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Futures Trading: Pricing and Hedging

This chapter covers more advanced aspects of the economics of futures trading. It has two sections. The first deals with the relationship between spot and futures prices while the second discusses the relationship between the 'basis' or price spread and hedging effectiveness. The discussion will be based primarily on futures in commodities, but the discussion is also applicable to futures in financial instruments etc., with minor modifications which will be discussed in subsequent chapters.

The relationship between spot and futures prices

Intuitively, it is not difficult to see that spot and futures prices must be interrelated. After all they are prices of the same asset, albeit at different points in time, which means that the basic factors affecting supply and demand are the same. Also, the option of delivery (meaning that a futures contract can be closed by means of actually giving or taking delivery of the physical commodity or financial instrument) means that on the maturity date spot and futures prices must be in close proximity. This implies that the difference between the two prices must narrow over time and eventually be whittled down to nil or thereabouts. This leaves the question of how the difference is determined. There are several theories which attempt to explain the relationship between spot and futures prices. The essence of these is set out below. In the following discussion, readers should note that:

- when the futures price is higher than the spot price, the futures price is said to be at a 'contango'; and
- when the futures price is lower than the spot price it is said to be at a 'backwardation'.

The expectations approach

This school of thought, owing its origins to such luminaries as J. M. Keynes, J. R. Hicks and N. Kaldor, sees the futures price as the market expectation of

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the price at the future date. Thus, the October gold futures price in June is what the market in June expects or forecasts will be the gold price in October. Any major deviation of the futures price from the expected price is likely to be corrected by speculative activity.

Example 4.1

On 3 June, the S&P 500 share index futures for October maturity is trading at 1,450 (say). It is generally expected that the level of the index in October will be 1,550. Thus, the futures price is below the expected price. Speculators will now see a profit opportunity. They can buy up futures contracts in the expectation of a profit. The speculative purchases will increase the demand in the futures market and push the price upwards. This tendency will continue until the futures price is close to the expected price. (Because of brokerage and other transaction costs, exact equality may not necessarily arise.)

Example 4.2

On 20 April, the price of silver for July delivery in the futures market is $40/oz. The general expectation is that the price of silver in July will only be $30 /oz. Speculators will now see a profit opportunity in short-selling silver futures, since they can sell at 40 dollars and hope to square up the contracts in July by buying back at 30 dollars. The speculative sales will increase the supply of silver in the futures market and push the price downwards. This tendency will continue until the futures price is close to the expected price.

It is obvious that the expectations approach has substance. However, it must be remembered that the speculative transactions described in the examples above are risky transactions, not arbitrage. The transactions are based on expectations which may or may not turn out to be correct. Since speculators, like other humans, are generally risk averse, it is quite possible that deviations from the expected price (over and above deviations due to transactions costs) may persist. It is only when the gap between futures and expectations is large, that speculative interest can be expected in large volume.

The theory of normal backwardation

It has been observed in many futures markets, that the volume of short hedging exceeds the volume of long hedging (see Table 3.1 for details of what is short vs. long hedging). This net short hedging pressure has to be taken up by long speculators. Keynes postulated that, in order to induce long speculators to take up the net short hedging volume, the hedgers had to pay a risk premium to the

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speculators.[1] Thus, according to Keynes, the futures price would generally be less than the expected price, by the amount of risk premium.

i.e., $F = E - r$

where, F = futures price for a future date

E = expected price at that date

r = risk premium

Keynes thus felt that futures price would be related to expected price but would normally be at a backwardation (i.e., discount) to expected prices.[2] A lot of empirical research has been conducted over the years to test whether futures prices do indeed exhibit a normal backwardation. Several studies have confirmed its existence while some others did not find any evidence of it. However, in thin markets where speculative volume is low, the normal backwardation does exist and plays a role in attracting sufficient speculation to balance the excess hedging pressure.[3]

Reasons for excess short hedging volume

The theory of normal backwardation is based on the existence of an excess of short hedging. Is there any underlying reason why short hedging tends to predominate in many different futures markets? The first attempt to provide a theoretical rationale for this phenomenon was by Hicks who attributed it to technological reasons.[4] He pointed out that entrepreneurs generally had a freer hand in acquiring new inputs (which are necessary for production processes), than in the disposal of outputs. Once the process of production is commenced it cannot be reversed and the entrepreneur has to necessarily arrange to sell the output, whereas he can always refrain from acquiring an input in the event of unfavourable price changes. Therefore, Hicks felt there would be a greater

1 J. M. Keynes, *A Treatise on Money,* Vol. II, Macmillan, London, 1930.

2 Normally, the term backwardation is used to refer to a situation where the spot price exceeds the futures price; in this case it is used to denote that the expected price exceeds the futures price. This may be a little confusing but since this was the terminology used by Keynes himself, it has been retained here.

3 R. W. Gray, 'The Characteristic Bias in Some Thin Futures Markets', in A E Peck (ed.), *Selected Writings on Futures Markets,* Vol II, Chicago Board of Trade, Chicago, 1977.

4 J. R. Hicks, *Value and Capital,* 2nd ed., Oxford University Press, 1964, 137.

need and urgency to hedge planned sales than to hedge planned purchases, thereby leading to an excess of short hedging. However, this argument was criticised by Houthakker.[5] The most important criticism is the fact that futures market participants include a large proportion of merchants. For merchants, the commodity does not go through any production process and the technological considerations are clearly irrelevant. The Hicks argument is thus an incomplete explanation at best.

The second important reason for the oft-observed excess of short hedging lies in the seasonality of agricultural production on the one hand and the non-seasonality of consumption on the other.[6] Because of this, the processors and exporters (long hedgers) only need to hedge a small quantity at a time (say, requirements for the next two months), whereas the merchants and stockists (short hedgers) need to hedge the whole stock that they are carrying. In the immediate post-harvest period, this may cover a year's production.

Excess of long hedging

The observation of an excess of short hedging volume, and its explanation, evolved primarily from studies of futures markets in agricultural commodities. The combination of seasonality and technological factors explains the phenomenon in these markets. In recent years, a number of futures markets in non-agricultural commodities have become active. It has also been observed that some of these markets do not have an excess of short hedging.[7] In markets where there is generally an excess of long hedging (which is conceivable though, in practice, not common) the futures price would exhibit a 'normal contango' instead of a normal backwardation, so that the long hedgers would pay a risk premium to short speculators. In such cases, the relationship between expected prices and futures prices would be as follows:

$F = E + r$

5 H. S. Houthakker, 'Normal Backwardation', in *Value, Capital and Growth—Papers in Honour of Sir John Hicks,* edited by J. N. Wolfe, Edinburgh University Press, Edinburgh, 1968.

6 B. A. Goss and B. S. Yamey, *The Economics of Readings Selected, Edited and Introduced* (2nd ed.), Macmillan, London, 1978, 27.

7 J. L. Stein, *The Economics of Futures Markets,* Basil Blackwell, Oxford, 1986, 12–14. He also shows that the predominance of short hedging has declined even in agricultural markets, 55.

The carrying cost approach

Holbrook Working, whose contribution to the economics of futures trading is as significant as Keynes' contribution to macro-economics, postulated that futures prices essentially reflect the carrying cost of commodities, rather than an expected price at a future date. According to Working, expectations affecting futures price would usually also affect spot price equally and thus not affect the difference between them. Instead, according to him, the inter-relationship between spot and futures prices reflect the carrying cost, i.e., the amount to be paid to store a commodity from the present time to the futures maturity date.[8]

Carrying costs are of several types. Firstly, there are costs of warehousing, insurance, etc. Secondly, there are costs due to deterioration of a commodity over time; these may be high in the case of crops like potatoes, low in the case of food grains and non-precious metals, and nil for precious metals. Thirdly, there is interest on capital locked up in the stocks. The first two are applicable only to commodities, not to financial instruments, but the interest cost applies to all assets. For a given time period, these costs are normally constant per unit of the asset held.

Apart from the carrying cost of holding stocks, however, there could be a 'convenience yield' from holding stocks. Take the case of a wheat miller-cum-bread manufacturer. However good his purchasing arrangements, there can be disruptions because of (say) bad weather holding up lorries, or strikes, or innumerable other reasons. If he runs out of stock of wheat, his costly machinery and labour have to remain idle, causing a loss, apart from the adverse effects on customer goodwill. These losses can be avoided by retaining a minimum level of stocks. Alternatively, assume that he receives a special urgent order for bread. If his stocks do not cover this extra requirement, he will have to turn down the order and forgo the profits involved. Thus, *up to a certain level, stock holding has a yield, this yield being the savings in lost profits that could occur in the event of a stock-out, plus the profits of unanticipated demand*.[9] Beyond this minimum level (the level required to avoid stock-outs), there is no convenience yield. The yield can be regarded as a negative carrying cost. (In the case of financial instruments,

8 H. Working, 'The Theory of the Price of Storage', *American Economic Review,* Vol. 31, December 1949.

9 M. J. Brennan, 'The Supply of Storage', in B.A. Goss and B.S. Yamey, *op. cit.*

there may be a real yield – going beyond mere convenience – by holding the financial instrument through interest or dividends.)

The net marginal carrying cost for any given quantity would thus be:

$C_t = c_t - y_t$

where C = net carrying cost for that quantity

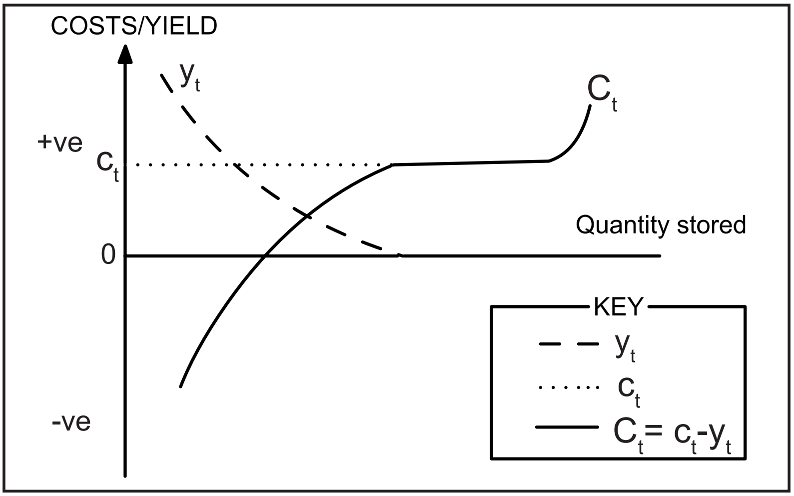
c = gross carrying cost for that quantity

y = convenience yield of that quantity

t = time period of storage

When the stock level in a particular commodity is low, the marginal convenience yield is higher because the chance of a stock-out is greater. As stocks rise, the chance of a stock-out recedes and the convenience yield diminishes gradually to zero. The marginal gross carrying cost remains constant over a large range of stock levels, but may increase at very high stock levels; this is because, for instance, godown space may be exhausted and godown keepers may demand a higher charge.[10] The net carrying cost can thus be portrayed as in Figure 4.1.

Figure 4.1: Carrying costs of a commodity at different storage levels



10 Brennan (see Reference) also postulates that at higher stock levels, the perceived risk of loss due to any unexpected price fall in the commodity is greater, and this further adds to carrying costs.

This curve is usually called the supply of storage curve (as per Working's original terminology). According to Working, merchandisers look at the spread between spot and futures and decide their quantity of storage accordingly. This can be viewed in another way – the spread is determined by the stocks available. When stocks are low, spreads are negative. When stocks are high, the spread is equal to the full carrying cost.[11]

If the prevailing price spread is below the carrying cost (including yield), it does not pay to store; instead it is optimal to sell the stock immediately. Such sales will tend to depress the spot price, thereby widening the spread until it matches the carrying cost. If the prevailing price spread is above the net carrying cost, merchandisers will buy spot stocks, sell futures and thus earn a profit. This will tend to increase spot prices and reduce futures prices, thereby narrowing the spread. Thus, according to the carrying cost approach, the futures price will approximate to the ready (spot) price plus the carrying cost:

i.e., *F is approximately equal to $S + C$*

where F = Futures price

S = Spot (i.e., ready) price

C = Carrying cost to the date of maturity of the contract.

The next section explores this *approximate* relationship so as to go to a more precise mathematical statement of the relationship.

Asymmetry in positive and negative spreads

At first sight, it would appear that the futures price cannot go above or below the carrying cost because of the mechanism referred to above. A closer examination shows that there is in fact an asymmetry.

Example 4.3

In May, the price of August pepper is ₹ 18,000 per quintal (say), while the spot price is ₹17,200. The carrying cost per quintal for three months is ₹ 200. Any market participant, whether a pepper merchant or a speculator now has the incentive to immediately:

—buy spot and store it

—sell futures and deliver it in August

11 For a comprehensive explanation of how spreads are determined by the interaction of the supply of storage and the demand for storage, see Brennan, ibid.

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By doing so, the profit is:

₹ (18,000 — 17,200 — 200) = ₹ 600.

Example 4.3 shows an arbitrage opportunity; the profit is a guaranteed riskless profit. Thus, traders can be expected to act immediately and on a large scale. The process of buying spot and selling futures will tend to raise spot prices and reduce futures prices until the spread equals the carrying cost.

Example 4.4

In May, the price of August pepper is ₹16,600. All other facts are as in example 4.3. Here, profits can be made by:

— selling spot and delivering it

— buying futures

The resulting profit would be ₹17,200 – 16,600 = ₹600

However, to carry out the strategy in Example 4.4, it is necessary to deliver physical stocks now. Only those already holding physical stocks or those who can borrow stocks can employ the strategy. The general speculator is excluded. Thus, *the extent to which such trades can be put through is limited by the extent of available stocks*. Besides, much of the existing stock may be committed to specific production or merchandising activities and may not be available for use in this type of transaction. Therefore, it is likely that the extent of arbitrage will not be adequate to increase the spread to the level of carrying costs.

Looking at the two examples together, an asymmetry is apparent. Arbitrage potential is unlimited in situations where spreads exceed carrying costs; arbitrage will thus go on until the spread is swiftly reduced to the level of carrying costs. On the other hand, in situations where spreads fall short of carrying costs, the potential for arbitrage is limited (especially in the case of commodities), and spreads may remain below the level of carrying costs indefinitely. *Therefore, while the spread cannot exceed the carrying cost, it can fall short of it.*[12] This asymmetry in turn leads to a difference in the expected returns to long and short hedging.

When this is taken into account, the approximate mathematical relationship mentioned earlier viz. '*F* is approximately equal to *S*+*C*' can be defined more precisely as follows:

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12 For the earliest clear identification and explanation of this asymmetry, see Gerda Blau (Miss), 'Some Aspects of the Theory of Futures Trading', *Review of Economic Studies,* Vol. 12, 1944–45, 11.

In the absence of a convenience yield:

$$F \leq S + C,$$

i.e., the futures price will not exceed the spot price plus the carrying cost, where carrying cost is calculated net of any convenience yield.

If the convenience yield is taken into account separately, then the price relationship can be stated as:

$$F \leq S + C - Y$$

Where, F = Futures price

S = Spot price

C = Carrying cost till maturity of the contract

Y = convenience Yield until maturity of the contract.

An integrated approach

The various theories presented above may well have left the reader confused. On the one hand, it appears that futures prices are based on expectations or forecasts, but on the other hand, they seem to depend purely on stock levels and carrying costs. A number of empirical studies have attempted to verify the correctness of these theories and have resulted in greater clarity on their applicability. This section attempts to integrate the various strands of theory into one coherent whole.

One of the key criteria which determines the futures price behaviour is the continuous or discontinuous nature of stock-holding in a particular asset.[13] A continuous storage good is one in which stocks are held throughout the year, even though production may be discontinuous (i.e., seasonal). Food grains are a good example; they are easily storable for long periods and stocks are held year-round. Several agricultural crops, like potatoes and other vegetables, are examples of discontinuous storage goods which are not stored year-round. There is often a gap between exhaustion of one crop and harvest of the next. Another type of good is one with continuous (i.e., non-seasonal) production – for example, metals and crude oil. The continuous production goods are generally also continuous storage goods but there are some exceptions: in the USA, there are

13 W. G. Tomek and R. W. Gray, 'Temporal Relationships among Prices in Commodity Futures Markets: Their Allocative and Stabilising Roles', in A. E. Peck (ed.), *op. cit.*

futures markets for pork bellies and eggs which are clearly perishable and thus not storable, but which can be produced continuously. (No doubt modern cold storage techniques have made these capable of storage for a considerable period in developed countries where power supply is reliable.) These characteristics of various assets are summarised below in Table 4.1.

Table 4.1: Production and storage characteristics of various assets

Production	**Storage**	
	Continuous	**Discontinuous (difficult to store)**
Continuous (non-seasonal)	Financial instruments, oil, metals, jute goods, industrial goods	Eggs, meat, dairy products, thermal electric power
Discontinuous (seasonal)	Food grains, jute, cotton, tea, non-perishable agricultural commodities	Potatoes, several fruits, vegetables and perishable agricultural commodities, hydro-electric, wind and solar power

Armed with this classification, one can summarise as follows:

a. Futures prices in goods which are continuous storage goods, broadly follow the carrying charge approach.

b. Financial instruments are not perishable and can be stored indefinitely without damage. They can be 'produced' (i.e., issued) at any time. They generally follow the carrying charge approach (with the change that there is a real yield rather than a convenience yield). Usually, expectations play little or no role and the futures pricing relationship becomes an equation rather than an inequality, i.e., $F=S+C-Y$ with Y denoting the actual yield in the form of interest or dividends. C becomes the interest cost forgone in holding the asset, plus some costs such as (say) fees to maintain a dematerialised account.

c. Commodities where production is continuous but storage is discontinuous may follow either approach, based on the degree to which the good can be stored and the available production capacity *vis-à-vis* current demand. If the goods can be stored for some time and the industry has surplus

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capacity to meet increases in demand, then they follow the carrying charge approach. An extreme case is electricity which is very difficult to store. In situations where there is little spare generation capacity *vis-à-vis* current demand, electricity futures prices are almost entirely expectations-based.

d. Futures prices in goods where production and storage are both discontinuous (Table 4.1, the shaded portion) tend to follow the expectations approach for months beyond the period for which existing stocks last. (For months relating to existing stocks, they behave like continuous storage markets.)

e. Even in continuous storage or production markets, expectations do play a role. It was seen that while there is a maximum limit for the spread, determined by the carrying cost, there is no minimum. Fluctuations within the maximum are often related to expectations. Prices for distant months which involve new harvests, do involve a substantial element of expectations, but such expectations also influence the spot price simultaneously. This is because the stocks become a link mediating between the current crop and future harvests.

f. Expectations may predominate even in continuous storage or production markets, for periods demarcated from the present by some future event which is expected to change the market situation.[14]

Example 4.5

In the month of February, there is a port strike in Chile and a railway wagon shortage in land-locked Zambia, both of which are leading copper producers. This disrupts the flow of copper supplies to world markets. Stocks are adequate to meet normal consumption requirements for about three months. The prices of copper on the London Metal Exchange (in dollars per tonne) are as follows:

Spot	*12,000*
March	*12,100*
April	*12,175*
July	*11,980*
Sept.	*11,750*

The prices for the near months reflect the fact that there is an on-going port strike/railway disruption in producing countries; thus, prices of these months would be formed on the basis of existing stocks only. The contango for near months reflects carrying costs; since stocks are

14 B. A. Goss and B. S. Yamey, *op. cit.*, 16.

adequate, the convenience yield is negligible. Prices for distant months are based on the expectation that the disruption will not continue for that long and hence a large quantity, including the backlog for the months with transport disruption, will reach the market by then. Because of this, prices for distant months are at a backwardation, reflecting the expected change in circumstances.

Another example of an external event in the context of financial futures markets, could be an expected election with, say, a proposal for major public borrowing through issue of government securities, which will take effect after a particular date if one of the parties wins, or an expected budget proposal affecting future periods only. These circumstances, depending on the exact nature of the expected changes, may well influence futures prices differently from spot prices.

Normal backwardation tends to exist in those markets which are relatively thin, where speculators have to be induced to come in. In other markets, it may or may not exist depending on the extent of *suo motu* speculative interest. A simple way of summarising the relationship is that:

- The carrying cost approach provides a limit or upper bound to the futures price. Thus, $F \leq S+C-Y$, i.e., the futures price cannot exceed the sum of the spot price and carrying cost (net of any convenience yield).
- However, in some cases, expectations may cause the price to fall below the upper limit.
- The relative influence of carrying costs vs. expectations varies. At one extreme is electricity futures where storage is very difficult and sometimes impossible and production of some kinds of electricity is discontinuous – this market is dominated by expectations. At another extreme are futures in financial instruments where carrying cost (net of yield) is the predominant factor with very rare exceptions. Most other markets fall somewhere in between.

Basis (price spread) and hedging regurns

The returns to hedging depend on the size and change in the gap between spot prices and futures prices. The difference between these two prices is generally called the 'basis'. The term 'price spread' is also used by economists (though in the financial markets this term usually has a different connotation connected with options) and this book uses both terms. Basis is usually defined as spot price minus futures price, and that is the definition adopted in this book. (However, readers should note that it is sometimes defined as futures price minus spot price; in such contexts, the pricing relationships and definitions given below will have to be suitably changed.)

When the futures price is greater than the spot price, the basis is negative. As mentioned at the beginning of this chapter, the term 'contango' is also used to describe such a relationship, i.e., 'the futures price is at a contango'. The extent of the negative basis is the extent of the contango. For instance, if the spot price of castor seed is ₹ 4,000 per quintal and the November futures price is ₹ 4,200, the basis is

₹ (4,000 – 4,200) = ₹ minus 200 per quintal.

In this situation, November castor is at a contango of ₹ 200 *vis-à-vis* spot.

When the futures prices is lower than the spot price, the basis is positive. As noted earlier, the term 'backwardation' is also used to describe such a relationship, i.e., 'the futures price is at a backwardation'. The extent of the positive basis is the extent of the backwardation. On the other hand, if the spot price of soya bean is ₹ 4,000 per quintal while the December futures price is ₹ 3,600, then the basis is:

4,000 – 3,600= ₹ 400 per quintal.

In this case, December soyabean is at a backwardation of ₹ 400.

The correspondence between these terms is summarised in Table 4.2

Table 4.2: Futures vs. spot price relationship

Futures price vis-à-vis spot price	**Basis**	**Description of relationship**
Futures price is higher than spot price	Negative	Contango
Futures price is lower than spot price	Positive	Backwardation

To make it easier to understand how basis affects hedging returns, assume initially that there are no carrying costs. A short hedger buys in the spot (ready) market and sells simultaneously in the futures market at the start of the hedging period (time *t*). At the end of the hedging period (time *t*), he sells in the spot market and buys in the futures market. In each market, his profit or loss is the difference between the sale price and purchase price.

Gain/loss in spot market = Sale price – Purchase price

$= S_t - S_0$

Gain/loss in futures market = Sale price – Purchase price

$= F_0 - F_t$

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$$\begin{aligned}\text{Total gain/loss} &= (F_0 - F_t) + (S_t - S_0) \\ &= F_0 - S_0 - F_t + S_t \\ &= (F_0 - S_0) - (F_t - S_t) \\ &= (S_t - F_t) - (S_0 - F_0) \qquad (4.1)\end{aligned}$$

But, by definition, the basis (spread) at any given time is the difference between the spot and futures prices.

Basis at time 0 = $S_0 - F_0$

Basis at time t = $S_t - F_t$

Thus, equation (4.1) shows that the return to short hedging is the difference between the closing basis and the opening basis.

In the case of a long hedger, the initial sale is on the ready market, say in the form of a non-transferable forward contract. Assuming there are no carrying costs, his price is likely to be same as the spot price. Thus, at time 0, he sells in the spot market and buys (to 'place' the hedge) in the futures market. At time t (end of the hedge period) he buys in the spot market (so as to deliver against his obligation) and sells in the futures market (to 'lift' the hedge). In each market, his gain or loss is the difference between the sale price and the purchase price.

$$\begin{aligned}\text{Gain/loss in spot market} &= \text{Sale price} - \text{Purchase price} \\ &= S_0 - S_t \\ \text{Gain/loss in futures market} &= \text{Sale price} - \text{Purchase price} \\ &= F_t - F_0 \\ \text{Total gain/loss} &= (F_t - F_0) + (S_0 - S_t) \\ &= F_t - S_t - F_0 + S_0 \\ &= (F_t - S_t) - (F_0 - S_0) \\ &= (S_0 - F_0) - (S_t - F_t) \qquad (4.2)\end{aligned}$$

Thus, from equation (4.2), it is seen that the return to long hedging is the difference between the opening basis and the closing basis. It should be noted that equation (4.2) is the exact negative or obverse of equation (4.1).

Though equations (4.1) and (4.2) are incomplete in as much as they ignore carrying costs, they illustrate the basic point that hedging returns depend on spread changes. Indeed, for this reason, some authors have gone so far as to say that hedging is merely speculation on the basis or price spread. This is, however, a somewhat misleading characterisation. It is true that hedging on a futures market substitutes basis risk (i.e., risk of spread change) for price risk, but this substitution usually results in a large reduction in the degree of risk for the following reasons:

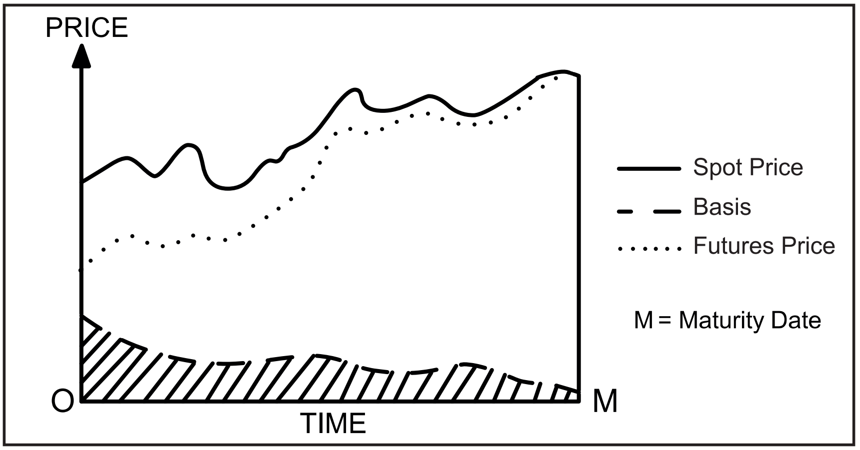
a. For hedges where the underlying held in the spot market is identical to a deliverable variety or grade in the futures market and where the hedge is held to the maturity of the futures contract and delivered against it, there is no 'basis risk', i.e., risk of unexpected change in the basis or price spread. The change in basis is entirely predictable and hence not a 'risk'.
b. In other cases, i.e., where the underlying held in the spot market is not identical to a deliverable variety or where the contract is not held until the maturity of the contract or where actual delivery is not given/taken, some basis risk remains.
c. Because the basis is smaller than the price itself, it is intuitively apparent (and empirically proven[15]) that basis changes are generally smaller in magnitude than price changes.
d. Because closing spreads normally tend to zero, the basis normally changes in a predictable way over the life of a futures contract, whereas prices fluctuate either way.

Convergence of spot and futures prices

The basis on a given date reflects the carrying costs or expected prices, as was seen earlier. However, on the maturity date, the spot and futures price would have to be equal, since they refer to the same commodity or asset, at the same point of time. If there was any difference, arbitrageurs could make riskless profits, and this arbitrage will ensure equality. Thus, the closing price spread or basis of a futures contract is expected to be zero. This means that the basis–positive or negative,shrinks over the life of a contract; thus the spot and futures price converge over time, though both may fluctuate heavily (see Figures 4.2 to 4.4).

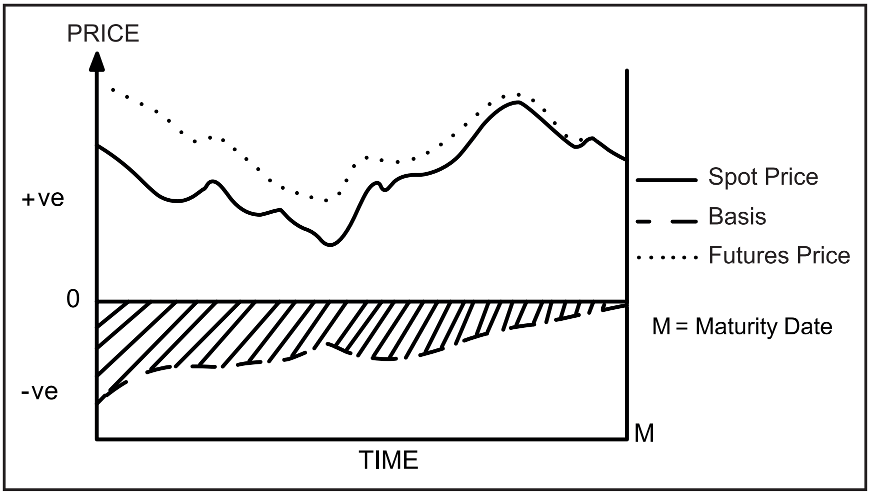
15 See for instance the studies by T. F. Graf and B. S. Yamey, cited by B. A. Goss in *The Theory of Futures Trading,* Routledge & Kegan–Paul, London, 1972, 32–33. The same result has been confirmed by several empirical investigations both in India and abroad.

Figure 4.2: Futures price at a backwardation



(The figure shows a typical profile of a backwardation, where the backwardation diminishes over time, though not necessarily uniformly.)

Figure 4.3: Futures price at a contango



(The figure shows a typical profile of a contango, where the contango diminishes over time, though not necessarily uniformly)

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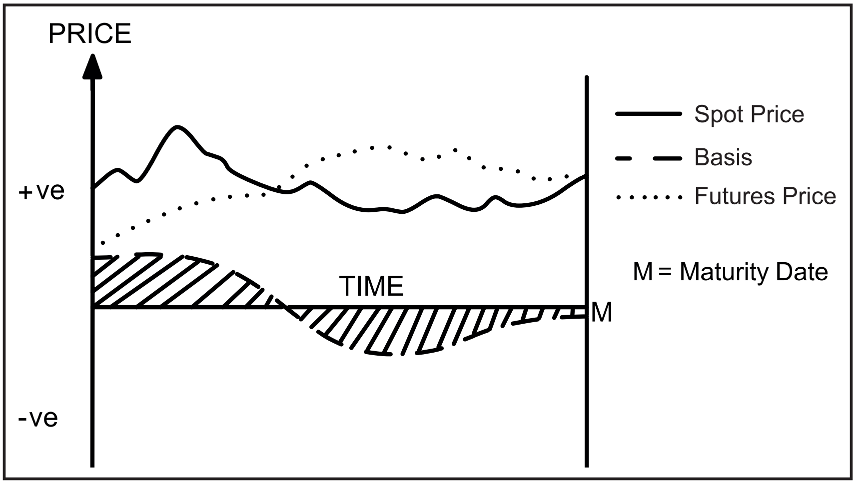
Figure 4.4: Backwardation turning to contango



(The figure shows an irregular spread pattern typical of a market which has received an exogenous shock in between,e.g., imposition of export controls during a period of shortage which suddenly makes domestic supply more abundant. Nevertheless, the basis diminishes to nil at maturity. Such irregular spread patterns can lead to perverse or risk-enhancing hedging returns for hedges lifted prior to maturity.)

Closing spreads may exist, however, where the spot market variety is different from the deliverable variety in the futures market. In a futures market, there is usually a 'deliverable variety' or 'contract grade';[16] other specified varieties can also be delivered but a premium or discount known as tendering difference is charged to reflect the quality difference. Such spreads are generally stable and predictable, and thus do not materially affect hedgers since they can be planned for. They do not vitiate the inherent principle that:

- on the maturity date, the spot and futures price of the same variety must be equal; and
- spot and futures prices converge over the life of a contract.

16 This may sometimes be called the 'basis grade' which should not be confused with the meaning of 'basis' as a price spread.

Hedging bias

Several early empirical studies showed that short hedgers earned lower returns than long hedgers. Such a result would be consistent with the theory of normal backwardation which postulated that futures prices had a downward bias. There is, however, a much more basic factor at work.

It was seen earlier, that there is an asymmetry between positive and negative spreads. Positive spreads (negative basis) have an upper limit, but there is no lower limit for negative spreads (positive basis). It was also seen that spreads tend to narrow over time. The existence of an asymmetry together with an inherent tendency for spreads to narrow, leads to a corresponding asymmetry in outcomes for short and long hedging. The link between the asymmetry in spreads and the effects thereof on hedging returns was initially identified by Houthakker, but he did not build the convergence tendency into this theory. A clear enunciation of what can be called the theory of inherent hedging bias, was made by M. G. Pavaskar.[17] He showed that futures markets are inherently biased against short hedgers, and that the bias is based on the asymmetry of the spreads. Subsequent research by Somanathan confirmed the inherent bias, but showed that the extent of the bias was less than originally propounded by Pavaskar. This resulted in the modified theory of inherent bias.[18] Based on the modified theory of inherent bias, the extent of *a priori* hedging bias in futures markets is summarised in Table 4.2.

Table 4.3: Hedging returns for long and short hedgers

Long hedgers	**Short hedgers**
Over the long-term, on the average:	Over the long-term, on the average:
(a) Spot market losses will be fully, or more than fully, compensated for by the futures market.	(a) Spot market losses will be partially, or at best fully, compensated for by the futures market.
(b) Spot market gains will be partially, or at worst fully, offset by the futures market.	(b) Spot market gains will be fully, or more than fully, offset by the futures market.

17 M. G. Pavaskar, *Economics of Hedging,* Asia Publishing House, Bombay, 1976, 16–18.

18 T. V. Somanathan, *Commodity and Financial Futures Markets: An Economic Analysis,* Unpublished Ph D Dissertation, Calcutta University, Calcutta, 1993.

Table 4.2 covers only the long-term scenario. A more comprehensive description of all possible scenarios of hedges in the deliverable variety on any futures market[19] is as follows:[20]

Individual hedges

a. Net return on long hedging cannot be negative if the hedge is held until maturity.

b. Net return on short hedging cannot be positive if the hedge is held until maturity.

c. Both long and short hedging may have positive or negative (or nil) net return, if hedges are lifted prior to maturity; the outcome depends on the nature of price-spread movements in each individual case.

d. Net return on long hedging cannot be negative when price spread decreases uniformly over time.

e. Net return on short hedging cannot be positive when price spread decreases uniformly over time.

Long term[21]

f. In the long-term, return on long hedging cannot be negative.

g. In the long-term, return on short hedging cannot be positive.

h. In the long-term, long hedgers:

- will be fully compensated or over-compensated by the futures market for adverse spot market price risks; and
- will have favourable risks partially or, at worst, fully offset by the futures market.

i. In the long-term, short hedgers:

- will be partially or, at best, fully compensated by the futures market for adverse spot market price risks; and

19 T. V. Somanathan, *ibid.*

20 This analysis holds for any market where carrying costs are positive.

21 The expression 'long-term' in this context signifies, at any given time, an average or aggregate computed over a period longer than the remaining duration of all currently traded futures contracts.

- will have favourable spot market price risks fully or more than fully offset by the futures market.

At first sight, the reader may well ask 'why should anyone engage in short hedging when he knows his returns are (generally) going to be negative?' To understand this, one should be clear that the 'return on hedging' referred to is the net return from his cash market and futures market transactions put together and after considering carrying costs. A negative return means the futures market did not fully compensate for the spot risks, but some compensation is better than none if one is seeking to reduce risk.

Appendix 4.1 presents a series of case studies which illustrate hedging in commodity markets and also illustrate the operation of the factors described above.

Liquidity and depth

In the context of markets, liquidity is the ability for a buyer or seller to carry out the purchase or sale that they intend to engage in, very quickly or instantaneously. A liquid market is one where a counterparty (i.e., seller to the buyer, buyer to the seller) is readily available. An illiquid market is one where a person wishing to trade does not find a counterparty at the prevailing market price immediately or readily. Depth is a related concept – a deep market is one which is not only liquid but has high trading volumes so that even large transactions can be done quickly. An exchange may allow trading in several different maturities for one particular underlying. However, not all of them may be liquid.

Roll over and attendant risks

When hedging through a futures contract, the maturity date of the futures contract may not exactly match the needs of the hedger. Also, though the period for which the hedge is needed is, say, seven months, the futures contracts which are liquid and easy to trade may be of only three months maturity. In these and similar situations, a hedger may have to first enter into a hedge in one futures contract and then close that hedge while simultaneously entering a new hedge in a contract with longer maturity. The process of rollover may however involve certain transaction costs (brokerage fees and taxes, for instance) and in addition, there may be a change in the basis when rolling over. Hedgers have to weigh these factors when deciding on which futures contract to choose.

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Cross-hedging

Often a futures market is used for cross-hedging, i.e., hedging one good or instrument by trading in another related but different good or instrument. For instance, one can hedge platinum prices through trading in gold futures, since the prices of platinum and gold are closely (though not fully) correlated. A holding of corporate debentures may be hedged using the gilt futures market. A holding of one company's shares may be hedged by using a futures contract on a broad stock market index or on another company's shares. Such cross-hedges are often necessary because a liquid futures contract corresponding exactly to the risk being hedged may not exist. (A liquid market is one where buyers and sellers are readily available for large volumes of trades.) However, cross hedges face the risk that the previously observed correlation between the two markets may not actually hold in the future.

Equivalency or hedge ratio

When a futures market in one underlying is used to hedge a different (albeit, correlated) underlying, there is always some residual risk. A cross hedge may not exactly offset the spot market risk. Nevertheless, the expectation is that the cross hedge,while not eliminating the risk,will reduce it.

The futures contract may fluctuate more or less than the spot exposure being hedged. Therefore, it becomes necessary to either increase or decrease the quantity of futures hedged vis-à-vis the quantity involved in the spot market, in order to achieve as close a hedge as possible. The number of futures contracts needed to hedge a single lot of the item being hedged is called the equivalency or hedge ratio. A commonly used method of calculating the ideal or 'optimal hedge ratio' is based on the assumption that the volatility of the hedged asset should be as low as possible (a perfect hedge would mean no volatility). To do this it is necessary to know the extent to which the futures contract is correlated with the spot (the correlation coefficient) and the respective volatilities (tendencies to fluctuate) of the two assets. In simple terms, the equivalency or hedge ratio can in most cases be derived from the following formula:

$$h = \frac{\text{SD of changes in the cash market price of the asset being hedged}}{\text{SD of changes in the futures price}} \times r$$

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Where,

h = optimal hedge ratio

SD = standard deviation for a given period

r = correlation coefficient between the SD of the changes in spot price of commodity and SD of the change in futures price

The hedge or equivalency ratio calculated in this manner is called the 'minimum variance hedge ratio' since it tries to achieve the minimum variance in the value of the hedged asset (i.e., spot plus futures combined). However, the data required to use this generic formula may often not be available. It should also be noted that, even when available, the information on correlation and standard deviation based on past trends may not accurately reflect what may happen in the future. Thus, such calculations are not fool-proof in ensuring an appropriate cross hedge.

Basis risk in cross hedging

The concept of basis risk was introduced earlier in this chapter – it is the risk that the price spread (basis) may change in an unexpected way. When comparing the spot price of a commodity with the futures price of the same commodity, the normal pattern or expectation is that the basis will diminish over time to nil. If the closing basis is not zero, it would be because the varieties delivered against the contract may be different from the variety used for calculating the spot price.

Basis risk is a bigger issue when cross-hedging. It should be noted that when cross-hedging, the basis is: Spot price of the item being hedged − Future/forward price of the contract used for hedging.

Thus, it is the spot price of one thing minus the futures price of another thing (e.g., spot price of palladium vs. futures price of gold or spot price of Reliance Petroleum vs. futures price of Reliance Industries or the spot price of petrol versus the futures price of crude oil). In such a case, the basis exists permanently and it does not become zero on the date of maturity of the futures contract. The basis in this case has two parts – a part related to carrying costs or expectations in the futures contract itself and a part related to the price difference between the underlying in the futures and the underlying being held in the cash market.

Appendix 4.1

Case studies in hedging through commodity futures

N.B.

1. All the case studies are on the turmeric futures market. In order to enable the reader to connect and compare the different scenarios, it is preferable that all the cases deal with the same market. A commodity has been used because examples involving financial futures have added complications, e.g., dividend yields, interest payments etc. which would obscure the essential features that the cases are intended to illustrate.
2. The case studies are hypothetical as also the prices and figures of carrying cost used therein and should not be construed as an indication of the prevailing level of prices or costs.

Series I

A: Hedges Held to Maturity

Case Study 1: F_0-R_0 < C_m*

On 1 May, turmeric prices at Sangli are as follows:

	₹ per quintal
Spot	9,250
Futures (July)	9,400

Storage costs of one quintal from 1 May up to delivery date (15 July) are estimated at ₹ 250 (i.e., ₹ 100 per month). On 15 July, both spot and futures are trading at ₹ 9,100. Mr. Long enters into the following transactions:

1 May: Sell small lots aggregating to one quintal to various retailers at a fixed price, of ₹ 9,500 per quintal for actual delivery in July.

1 May: Buy one quintal July futures at ₹ 9,400

15 July: Buy one quintal spot at ₹ 9,100

15 July: Sell one quintal July futures at ₹ 9,100

The financial outcome of this sequence of transactions is summarised in the following table:

* C_m denotes carrying cost to maturity. Fo/Ro and Fn/Rn denote futures and ready prices at time 0 and time n, respectively.

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Exhibit 1(a)
Mr Long: Return from Holding Hedged Commitment

Transaction	Spot market		Future market	
	Date	Price (₹)	Date	Price (₹)
Sell	1/5	9,500	15/7	9,100
Buy	15/7	9,100	1/5	9,400
Gain/(Loss)		400		(300)
Net return (₹)				100

During the same period, Mr. Short carried out the following transactions:*

1 May: Buy one quintal spot at ₹ 9,250**

1 May: Sell one quintal July futures at ₹ 9,400

15 July: Buy one quintal July futures at ₹ 9,100

15 July: Sell one quintal spot at ₹ 9,100

* In practice, forward sales/purchase by long/short hedgers might be made in small instalments at different points of time, with the aggregate being hedged on a particular day. Also, it is not necessary that there is an actual spot market 'sale' or 'purchase' behind every long or short hedge; hedging may be undertaken merely to 'lock in' a particular price, based on which other economic transactions are undertaken. For instance, a farmer would hedge (as a short hedger) without 'buying' on the spot market--- his hedge would be against his anticipated crop of the commodity: the hedge would be placed to ensure that his income from the crop does not fall below that indicated by the current market price. In order to avoid obfuscating the basic theoretical issues, such complications have been ignored in the Case Studies, in which each long/short hedge is placed against an actual spot market sale/purchase.

** In real life the market lot is 50 quintals. One quintal is used here purely to simplify the illustration.

Exhibit 1(b)
Mr. Short: Return from Holding Hedged Stocks

Transaction	Spot market		Future market	
	Date	Price (₹)	Date	Price (₹)
Sell	15/7	9,100	1/5	9,400
Buy	1/5	9,250	15/7	9,100
		(150)		300
Pay Storage Cost	15/7	(250)		
Gain (Loss)		(400)		300
Net Return (₹)			(100)	

A comparison of Exhibits 1(a) and 1(b) shows that Mr. Long obtained a positive return of ₹ 100 while Mr. Short lost ₹ 100. To put it differently, the futures market did not fully offset Mr. Long's spot market gain; correspondingly it did not fully compensate Mr. Short for his spot market loss.

Case Study 2: F_0 - R_0 = C_m

On 1 June, turmeric prices at Sangli are quoted as follows:

	₹ per quintal
Spot	9,600
Futures (July)	9,750

Storage cost of one quintal from 1 June till 15 July (maturity date) is estimated at ₹ 150. On 15 July, as already described earlier, the price is ₹ 9,100.

Mr. Long has the following transactions:

1 June: Sell one quintal for actual delivery in July at ₹ 9,750

1 June: Buy one quintal July futures at ₹ 9,750

15 July: Sell one quintal July futures at ₹ 9,100

15 July: Buy one quintal spot at ₹ 9,100

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Exhibit 2(a)
Mr. Long: Return from Holding Hedged Commitment

Transaction	Spot market		Future market	
	Date	Price (₹)	Date	Price (₹)
Sell	1/6	9,750	15/7	9,100
Buy	15/7	9,100	1/6	9,750
Gain (Loss)		650		(650)
Net Return (₹)			NIL	

Mr. Short's is transactions are as follows:

1 June: Buy one quintal spot ₹ 9,600

1 June: Sell one quintal July futures at ₹ 9,750

15 July: Buy one quintal July futures at ₹ 9,100

15 July: Sell one quintal spot at ₹ 9,100

Exhibit 2(b)
Mr. Short: Return from Holding Hedged Stocks

Transaction	Spot market		Future market	
	Date	Price (₹)	Date	Price (₹)
Sell	15/7	9,100	1/6	9,750
Buy	1/6	9,600	15/7	9,100
		(500)		650
Pay storage cost	15/7	(150)		
Gain/(Loss)		(650)		650
Net return (₹)			Nil	

Thus, where the price spread exactly equals the carrying cost to maturity, long and short hedgers obtain nil return, or in other words, the futures market exactly offsets the gains/losses in the cash market.

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B: Hedges Lifted Prior to Maturity

Case Study 3

On 15 June, turmeric prices at Sangli are as below:

	₹ per quintal
Spot	9,700
Futures (September)	9,791

Storage cost is estimated at ₹ 100 per mensem. On 15 August, prices are as follows:

	₹ per Quintal
Spot	9,200
Futures (September)	9,260

Mr. Long undertakes the following transactions:

15 June: Sell one quintal for actual August delivery at ₹ 9,700

15 June: Buy one quintal September futures at ₹ 9,791

15 August: Sell one quintal September futures at ₹ 9,260

15 August: Buy one quintal spot at ₹ 9,200

Exhibit 3(a)

Mr. Long: Return from Holding Hedged Commitment

Transaction	Spot market		Future market	
	Date	Price (₹)	Date	Price (₹)
Sell	15/6	9,700	15/8	9,260
Buy	15/8	9,200	15/6	9,791
Gain (Loss)		500		(531)
Net Return (₹)			(31)	

Mr. Short's transactions are as follows:

15 June: Buy one quintal spot at ₹ 9,500

15 June: Sell one quintal September futures at ₹ 9,791.

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15 August: Buy one quintal September futures at ₹ 9,260
15 August: Sell one quintal spot at ₹ 9,200

Exhibit 3(b)
Mr. Short: Return from Holding Hedged Stocks

Transaction	Spot market		Future market	
	Date	Price (₹)	Date	Price (₹)
Sell	15/8	9,200	15/6	9,791
Buy	15/6	9,500	15/8	9,260
		(300)		531
Pay Storage Cost	15/8	(200)		
Gain/(Loss)		(500)		531
Net Return (₹)			31	

In the above transaction, Mr. Short was over-compensated by the futures market for his spot market loss; Mr. Long lost more on the futures market than he gained on the spot. It should be noted that this Case Study brings out clearly the fact that a short hedger can earn a positive return. This result has come about without violating the condition at any time:

$$F_n - R_n \leq C_m$$

as 7,790 - 7,500 < 300 (storage cost for three months 15/6 to 15/9) and 7,260 - 7,200 < 100 (storage cost for one month from 15/8 - 15/9)

Case Study 4

On 30 June, turmeric prices at Sangli are as below:

	₹ per Quintal
Spot	9,600
Futures (September - matures on 15/9)	9,830

Carrying cost is estimated at ₹ 100 per mensem. On 30 August, prices are as follows:

	₹ per quintal
Spot	9,250
Futures (September)	9,300

Mr. Long's transactions are as follows:

30 June: Sell one quintal for actual August delivery at (fixed price) ₹ 9,800

30 June: Buy one quintal futures at ₹ 9,830

30 August: Sell one quintal futures at ₹ 9,300

30 August: Buy one quintal spot at ₹ 9,250

Exhibit 4(a)

Mr. Long: Return from Holding Hedged Commitment

Transaction	Spot market		Future market	
	Date	Price (₹)	Date	Price (₹)
Sell	30/6	9,800	30/8	9,300
Buy	30/8	9,250	30/6	9,830
Gain/(Loss)		550		(530)
Net return (₹)			20	

Mr. Short's dealings are as follows:

30 June: Buy one quintal spot at ₹ 9,600

30 June: Sell one quintal September futures at ₹ 9,830

30 August: Buy one quintal September futures at ₹ 9,300

30 Augus: Sell one quintal spot at ₹ 9,250

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Exhibit 4(b)

Mr. Short: Return from Holding Hedged Stocks

Transaction	Spot Market		Future Market	
	Date	Price (₹)	Date	Price (₹)
Sell	30/8	9,250	30/6	9,830
Buy	30/6	9,600	30/8	9,300
		(350)		530
Pay storage cost	30/8	(200)		
Gain/(Loss)		(550)		530
Net Return (₹)			(20)	

This case study ends up with a result opposite to that in case study 3, the long hedger gains while the short hedger losses.

C. Uniform Decline in Price Spreads

(Note: The term 'uniform decline in price spread' is used to mean that the spread exhibited by the futures market declines by equal instalments in equal internals of time, in such a way that the spread on the maturity date is nil. For instance, three months before maturity date, spot and futures turmeric might be trading at ₹ 8,000 and ₹ 8,150 respectively. For uniform decline, every month the spread should diminish by ₹ 50. Thus when there are two months left to maturity the spread would be ₹ 100, when one-and-a-half months are left it would be ₹ 75 and so on).

Case Study 5

Assume all details as in Case Study 3 supra, except that, on 15 August prices are as follows:

Spot	₹ 9,200
Futures	₹ 9,297

The price spread between spot and futures has declined to ₹ 97 when a month remains. In the two months which have elapsed, the spread has decreased by ₹ 194, which gives a rate of decline of ₹ 97 per month.)

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Exhibit 5(a)
Mr. Long: Return from Holding Hedged Commitment

Transaction	Spot Market		Future Market	
	Date	Price (₹)	Date	Price (₹)
Sell	15/6	9,700	15/8	9,297
Buy	15/8	9,200	15/6	9,791
		500		(494)
Net Return (₹)			6	

Exhibit 5(b)
Mr. Short: Return from Holding Hedged Stocks

Transaction	Spot Market		Future Market	
	Date	Price (₹)	Date	Price (₹)
Sell	15/8	9,200	15/6	9,791
Buy	15/6	9,500	15/8	9,297
		(300)		494
Pay Storage Cost	15/8	(200)		
Gain/(Loss)		(500)		494
Nett Return (₹)			(6)	

Despite the fact that the spread at the time of placing the hedges was identical to that in case study 3, it is found that in this instance Mr. Long makes a small gain while Mr. Short makes a small loss. The difference between this case and Case Study 3 is that the price spread decreased uniformly over time.

Series II

Case Study 6

Assume all the facts and transactions as in Case Study 3; in that instance Mr. Short earned a positive return, while Mr. Long had a corresponding negative

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return. That transaction (referred to as the 1st Hedge) was immediately followed by another set of hedge transactions (2nd Hedge), which were completed only on the maturity date, 15 September. Prices were as follows:

		₹ per quintal
15 August:	Spot	9,200
	Futures (September)	9,260
	[As in Case Study 3]	
15 September:	Spot	9,100
	Futures	9,100

The transactions undertaken on the 2nd hedge were as follows:

Mr. Long

15 August: Sell one quintal for actual September delivery at fixed rate of ₹ 9,300

15 August: Buy one quintal September futures at ₹ 9,260

15 September: Sell one quintal September futures at ₹ 9,100

15 September: Buy one quintal spot at ₹ 9,100

Exhibit 6(a)

Mr. Long: Return from Holding Hedged Commitment (2nd Hedge)

Transaction	Spot Market		Future Market	
	Date	Price (₹)	Dat	Price (₹)
Sell	15/8	9,300	15/9	9,100
Buy	15/9	9,100	15/8	9,260
Gain/(Loss)		200		(160)
Net. Return (₹)			40	

Mr. Short

15 August: Buy one quintal spot at ₹ 9,200

15 August: Sell one quintal September futures at ₹ 9,260

15 September: Buy one quintal September futures at ₹ 9,100

15 September: Sell one quintal spot at ₹ 9,100

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Exhibit 6(b)
Mr. Short: Return from Holding Hedged Stocks (2nd Hedge)

Transaction	Spot Market		Future Market	
	Date	Price (₹)	Date	Price (₹)
Sell	15/9	9,100	15/8	9,260
Buy	15/8	9,200	15/9	9,100
		(100)		160
Pay Carrying Cost	15/9	(100)		
Gain/(Loss)		(200)		160
Net Return (₹)			(40)	

It can be seen that the 2nd hedge has yielded a gain of ₹ 40 to Mr. Long with a ₹ 40 loss to Mr. Short. Considering the results of the 1st and 2nd hedges together:

		₹
Mr. Long:	1st Hedge - Loss	(31)
	2nd Hedge - Gain	40
	Net Gain	**9**
Mr. Short: 1st Hedge - Gain		31
	2nd Hedge - Loss	(40)
	Net Loss	(9)

In spite of the 1st hedge having yielded positive return to short hedgers, this has been wiped out by the 2nd hedge which was held to maturity. The 1st hedge had a negative spot market price risk of:

$$R_t - R_0 - C = ₹\ (9{,}200 - 9{,}500 - 200) = ₹\ 500\ (\text{-ve})$$

This represented a gain to short hedgers and a loss to long hedgers. The futures market compensated for this by a price change of:

$$F_o - F_o = ₹\ (9{,}260 - 9{,}791) = ₹\ 531\ (\text{-ve})$$

In short, the futures market over-compensated for the spot market price risk. On this occasion, this benefitted Mr. Short at the expense of Mr. Long.

The 2nd hedge also had a downward (negative) price risk of:

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This was compensated for by the futures market by a price movement of

₹ (9,100 - 9,260) = ₹ 160 (-ve)

On this occasion the futures market under-compensated for the spot market price risk, thereby benefitting Mr. Long to the detriment of Mr. Short.

Considering the two hedges together:

Combined (downward) spot market price risk

= ₹ (9,100 - 9,500 - 300) = - ₹ 700

Futures market price change

= ₹ (9,100 - 9,791) = - ₹ 691

Percentage compensation

= -691/-700 = 98.7 per cent

This case study illustrates the fact that, over the long-term, downward price risks will be compensated for by 100 per cent or less, but not more.

Case Study 7

On 15 January, turmeric prices were as follows:

	₹ per quintal
Spot	8,100
Futures (March)	8,290

Storage costs of turmeric are ₹ 100 per mensem per quintal. On 15 February and 15 March (delivery date), prices are as follows:

	₹ per quintal
15 February: Spot	8,300
Futures (March)	8,250
15 March: Spot	8,500
Futures (March)	8,500

Mr. Long's transactions are as follows:

1st Hedge:

15 January: Sell one quintal for actual February delivery at ₹ 8,200

15 January: Buy one quintal March futures at ₹ 8,290

2nd Hedge:

15 February: Sell one quintal for actual March delivery at ₹ 8,400

15 February: Buy one quintal March futures at ₹ 8,250

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15 March: Sell one quintal March futures at ₹ 8,500
15 March: Buy one quintal spot ₹ 8,500

Exhibit 7(a)
Mr. Long: Return from Holding Hedged Commitments

Transaction	Spot Market		Future Market	
	Date	Price (₹)	Date	Price (₹)
1st Hedge				
Sell	15/1	8,200	15/2	8,250
Buy	15/2	8,300	15/1	8,290
Gain/(Loss)		(100)		(40)
2nd Hedge				
Sell	15/2	8,400	15/3	8,500
Buy	15/3	8,500	15/2	8,250
Gain/(Loss)		(100)		250
Net Returns:				
1st Hedge	₹ (140)			
2nd Hedge	₹ 150			
Total	₹ 10			

Mr. Short's transactions were as follows:

1st Hedge

15 January: Buy one quintal spot at ₹ 8,100
15 January: Sell one quintal March at ₹ 8,290
15 February: Buy one quintal March at ₹ 8,250
15 February: Sell one quintal spot at ₹ 8,300

2nd Hedge

15 February: Buy one quintal spot at ₹ 8,300
15 February: Sell one quintal March at ₹ 8,250
15 March: Buy one quintal March at ₹ 8,500
15 March: Sell one quintal spot at ₹ 8,500

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Exhibit 7(b)
Mr. Short: Return from Holding Hedged Stocks

Transaction	Spot Market		Future Market	
	Date	Price (₹)	Date	Price (₹)
1st Hedge				
Sell	15/2	8,300	15/1	8,290
Buy	15/1	8,100	15/2	8,250
		200		40
Pay Carrying Cost	15/2	(100)		
Gain/(Loss)		100		40
2nd Hedge				
Sell	15/3	8,500	15/2	8,250
Buy	15/2	8,300	15/3	8,500
		200		(250)
Pay Carrying Cost	15/2	(100)		
Gain / (Loss)		100		(250)
Net Returns (₹)	1st Hedge	140		
	2nd Hedge	(150)		
	Total	(10)		

This case study is an example of positive (upward) price risk. Although the 1st hedge gave positive return to Mr. Short, this was wiped out by the 2nd hedge. Mr. Long lost in the 1st hedge but more than recouped his loss in the 2nd hedge. The 1st hedge had a spot market price risk of

$$R_1 - R_0 - C = ₹\ (8{,}300 - 8{,}100 - 100) = ₹\ 100\ (+ve)$$

However, the futures market exihbibited a negative price change:

$$F_1 - F_0 = ₹\ (8{,}250 - 8{,}290) = ₹\ (40)\ (-ve)$$

Thus, short hedgers had their spot market gains increased by the futures market, while losses of long hedgers were exacerbated the futures market.

The 2nd hedge had a spot market risk of

$$₹\ (8{,}500 - 8{,}300 - 100) = ₹\ 100\ (+ve)$$

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This represented a gain to short hedgers and a loss to long hedgers. The futures market offset this by a price change of

₹ (8,500 - 8,250) = ₹ 250 (+ve)

Considering the two hedges together:
Combined (upward) spot market price risk

= ₹ (8,500 - 8,100 - 200) = ₹ 200 (+ve)

Futures market price change

= ₹ (8,500 - 8,290) = ₹ 210 (+ve)

Percentage compensation = (210/200) = 105 per cent

This case study illustrates the fact that upward price risks (adjusted for carrying costs) will, over the long-term, be compensated for by 100 per cent or more, but not less.

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