6 FUTURES CONTRACTS ON PHYSICAL COMMODITIES

Organized futures markets began in response to the risks associated with the marketing of seasonal commodities such as wheat and corn. Farmers would enter into forward contracts with users to dispose of their harvests, and futures markets arose to provide users and farmers a financial instrument to hedge risks while forward contracts were being negotiated. The principal U.S. futures markets are in Chicago because, at one time, Chicago was the key location for grain elevators and the transportation point for shipments to the East. Today, futures contracts are traded not only on seasonal agricultural products, but also on other real commodities such as metals and various industrial materials. The greatest expansion in futures trading has occurred in the 1970s and 1980s with the advent of financial futures.

This chapter focuses on physical commodities. We begin with a discussion of why futures markets arise in certain physical commodities and not in others. We then focus on the seasonal patterns of inventories and prices, on hedging by storers and producers, on the behavior of the basis, on returns to speculators and other issues.

6.1 FUTURES CONTRACTS ON PHYSICAL COMMODITIES

The most actively traded futures contracts on physical commodities are listed in Table 6.1 by major category—grains and oil seeds, livestock, food and fiber, metals, and petroleum. The oldest futures contracts are those for the grains, which began trading in 1859. The livestock contracts date to the 1960s. The most recent additions to the list are the petroleum products. Crude oil and heating oil began trading in the 1970s and gasoline futures began in 1981.

TABLE 6.1 Physical commodity futures contracts specifications (most active contracts in U.S. markets).

Commodity (Exchange)	Trading Hours	Contract Months[a]	Units/ Minimum Price Change	Last Day of Trading
Grains and Oil Seeds				
Corn (CBT)	9:30–1:15 (CST)	12,3,5,7,9	5,000 bushels/ 1/4($12.50)	7 business days before last business day of month
Oats (CBT)	9:30–1:15 (CST)	12,3,5,7,9	5,000 bushels/ 1/4($12.50)	7 business days before last business day of month
Soybeans (CBT)	9:30–1:15 (CST)	9,11,1,3,5, 7,8	5,000 bushels/ 1/4($12.50)	7 business days before last business day of month
Soybean meal (CBT)	9:30–1:15 (CST)	1,3,5,7,8, 9,10,12	100 tons 10($10)	7 business days before last business day of month
Soybean oil (CBT)	9:30–1:15 (CST)	1,3,5,7,8, 9,10,12	60,000 pounds $0.0001($6)	7 business days before last business day of month
Wheat (CBT)	9:30–1:15 (CST)	7,9,12,3,5	5,000 bushels 1/4($12.50)	7 business days before last business day of month

a. The notation used in this column corresponds to the month of the calendar year (e.g., 1 is January, 2 is February, and so on).

TABLE 6.1

Livestock				
Live cattle (CME)	9:05-1:00 (CST)	2,4,6,8,9, 10,12	40,000 pounds $0.00025($10)	20th calendar day of contract month
Hogs (CME)	9:10–1:00 (CST)	2,4,6,7,8, 10,12	30,000 pounds $0.00025($7.50)	20th calendar day of contract month
Pork bellies (CME)	9:10–1:00 (CST)	2,3,5,7,8	40,000 pounds $0.00025($10)	business day before last 5 business days of contract month
Food and Fiber				
Cocoa (CSCE)	9:30–2:15 (EST)	12,3,5,7,9	10 metric tons $1($10)	
Coffee (CSCE)	9:15-1:58 (EST)	3,5,7,9,12	37,500 pounds $0.0001($3.75)	
Sugar(world) (CSCE)	10:00–1:43 (EST)	1,3,5,7,10	112,000 pounds $0.0001($11.20)	last business day of month preceding delivery month
Cotton (CTN)	10:30–3:00 (EST)	current + 17 suc.	50,000 pounds $0.0001($5)	
Orange juice (CTN)	10:15-2:45 (EST)	1,3,5,7,9, 11	15,000 pounds $0.0005($7.50)	

continued

TABLE 6.1

Commodity (Exchange)	Trading Hours	Contract Months[a]	Units/ Minimum Price Change	Last Day of Trading
Metals				
Copper (CMX)	9:25-2:00 (EST)	1,3,5,7,9, 12,1,3,5,7, 9,12+ cur.3	25,000 pounds $0.0005($12.50)	3rd to last business day of maturing delivery month
Gold (CMX)	8:20–2:30 (EST)	2,4,6,8,10, 12,cur.+ 2	100 troy ounces 10 cents($10)	
Platinum (NYM)	8:20–2:30 (EST)	1,4,7,10 incl.cur.3	50 troy ounces 10 cents($5)	
Silver (CMX)	8:25-2:25 (EST)	1,3,5,7,9, 12,cur.+ 2	5,000 troy ounces 1/10 cent($5)	
Petroleum				
Crude oil (NYM)	9:45-3:10 (EST)	18 cons.mos. begin w/cur.	1,000 barrels 1 cent($10)	
Heating oil (NYM)	9:50–3:10 (EST)	15 cons.mos. begin w/cur.	42,000 US gal. $0.0001	
Gasoline (NYM)	9:50–3:10 (EST)	15 cons.mos. begin w/cur.	42,000 US gal. $0.0001	

Source: Various futures exchange publications.

Futures contracts on physical commodities call for delivery at the option of the short sometime in the delivery month. The first day on which delivery may be made is the first notice day. In many commodities, the long that receives a notice of delivery has the opportunity to sell his futures contract and redeliver the notice; but once futures trading is ended, all outstanding longs have no choice other than taking delivery. In practice, only a small fraction of the futures contracts entered into ever results in delivery.

The trading activity in various futures contracts varies as customer needs change and as competing contracts arise. At the end of 1989, 121 futures contracts on physical commodities were approved by the CFTC.[1] Some of these have never

[1]Commodity Futures Trading Commission *Annual Report 1989.*

been successful. Some had once been successful and are now dormant. Others are traded but are very inactive. We turn now to the factors that give rise to futures markets in physical commodities and that determine their success or failure.

6.2 WHY DO FUTURES MARKETS IN PHYSICAL COMMODITIES ARISE?

Uncertainty

Since the principal purpose of futures markets is to hedge risks, futures markets do not arise if the price of the commodity is not uncertain. If agricultural price supports determine the price of wheat, no wheat futures market will arise. Currency futures would not exist in a system of fixed exchange rates. Coffee futures trading dies out when the international coffee cartel "stabilizes" the price of coffee at a fixed level. Uncertainty about prices arises from uncertainty about the supply of commodities and uncertainty about the demand for commodities. The relative amount of supply side and demand side uncertainty varies by commodity type.

Even though most seasonally produced agricultural commodities are grown during some part of the year around the world, supply is uncertain because the size of harvest is greatly affected by weather conditions. On the other hand, overall demand for most agricultural foodstuffs and oils is reasonably stable since final consumption patterns do not change dramatically from period to period. Demand uncertainty may arise, however, even after a crop is harvested because the supply of a substitute commodity may be uncertain. A bumper harvest of corn, for example, can adversely affect the price of wheat.

Commodities in continuous production—such as petroleum, gas, lumber, and certain metals—face uncertainty from both the demand side and the supply side. Strikes and unexpected increases in costs affect the supply. At the same time, demand uncertainty is greater than in the agricultural commodities because the commodities in continuous production tend to be industrial materials that are subject to the business cycle.

A few physical commodities, namely gold and silver, are in nearly fixed supply in the sense that the outstanding stock of these commodities is large relative to annual production. As a result, price uncertainty arises primarily from the demand side. Gold is like many financial instruments that are also in nearly fixed supply. The prices of gold and of financial instruments depend on interest rates, inflation, and other macroeconomic factors.

Large and Competitive Market

Futures markets do not succeed if the market for the underlying commodity is small, because there is insufficient futures trading to maintain market liquidity. Furthermore, Telser and Higgonbotham (1977, p. 998) make the point that "an organized futures market facilitates trade among strangers." In small markets, producers and users of the commodity find it preferable to deal directly with each other rather than have someone incur the expense of setting up a futures market.

A liquid futures market arises only if the market in the underlying commodity is one in which a large number of units of a standard commodity are available. The automobile market is large, but the units are not standard. Commodity futures markets arise only for commodities that can be standardized and thus easily traded. For some commodities, such as gold, standardization is easy to achieve. For others, standardization is more difficult. For example, standardizing live cattle (traded on the CME) requires a complex contract specification. Even commodities like corn and wheat have a considerable range of grades. As we noted in Chapter 2, futures contracts are designed to allow delivery of a variety of grades at a variety of delivery points so that the danger of a corner is limited, but broadening the definition of the commodity in this way reduces its standardization. The success of the market depends on the degree to which the various grades of the commodity are correlated. A market is large if the prices of a large number of units are strongly correlated with the price of the futures contract.

Futures contracts are unlikely to succeed in non-competitive markets where production of the underlying commodity is monopolized or where buyers of the commodity are few. In such markets, the danger is too great that the cash price can be manipulated to produce artificial gains on the futures contract (as in a corner). At the same time, futures markets can enhance competition in a market that is not fully competitive. For example, crude oil futures trading gives users the opportunity to lock in the future price of oil without negotiating long term contracts with producers. The futures market provides an alternative to dealing directly with the producer. As a result, the producer is compelled to sell in the cash market where he loses control of the supply. For this reason, producers often oppose introduction of futures markets. The most famous example of producer opposition to the introduction of futures markets is the opposition by onion growers to the introduction of onion futures, which resulted in a congressional ban against onion futures trading in 1958.

Storability and Deliverability

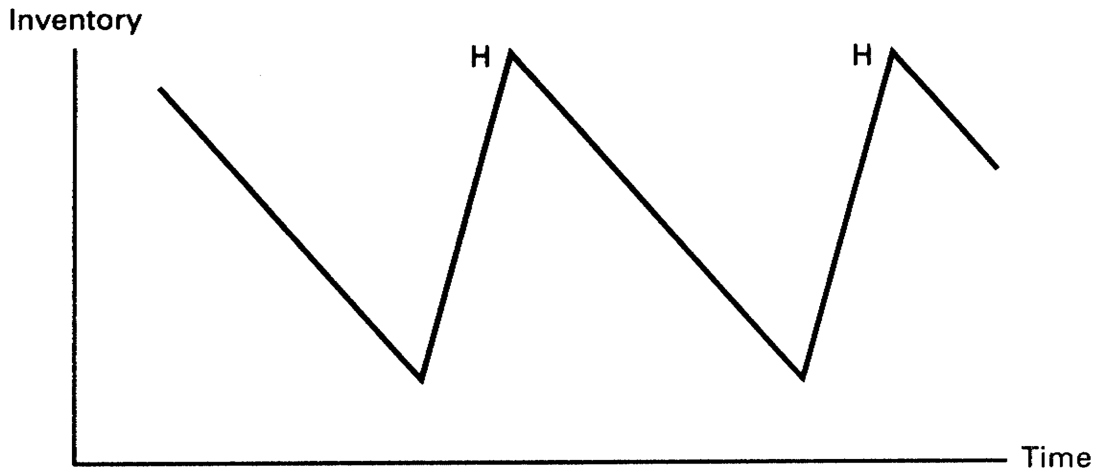
Physical commodities on which futures contracts are written are storable either directly or indirectly. Storability has usually been considered a necessity for a successful futures contract on the grounds that the contract calls for delivery of the commodity at a later date, and delivery can only be made if the commodity can be carried over to the delivery date. If the commodity can be produced for delivery, however, storability would not seem necessary. Thus, a futures contract on fresh eggs exists, yet eggs are clearly not storable in the usual sense. Deliverability is not a problem because future availability of the eggs can be assured by having the chickens. The eggs are stored indirectly, as it were, in the chickens. Similarly, live cattle are not storable in the usual sense; yet they clearly can be stored (and fed) for later delivery. Thus, in this broader sense, the requirement of storability and deliverability are met by all physical commodities.

6.3 INVENTORY AND PRICE PATTERNS

Commodities in Seasonal Supply

The pattern of inventories of commodities in seasonal supply can be represented by the saw tooth pattern in Figure 6.1. The high points reflect the harvests when

FIGURE 6.1 Seasonal Inventory Pattern in Agricultural Commodities



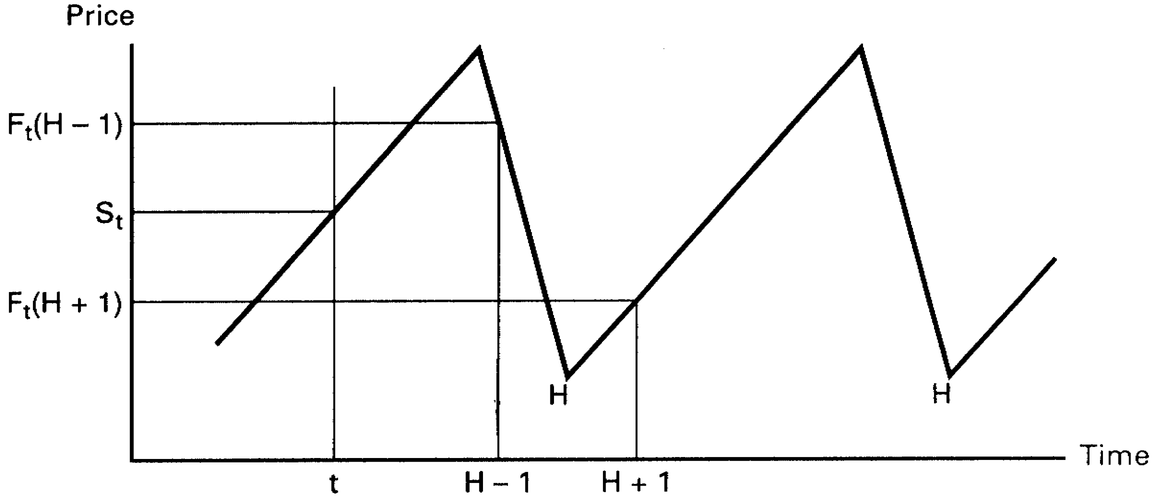
inventories are replenished, and the low points represent the fact that the old crop is used up just before the harvest. The downward sloping line represents the gradual consumption of the commodity out of inventory. Of course, the simple and regular pattern of Figure 6.1 is unrealistic for a number of reasons. First, harvests do not occur all at once but over a period of time. For example, the U.S. harvest of wheat begins in the Southwest in May, when winter wheat planted in the preceding fall is harvested, and continues in the northern states into September, when spring wheat planted in early spring is harvested. The peak inventories in the U.S. usually occur in September. The gradual harvest smooths out the peaks and valleys in the figure. Second, harvest quantities are not the same in each year as is implied by the regularity of the pattern in Figure 6.1. Some years are better than others, with the result that some peaks are higher than others. In some years, the new crop is so small that the old crop is carried over to the next year.

The pattern of the spot price, S, that corresponds to the inventory pattern is shown in Figure 6.2. As might be expected, it is simply the reverse—low prices when inventory is high and high prices when inventory is low. Actual spot prices do not follow this simple stereotype since harvests occur over a period of time. Peaks and troughs in spot prices will be attenuated just as peaks and troughs in inventory are attenuated.

At a time before the harvest, such as t in Figure 6.2, a futures price for a contract maturing at time $H - 1$ just before the harvest and for a contract maturing at a time, $H + 1$, just after the harvest typically exist. These futures prices are forecasts of spot prices at the respective maturities of the two futures contracts. The basis at time t for the futures contract maturing before the end of the old crop year, $F_t(H-1) - S_t$, represents a *carrying charge market* and is typically positive to reflect storage costs. The basis at time t for the futures contract maturing immediately after the new crop, $F_t(H+1) - S_t$, represents an *inverted market* because the new crop is expected to lower prices below the level at time t.

The figures are useful for identifying the three major sources of risk in seasonal commodities. For an individual farmer, the most important risk is quantity

FIGURE 6.2 Seasonal Price Pattern in Agricultural Commodities



risk, that is, risk relating to the size of the crop at the seasonal harvest. Because of the weather and other factors, the farmer does not know the amount of the crop that will be harvested.

The second risk is price risk, which is present not only at the harvest point but also during the rest of the year. Around the harvest, variability of prices reflects uncertainty about the aggregate harvest. Price risk and quantity risk are related. If the aggregate crop is poor, the price will be higher than normal. If the aggregate crop is good, the price will be lower than normal. The farmer whose harvest is representative of the aggregate will find that price and quantity are negatively correlated—a poor crop is associated with higher-than-normal prices, and a good crop is associated with lower-than-normal prices. This negative association collectively mitigates the price and quantity risks. The harvest of each farmer, however, is not perfectly correlated with the aggregate harvest since weather conditions in different parts of the country vary. The farmer who has a poor crop when other farmers have good crops is in particularly bad shape because the price of the crop is low at the same time she has little to sell. Correspondingly, a farmer with a bumper crop profits greatly when other farmers have a poor crop. After the harvest, price risk still remains because demand for the commodity is uncertain. Commodity demand is uncertain because the supply of substitutes is uncertain and because final consumer demand may fluctuate.

Once the harvest is in, the crop is supplied out of storage. As already noted, most of the risk during this part of the cycle comes from the demand side. However, a third source of risk—storage risk—is also present. Storage costs include warehouse rent, the interest cost of funds tied up in the commodity, insurance, labor and handling, and spoilage. Fluctuations in these costs affect the profitability of storage and the price of the commodity in the period between harvests.

Futures markets can be used to hedge commodity price risk, but futures markets are less well suited to hedge quantity risk or storage cost risk. The discussion of hedging that follows, therefore, emphasizes commodity price risk.

Non-Seasonal Commodities

Non-agricultural commodities such as metals and oils are produced continuously. For all except the precious metals, inventories are small relative to consumption and do not fluctuate seasonally as do the inventories of agricultural commodities. Inventories, however, can be quickly depleted if production is interrupted. For example, a copper miners' strike can halt production of copper and cause copper inventories to be depleted. Similarly, restrictions on the production of crude oil by OPEC can deplete petroleum inventories. In such cases, the spot price can be dramatically affected. In the case of the precious metals gold and silver, inventories are large relative to production, and prices are determined mostly by demand factors. Interruption of production of precious metals takes a longer time to affect inventories.

The pattern of prices of natural resources was first analyzed by Hotelling (1931), and most recently, by Miller and Upton (1985). In a world of certainty, the Hotelling Principle states that the profit margin from mining a natural resource—the price of the extracted resource, S_T, net of per unit marginal production costs, C_T—increases at the rate of interest, r^*:

$$(S_T - C_T) = (S_0 - C_0)(1 + r^*), \tag{6.1}$$

where T refers to a future period and 0 refers to the present period.[2] Intuitively, the idea is that the profit margin must increase to cover the cost of funds tied up in the reserves of the natural resource. If the profit margin in the future period, T, is less than the amount specified by (6.1), producers would increase production at time 0 rather than waiting to produce at T. The profit margin could be invested at r^* to yield more at T than if production had been delayed until tomorrow. That action depresses S_0 and lowers the profit margin at time 0 until condition (6.1) is met. Conversely, if the profit margin at T is greater than the amount specified by (6.1), the present value of what the producer could earn tomorrow would exceed today's profit margin. The producer would be better off restricting production today and producing more tomorrow. He could borrow against tomorrow's profit to give a present amount that exceeds the profit margin at time 0. The process of producing more tomorrow depresses S_T until condition (6.1) is again met. In a world with uncertainty, a modified version of the Hotelling Principle continues to hold in which the expected values of $\tilde{S}_T$ and $\tilde{C}_T$ are used and r^* is a risk-adjusted, expected rate of return.

If there is a futures market, (6.1) holds with $\tilde{F}_T$ substituted for $\tilde{S}_T$. With that substitution and some manipulation, (6.1) can be written as

$$\tilde{F}_T = S_0(1 + r^*) + \tilde{C}_T - C_0(1 + r^*). \tag{6.2}$$

[2] Again, we adopt the convention of using an asterisk to denote a rate applied over the futures contract life or the hedge period.

If there are no production costs either in the present or the future, the futures price is above the spot price by the interest cost of the funds tied up in the commodity. This is the same as the cost-of-carry model discussed in Chapter 3. The cost-of-carry model says the futures price on a contract maturing at T exceeds the spot price by the cost of carrying the commodity. In the absence of storage cost other than the interest cost, that means $\tilde{F}_T = S_0(1 + r^*)$. This simple equilibrium is appropriate for a commodity like gold that exists in large quantities in refined form.

Equation (6.2) also shows why the futures price for natural resources may be temporarily below the spot price. This can happen if the current production cost, C_0, is abnormally high, as in the case of a strike or a disruption of supply. In the Kuwait crisis of 1990–91, the spot oil price rose dramatically relative to the futures price, reflecting a rise in C_0 relative to $\tilde{C}_T$. Over time, as current production costs returned to normal, the oil futures price returned to its normal premium over the oil cash price.

6.4 HEDGING COMMODITY PRICE RISK

Storer's Short Hedge

Commodities are often held by storers for resale to users. The storer's hedging decision was analyzed in Chapter 4, and the example of Chapter 4 is repeated in Table 6.2. On September 1, the storer decides to store grain for three months and sell December futures because the three-month basis of nine cents per bushel covers the storage costs of three cents a month. The success of the hedge depends in part on the eligibility of the commodity for delivery against the futures contract. Assume first that the commodity is deliverable. If the position is held to maturity, the storer can simply deliver the grain against the futures contract and lock in a gain of nine cents that covers storage costs. The only risk is that storage costs turn out to be greater than expected. For example, if storage costs turn out to be 3.5 cents per month, the storer makes a loss of 1.5 cents by purchasing the commodity at $3.00 on September 1 and delivering it against the futures contract for $3.09 on December 1. The only way to protect against this risk is to contract forward for storage costs, something that may not always be possible. If all storage costs are locked in before hand, the storer is in the position of having a riskless return (assuming no default risk). In practice, it is unlikely that storers lock in all costs.

Table 6.2 analyzes the outcome of the storer's hedge if the commodity is sold to a customer on November 1, one month before maturity of the futures contract. The price of the cash commodity on November 1 is assumed to be $2.70, a thirty-cent decline from September 1. By selling futures, the storer has eliminated the risk of such adverse moves in the price of the commodity. Basis risk, however, remains. As we noted in Chapter 4, basis risk is the same as storage cost risk if the commodity is deliverable. The effect of basis risk is illustrated by assuming three alternative futures prices on November 1—$2.73, $2.75, $2.71—each implying a different basis. An increase in the basis (weakening) to five cents results when the futures price falls to $2.75 rather than to $2.73. This produces a net loss of two

TABLE 6.2 Profit results from a short hedge.

	Cash Market		December Futures			
Date	Transaction	Price	Transaction	Alternative Prices		
Sept 1	Buy bushel at	3.00	Sell futures at	3.09	3.09	3.09
Nov 1	Sell bushel at	2.70	Buy futures at	2.73	2.75	2.71
Gain		–0.30		0.36	0.34	0.38
Net gain				0.0	0.04	0.08
Net gain less storage costs of $.03 per month				0.0	–0.02	0.02

cents. The storer has the option to store again on November 1 to earn a basis of five cents per month, but that is profitable only if storage costs are locked in at a lower level. If storage costs are not locked in, the increase in the basis reflects a market-wide increase in storage costs which will likely affect the particular storer analyzed in Table 6.2. On the other hand, a narrowing (strengthening) of the basis to one cent results in a net gain of two cents for the storer, assuming she has no obligation to pay storage costs for the month of November.

Assume now that the commodity is not deliverable against the futures contract. In this case, basis risk reflects price risk of the commodity as well as storage cost risk. In the absence of deliverability, the cash and futures prices need not converge at maturity. For example, the storer of wheat in Oklahoma cannot at reasonable cost deliver his wheat against the futures contract in Chicago. As a result the price of Oklahoma wheat can fall relative to the price of the futures contract, albeit the differential fall can be no greater than transportation costs. A short hedge is therefore not fully effective. The more distant the cash commodity in grade and in space, the greater the possibility that the cash price and the futures price will move in different directions between the time of the hedge and the maturity of the futures contract. As shown in Chapter 4, the effectiveness of the hedge will depend on the degree of correlation between the cash price and the futures price.

Merchandiser's Long Hedge

A long hedge involves the purchase of futures to protect against an increase in the price of a commodity. A typical situation is that of an exporter who, on September 1, enters into a forward contract to sell 500,000 bushels of corn for delivery in New Orleans in three months. The exporter does not possess the corn and must make arrangements to acquire it and ship it to New Orleans. To protect against increases in the price of corn while making those arrangements, the exporter buys 100

December futures contracts. If the price of corn goes up, the gain on the futures contract offsets the loss on the export contract. As the particular grade of corn is acquired and shipped to New Orleans, the exporter lifts the futures position.

Producer's Hedge

A producer transforms an input, such as wheat, into an output, such as flour, that is sold to her customers. The producer maintains an inventory of raw materials (wheat) and an inventory of finished goods (flour). She must also acquire raw materials and market the final product to customers. The optimal futures market hedge for the producer depends on whether she wishes to hedge inventory risk, like the storer, or whether she wishes to protect against an increase in the cost of the commodity, like the merchandiser, or both.

Producer's Short Hedge. The producer is in the same position as the storer with respect to finished goods inventory and raw materials inventory if the final product price and the commodity price are positively correlated. Because of the positive correlation, a drop in the price of the final product is like a drop in the price of the commodity, resulting in a loss with respect to the cost of both inventories. A short futures market position hedges inventory risk of this type, and the effectiveness of the hedge depends on the basis risk for the raw materials or finished goods inventory. If the final product price is uncorrelated with the futures price, the producer can still use a short futures hedge to limit raw materials inventory risk, but the futures market provides no hedge against adverse changes in the final product price.

Unlike storers, producers may be willing to hold the commodity even if the basis is zero or negative. For example, suppose that on February 1 the May futures price and the spot price of wheat are both \$3.00, while the marginal storage costs are nine cents. A terminal elevator operator would not store the wheat because the revenue from storage is zero, while the costs are positive. The producer, however, may store the wheat because the convenience of having the wheat and maintaining production more than offsets the fact that he has locked in a net loss. The amount by which marginal storage costs exceed the basis is called the *convenience yield*—nine cents in the above example. The producer may choose to lock in a net loss of nine cents to guard against the possibility of an even greater loss if the price of the commodity should fall below \$3.00.

Producer's Long Hedge. A producer enters into a long hedge in order to lock in the price of future supplies of the commodity. A flour miller, for example, may wish to guard against increases in the cost of wheat. A long hedge is optimal if the producer has negotiated a price for the final product and wishes to fix costs. If the final product price is uncertain, however, it is not a hedge to lock in a fixed price for inputs. The product price could fall to a point that makes it difficult to cover the cost of the inputs locked in by the futures contract.

The term *anticipatory hedge* is used to describe a futures market purchase in the absence of a fixed price for the final product. An anticipatory hedge is no hedge at all if the final product price is uncertain. An anticipatory hedge can also be a mistake because the price of the commodity might be even lower later. On the other hand, a knowledgeable purchasing agent may be able to predict the likely future cost of the commodity.

Natural Hedge Versus Futures Market Hedge

Producers incur costs for inputs and receive revenues from the sale of the final product. If the cost of inputs is correlated with the price of the final product, a natural hedge exists. For example, a flour miller may find that increases in the price of wheat are generally accompanied by increases in the price of flour. If that is the case, the profit margin is maintained, and hedging does not reduce risk. For example, if the miller locks in the price of wheat with a futures contract and wheat and flour prices fall, he suffers a loss because of the decline in the price of the output while the input price is fixed at the original higher level by the hedge. Had he not hedged the cost of the input, wheat, he would have been better off because the decline in flour prices would have been offset by the decline in the price of the input. On the other hand, if wheat and flour prices rise, hedging the price of wheat produces an overall gain because the price of the output rises while the input price is fixed by the hedge. This example, which assumes that input and output prices are correlated, is summarized in Table 6.3.

TABLE 6.3 Effect of hedging on profits if input and output prices are correlated.

	Hedge	Do Not Hedge
Prices fall	Loss	No effect
Prices rise	Gain	No effect

It is evident that "hedging"—by which we mean locking in the price of the input—actually *increases* the variability of profits in this case. If input and output prices are not correlated, however, hedging would tend to reduce risk.

Many producers face this kind of problem. Candy manufacturers must determine whether to hedge the price of sugar, cocoa, and other raw materials. Cereal producers may wish to hedge grain costs. Producers of electrical wiring may wish to hedge the cost of copper. Cattle ranchers may wish to hedge the price of feed. In each case, the desirability of locking in the price of the input must be determined. Further, if locking in the prices of inputs is desirable, the producer can choose forward contracts with suppliers or futures market hedging.

A more precise formulation of optimal hedging when output and input prices are uncertain is now presented. The formulation is a modification of the optimal hedging discussion presented in Chapter 4 to allow for uncertainty concerning the price of the producer's output as well as the price of commodity inputs.

The notation used in this section is as follows:

$\tilde{P}_T$ = uncertain price of a unit of output at future time T.

Q_P = number of units of the product to be sold.

$\tilde{S}_T$ = uncertain cash price of the input at future time T. We assume one input, although additional inputs could easily be included.

Q_S = number of units of the input required to produce Q_P units of the product.

F_0 = futures price at time 0.

$\tilde{F}_T$ = uncertain futures price at future time T.

n_F = number of futures contracts held. (n_F is positive for a long position and is negative for a short position.)

K = fixed costs incurred in the manufacturing process.

The uncertain profit, $\tilde{\pi}_h$, of a producer who sells Q_P units, uses Q_S units as inputs, and hedges n_F units in the futures market is

$$\tilde{\pi}_h = \tilde{P}_T Q_P - \tilde{S}_T Q_S + (\tilde{F}_T - F_0) n_F - K \qquad \textbf{(6.3)}$$

By dividing through by Q_P, the equation may be restated in terms of profit per unit of output:

$$\frac{\tilde{\pi}_h}{Q_p} = \tilde{P}_T - \tilde{S}_T \frac{Q_S}{Q_P} + (\tilde{F}_T - F_0)\frac{n_F}{Q_P} - \frac{K}{Q_P} \qquad \textbf{(6.4)}$$

We now define one unit of the input as the size of the futures contract. In other words, if the input is sugar, we define one unit of sugar as 112,000 pounds, which is one futures contract. We also define one unit of output as the amount produced by the number of units contained in the futures contract. Thus, if 112,000 pounds of sugar are used in producing 1,000,000 candy bars, one unit of output is 1,000,000 candy bars. That means $Q_S/Q_P = 1.0$.[3] Given these conventions, the equation may be written as

$$\frac{\tilde{\pi}_h}{Q_p} = \tilde{P}_T - \tilde{S}_T + (\tilde{F}_T - F_0)h - \frac{K}{Q_P},$$

[3]It should be noted that this firm has a fixed input/output ratio and that it plans to produce a fixed number of units, all of which will be sold. In actuality, firms have some flexibility in how they combine factors of production, and they may not be able to sell everything they produce.

where $h = n_F/Q_P$ is the hedge ratio. To be consistent with Chapter 4, we write the equation in price changes by adding and subtracting $P_0 - S_0$ on the right-hand side:

$$\frac{\tilde{\pi}_h}{Q_p} = c + \tilde{\Delta}_P - \tilde{\Delta}_S + h\tilde{\Delta}_F, \tag{6.5}$$

where

$$c = P_0 - S_0 - \frac{K}{Q_P}.$$

Following the procedure of Chapter 4, the variance of the per unit profit can be calculated as

$$\sigma_h^2 = \sigma_P^2 + \sigma_S^2 + h^2\sigma_F^2 - 2\sigma_{PS} + 2h\sigma_{PF} - 2h\sigma_{SF}. \tag{6.6}$$

If the producer does not hedge with futures so that $h = 0$, the risk is

$$\sigma_h^2 = \sigma_P^2 + \sigma_S^2 - 2\sigma_{PS}. \tag{6.7}$$

Note that $\sigma_{PS} = \rho_{PS}\sigma_P\sigma_S$, where ρ is the correlation coefficient. If the price change of the input and the output are perfectly correlated, $\rho_{PS} = 1.0$, which implies $\sigma_h^2 = 0.0$, assuming the variances of the price changes of the input and output are the same. This is the case of a perfect natural hedge. If the price of the output and the input are not perfectly correlated, however, hedging with futures may be desirable. In that case, the problem is to find the hedge ratio that minimizes the variance of the producer's per unit profit.

The value of h that minimizes σ_h^2 in (6.6) is found by taking the derivative of σ_h^2 with respect to h and setting it equal to zero:

$$\frac{d\sigma_h^2}{dh} = 2h^*\sigma_F^2 + 2\sigma_{PF} - 2\sigma_{SF} = 0.$$

Solving for h^*, the optimal hedge ratio, gives

$$h^* = \frac{\sigma_{SF} - \sigma_{PF}}{\sigma_F^2}. \tag{6.8}$$

Note that $\sigma_{SF}/\sigma_F^2 \equiv b_S$ is the slope coefficient of a regression of $\tilde{\Delta}_S$ on $\tilde{\Delta}_F$ and that $\sigma_{PF}/\sigma_F^2 \equiv b_P$ is the slope coefficient of a regression of $\tilde{\Delta}_P$ on $\tilde{\Delta}_F$. Another way of writing the optimal hedge is, therefore,

$$h^* = b_S - b_P. \tag{6.9}$$

If both the input and output react in the same way to a change in the futures price, that is, if the regression coefficients are equal, $h^* = 0.0$, the case of the perfect natural hedge.

For some producers, output prices may be very stable or may be fixed by long-term contracts so that $b_P = 0.0$. In this case, the optimal hedge is determined by b_S, the sensitivity of the input price to the futures price. The producer would purchase futures to lock in the cost of inputs. For other producers, the input price might be stable or fixed by long-term contracts so that $b_S = 0.0$. In this case, the producer would sell futures to protect against a decline in the output price.

As noted in Chapter 4, the optimal hedge can also be developed by starting with the regression equations that relate the output and input prices to the futures price:

$$\tilde{\Delta}_P = a_P + b_P \tilde{\Delta}_F + \tilde{e}_P, \tag{6.10}$$

$$\tilde{\Delta}_S = a_S + b_S \tilde{\Delta}_F + \tilde{e}_S, \tag{6.11}$$

where a and b are the intercept and slope terms, respectively, and e is a random disturbance term. Substituting these equations in the equation for the per unit profit (6.5) yields

$$\frac{\tilde{\pi}_h}{Q_p} = c + a_P - a_S + (b_P - b_S + h)\tilde{\Delta}_F + \tilde{e}_P - \tilde{e}_S. \tag{6.12}$$

It is clear that the per unit profit can be made independent of movements in input and output prices by setting $h^* = b_S - b_P$, the result derived above by minimizing the variance.

The effectiveness of the hedge depends on the extent to which the residual errors, $\tilde{e}_P$ and $\tilde{e}_S$, are eliminated. The variance of the per unit profit remaining after the hedge is the variance of (6.12). When $h = b_S - b_P$, this equals $\text{Var}(\tilde{e}_P - \tilde{e}_S)$.

Estimating the Hedge Ratio

The optimal hedge requires an estimate of b_S and b_P in equations (6.10) and (6.11). As noted in Chapter 4, the usual procedure is to estimate these parameters using historical time-series data. To illustrate the amount to hedge when an input and output price are correlated, we consider the case of an oil refiner who produces gasoline from crude oil. Suppose that one barrel of crude oil produces thirty gallons of gasoline. For the purposes of equation (6.4), the price of the output, $\tilde{P}_T$, refers to thirty gallons of gasoline; and the price of the input, $\tilde{S}_T$ refers to one barrel of crude oil. The hedging vehicle is the crude oil futures contract traded on the New York Mercantile Exchange, the price of which is quoted in dollars-per-barrel. Weekly price data (Tuesdays) were collected for 53 weeks in the period November 1988 to November 1989 for unleaded gasoline sold in New York, for West Texas "sour" crude oil, and for "light sweet" crude oil futures.

The following regressions were estimated:

$$\tilde{\Delta}_P = a_p + b_P\tilde{\Delta}_F + \tilde{e}_p, \tag{6.13}$$

and

$$\tilde{\Delta}_S = a_s + b_S\tilde{\Delta}_F + \tilde{e}_s. \tag{6.14}$$

In regression analysis, the assumptions governing the error term are that $E(\tilde{e}) = 0$, $E(\tilde{e}\tilde{\Delta}_F) = 0$. We also assume that successive error terms in time are independent. The regression results are provided in Table 6.4.

TABLE 6.4 Summary of regression estimates for weekly "sour" crude oil, "light sweet" crude oil futures, and unleaded gasoline futures price changes during November 1988 to November 1989.

No. of observations = 53

$\overline{\Delta_P} = -0.0312$ dollars	$\hat{\sigma}_P = 0.9000$ dollars
$\overline{\Delta_S} = 0.1161$ dollars	$\hat{\sigma}_S = 0.7994$ dollars
$\overline{\Delta_F} = 0.2580$ dollars	$\hat{\sigma}_F = 0.6370$ dollars
$\hat{a}_P = -0.1985$	$s(\hat{a}_P) = 0.1187$
$\hat{b}_P = 0.6487$	$s(\hat{b}_P) = 0.1741$
$\bar{R}^2 = 0.1956$	$\hat{\sigma}_{e_p} = 0.6516$
$\hat{a}_S = -0.1351$	$s(\hat{a}_S) = 0.0748$
$\hat{b}_S = 0.9738$	$s(\hat{b}_S) = 0.1098$
$\bar{R}^2 = 0.5944$	$\hat{\sigma}_{e_s} = 0.2592$

a. $\overline{\Delta}$ denotes the mean weekly price change and $\hat{\sigma}$ is the standard deviation estimate. $s(\cdot)$ is the standard error of coefficient estimate. $\hat{\sigma}_e$ is the standard error of the regression.

The estimate of the optimal hedge ratio is

$$\hat{h}^* = \hat{b}_S - \hat{b}_P = 0.9738 - 0.6487 = .3251.$$

In other words, for every thirty gallons of gas that the refinery produces, it should purchase futures contracts on only .3251 barrels of oil even though it takes one barrel to produce thirty gallons of gas. The reason that only .3251 barrels of oil futures are purchased is that the refinery has a partial natural hedge arising from the fact that the price received for gas offsets part of any price change in the oil used to produce the gas.

The small values of the $\bar{R}^2s$ imply that the effectiveness of the hedge is not great. Changes in oil futures prices explain only 19.56 percent of the variation in gas prices and only 59.44 percent of the variation in Texas crude oil prices. Thus, a hedge ratio of 0.3251 may prove to be incorrect after the fact. For example, suppose the estimate $\hat{b}_S$ is one standard error below its true value and the estimate $\hat{b}_P$ is one standard error above its true value. Then

$$h^* = (0.9738 + 0.1098) - (0.6487 - 0.1741) = 0.6090,$$

which is nearly twice the estimated hedge ratio.

6.5 SUPPLY OF STORAGE AND DEMAND FOR STORAGE

We showed in Chapter 3 that the futures price cannot exceed the spot price by more than the cost of storing the commodity:

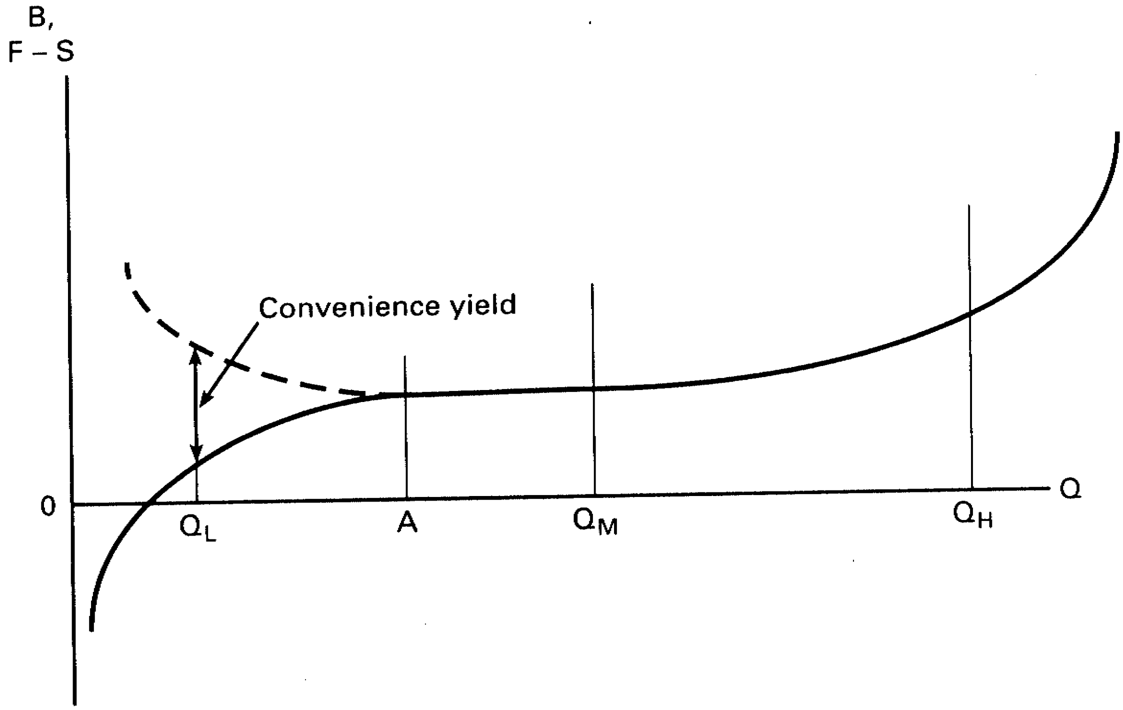
$$F_t \leq S_t + B_t. \tag{3.1}$$

Another way to express this relation is to say that the basis cannot exceed the cost of storage: $F_t - S_t \leq B_t$. Storers will hold a commodity only if the basis, which can be thought of as the price of storage, covers storage costs. It should be noted that the storage cost, B_t, is the marginal cost of storage for the time period in question. Another bushel of wheat will be stored if the marginal cost, B_t, of storing that bushel is less than the price received, $F_t - S_t$, for storing that bushel.

The individual storer takes the price of storage as given, but in the aggregate the price of storage depends on the interaction of the demand for and the supply of storage. The solid line in Figure 6.3 plots the aggregate supply curve of storage for agricultural commodities like wheat, corn, and soybeans. The curve is based on actual data showing how much is stored at each value of the basis, $F - S$. To the left of point A, the out-of-pocket marginal cost of storage, B, represented by the dotted line, exceeds the basis.[4] To the right of point A, the supply curve of storage is coincident with the marginal cost of storage, B. The extended horizontal segment of the supply curve means that storage costs are constant over this range. To the left of point A, positive quantities are stored even when the basis is less than the marginal cost of storage, B, because producers derive a convenience yield from

[4]The dotted line slopes upward on the assumption that the marginal costs of storage of the producers that store are higher when small amounts are stored; in other words, there are economies of scale up to point A.

FIGURE 6.3 Supply Curve of Storage



having the commodity. The smaller the amount of the commodity in existence, the greater the convenience yield must be to offset the fact that the price received for storage is less than the marginal cost of storage. The producer presumably passes on the cost of storage in the final price of the product.

The demand for storage varies over the crop year. It is greatest immediately after the harvest and declines thereafter as the crop is used up. The vertical line at Q_H represents the demand for storage after a bumper crop. It intersects the supply curve where marginal storage costs are rising, which reflects the fact that inefficient, high-cost storage facilities must be used to handle the bumper crop. Later in the storage season, the demand curve shifts left to a point like Q_M, and the basis falls.

Finally, near the end of the storage season and just before a new harvest is due, the demand curve is at a point like Q_L. At this point, the basis is small or negative in anticipation of the new crop, and marginal storage costs exceed the basis. Thus, over the storage season, the one-month basis would normally decline as storage facilities are used less and less.

At the beginning of the storage season, storers and producers can use futures prices to decide how much to store for how long. The term structure of futures prices provides an estimate of the basis for different future periods. For example, Table 6.5 lists soybean futures prices in October 1989, and calculates a monthly basis from the difference in successive futures prices. Thus, the implied basis between November and January is 5.88 cents. The peak storage demand appears to occur from November to March and then declines. Storage costs appear to be lower in March to April and in May to July. After July, the basis becomes negative

TABLE 6.5 Soybean futures prices and the implied monthly basis in October, 1989.

Contract Maturity	Soybean Price in Cents	Monthly Basis[a]
November '89	552.5	
January '90	564.25	5.88
March '90	576.00	5.88
May '90	586.00	5.00
July '90	592.25	3.13
August '90	590.00	–2.25
September '90	573.00	–17.00
November '90	572.00	–0.50

a. The basis is calculated as the difference between adjacent futures contract prices divided by the number of months separating the contract maturities.

in anticipation of the new crop to be harvested. To the extent that storage facilities can be used for several crops, the pattern of the expected basis in soybeans depends not only on the supply and demand for soybean storage but also on the supply and demand for storage of other crops. This means it is not perfectly accurate to relate the basis pattern in soybeans to the harvest cycle in soybeans. The matter is actually more complicated. But for the storer of different commodities, the implied basis derived from the term structure of futures prices provides useful guidance in planning what commodities to store, when to store them, and for how long. In general, high-cost storers will store when the demand for storage is high, whereas low-cost storers will store for a longer period of time.

The supply of storage for non-seasonal commodities such as oil, copper, and so forth would have a similar shape. The demand for storage, however, would not have the predictable seasonal pattern that is typical for agricultural commodities. Overproduction of oil would put demand pressure on storage facilities (a movement to the right on the supply of storage function) and cause an increase in the basis. A labor strike in copper production would reduce the demand for storage and cause a movement to the left on the supply of storage function, perhaps even to a point where the basis is negative. As in agricultural commodities, a negative basis means that an increase in production is anticipated, in this case, when the strike ends.

6.6 RETURNS TO SPECULATORS

Unlike hedgers who try to avoid commodity price risk, speculators take risk in the hopes of profit. The riskiest position a speculator can take is simply to go long or short a commodity. A less risky position is to do a spread—to buy (sell) one futures contract and sell (buy) a related contract. For example, a meteorologist who anticipates a drought in Kansas may decide she can profit handsomely by buying corn futures. If she is wrong, she can lose a great deal. A spread is less risky because the futures prices tend to move together. Typical spreads are made up of one maturity against another maturity in the same commodity or one commodity against a related commodity. For example, the drought may affect corn prices differently than wheat prices. In this case, it might be desirable to buy corn futures and sell wheat futures. If corn and wheat futures prices go down together, there is no loss. Only if corn declines more than wheat is there a loss for the speculator.

Speculators in commodity futures, as in other investment vehicles, decide what to buy or sell on the basis of *fundamental* or *technical analysis.* Fundamental analysts examine the supply and demand for a commodity and try to predict future supply and demand and thereby future price changes. In agricultural commodities, the weather is an important factor in supply. In other commodities, political factors or the likelihood of labor disputes may be important. Technical analysis focuses on the pattern of past prices in hopes of predicting future price changes. Technicians chart the behavior of prices and trading volume and look for patterns that will predict futures price changes.

In an efficient market, neither the technician nor the fundamental analyst can expect to make abnormal profits. As in the stock market, the evidence for commodity futures markets is that they are efficient. Studies of the efficiency of the futures markets in physical commodities have taken different approaches. As we noted in Chapter 5, one approach has been to ask whether speculators as a group earn a risk premium. As also noted there, little evidence exists to show that speculators as a group make profits. That may be because the risk taken by speculators is fully diversifiable, which, under the capital asset pricing model, means no risk premium need be paid. Or it may mean that a certain class of speculators—gamblers and fools—lose money to professional speculators so that speculators as a group do not earn abnormal returns.

A second approach has been to analyze the time-series pattern of futures prices to see if any dependencies exist that may be exploited for profit. In the stock market, Fama (1970) has dubbed such tests "weak form" tests of market efficiency since they seek to determine whether a "weak" information set—the past sequence of prices—can predict future price changes. If the market is efficient, the futures price at t reflects all available information at that point, including the past history of prices. The past history of prices therefore cannot be used to generate a positive profit in the period t to $t + 1$. A simple empirical implication of efficient markets is that today's futures return should not be correlated with tomorrow's futures return, that is, $\rho(R_t, R_{t+1}) = 0.0$. Several investigators have examined the correlation of successive futures returns. See, for example, Smidt (1965) and Stevenson and Bear (1970). They find that serial correlation is not economically significant. When serial dependence is observed, it is not large enough to overcome the transaction costs incurred in trying to profit from it.

An alternative form of time-series investigation is to simulate a trading rule based on the past sequence of prices. For example, such a rule might be to buy after the futures price has increased by three percent, hold until the price decreases by three percent, at which time the position is sold and a short position is taken, and so forth. If markets are efficient and the normal return is zero, such a technical trading rule should not be profitable. Empirical tests conclude that such rules are not profitable. In carrying out such tests, one must be careful to specify the rule in advance before seeing the data since one can always find some rule that will make money if applied to a particular sequence of historical prices.

A further implication of efficient markets is that fundamental analysis also cannot yield abnormal returns if that analysis is based solely on public information available to all analysts. In efficient markets, all public information is reflected in the current price. In other words, public information available at t cannot be used to predict the price at $t + 1$. Presumably, resources are spent in gathering information in the hopes of discovering information that is not general knowledge, so abnormal returns may be periodically earned. In an efficient market, such abnormal returns should not, on average, exceed the cost of acquiring the special information that yields those abnormal returns.

A third approach to testing the efficiency of commodity futures markets is to examine subgroups of investors, such as professional traders and investment advisers, to see if they can earn abnormal returns. What is a normal return now requires discussion. It is unlikely that the normal return of professional traders and advisers is zero; for if it were, how would they feed their families? One would expect professional investors, those who spend time and resources in analysis, to generate positive trading profits or to charge fees. In the stock market, a popular subgroup to examine is mutual funds. The finding there is that the typical mutual fund does not outperform the market, although they charge fees that allow portfolio managers to feed there families (sometimes very handsomely). The findings in the physical futures markets are consistent with efficient markets. Papers by Rockwell (1967) and Houthakker (1957) examine returns to large hedgers, large speculators and to small traders in physical futures markets. These studies conclude that large speculators do make profits, which is consistent with the idea that professional speculators should make a profit. The studies disagree on whether other speculators make or lose money. Under the null hypothesis of zero expected returns to speculators, gains by one group of speculators should be offset by losses of the remaining speculators. Rockwell argues that this is the case. Houthakker argues that small speculators also make money, which means he rejects the null hypothesis of zero return to speculators.

Elton, Gruber, and Rentzler (1987, 1989) have recently examined the investment performance of commodity funds for the period 1979 to 1985. Commodity funds are the analog of mutual funds in the stock market in that they are professionally managed. Over the six years analyzed, the average annual holding period return is -0.0007. This return does not reflect all the transaction costs that investors are required to pay. Thus, commodity funds underperformed other much less risky investment instruments such as government securities. The performance of commodity funds does not support the idea that professional managers can earn positive profits. Indeed, the performance is so bad, Elton, Gruber, and Rentzler (1989) question the rationality of investors in the funds.

6.7 INTERNATIONAL PRICE LINKS: THE LAW OF ONE PRICE

Most physical commodities are actively traded internationally. The United States is an important exporter of agricultural products. Crude oil produced in the Middle East is imported by Europe and by the United States. Cocoa and coffee are produced in Africa and imported by other countries. It is important, therefore, to specify the relation of the prices of the same commodity denominated in different currencies and to determine if it is possible to use futures contracts traded in the United States and denominated in dollars to hedge positions in a commodity in a different country.

In the absence of transportation costs and transaction costs, the dollar price, S_d, of a commodity must equal the foreign price, S_f, of the same commodity adjusted for the exchange rate, X:

$$S_d = XS_f. \tag{6.15}$$

The exchange rate is defined as the dollar price of the foreign currency. The above relation, known as the *Law of One Price* (*LOP*), holds because of commodity arbitrage. If the dollar price of a commodity were to exceed the cost of buying the commodity in a foreign country, an arbitrageur would purchase the commodity in the foreign country and import it to the United States, thereby depressing prices in the United States and raising prices in the foreign country. Conversely, if the U.S. price were too low, the commodity would be exported from the U.S. to the foreign country. Suppose, for example, that the price of a bushel of wheat in Britain is 2.00 pounds; the exchange rate is 1.60 dollars per pound; and the U.S. price of a bushel of wheat is 3.10 dollars. An arbitrageur could buy a bushel for 3.10 in the U.S., sell the bushel in Britain for 2.00 pounds and convert the pounds into (1.6)(2) = 3.20 dollars, which yields a profit of 10 cents per bushel. Such arbitrage raises the price of wheat in the U.S. and lowers it in Britain until the *LOP* is re-established.

In practice, the *LOP* does not hold exactly because commodity arbitrage is costly. Transportation costs and other transaction costs lead to spatial differences in price across countries. Just as the price of wheat is different in Kansas and New

York City, so the price of wheat stated in dollars may differ across countries. In addition, comparisons of prices, even of narrowly defined commodities, do not usually fully account for grade differences in the commodities.

The *LOP* can also be defined for futures prices:

$$F_{d,t}(T) = F_t^X(T)F_{f,t}(T), \tag{6.16}$$

where $F_{d,t}(T)$ and $F_{f,t}(T)$ are respectively the domestic and foreign futures prices for commodity contracts maturing at T, and $F_t^X(T)$ is the futures price of the foreign currency contract with maturity T. The *LOP* should hold more closely for futures or forward prices because optimal arrangements for transport can be made over the time until maturity.

Table 6.6 presents evidence, taken from Protopapadakis and Stoll (1983), on deviations from the *LOP* for certain spot, forward, and futures prices. Under the *LOP*, the mean and the standard deviation of deviations from the *LOP* would be zero because the *LOP* is a non-stochastic arbitrage relation. The average deviation is small for most of the commodities, particularly for a commodity like silver that is precisely defined. The large mean deviations in coffee and wheat can be ascribed to special factors. The U.S. coffee futures price was high relative to the British futures price because of a manipulation of the New York coffee futures contract by the South American coffee cartel in 1977–80. The U.S. wheat futures price was low in comparison to the British futures price because agricultural price supports in Britain and the EEC artificially maintained a high price.

6.8 CORNERS AND SHORT SQUEEZES

A corner or short squeeze arises if someone gains control of the deliverable supply of a commodity and concurrently holds a long futures position. At maturity, shorts can either liquidate their futures position by trading with a long; or they can deliver the commodity. In a short squeeze, both options are closed off. The short position in the futures market cannot be liquidated because the long refuses to sell, and the commodity cannot be delivered because the long also controls ownership of the deliverable supply and refuses to sell. Shorts usually attempt to cover their futures market short position by buying futures, thereby driving up the futures price. The rise in the futures price in the delivery month relative to other futures prices and to the cash price usually signals the presence of a short squeeze. In the absence of intervention by exchanges or regulators, the long would refuse to sell until the futures price rose substantially. Today, exchanges and the CFTC usually intervene when a short squeeze is suspected and require the person or firm undertaking the squeeze to liquidate futures contracts.

The most recent example of a near short squeeze was the attempt by an Italian grain trading firm, Ferruzzi Finanziaria S.p.A., to corner the July 1989 soybean contract. The July contract expired on July 19. At the beginning of July, Feruzzi

TABLE 6.6 Deviations from the Law of One Price for U.S. and British commodities' prices.[a]

	$lnS_d - lnS_f - lnX$	
Commodity	Mean	Standard Deviation
Silver spot	0.0005	0.0200
Silver 3 month forward	−0.0050	0.0146
Copper spot	0.0038	0.1959
Copper 3 month forward	0.0116	0.0258
Coffee futures	0.1991	0.0941
Cocoa futures	−0.0386	0.0795
Wheat futures	−0.2305	0.2023

a. Commodity price and exchange rate observations are weekly. The period covered is 1972–1980 for most of the commodities. Wheat data are for the period 1976–79.

Source: Protopapadakis and Stoll (1983).

held more than half of the net long July futures positions, which was double the deliverable supply, and owned 85 percent of the soybeans in deliverable position. The shorts would have to move massive amounts of soybeans to the approved delivery points (Chicago and Toledo) in order to make delivery on their futures contracts, an impossibility in the short time remaining to expiration. In reaction to the potential corner, the Chicago Board of Trade ordered those holding futures positions in excess of three million bushels to liquidate. This meant that Feruzzi had to sell much of its long position to the shorts, thereby avoiding a short squeeze. July soybean futures prices, which had risen in reaction to the developing short squeeze, fell back to normal levels.[5]

Futures markets try to guard against a corner by broadening delivery terms to several grades and locations (Chicago and Toledo, in the case of soybeans); but in the event that supplies of the commodity are still monopolized, it is quite appropriate for the exchange to take actions such as forced liquidation to break the short squeeze.

[5]Details of the attempted short squeeze are in Chicago Board of Trade (1990).

6.9 SUMMARY

In this chapter, the major futures contracts on physical commodities are identified, and the factors giving rise to futures markets in physical commodities are discussed. Inventory and price patterns for commodities in seasonal supply and for non-seasonal commodities are analyzed.

The use of futures contracts as a hedging tool by commodity storers, by commodity merchandisers, and by producers is explained and modeled. A producer often has uncertain input and output prices, something that makes the hedging problem more difficult than if uncertainty about only one commodity price exists. A framework for optimal hedging in this situation is presented, and calculation of the optimal hedge is illustrated.

The basis in physical commodities depends on the amount of the commodity that must be stored. After a harvest, the demand for storage is high, which causes a movement along the supply curve of storage to a higher cost of storage and a higher basis. When the demand for storage declines, the basis also declines.

Speculators in futures on physical commodities have a difficult time making profits, just as they do in other markets. The evidence implies that futures markets are efficient in the sense that abnormal profits are not consistently achievable. Technical trading rules are not found to be profitable (after trading costs). Professionally managed commodity funds underperform the market. The fact that speculators do not seem to make profits implies that hedgers are provided risk-bearing services at very low cost.

Commodity futures contracts are used by hedgers and speculators in many countries. This chapter shows how prices of the same commodity are linked in terms of different currencies. The chapter ends with a discussion of corners and short squeezes.