Pearson New International Edition

Financial Theory and Corporate Policy

Thomas E. Copeland
J. Fred Weston Kuldeep Shastri

Fourth Edition

ALWAYS LEARNING

PEARSON

Pearson New International Edition

Financial Theory and Corporate Policy
Thomas E. Copeland
J. Fred Weston Kuldeep Shastri
Fourth Edition

PEARSON

rate, $r_f = 10\%$, since there is no uncertainty:

$$\begin{aligned} S_0 &= E(S_T)e^{-r_f T} \\ &= 10{,}000e^{-.10(6/52)} \\ &= 10{,}000(.988528) \\ &= \$9{,}885.28. \end{aligned}$$

One pays the spot price for immediate delivery and the futures price at the time of future delivery.

When the forward/futures contract matures, six weeks from now, you receive a car worth $10,000 from the dealer and pay $10,000 in cash. Your net profit at delivery is zero because there was no uncertainty in our simple example. Had the future value of the car been uncertain, you could have gained or lost the difference between the market value of the car at the delivery date, T, and the $10,000 contract price that you must pay at T. In Section D we shall examine some of the complications that arise in pricing futures contracts when the future commodity price is uncertain, when storage of the commodity is costly, and when taxes must be taken into consideration.

2. Standardization

Of course, if a secondary market existed, other buyers would like to know exactly what kind of car they would be buying (e.g., a blue four-cylinder Chevrolet with bucket seats and a four-speed manual transmission). The same is true of actual futures markets. The asset to be delivered must be standardized as much as is practical. Standardization helps make the market large enough to attract active trading and to provide liquidity.

As an example of standardization the New York Mercantile Exchange (NYMEX) defines a contract in "light, sweet" crude oil as follows:[8]

1. The seller agrees to deliver 1,000 U.S. barrels (42,000 gallons) of "light, sweet" crude oil meeting the following specifications:
   (a) Sulfur—.42% or less by weight.
   (b) Gravity—not less than 37 degrees nor more than 42 degrees API.
   (c) Domestic crudes that are deliverable include West Texas Intermediate, Low Sweet Mix, New Mexican Sweet, North Texas Sweet, Oklahoma Sweet, and South Texas Sweet.
   (d) Price adjustments can be made for specific foreign crudes of gravity not less than 34 degrees nor more than 42 degrees API.
2. Delivery shall be made FOB (free on board) seller's facility, Cushing, Oklahoma, or any pipeline or storage facility with pipeline access to TEPPCO, Cushing storage, or Equilon Pipeline Co.
3. Delivery shall take place no earlier than the first calendar day and no later than the last calendar day of the delivery month. Delivery months are the 30 consecutive calendar months following the current calendar month as well as long-dated futures initially listed 36, 48, 60, 72, and 84 months prior to delivery.
4. Speculative position limits are imposed. No person shall own or control a net long or short position in all months combined of more than 5,000 contracts and in the month preceding delivery no more than 750 contracts for the delivery month.

[8] Actual contract terms have been simplified for expositional purposes. Contact the NYMEX for full details.

Although the definition of the commodity to be delivered seems very precise, to the extent that variations exist, the seller has an *implied delivery option* and will, if possible, deliver the lowest-quality product at the latest possible date. The value of the implied delivery option varies from contract to contract and is implicit in the futures price.[9]

3. Clearing, Volume, and Open Interest

Both standardization of contracts and ease of clearing have helped to provide liquidity to futures markets. The futures *clearinghouse* stands between the buyer and seller in order to facilitate transactions. Think of the clearinghouse as an accounting system for long and short positions in futures contracts. Figure 6 illustrates a simple example.

At 11:15 A.M. Mr. A buys two December contracts at a market price of $25.69 per barrel. He never knows the identity of the seller or sellers and probably does not care. The clearinghouse records his purchase along with the fact that one contract was sold at $25.69 per barrel by Mr. B and another by Mr. C. Next, at 1:20 P.M., Mr. A sells a contract at $25.85 per barrel (for a $0.16 gain), and Mr. D is on the buying side. At 1:40 P.M., Mr. D buys another contract at $25.64 with Mr. B on the selling side. Finally, Mr. C sells one contract for $25.79 a barrel to Mr. A at 2:10 P.M. There are no further transactions and the market closes at $25.79 per barrel. The *Wall Street Journal* reports (see Fig. 6) that the market for December contracts opened at $25.69, the high was $25.85, the low was $25.64, and the closing price was $25.79. The price change from the previous day's close was $0.00.

At the end of the trading day, each trader's position is *marked to market* by the clearinghouse in its *daily settlement* operation. As shown in Fig. 6, Mr. A's net position for the day is a gain of $260. This amount of money is credited to his interest-bearing account at the clearinghouse. On the other hand, Mr. C. lost $100 and he must pay the clearinghouse. In actuality, only brokers belong to the clearinghouse, and it is their accounts that are settled daily. Each brokerage firm then acts as a clearinghouse for its clients.

Note that five contracts were traded during the day in our example. Actual trading volume in December contracts is not reported in the *Wall Street Journal*, but total trading volume for all oil contracts was estimated at 75,560. In addition to volume per day, the *Wall Street Journal* reports *open interest*, which is the total number of contracts outstanding as of the previous day. In most futures markets the open interest, as illustrated in Fig. 7, is relatively low during the early months of a contract, when it still has a long time before expiration. Then it arises as hedgers and speculators become more active in the market, and finally it falls rapidly as the contract expiration approaches. For example, in crude oil the open interest in April 2003 contracts, which have almost one year to maturity, was only 6,656, whereas for the September 2002 contracts, open interest was 137,443. In some futures markets (e.g., stock index futures), there cannot be any open interest at the contract expiration date because it is not possible to actually deliver the underlying asset—the stock index. Even when the commodity can be delivered, relatively few of the futures positions (less than 3% on average) end in actual delivery of the commodity involved. Later on, in the theory section of the chapter, we shall discuss some reasons why open interest is so high relative to the number of contracts that result in delivery.

[9] Chance and Hemler [1993] provide an excellent survey of the literature in this area. They report that most studies estimate that the quality option is worth less than 1–2% of futures price three months prior to delivery. Exceptions include Johnston and McConnell [1989], who obtain values as high as 19% for GNMA CDR futures, and Kane and Marcus [1986], who obtain expiration values exceeding 4% for T-bond futures.

Figure 6 A clearinghouse illustration.

Record of Transactions during the Trading Day:

Long Positions				***Short Positions***			
Buyer	**Quantity**	**Price**	**Time**	**Seller**	**Quantity**	**Price**	**Time**
Mr. A	2	$25.69	11:15A	Mr. B	1	$25.69	11:15 A
Mr. D	1	25.85	1:20P	Mr. C	1	25.69	11:15 A
Mr. D	1	25.64	1:40P	Mr. A	1	25.85	1:20 P
Mr. A	1	25.79	2:10P	Mr. B	1	25.64	1:40 P
	5			Mr. C.	1	25.79	2:10 P
					5		

Net Positions: ***(Market closing price = $25.79 per barrel)***

Mr. A:	2 purchased	at $25.69 =	−	$51,380
	1 purchased	at $25.79 =	−	25,790
	1 sold	at $25.85 =	+	25,850
			−	51,320
	2 long	at $25.79 =	+	51,580
	At settlement		+	260
Mr. B	1 sold	at $25.69 =	+	25,690
	1 sold	at $25.64 =	+	25,640
			+	51,330
	2 short	at $25.79	−	51,580
	At settlement		−	250
Mr. C	1 sold	at $25.69 =	+	25,690
	1 sold	at $25.79 =	+	25,790
			+	51,480
	2 short	at $25.79 =	−	51,580
	At settlement		−	100
Mr. D	1 purchased	at $25.85 =	−	25,850
	1 purchased	at $25.64 =	−	25,640
			−	51,490
	2 long	at $25.79 =	+	51,580
	At settlement		+	90

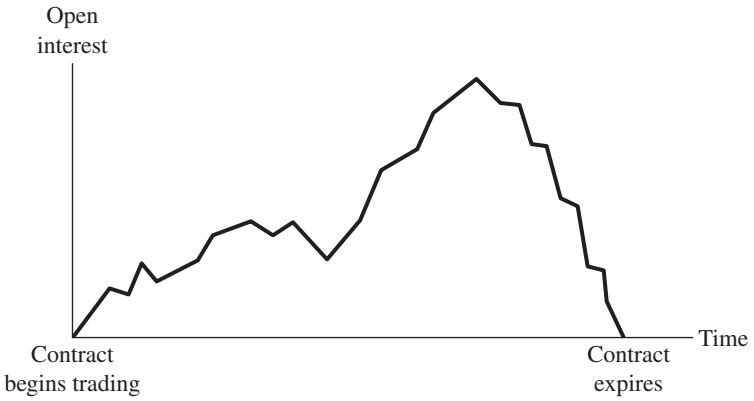

Figure 7 Typical pattern for open interest over the life of a futures contract.

4. Margins

The example in Fig. 6 implicitly assumed that all traders invested an amount equal to the full value of the underlying commodity. This is rarely the case. Usually, the futures trader is required to put up only enough money to insure that the probability of reaching a negative equity position in one day is quite small. Each futures market has its own regulations, but the *initial margin* when a position is first opened is usually only 5–10% of the total value of the contract. The *maintenance margin* is the minimum amount of equity that the account may have and is usually set at 75–80% of the initial margin. If losses drive down the value of equity in the account below the maintenance margin, then the investor receives a *margin call* requiring that additional cash (or interest-bearing certificates) be placed into the account to bring the equity in the account above the initial margin. If the investor fails to meet the requirements of the margin call, then the broker may close out the investor's futures position.

There is, of course, nothing that requires an investor to use a margin account. The effect of trading on margin is to leverage any position so that the systematic and unsystematic risks are both greater per dollar of investment. High margin has given commodity futures markets the reputation of being very risky when in fact, as we shall see later on (in Section E), 100% margin positions have about the same variance as common stock portfolios, although they have very different covariances with the market portfolio.

There are commonly cited reasons for having margin requirements. First, a margin on a futures contract represents a performance bond, which serves to protect the integrity and reputation of the futures exchange and to protect the middleman (known as the futures commission merchant) from customer default. Second, it is often argued (by regulators) that higher margin requirements serve to reduce price volatility caused by speculative activity.

Hartzmark [1986] analyzes the effect of changes in margin requirements on futures markets and concludes (1) that when margin levels are raised (lowered) the number of open contracts falls (rises), (2) that there is weak evidence to support the conclusion that there is an inverse relationship between margin changes and trading volume, (3) that there are significant but unpredictable changes in the composition of traders in the market, and (4) that there is no systematic or significant relationship between margin changes and price volatility. More recently Adrangi and Chatrath [1999] report that margin increases have a negative impact on the trading activities of all types of traders, with the closest to delivery contract being the most sensitive. They also find that margins

are increased in high-volatility environments, while the reverse occurs in stable or low-volatility environments.

5. Price Limits

Another interesting feature of commodities markets is *price limits*. The U.S. Commodity Futures Trading Commission, which regulates trading on U.S. commodity exchanges, places limits on the extent to which futures prices are allowed to vary from day to day. For example, a simplified description of the price limits on frozen concentrated orange juice futures (after 1979) is that (1) prices may move no more than $0.05 per pound ($750 per contract); (2) when three or more contract months have closed at the limit in the same direction for three successive business days, the limit is raised to $0.08 per pound; and (3) on the last three days before the near contract's expiration, its limit is $0.10 per pound. It is not unusual for the price to move up (or down) the limit (i.e., up or down by $0.10 per pound) for several days without any trading taking place.

There are arguments for and against price limits. For example, Roll [1984] notes that the orange juice futures price is rendered informationally inefficient by the imposition of price limits on price movements because prices respond to weather changes (especially freezes, which damage the crop) slower than they otherwise might in the absence of price limits. Brennan [1986b], however, provides an economic rationale for price limits. Against the clear costs on market participants imposed by prohibiting mutually beneficial trades at prices outside the price limits, he suggests that a benefit of price limits is that their imposition allows lower margin requirements than would otherwise prevail. Margin requirements and price limits are substitutes in ensuring contract performance without costly litigation. If margin requirements are costly, then having lower margin requirements is a benefit that results from price limits.

That margin requirements are costly is itself a debated proposition. Black [1976], for example, argues that the opportunity cost of margins is zero with daily settlement because the value of the futures position goes to zero. This argument, however, fails to account for the costs associated with the initial margin. Others (e.g., Anderson [1981]) believe that the margin positions have no opportunity cost because they can be satisfied with interest-bearing securities. However, Telser [1981a] provides a sensible argument for costly margin requirements, namely, that interest-bearing securities such as Treasury bills are part of the holder's precautionary balance and if they are committed for use as margin, they are unavailable for other uses. Brennan [1986b] also points out that the bonding feature of margin requirements helps to avoid costly litigation that would otherwise be needed to enforce daily settlement on futures contracts.

Brennan [1986b] is also able to explain why some futures markets have price limits while others do not. A futures market with daily price limits helps to prevent default because the losing trader cannot be absolutely certain that defaulting is the best thing to do. For example, if the price moves down the limit, the trader may be subject to a margin call but will not necessarily be wiped out. Furthermore, the trader does not know what the futures price will be when the daily price limits no longer apply. Therefore he will tend to meet the maintenance margin rather than defaulting. An analogy (provided by Phil Dybvig when he was at Yale) is that you take your aging car to the mechanic to ask him to fix it. The car is only worth $4,000 and the mechanic knows it will take $4,500 to complete all repairs. Rather than telling you the total cost of repair, and having you respond by junking the car instead of repairing it, the mechanic gives you a price limit. He says that the first repair will cost $450. Once this is paid for, he announces that the second repair will cost $450. And so it goes. Of course, your ability to estimate the total cost of repairs is crucial. The

reason the mechanic can fool you is that on average the total cost of the repair is, let's say, only $550. It pays for you to pay $450 now because you are "saving" $100 on average. But occasionally you have bad luck and can be persuaded to pay up even when the eventual repair is much more. Similar, argues Brennan, is the investor's ability to estimate what the equilibrium futures price will be when the price limits are lifted. If there is an active spot market where spot prices are good predictors of futures prices (e.g., in interest rate, currency, stock index, and possibly metals futures) price limits will serve little use because investors can use the spot prices to learn the bad news. Also, price limits on short-term contracts should be larger or nonexistent because spot and futures prices are equal at maturity. Note that for orange juice futures the price limit is doubled for near-maturity contracts. For agricultural commodities futures with some time before delivery is due, there is usually no spot market (it's hard to trade orange juice when the crop is still in blossom) and price limits serve a useful role.

The evidence on the impact of price limits on price discovery is mixed. Kuserk and Locke [1996] examine the trading activities of floor traders of pork belly futures over the 1990–92 period and conclude that price discovery is suspended rather than aided by price limits. Chen [1998] also finds that price limits delay price discovery and that prices one day after a locked limit day move in the same direction as the locked limit day. On the other hand, in an analysis of NIKKEI futures contracts that trade on both the Osaka Securities Exchange (OSE) and the Singapore International Monetary Exchange (SIMEX), Berkman and Steenbeck [1998] report that prices do not differ substantially across exchanges even as the limit is approached. On the other hand, they find that trading migrated from the stricter price limit exchange (the OSE) to the SIMEX as prices get closer to limits on the OSE price.

6. Taxation of Futures Contracts

The Internal Revenue Service distinguishes between *hedgers* and *speculators* for tax purposes. Hedgers are market participants whose positions are considered to be part of their normal commercial activities. Their profits and losses are treated as ordinary income for tax purposes. All other traders are defined as speculators and are considered to have a capital asset for tax purposes. The capital gain or loss is recorded when the position is closed out. The length of time that the position is maintained determines whether or not the capital gain is short or long term for tax purposes.

In 1982 Congress changed the capital gains treatment by stipulating that all futures positions must be marked to market at year's end. In addition, 40% of any gains or losses are treated as short-term capital gains or losses, with the remaining 60% as long term. The motivation for the change was the elimination of "tax straddles," which were being used for tax avoidance. A tax straddle was established by selling a contract in one commodity and buying a contract in a highly correlated commodity (e.g., corn and wheat). Gains in one contract would presumably offset losses in the other. Near year's end the losses in the declining contract were realized in order to shelter this year's income, and shortly after the end of the year, the winning position would be closed out but not taxed until next year. The only risk involved was the fact that the position was not hedged during the interval between the closing of the loss position and the closing of the gain position shortly thereafter.

Cornell and French [1983b] point out that the 1982 change in the tax code affected the pricing of stock index futures. The portfolio of stocks (e.g., the Standard and Poor's 500) from which the index is constructed does not have to be marked to market at year's end for tax purposes, but the stock futures contract on the index must be. Consequently, the index portfolio contains a valuable tax-timing option (see Constantinides [1983]) that the futures contract does not. A portfolio manager