8\%$

The risk-less rate for 72 days $= \frac{.10 \times 72}{360} \equiv 2\%$

Therefore, the rate of return on the portfolio is:

$$2 + 1.25\,(8 - 2) = 9.5\%$$

The portfolio is hence worth:

$$10(1 + .095)\ \text{MM} = \$\ 10.95\ \text{MM}$$

The profit/loss from the futures market is:

$$(245 - 260) \times 250 \times 200 = \$\ (750{,}000)$$

Thus, the net value of our holdings is:

$$10.95 - .75 = \$\ 10.2\ \text{MM.}$$

As we can see, the hedged portfolio has earned a 2% rate of return. How can we explain this? The futures contract has helped remove all the inherent market risk. Therefore, the portfolio will earn the riskless rate of return, which is 2% for 72 days.

Case B: The index declines in value

Let the index value at expiration be 220. Then

The return on the index $= \dfrac{220-250}{250} \equiv -12\%$

The dividend yield $= \dfrac{10\times 250}{250\times 250} \equiv 4\%$

The total return on the market = –12% + 4% = –8%

The risk-less rate for 72 days $= \dfrac{.10\times 72}{360} \equiv 2\%$

Therefore, the rate of return on the portfolio is:

$$2 + 1.25(-8 - 2) = -10.5\%.$$

The portfolio is hence worth:

$$10(1 - .105)\text{ MM} = \$\ 8.95\text{ MM}$$

The profit/loss from the futures market is:

$$(245 - 220)\times 250\times 200 = \$\ 1{,}250{,}000$$

Thus, the net value of the holdings = 8.95 + 1.25

= $ 10.2 MM

Once again, the rate of return on the hedged portfolio is 2%.

In practice, however, a hedge may not be perfect. Firstly, dividends and interest rates may change over the life of the hedge. Secondly, the return on the index over 72 days may not be perfectly correlated with the return on a portfolio.

Changing the Beta of a Portfolio

It can be shown that the number of futures contracts required to change the beta of a portfolio from β^* to β_T is given by:

$$N = (\beta_T - \beta^*)\,\frac{P_t}{I_t}$$

where P_t is the value of the portfolio and I_t is the value of the index in dollars.

If we want to increase the beta, N will be greater than zero, and we should go long in the required number of futures contracts. If we want to decrease the beta, we should go short.

Example 4.2

An investor is holding a portfolio that is worth $ 300,000,000. The current beta is 0.85. The investor is bullish about the market and wants to increase the beta to 1.20. The S&P 500 index is currently at 800 and the index multiplier is 250.

The number of futures contracts required is given by:

$$\text{N} = (1.20 - 0.85)\,\frac{300{,}000{,}000}{800 \times 250} = 525$$

Quite obviously, the investor needs to go long.

Program Trading

Program trading is nothing but cash and carry and reverse cash and carry arbitrage using stock index futures. If the futures contract is overpriced, the arbitrageur will go short in futures contracts and buy the stock underlying the index in the same proportions as contained in the index. On the contrary, if the contract were to be underpriced, the arbitrageur would short sell the stocks contained in the index, and go long is futures contracts.

Since index arbitrage requires the taking of a long or a short position in all the stocks constituting the index on a simultaneous basis, a computerised system is required for its initiation. Index arbitrage has come to be referred to as *program trading* because of the use of computer programs to facilitate it.

Example 4.3

Consider a hypothetical price weighted index based on five stocks, with the prices as follows:

Table 4.1

PRICES OF THE CONSTITUENTS OF THE STOCK INDEX

Stock	*Price*
3M	90
American Express	60
Coca Cola	45
IBM	90
Merck	45
Total	330

If we assume that the divisor is five, the index value is 66.00.

Assume that today is 1 July, 20XX and that there is a futures contract based on the above index that expires on 21 September, 20XX, that is, 82 days later. We will also assume that 3M will pay a dividend of \$ 10 on 21 July, that IBM will pay a dividend of \$ 15 on 10 August and that American Express will pay a dividend of \$ 10 on 1 September. The borrowing/lending rate for all investors will be taken to be 10% per annum.

Let us first compute the future value of the dividends. On 21 July, a dividend of \$ 10 will be received. This can be reinvested till 21 September to yield:

$$10 \times \left(1 + .10 \times \frac{62}{360}\right) = 10.1722.$$

Similarly, the future values of the other two dividends, as of 21 September, are 15.175 and 10.0556.

To preclude arbitrage opportunities, the futures price, in dollar terms, should be a value F such that:

$$F + 15.175 + 10.1722 + 10.0556 = 66.00 \times 5 \times \left[1 + 0.10 \times \frac{82}{360}\right] = 337.5166$$

$$\Rightarrow \quad F = \$\ 302.1138$$

However, the convention is to express the futures price in terms of index units and not in dollars. Thus the futures price should be:

$$\frac{302.1138}{5} = 60.4228$$

If F is not equal to this value, there will be arbitrage opportunities.

Cash and carry index arbitrage

Example 4.4

Continuing with Example 4.3, let us assume that $F = 62$.

Consider the following strategy. The investor can borrow \$ 330 to buy the five stocks which constitute the index and go short in one futures contract. When the dividends are received periodically, he can reinvest them till the expiration of the futures contract at the lending rate. At expiration, the futures price will be set equal to the spot index value at that point in time, since *index futures contracts are always cash settled.* Therefore, at the time of expiration, the shares should be sold at the prevailing market prices.

Assume that the spot prices of the shares at the time of expiration are as follows:

Table 4.2

STOCK PRICES AT EXPIRATION

Stock	*Price*
3M	95
American Express	65
Coca Cola	50
IBM	95
Merck	45
Total	350

The corresponding index value is 70.

The profit/loss from the futures market is 62 – 70 = (8) index units, which is equivalent to $8 \times 5 = \$\ (40)$.

The cash inflow when the stocks are sold is $ 350. The payoffs from the reinvested dividends is:

$$10.1722 + 15.175 + 10.0556 = \$\ 35.4028.$$

The net cash flow at expiration is therefore:

$$350 + 35.4028 - 337.5166 - 40 = \$\ 7.8862$$

$ 7.8862 is equivalent to

$$\frac{7.8862}{5} = 1.5772 \text{ index units,}$$

which is the difference between the quoted futures price of 62 and the no-arbitrage price of 60.4228. It is important to note that the profit will always be equal to this difference and will be independent of the actual stock prices prevailing at expiration. This is because we have made the assumption that the arbitrageur will be able to sell the shares in the market at the same prices as those used to compute the index value at expiration.

Reverse cash and carry index arbitrage

Example 4.5

Consider the same information as in Example 4.4, but assume that the futures price is 59.50.

A potential arbitrageur will short sell all the five stocks which constitute the index and invest the proceeds at the lending rate of 10%. Simultaneously, he will go long in a futures contract. When the dividends are due, he will borrow the requisite amounts and pay the person(s) who have lent him the shares. At expiration, he will acquire the shares at the prevailing spot prices and return them. He will also be required to repay the amounts borrowed for the dividend payments (with interest). He will be entitled to the profit/loss from the futures market. The amount that he had originally lent out after selling the shares short will now be returned to him with interest.

Therefore, the net cash flow at expiration will be:

$$-350 - 35.4028 + 337.5166 + 5(70 - 59.50) = \$\ 4.6138$$

which is equivalent to 0.9228 index units, which is the difference between the futures price of 59.50 and the no-arbitrage price of 60.4228. Once again, the profit will be independent of the stock prices prevailing at expiration.

Stock Picking

Stock picking refers to the art of finding stocks that are underpriced or overpriced. Consider the following representation of the rate of the return on stock *i*:

$$r_i = r + \beta_i(r_m - r) + \varepsilon_i + \alpha_i$$

ε_i is the unsystematic error that is, the return due to unsystematic risk. This is expected to have a value of zero. The term $\beta_i(r_m - r)$ is the excess return due to market risk. α_i is what we call an *abnormal return*, which is due to mispricing of the stock. If the stock is correctly priced, then α_i will be zero. If $\alpha_i > 0$, then it implies that the stock is underpriced, whereas if $\alpha_i < 0$, it implies that the stock is overpriced.

A stock picker is a person who believes that a stock is underpriced or overpriced and seeks to take advantage of this. However, if he takes a position in the stock without hedging against movements in the market as a whole, there is a risk that (even if he were to realise the abnormal return that he expects) the general market movement may be such that he would make an overall loss.

Example 4.6

A stock picker believes that Coca Cola is underpriced and that he will get a positive abnormal return if he buys it. Assume that the risk-less rate is 2% and that the beta of Coca Cola is 1.5.

Let us assume that his hunch turns out to be correct and that α_i does turn out to be .5%. However, it so happens that $r_m = -5\%$, that is, the market goes down. If we assume that $\varepsilon_i = 0$ then:

$$r_i = 2 + 1.5(-5 - 2) + .5 = -8\%.$$

Thus although he backed the right horse, he has ended up with a negative rate of return. This situation could have been avoided if he had hedged using stock index futures.

Let us assume that he invests \$ 1,000,000 in the stock and goes short in S & P index futures when the index level is 250 and the futures price is at 245. The dividend yield is 4%. The appropriate number of futures contracts is given by:

$$h = \beta_P \times \frac{P_t}{I_t}$$

$$= 1.5 \times \frac{1{,}000{,}000}{250 \times 250} = 24$$

If the dividend yield is taken to be 4%, a return of –5% on the market corresponds to a decline of 9% in the index level. Thus the corresponding index value is 227.50.

The rate of return on the stock in such a scenario is –8%, which means that the terminal stock value is

$$1{,}000{,}000\ (1 - .08) = \$\ 920{,}000.$$

The profit/loss from the futures position is:

$$24 \times 250(245 - 227.5) = \$\ 105{,}000$$

The value of the stock plus the futures profit/loss is:

$$920{,}000 + 105{,}000 = \$\ 1{,}025{,}000$$

The overall rate of return is therefore 2.5%. This corresponds to the risk-less rate of 2% plus the abnormal return of .5%.

Thus, if you believe that the stock is underpriced but want to hedge yourself against market risk, you should buy the stock and go short in stock index futures. Similarly, if you believe that the stock is overpriced, short sell the stock and go long in stock index futures.

Portfolio Insurance

We have seen earlier that an investor can move from an actual spot position to a synthetic T-bill position by going short in futures contracts. The end result is the creation of a risk free investment, which gives the risk-less rate of return.

In practice, a portfolio manager may convert a fraction of his risky portfolio into equivalent synthetic T-bills using futures contracts and continue to hold the balance in the form of the risky portfolio. Now in principle, the value of this risky component can at worst go to zero. The risk-less equivalent will continue to earn the risk-free rate of return. Hence, such a strategy puts a floor on the value of the overall portfolio. The portfolio may end up earning more, but cannot earn less.

Such a risk management strategy is called *portfolio insurance*. In practice, fund managers will constantly watch the market and sell and buy futures contracts in order to move from equities to synthetic debt and vice versa. At any point in time, the greater the level of insurance required, the more will be the number of futures contracts to be sold. The technique of constantly switching from one asset position to another is called *dynamic hedging*.

Covered Interest Arbitrage

Cash and carry and reverse cash and carry arbitrage strategies using foreign exchange forward/futures contracts are known as covered interest arbitrage strategies.

Cash and Carry Covered Interest Arbitrage

Example 4.7

Consider the following information. The spot rate for Singapore dollars is $ 0.5275 and the three-month outright forward rate is $ 0.5575. The rate of interest applicable for a three-month loan in Singapore is 7.5% on an annual basis, while the rate for the same period in the US is 4.5% on an annual basis.

Let us consider the following strategy. The investor should borrow \$ 0.5275 and buy one Singapore dollar in the spot market. This can be immediately invested in Singapore to yield:

$$\left(1+\frac{.075}{4}\right) = 1.01875 \text{ SGD}$$

after three months. Simultaneously, at the outset, he should go short in a forward contract to sell 1.01875 SGD.

After three months, when the deposit in Singapore matures, he can sell the proceeds under the forward contract. He will receive $0.5575 \times 1.01875 = \$\ 0.5680$. Out of this he can use:

$0.5275 \times \left(1+\frac{.045}{4}\right) = \$\ 0.5334$, to pay off the loan in the US. The balance 0.5680 – 0.5334 = \$ 0.0346, is a pure arbitrage profit.

Covered Interest Reverse Cash and Carry Arbitrage

Example 4.8

Let us assume that all the other variables have the same values as in the above example, except the forward rate, which we will assume is \$ 0.5025. The cash and carry strategy will not yield profits but this one will pay off.

The investor should borrow one Singapore dollar and convert it into US dollars. He will get \$ 0.5275. If he lends this money out at 4.5%, after three months he is assured a sum of \$ 0.5334. At the outset, he should go long in a forward contract to buy

$\left(1+\frac{.075}{4}\right) = 1.01875$ Singapore dollars after three months.

This will cost $0.5025 \times 1.01875 = \$\ 0.5119$.

At the end of three months, he can take delivery under the forward contract and pay off his loan in Singapore. The balance of

$\$\ 0.5334 - \$\ 0.5119 = \$\ 0.0215$ is a pure arbitrage profit.

If we denote the spot rate as *S*, the forward rate as *F*, the domestic interest rate as i_d and the foreign interest rate as i_f, then[2] the no-arbitrage condition can be expressed as:

$$S(1 + i_d) = F(1 + i_f)$$

$$\Rightarrow \qquad F = S \times \frac{(1+i_d)}{(1+i_f)}$$

The kind of arbitrage illustrated above is called *covered interest arbitrage* and the relationship:

$$\frac{F}{S} = \frac{(1+i_d)}{(1+i_f)}$$

is called the *interest rate parity* equation.

$$\frac{F}{S} = \frac{(1+i_d)}{(1+i_f)} \Rightarrow \frac{(F-S)}{S} = \frac{(i_d - i_f)}{(1+i_f)}$$

In practice, this is often approximated as:

$$\frac{(F-S)}{S} = (i_d - i_f)$$

because $1 + i_f \cong 1$, if i_f is very small.

In practice, however, there could be deviations from the interest rate parity relationship, which would-be arbitrageurs are unable to exploit. There could be many reasons for this. Firstly, buying and selling foreign exchange either in the spot or the forward markets entails the payment of transactions costs. Secondly, not all countries permit the free flow of capital across borders. Thus if governments impose exchange control, one may observe deviations from interest rate parity that cannot be arbitraged away. In practice, even a perception that exchange rate controls may be imposed in a country in the future can be enough to preclude investors from attempting to arbitrage away perceived deviations. Finally, investors have to pay taxes on income and profits, which vary from country to country. Thus, an investor's ability to make arbitrage profits on a post tax basis could depend on his tax status.

Hedging an Export Transaction

Example 4.9

Assume that today is 21 June, 20XX. Eli Lilly has exported a consignment of antidepression drugs to a company in Zurich and is scheduled to receive 25MM Swiss francs, after two months. The company is worried that the dollar will appreciate by then and therefore decides to hedge using September futures contracts. Since the company will be selling the Swiss francs on receipt, it requires a short hedge.

Each Swiss franc futures contract is for 125,000 CHF. Consequently, 200 contracts are required. We will assume that the price of the September contract on 21 June is 0.5150 USD/CHF.

On 20 August, assume that the following prices prevail in the market:

Spot: 0.4985 USD/CHF

September futures: .5025 USD/CHF

If Eli Lilly had not hedged, it would have received:

$$25{,}000{,}000 \times 0.4985 = \text{USD } 12{,}462{,}500$$

On the other hand, since it has hedged using the futures contracts, the payoff would be as follows. The profit/loss from the futures market is:

$$200 \times 125{,}000 \times (.5150 - .5025) = \text{USD } 312{,}500$$

Therefore, the total proceeds are:

$$12{,}462{,}500 + 312{,}500 = \text{USD } 12{,}775{,}000$$

The effective exchange rate is:

$$\frac{12{,}775{,}000}{25{,}000{,}000} = 0.5110 \text{ USD/CHF}$$

Hedging an Import Transaction

Example 4.10

American Airlines has ordered spare parts for its aircraft from Rolls Royce, UK. The total cost is GBP 4MM and the payment is due one month from today. Let us assume that we are standing on 1 August, 20XX. The company is worried that the dollar will depreciate, which means that the cost in dollars will go up. Since it will be buying British pounds, if it decides to hedge the appropriate hedge is a long hedge.

The following prices are observable on 1 August:

Table 4.3

PRICES ON 1 AUGUST

	Bid	*Ask*
Spot	1.4025	1.4075
Sep Futures	1.4120	1.4190

Let us assume that the following rates prevail on 1 September:

Table 4.4

PRICES ON 1 SEPTEMBER

	Bid	*Ask*
Spot	1.4150	1.4220
Sep Futures	1.4250	1.4335

If the company does not hedge, then it would have to purchase 4MM GBP at the ask price of 1.4220, leading to a total outflow of USD 5,688,000. However, if it hedges, its effective cost can be calculated as follows. The appropriate number of futures contracts required is:

$$\frac{4,000,000}{62,500} = 64$$

The profit loss from the futures market is[3]:

$$62{,}500 \times 64 \times (1.4250 - 1.4190) = \text{USD } 24{,}000$$

The effective cost = 5,688,000 – 24,000 = USD 5,664,000 and the effective exchange rate is:

$$\frac{5{,}664{,}000}{4{,}000{,}000} = 1.4160 \text{ USD/GBP}$$

ENDNOTES

1. Futures prices are always quoted in index points. To calculate the value of a futures contract in terms of the domestic currency, the futures price has to be multiplied by the lot size specified by the exchange. For the S&P 500 futures contract, the lot size is $ 250.
2. In this case, the US interest rate is the domestic rate and the Singapore interest rate is the foreign rate.
3. It would have gone long at the ask price on 1 August, and would have to offset at the bid price on 1 September.

I
APPENDIX

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II

APPENDIX

Test Your Concepts

1. Which of these aspects of a futures contract is not decided by the exchange:
   (a) The number of units of the underlying asset per contract
   (b) The grade(s) of the underlying asset that may be delivered
   (c) The location(s) where delivery may be made
   (d) The transaction price
2. If two investors who already have open positions in the futures market enter into a fresh trade with each other:
   (a) Open interest will rise
   (b) Open interest will fall
   (c) Open interest will remain unchanged
   (d) Cannot say
3. When a short delivers the asset under a futures contract, he will receive:
   (a) The spot price that was prevailing at the inception of the contract

(b) The futures price that was prevailing at the inception of the contract
(c) The spot price that is prevailing at the time of delivery
(d) None of the above

4. While marking a futures contract to market, the profit/ loss between one day and the previous day, is calculated by:
(a) Comparing that day's closing spot price with the previous day's closing spot price
(b) Comparing that day's futures settlement price with the previous day's futures settlement price
(c) By comparing that day's futures settlement price with the previous day's closing spot price
(d) None of the above

5. If cash and carry arbitrage is possible:
(a) The implied repo rate is greater than the borrowing rate
(b) The futures contract is overpriced
(c) The implied reverse repo rate is less than the lending rate
(d) (a) and (b)

6. Which of these price sequences is a manifestation of Backwardation:
(a) Spot = 100; 1 Month Futures = 105; 2 Month Futures = 108
(b) Spot = 100; 1 Month Futures = 108; 2 Months Futures = 112

(c) Spot = 100; 1 Month Futures = 98; 2 Month Futures = 95
(d) None of the above

7. If an asset is in Contango:
   (a) The net carry is positive
   (b) The marginal convenience value is zero
   (c) The market is at full carry
   (d) None of the above

8. A hedger plans to terminate the hedge on 15 September. Futures contracts expiring on the 21st of every month are available. The hedger will choose:
   (a) September futures
   (b) October futures
   (c) November futures
   (d) December futures

9. The minimum hedge ratio will always be:
   (a) Equal to 1.0
   (b) Greater than 1.0
   (c) Less than 1.0
   (d) None of the above

10. A calculated risk taker is known as:
   (a) A hedger
   (b) A speculator
   (c) A gambler
   (d) None of the above

11. If the standard deviation of the spot price is less than the standard deviation of the futures price, then the minimum variance hedge ratio:
    (a) Will always be greater than 1.0
    (b) Will always be less than 1.0
    (c) Will always be equal to 1.0
    (d) None of the above
12. The basis will be equal to zero on the expiration date of the futures contract:
    (a) Only if the market is in Contango
    (b) Only if the market is in Backwardation
    (c) Irrespective of whether the market is in Contango or Backwardation
    (d) None of the above
13. The further away the expiration of the futures contract chosen for hedging, the greater is the basis risk for:
    (a) Buying hedges
    (b) Selling hedges
    (c) Both buying as well as selling hedges
    (d) None of the above
14. A party which has exported goods and expects to be paid in foreign exchange will need to take:
    (a) A short position in forward contracts
    (b) A short position in futures contracts
    (c) A long position in futures contracts
    (d) (a) or (b)

15. A party which has exported goods and expects to be paid in domestic currency will need to take:
    (a) A short position in forward contracts
    (b) A short position in futures contracts
    (c) A long position in futures contracts
    (d) None of the above
16. Portfolio insurance imposes:
    (a) A floor on the rate of return from the portfolio
    (b) A ceiling on the rate of return from the portfolio
    (c) Both a floor and a ceiling on the rate of return from the portfolio
    (d) Neither a floor nor a ceiling on the rate of return from a portfolio
17. If a stock is underpriced:
    (a) The excess return will be positive
    (b) The abnormal return will be positive
    (c) The abnormal return will be negative
    (d) None of the above
18. Program trading is a term used for:
    (a) Cash and carry index arbitrage
    (b) Reverse cash and carry index arbitrage
    (c) Both (a) and (b)
    (d) Neither (a) nor (b)
19. Which of these statements is true:
    (a) A short hedger is long the basis
    (b) A long hedger is short the basis
    (c) Both (a) and (b)
    (d) None of the above

20. Which of these statements is true in the case of a physical asset:
    (a) The net carry will always be positive
    (b) The net carry will always be negative
    (c) The net carry will be equal to the marginal convenience value
    (d) None of the above

III
APPENDIX

Solutions to Test Your Concepts

Box A3.1

Q.No.	*Answer*	*Q.No.*	*Answer*
1	d	11	b
2	d	12	c
3	c	13	c
4	b	14	d
5	d	15	d
6	c	16	a
7	a	17	b
8	b	18	c
9	d	19	c
10	b	20	a