

CHAPTER 1

Futures Markets

In the mid-1800s, Chicago was the transportation and distribution center for agriculture products. Farmers in the Midwest transported and sold their products to wholesalers and merchants in Chicago, who often would store and later transport the products by either rail or the Great Lakes to population centers in the East. Because of the seasonal nature of grains and other agriculture products and the lack of adequate storage facilities, farmers and merchants began to use *forward contracts* as a way of avoiding storage costs and pricing risk. These contracts were agreements in which two parties agreed to exchange commodities for cash at a future date, but with the terms and the price agreed upon in the present. An Ohio farmer in June might agree to sell his expected wheat harvest to a Chicago grain dealer in September at an agreed-upon price. This forward contract enabled both the farmer and the dealer to lock in the September wheat price in June. In 1848, the Chicago Board of Trade (CBT) was formed by a group of Chicago merchants to facilitate the trading of grain. This organization subsequently introduced the first standardized forward contract, called a “to-arrive” contract. Later, it established rules for trading the contracts and developed a system in which traders ensured their performance by depositing good-faith money to a third party. These actions made it possible for speculators as well as farmers and dealers who were hedging their positions to trade their forward contracts. By definition, *futures* are marketable forward contracts. Thus, the CBT evolved from a board offering forward contracts to the United States’ first organized exchange listing futures contracts—a futures exchange.

Introduction to Futures and Options Markets

Futures and options contracts on stock, debt, and currency, as well as such hybrid derivatives as swaps, interest rate options, caps, and floors, are an important risk-management tool. Farmers, portfolio managers, multinational businesses, and financial institutions often buy and sell derivatives to hedge positions they have in the derivative's underlying asset against adverse price changes. Derivatives also are used for speculation. Many investors find buying or selling options or taking futures positions an attractive alternative to buying or selling the derivative's underlying security. Finally, many institutional investors, portfolio managers, and corporations use derivatives for *financial engineering*, combining their debt, equity, or currency positions with different derivatives to create a structured investment or debt position with certain desired risk-return features.

This book is an exposition on derivatives, describing the markets in which derivatives are traded, how they are used for speculating, hedging, and financial engineering, and how their prices are determined. Part 1 examines the markets, strategies, and pricing of futures and forward contracts, while Parts 2 and 3 focus on options contracts and pricing. Part 4, in turn, examines the swap market.

Overview of Futures Markets

As new exchanges were formed in New York, London, Singapore, and other large cities throughout the world, the types of futures contracts grew from grains and agricultural products to commodities and metals and finally to financial futures: futures on foreign currency, debt securities, and security indexes. Because of their use as a hedging tool by financial managers and investment bankers, the introduction of financial futures in the early 1970s led to a dramatic growth in futures trading. The financial futures market formally began in 1972 when the Chicago Mercantile Exchange (CME) created the International Monetary Market (IMM) division to trade futures contracts on foreign currency. In 1976, the CME extended its listings to include a futures contract on a Treasury bill. The CBT introduced its first futures contract in October 1975 with a contract on the Government National Mortgage Association (GNMA) pass-through, and in 1977, it introduced the Treasury bond futures contract. The Kansas City Board of Trade was the first exchange to offer trading on a futures contract on an equity index, when it introduced the Value Line Composite Index (VLCI) contract in 1983. This was followed by the introduction of the Standard & Poor's (S&P) 500 futures contract by the CME and the New York Stock Exchange (NYSE) index futures contract by the New York Futures Exchange (NYFE).

Whereas the 1970s marked the advent of financial futures, the 1980s saw the globalization of futures markets with the openings of the London International Financial Futures Exchange (LIFFE) in 1982, Singapore International Monetary Market in 1986, and the Toronto Futures Exchange in 1984. The increase in the number of futures exchanges internationally led to a number of trading innovations: electronic trading systems, 24-hour worldwide trading, and alliances between exchanges. Concomitant with the growth in future trading on organized exchanges has been the growth in futures contracts offered and traded on the over-the-counter (OTC) market.

In this market, dealers offer and make markets in more tailor-made forward contracts in currencies, indexes, and various interest rate products. The combined growth in the futures and forward contracts has also created a need for more governmental oversight to ensure market efficiency and to guard against abuses. In 1974, Congress created the Commodity Futures Trading Commission (CFTC) to monitor and regulate futures trading. In that legislation, Congress also allowed the creation of self-regulatory organizations, and in 1982, the National Futures Association (NFA), an organization of futures market participants, was established to oversee futures trading. Finally, the growth in futures markets led to the consolidation of exchanges. In 2006, the CME and the CBT approved a deal in which the CME acquired the CBT, forming the CME Group, Inc. With this and other consolidations, the major exchanges today offering derivatives include CBT/CME, Eurex, ICE, Hong Kong Futures Exchange, Singapore Exchange, Dubai Mercantile Exchange, Bolsa De Mercadorias & Futuros, and the Australian Stock Exchange. Exhibit 1.1 shows the Bloomberg CTM screen that lists the major exchanges trading futures and derivatives today.

EXHIBIT 1.1 Major Futures and Derivative Exchanges

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Cancel: Screen not saved

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Related Functions

Page 1/4 Contract Table Menu

Show

Categories

Exchange

Region

1) Agriculture and Livestock

1) CORN - Corn

2) FIBR - Fibers

3) FOOD - Foodstuff

4) LSTK - Livestock

5) OGRN - Other Grain

6) SOY - Soy

7) WHET - Wheat

Energy and Environment

8) COAL - Coal

9) CRDO - Crude Oil

10) ETCY - Electricity

11) EMIS - Emissions

12) NATG - Natural Gas

13) REFP - Refined Products

14) SHIP - Shipping

15) WTHR - Weather

Financial Contracts

16) BOND - Bond

17) CDS - Credit Derivatives

18) XCUR - Cross Currency

19) CURR - Currency

20) INTR - Interest Rate

21) CURO - Spot Currency Options

22) SWAP - Swap

23) SYNS - Synthetic Interest Rate Strip

24) WBON - Weekly Bond Options

25) WCUR - Weekly Currency Options

Index Contracts

26) EQIX - Equity Index

27) EIDX - Equity Index Spot Options

28) VIDX - Equity Volatility Index Option

29) NEIX - Non-Equity Index

30) NEXD - Non-Equity Index Spot Options

31) WIDX - Weekly Index Options

Metals and Industrials

32) BMTL - Base Metal

33) IMAT - Industrial Material

34) PMTL - Precious Metal

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Japan \$1 3 3201 6900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2012 Bloomberg Finance L.P.

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Search

Related Functions

Page 1/4 Contract Exchange Menu

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Categories

Exchange

Region

1) North America

1) AMX - American Stock Exchange

2) CB2 - C2 Options Exchange

3) CBF - CBOE Futures Exchange

4) CBT - Chicago Board of Trade

5) CBO - Chicago Board Options Exchange

6) CME - Chicago Mercantile Exchange

7) CMX - COMEX division of NYMEX

8) ELX - ELX Futures

9) ERI - Eris Exchange

10) GEV - Green Exchange Venture

11) WCE - ICE Futures Canada

12) FMX - ICE Futures US Currencies

13) NYF - ICE Futures US Indices

14) NYB - ICE Futures US Softs

15) ISE - International Securities Exchange

16) KCB - Kansas City Board of Trade

17) MDX - Mercado Mexicano de Derivados

18) MGE - Minneapolis Grain Exchange

19) MCE - Montreal Climate Exchange

20) MSE - Montreal Exchange

21) NFX - NASDAQ OMX Futures Exchange

22) PHL - NASDAQ OMX PHLX

23) NCP - NYMEX Clearport

24) NDM - NYMEX DME

25) NYM - NYMEX Exchange

26) NYL - NYSE LITFE U.S.

27) OCG - OneChicago

28) OTC - Over The Counter

South America

29) BMF - Bolsa De Mercadorias & Futuros

30) BOV - Bolsa de Valores de Sao Paulo

31) CDE - Colombia Derivatives Exchange

32) DVX - Colombia Derivex

33) SBA - Merc. de Valores Buenos Aires

34) MBA - Mercado a Termino Buenos Aires

35) MAE - Mercado Abierto Electronico

36) RFX - Rosario Futures Exchange

Europe

37) ADE - Athens Derivative Exchange

38) BNF - Bluenext

39) MIL - Borsa Italiana (IDEM)

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EXHIBIT 1.1 (Continued)

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Europe 1) BTS - Bucharest Stock Exchange 2) BSE - Budapest Stock Exchange 3) EPD - EEX Power Derivatives 4) EDX - ENEDEX 5) EUX - Eurex 6) EEE - European Energy Exchange 7) FPL - Fish Pool ASA 8) GME - Gestore del Mercato Elettrico 9) ICE - ICE Futures Europe 10) IGE - Istanbul Gold Exchange 11) LMF - LME 3rd Wednesday Prices & Options 12) LME - LME Benchmark Monitor 13) LMS - LME Swaps 14) MFP - MEFF Power 15) MFM - Meff Renta Variable (Madrid) 16) MFA - MFAO Olive Oil Exchange 17) MCX - Moscow Interbank Currency Ex. 18) NZX - NZEX UK Power Market 19) NPE - NASDAQ OMX Commodities 20) PMI - NASDAQ OMX Swedish Fixed Income Deriv		21) EOE - NYSE LIFFE - Amsterdam 22) BFO - NYSE LIFFE - Brussels 23) BDP - NYSE LIFFE - Lisbon 24) LIF - NYSE LIFFE - London 25) EOP - NYSE LIFFE - Paris 26) COP - OMX Nordic Exchange Copenhagen 27) HEX - OMX Nordic Exchange Helsinki 28) SSE - OMX Nordic Exchange Stockholm 29) OBX - Oslo Stock Exchange 30) OMP - Portugal Power Exchange 31) PXE - Power Exchange Central Europe 32) PNK - Powermex 33) PRG - Prague Stock Exchange 34) RTS - Russian Trading System 35) SIB - Sibiu Monetary Financial and Commodities 36) SPX - SPIMEX Commodity Exchange 37) TKD - Turkish Derivatives Exchange 38) TQD - Turquoise Derivatives 39) UKR - Ukrainian Exchange 40) WSE - Warsaw Stock Exchange 41) WSA - Wiener Borse	
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Asia/Pacific 1) ACE - ACE Derivs & Cmty Exchange 2) AFE - Agricultural Futures Exchange of Thailand 3) SFE - ASX Trade24 4) ASX - Australian Stock Exchange 5) BBX - Bombay Stock Exchange 6) CFF - China Financial Future Exchange (CFFEX) 7) DCE - Dalian Commodity Exchange 8) HKG - Hong Kong Futures Exchange 9) HKM - Hong Kong Mercantile Exchange 10) INX - Indian Commodity Exchange 11) IDC - Indonesia Commodity and Derivatives Exch 12) IDX - Indonesia Stock Exchange 13) KAN - Kansai Commodity Exchange 14) KFE - Korea Exchange 15) MDE - Malaysia Derivatives Ex. (KLDO) 16) MSX - MCK Stock 17) MCI - Multi Commodity Ex. of India 18) NDX - National Commodity & Derivatives Exchang 19) NSE - National Stock Exchange 20) NZX - NZX Derivatives		21) DSE - Osaka Securities Exchange 22) PMX - Pakistan Mercantile Exchange 23) SHF - Shanghai Futures Exchange 24) SGX - Singapore Exchange (was SIMEX) 25) SME - Singapore Mercantile Exchange 26) FTX - Taiwan Futures Exchange 27) TEF - Thailand Futures Exchange 28) TCM - Tokyo Commodity Exchange 29) TFX - Tokyo Financial Exchange 30) TGE - Tokyo Grain Exchange 31) TSE - Tokyo Stock Exchange 32) USE - United Stock Exchange 33) ZCE - Zhengzhou Commodity Exchange Africa 34) YLX - JSE Interest Rate Market 35) GBT - Mauritius Global Board of Trade 36) SAF - South African Futures Exchange Middle East 37) BFX - Bahrain Financial Exchange 38) DGC - Dubai Gold & Commodities Exchange 39) DME - Dubai Mercantile Exchange	
Australia 61 2 9277 8600 Brazil 55 11 3048 4500 Europe 44 20 7230 7500 Germany 49 69 3204 1210 Hong Kong 852 2597 6000 Japan 81 3 3281 8900 Singapore 65 6212 1000 U.S. 1 212 518 2000 Copyright 2012 Bloomberg Finance L.P. SR 608044 EDT GMT+4:00 GMT-4:00 21-Nov-2012 10:55:44		<HELP> for explanation. Screen saved as C:\Documents and Settings\johnson\My Documents\Staff Stuff\Bloo Search [] Related Functions [] Page 4/4 Contract Exchange Menu Show Categories Exchange Region	

Formally, a forward contract is an agreement between two parties to trade a specific asset at a future date with the terms and price agreed upon today. A futures contract, in turn, is a “marketable” forward contract, with marketability (the ease or speed in trading a security) provided through futures exchanges that not only list hundreds of contracts that can be traded but provide the mechanisms for facilitating the trades. Futures and forward contracts are known as *derivative securities*. A derivative security is one whose value depends on the values of another asset (e.g., the price of the underlying commodity or security). Another important derivative is an option. An option is a security that gives the holder the right, but not the obligation, to buy or sell a particular asset at a specified price on, or possibly before, a specific date.

Overview of Options Markets

Like the futures market, the US options market can be traced back to the 1840s when options on agriculture commodities were traded in New York. These option contracts gave the holders the right, but not the obligation, to purchase or to sell a commodity at a specific price on or possibly before a specified date. Like forward contracts, options made it possible for farmers or agriculture dealers to lock in future prices. In contrast to commodity futures trading, however, the early market for commodity options trading was relatively thin. The market did grow marginally when options on stocks began trading on the over-the-counter (OTC) market in the early 1900s. This market began when a group of investment firms formed the Put and Call Brokers and Dealers Association. Through this association, an investor who wanted to buy an option could do so through a member who either would find a seller through other members or would sell (write) the option himself.

The OTC option market was functional, but suffered because it failed to provide an adequate secondary market. In 1973, the CBT formed the Chicago Board Options Exchange (CBOE). The CBOE was the first organized option exchange for the trading of options. Just as the CBT had served to increase the popularity of futures, the CBOE helped to increase the trading of options by making the contracts more marketable. Since the creation of the CBOE, organized stock exchanges in the United States, most of the organized futures exchanges, and many security exchanges outside the United States also began offering markets for the trading of options. As the number of exchanges offering options increased, so did the number of securities and instruments with options written on them. Today, option contracts exist not only on stocks but also on foreign currencies, indexes, futures contracts, and debt and interest rate-sensitive securities.

In addition to options listed on organized exchanges, there is also a large OTC market in currency, debt, and interest-sensitive securities and products in the United States and a growing OTC market outside the United States. OTC debt derivatives are primarily used by financial institutions and nonfinancial corporations to manage their interest rate positions. The derivative contracts offered in the OTC market include spot options and forward contracts on Treasury securities, London Interbank Offered Rate-related (LIBOR-related) securities, and special types of interest rate products, such as interest rate calls and puts, caps, floors, and collars. OTC interest rate derivatives products are typically private, customized contracts between two financial institutions or between a financial institution and one of its clients.

The Nature of Futures Trading and the Role of the Clearinghouse

Futures Positions

A speculator or hedger can take one of two positions on a futures (or forward) contract: a long position (or futures purchase) or a short position (futures sale). In a long futures position, one agrees to buy the contract's underlying asset at a specified price, with the payment and delivery to occur on the expiration date (also referred to as the delivery

date). In a short position, one agrees to sell an asset at a specific price, with delivery and payment occurring at expiration.

To illustrate how positions are taken, suppose in December, Speculator X believes that summer will be unusually dry in the Midwest, resulting in increases in the price of corn. With hopes of profiting from this expectation, suppose on 12/14/15 Speculator X decides to take a long position in a July corn futures contract and instructs her broker to buy one July corn futures contract listed on the CBT (one contract is for 5,000 bushels, see Exhibit 1.2). To fulfill this order, suppose X's broker finds a broker representing Speculator Y, who believes that the summer corn harvest will be above normal and therefore hopes to profit by taking a short position in the July corn contract. After negotiating with each other, suppose the brokers agree to a price of \$3.89/bu. on the July contract for their clients. In terms of futures positions, Speculator X would have a long position in which she agrees to buy 5,000 bushels of corn at \$3.89/bu. from Speculator Y at the delivery date in July, and Speculator Y would have a short position in which he agrees to sell 5,000 bushels of corn at \$3.89/bu. at the delivery date in September.

If both parties hold their contracts to delivery, their profits or losses would be determined by the price of corn on the spot market (also called cash, physical, or actual market). For example, suppose the summer turns out to be mild, causing the spot price of corn to trade at \$3.32/bu. at the grain elevators in the Midwest at or near the delivery date on the July corn futures contract. Accordingly, Speculator Y with his short position would buy the corn on the spot market for \$3.32/bu, and then sell it on the futures contract to Speculator X for \$3.89/bu., resulting in a \$2,850 profit minus commission and transportation costs. Speculator X with her long position, in turn, would have to buy 5,000 bushels of corn on her corn futures contract at \$3.89/bu. from Speculator Y, and then sell the corn for \$3.32/bu. on the spot market, losing \$2,850 plus commission and transportation costs.

Clearinghouse

To provide contracts with marketability, futures exchanges use clearinghouses. The clearinghouses associated with futures exchanges guarantee each contract and act as intermediaries by breaking up each contract after the trade has taken place. Thus, in the previous example, the clearinghouse (CH) would come in after Speculators X and Y have reached an agreement on the price of the July corn, becoming the effective seller on X's long position and the effective buyer on Y's short position. Once the clearinghouse has broken up the contracts, then X's and Y's contracts would be with the clearinghouse. The clearinghouse, in turn, would record the following entries in its computers:

Clearinghouse Record:

1. Speculator X agrees to buy July corn at \$3.89/bu. from the clearinghouse.
 2. Speculator Y agrees to sell July corn at \$3.89/bu. to the clearinghouse.
-

This intermediary role of the clearinghouse makes it easier for futures traders to close their positions before expiration. Returning to our example, suppose that early summer is dry in the Midwest, leading a third speculator, Speculator Z, to want to take a long position in the listed July corn futures contract. Seeing a profit opportunity from the greater demand for long positions in the July contract, suppose in June Speculator X agrees to sell a July corn futures contract to Speculator Z for \$4.14/bu. Upon doing this, Speculator X now would be short in the new July contract, with Speculator Z having a long position, and there now would be two contracts on July corn. After the new contract between X and Z has been established, the clearinghouse would step in and break it up. For Speculator X, the clearinghouse's record would now show the following:

Clearinghouse Record for X:	
1.	Speculator X agrees to buy July corn at \$3.89/bu. from the clearinghouse.
2.	Speculator X agrees to sell July corn at \$4.14/bu. to the clearinghouse.
Close	Thus, to close, the Clearinghouse owes X \$0.25 per contract to be paid at expiration: $(\$0.25/\text{bu.})(5,000 \text{ bu.}) = \$1,250.$

The clearinghouse accordingly would close Speculator X's positions by paying her \$0.25/bu. ($\$4.14/\text{bu.} - \$3.89/\text{bu.}$), a total of \$1,250 on the contract $[(5,000 \text{ bu.})(\$0.25/\text{bu.})]$. Since Speculator X's short position effectively closes her long position, it is variously referred to as a *closing*, *reversing out*, or *offsetting position* or simply as an *offset*. Thus, the clearinghouse makes it easier for futures contracts to be closed prior to expiration.

Commission costs and the costs of transporting commodities cause most futures traders to close their positions instead of taking delivery. As the delivery date approaches the number of outstanding contracts, known as *open interest*, declines, with only a relatively few contracts still outstanding at delivery. Moreover, at expiration, the contract prices on futures contracts established on that date (f_T) should be equal (or approximately equal) to the prevailing spot price on the underlying asset (S_T). That is, at expiration: $f_T = S_T$. If f_T does not equal S_T at expiration, an arbitrage opportunity would exist. Arbitrageurs could take a position in the futures contract and an opposite position in the spot market. For example, if the July corn futures contract were available at \$3.25 on the delivery date in July and the spot price for corn were \$3.32 at a grain elevator near the delivery place specified on the contract (resulting in no hauling cost), then arbitrageurs could go long in the July contract, take delivery by buying the corn at \$3.25 on the futures contract, and then sell the corn on the spot at \$3.32 to earn a riskless profit of \$0.07/bu. Arbitrageurs' efforts to take long positions, however, would drive the contract price up to \$3.32. On the other hand, if f_T exceeds \$3.32, then arbitrageurs would reverse their strategy, pushing f_T to \$3.32/bu. Thus, at delivery, arbitrageurs will ensure that the prices on expiring

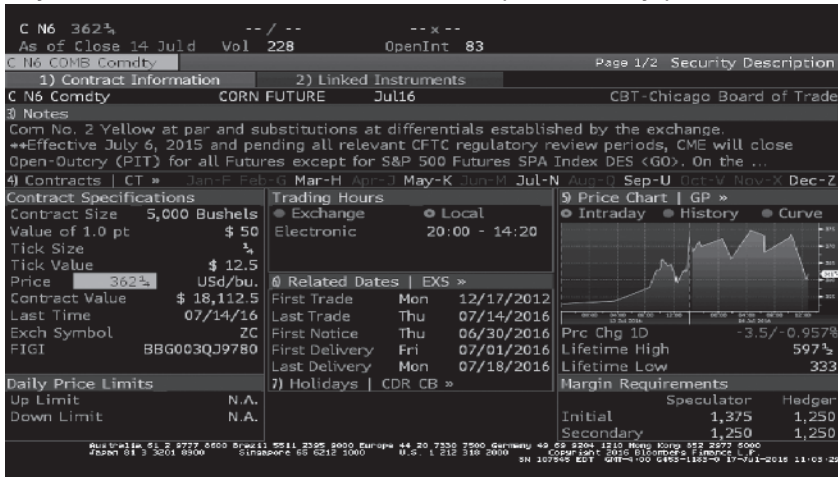
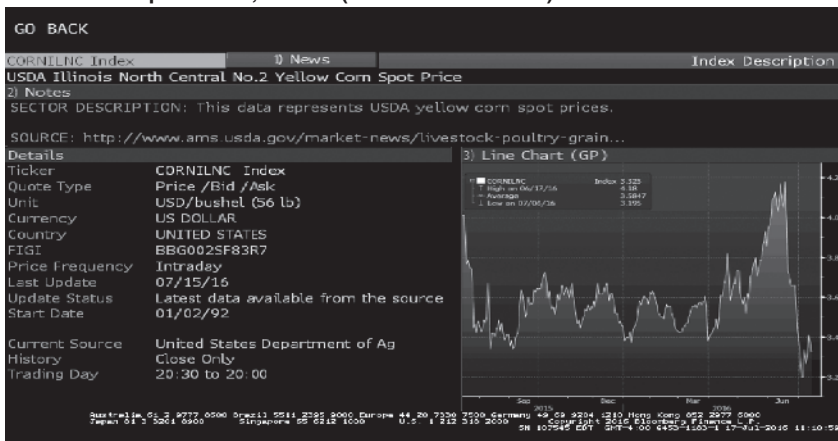
contracts are equal to the spot price or the spot prices plus the hauling cost. As a result, closing a futures contract with an offsetting position at expiration will yield the same profits or losses as closing futures positions on the spot by purchasing (selling) the asset on the spot and selling (buying) it on the futures contract.

Returning to our example, suppose that near the delivery date on the July contract, the spot price of corn and the price on the expiring corn futures contracts are \$3.63/bu. To close his existing short contract, Speculator Y would need to take a long position in the July contract, while to offset her long contract, Speculator Z would need to take a short position. Suppose Speculators Y and Z take their offsetting positions with each other on the expiring July corn contract priced at $f_T = S_T = \$3.63/\text{bu}$. After the clearinghouse breaks up the new contract, Speculator Y would receive \$0.26/bu. from the clearinghouse and Speculator Z would pay \$0.51/bu. to the clearinghouse:

Clearinghouse Records for Speculator Y:	
1.	Speculator Y agrees to <i>sell</i> July corn to CH for \$3.89/bu.
2.	Speculator Y agrees to <i>buy</i> September wheat from CH at \$3.63/bu.
Close	Thus, to close Speculator Y owes the Clearinghouse \$0.26/bu. $(\$0.26/\text{bu.})(5,000 \text{ bu.}) = \$1,300.$
Clearinghouse Records for Speculator Z:	
1.	Speculator Z agrees to <i>buy</i> September wheat at \$4.14/bu.
2.	Speculator Z agrees to <i>sell</i> September wheat for \$3.63/bu.
Close	Thus, to close the Speculator Z owes Clearinghouse \$0.51/bu. $(-\$0.51/\text{bu.})(5,000 \text{ bu.}) = -\$2,550.$

To recapitulate, in this example, the contract prices on July corn contracts went from \$3.89/bu. on the X and Y contract, to \$4.14/bu. on the X and Z contract, to \$3.32/bu. on the Y and Z contract at expiration. Speculator X received \$0.25 and Speculator Y received \$0.26/bu. from clearinghouse, while Speculator Z paid \$0.51/bu. to the clearinghouse. The clearinghouse with a perfect hedge on each contract received nothing (other than clearinghouse fees attached to the commission charges), and no corn was purchased or delivered.

Note: This example is based on a July 2016 corn futures prices and spot prices. As shown in the Bloomberg Description screen in Exhibit 1.2, the July contract calls for purchase or delivery of 5,000 bushels of No. 2 yellow corn. The futures and spot price graphs (GP) in Exhibit 1.3 show the futures price was ¢389 (cents per bushel) on 12/14/15, ¢414 on 6/1/16, and ¢363 $\frac{1}{2}$ on 7/15/16 (expiration date) when the spot corn price was \$3.32 $\frac{1}{2}$ and the implied hauling cost was \$0.31/bu.

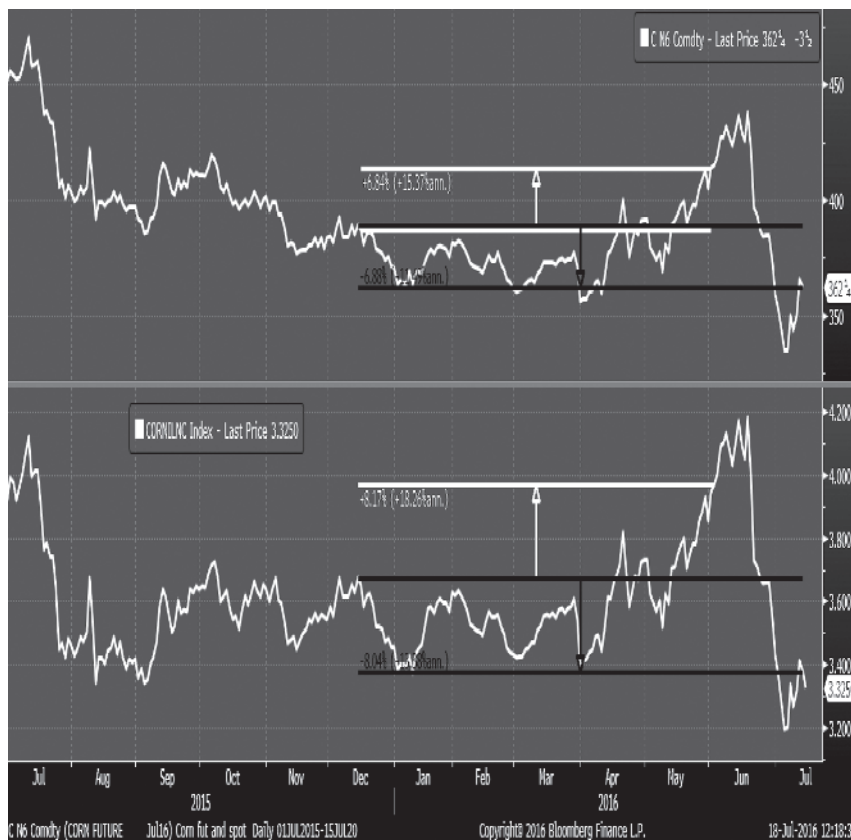
EXHIBIT 1.2 Bloomberg Spot and Futures Corn Prices**July 2016 CBT Corn Futures Contract on 7/15/16 (C N6 <Comdty>)****Yellow Corn Spot Prices, 7/15/16 (CORNILNC <Index>)****Types of Futures Contracts**

Various types of futures contracts are traded on the CBT, CME, Eurex, Singapore, and other exchanges. There are also a number of competing contracts offered by dealers on the OTC market. Futures and forward contracts can be classified either as a physical commodity, energy, equity index, foreign currency, bond, and interest rate.

Physical Commodities

Physical commodities include both agriculture and metallurgical. Agriculture commodities consist of grains (e.g., wheat, corn, and oats), oil and meal (e.g., soybeans and sunflower), livestock (e.g., cattle, pork bellies, and live hogs), forest products

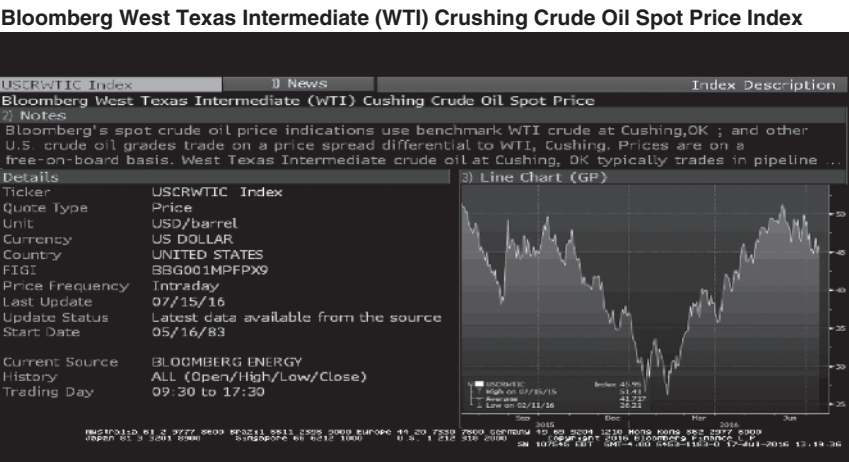
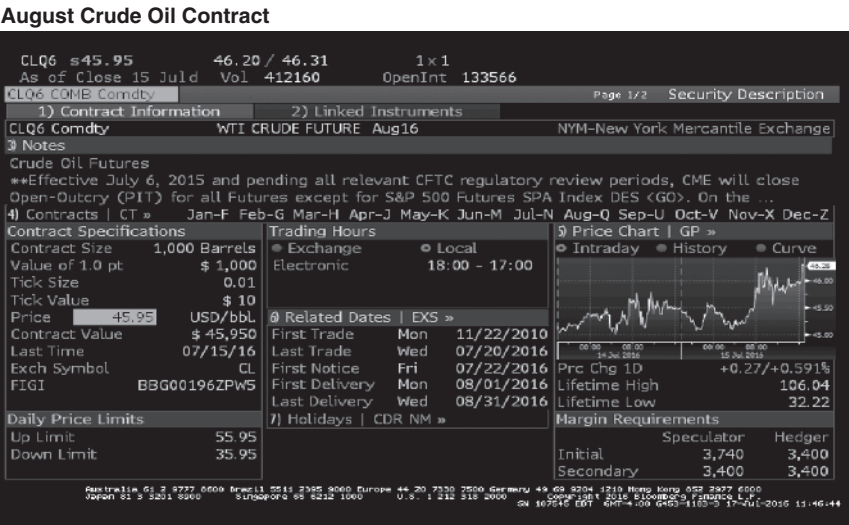
EXHIBIT 1.3 Prices on July 2016 CBT Corn Futures Contracts and Yellow Corn Spot Prices, 7/1/15 to 7/15/16



(e.g., plywood), foodstuffs (e.g., orange juice, coffee, and sugar) and textile (e.g., cotton). Many of the agricultural commodities have different contracts for different grades and expiration months, with the expiration months on crops typically set up to conform to their harvest patterns. Metallurgical contracts include metal (e.g., gold, silver, platinum, and copper) and petroleum products (e.g., heating oil, crude oil, gasoline, and propane).

The New York Mercantile Exchange (NYMEX), ICE, Dubai Exchange, and other exchanges offer a number of futures contracts on crude oil, gasoline, and heating oil. Some of these contracts require a cash settlement, while others require physical delivery. Exhibit 1.4 shows the Bloomberg Description screen for the NYMEX's July 2016 crude oil futures contract and a spot contract on West Texas crude. The NYMEX also offers contracts on natural gas. One of the NYMEX contracts calls for the physical delivery of 10,000 million British thermal units (Btu) of natural gas to be made during the delivery month at a uniform rate. Finally, the NYMEX offer contracts on electricity. A typical contract calls for receiving (delivering) a specified number of megawatt-hours for a specified price at a specified location during a particular month. The contracts can vary from a 5×8 contract in which power is received five days a week during the

EXHIBIT 1.4 NYMEX August 2016 Crude Oil Futures Contract and Spot Index, 7/15/16
Bloomberg Description Screen (CLQ6 <Comdty>, USCRWTIC <Index>)



off-peak hours for a specified month to a 7×24 contract that calls for receiving power every day and hour during the month.

A somewhat-related contract is a weather derivative. In 1999, the CME offered contracts on cumulative heating degree days (*HDD*) and cooling degree days (*CDD*). A day's *HDD* is a measure of the volume of energy needed for heating during a day, and a *CDD* is measure of the volume of energy required for cooling during a day. Each can be measure as

$$HDD = \text{Max} [65^\circ - A, 0]$$
$$CDD = \text{Max} [A - 65^\circ, 0]$$

where:

A = average high and low temperature during a day.

The CME contracts are measured in terms of cumulative *HDD* or *CDD* for a specified month at a specified weather station (e.g., Atlanta, New York, or Cincinnati). These contracts call for a cash settlement. Exhibit 1.5 shows the Bloomberg Description screen for the CME's October 2016 Cincinnati *HDD* futures contract.

In addition to exchange-traded energy and weather futures contracts, the exchanges also offer spot options and futures option contracts on energy and weather products. There is also an extensive OTC market for energy derivatives, as well as other commodity contract. For example, OTC dealers have offered for a number of years a long-term swap arrangement on crude oil in which one party agrees to exchange a fixed price on oil to another party who agrees to exchange a floating price. Weather derivatives have been offered since the 1970s by OTC dealers.

Currency Futures and Forward Contracts

As noted in the introduction, foreign currency futures contracts were introduced in May of 1972 by the CME. Today, currency futures are listed on various futures exchanges (see Exhibit 2.1 in Chapter 2). The CME is the largest currency futures exchange. The contracts on the CME call for the delivery (or purchase) of a specified amount of foreign currency at the delivery date. The contract prices are quoted in terms of dollars per unit of foreign currency.

Forward contracts on foreign currencies are provided in the Interbank Foreign Exchange Market. This OTC market is larger than the currency futures market,

EXHIBIT 1.5 CME October 2016 Cincinnati HDD Oil Futures Contract, 7/15/16 Bloomberg Description Screen (CJV6 <Index>)

CJV6 926.0		-- / --	-- x --
As of Close 14 Jul		Vol --	OpenInt --
CJV6 Index		Page 1/2 Security Description	
1) Contract Information		2) Linked Instruments	
CJV6 Index		CINCINN HDD IX FT Oct16	
3) Notes		CME-Chicago Mercantile Exchange	
Description:Cincinnati Heating Degree Days (HDD) Index Future. The Measuring Station is located at Northern Kentucky Airport.			
Exchange ticker: H3...			
4) Contracts CT » Jan-F Feb-G Mar-H Apr-J May-K Jun-M Jul-N Aug-O Sep-U Oct-V Nov-X Dec-Z			
Contract Specifications		Trading Hours	
Contract Size 20 \$ x index		● Exchange ● Local	
Value of 1.0 pt \$ 20		18:00 - 16:15	
Tick Size 1.0			
Tick Value \$ 20			
Price 926.0 index point		5) Price Chart GP »	
Contract Value \$ 18,520		● Intraday ● History ● Curve	
Last Time 07/14/16		6) Related Dates EXS »	
Exch Symbol H3		Cash Settled	
FIGI BBG005JYQOM0		First Trade Tue 11/05/2013	
		Last Trade Wed 11/02/2016	
		Valuation Date Wed 11/02/2016	
Daily Price Limits		7) Holidays CDR CE »	
Up Limit N.A.		Margin Requirements	
Down Limit N.A.		Speculator Hedger	
		Initial 1,630 1,482	
		Secondary 1,482 1,482	
Australia 61 2 9777 8600 Brazil 55 11 2395 9000 Europe 44 20 7330 7500 Germany 49 69 3204 1210 Hong Kong 852 2377 6000 Japan 61 3 3201 6900 Singapore 65 6212 1000 U.S. 1 212 318 2050 Copyright 2016 Bloomberg Finance L.P. SN 107645 EDT GMT+8:00 G453-1103-1 17-Jul-2016 12:55:51			

consisting primarily of major banks that provide forward contracts to their clients, which often are large multinational corporations and institutions. In the interbank market, banks provide tailor-made contracts to their customers. Typically, the minimum size of an interbank forward contract is \$1 million, with expirations ranging from one to 12 months, although longer-term maturities can be arranged. Currency futures and forward contracts are examined in Chapter 2.

Equity Indexes

There are a number of index futures contracts available on various US and non-US derivative exchanges. Many of the contracts are on equity indexes, but there are also non-equity indexes on bond, commodity, currency, volatility, and spread indexes. The size of index futures contracts is equal to a multiple of the index value, and the futures contracts are cash-settled contracts. Equity index futures contracts are examined in Chapter 3.

Bond and Interest Rate Futures

The most popular bond and interest rate futures contracts are the Eurodollar deposit, T-bonds, and T-notes contracts. T-bills offered on the CME were at one time popular, but due to the popularity of Eurodollar futures contracts, they were delisted. The features of bond and interest rate contracts and their uses are examined in Chapter 4.

The Organized Markets and Characteristics of Futures Trading

The purpose of organized exchanges is to provide marketability: the ease and speed of trading securities. As we examined earlier, one important way that futures exchanges provided marketability is by setting up a clearinghouse for guaranteeing and intermediating contracts. The exchanges also provide marketability by providing physical or electronic platforms for brokers and dealers to trade, standardizing contracts, and establishing trading rules.

For many years, the mode of trading on futures exchanges was that of brokers and dealers going to a pit and using the *open-outcry* method to trade. In this system, orders were relayed to the floor by runners or by hand signals to a specified trading pit. An order was then offered in open outcry to all participants (e.g., commission brokers or locals [those trading for their own accounts]) in the pit, with the trade being done with the first person to respond.

Although the open-outcry system is still used, electronic trading systems are today the primary mode used by the organized exchanges to trade derivatives. The CME and CBT developed with Reuters (the electronic information service company) the *GLOBEX* trading system. This is a computerized order-matching system with an international network linking member traders. Since 1985, all new derivative exchanges

have been organized as electronic exchanges. Most of these electronic trading systems are order-driven systems in which customer orders (bid and ask prices and size) are collected and matched by a computerized matching system. In addition to linking futures traders, the futures exchanges also make contracts more marketable by standardizing contracts, providing continuous trading, establishing delivery procedures, and providing 24-hour trading through exchange alliances.

Standardization

The futures exchanges provide standardization by specifying the grade or type of each asset and the size of the underlying asset. Exchanges also specify how contract prices are quoted. For example, the contract sizes on most wheat and corn contracts on the Chicago Board of Trade are 5,000 bushels, the size of the crude oil contracts on the New York Mercantile Exchange are 1,000 barrels, gold contracts listed on the CMX Commodity Exchange are 100 troy ounces, and euro contracts on the Chicago Mercantile Exchange are for 125,000 euros.

Continuous Trading

On many futures exchanges, continuous trading is through locals who are dealers that are willing to take temporary positions in one or more futures. These dealers fall into one of three categories: *scalpers*, who offer to buy and sell simultaneously, holding their positions for only a few minutes and profiting from a bid-ask spread; *day traders*, who hold positions for less than a day; and *position traders*, who hold positions for as long as a week before they close. Collectively, these dealers make it possible for the futures markets to provide frequent, if not continuous, trading.

Price and Positions Limits

Futures exchanges often impose price limits as a tool to stop possible destabilizing price trends from occurring. When done, the exchanges specify the maximum price change that can occur from the previous day's settlement price. The price of a contract must be within its daily price limits, unless the exchange intervenes and changes the limit. For example, the crude oil futures contract shown in Exhibit 1.4, in turn, is shown trading at \$45.90 per barrel on 7/15/16, with an up limit of \$55.95 and down limit of \$35.95. When the contract price hits its maximum or minimum limit, it is referred to as being limited up or limited down. In addition to price limits, futures exchanges also can set position limits on many of their futures contracts. This is done as a safety measure both to ensure sufficient liquidity and to minimize the chances of a trader trying to corner a particular asset.

Delivery Procedure

Only a small number of futures contracts are actually delivered. Nevertheless, detailed delivery procedures are important to ensure that the contract price on a

futures contract is determined by the spot price on the underlying asset and that the futures price converges to the spot price at expiration. The exchanges have various rules and procedures governing the deliveries of contracts and delivery dates. The date or period in which delivery can take place is determined by the exchange. When there is a delivery period, the party agreeing to sell has the right to determine when the asset will be delivered during that period. For example, the first delivery date on the July 2016 corn futures contract shown in Exhibit 1.2 is 7/1/16, the last delivery date is 7/18/16, and the first notification date is 6/30/16.

Alliances and 24-Hour Trading

In addition to providing off-hour trading via electronic trading systems, 24-hour trading is also possible by using futures exchanges that offer trading on the same contract. A number of exchanges offer identical contracts. This makes it possible to trade the contract in the United States, Europe, and the Far East. Moreover, these exchanges have alliance agreements making it possible for traders to open a position in one market and close it in another.

Margin Requirements

Since a futures contract is an agreement, it has no initial value. Futures traders, however, are required to post some security or good faith money—margin—with their brokers. Depending on the brokerage firm, the customer's margin requirement can be satisfied either in the form of cash or cash equivalents. The margins differ depending on whether the trader is a hedger or speculator. The dollar margin requirements are shown in the lower right corner of the Bloomberg Description screens (Exhibits 1.2, 1.4, 1.5, 1.11, 1.13, and 1.16). As a proportion of their contract values, the margins are approximately 5% for speculator and slightly less for hedgers.

Futures contracts have both initial and maintenance margin requirements. The *initial* (or *performance*) *margin* is the amount of cash or cash equivalents that must be deposited by the investor on the day the futures position is established. The futures trader does this by setting up a margin (or commodity) account with the broker and depositing the required cash or cash equivalents. The amount of the margin is determined by the margin requirement, defined as a proportion (m) of the contract value (e.g., 5%). For example, if the initial margin requirement is 5%, then corn Speculators X and Y in our first example would be required to deposit \$972.50 in cash or cash equivalents in their commodity accounts as good faith money on their \$3.89 July wheat futures contracts:

$$m[\text{Contract Value}] = 0.05[(\$3.89/\text{bu.})(5,000 \text{ bu.})] = \$972.50$$

At the end of each trading day, the futures trader's account is adjusted to reflect any gains or losses based on the settlement price on new contracts. In our example, suppose the day after Speculators X and Y established their respective long and short

positions, the settlement price on the July corn contract were $f_T = \$3.85/\text{bu.}$ The value of X's and Y's margin accounts would therefore be:

$$X: \text{Account Value} = \$972.50 + (\$3.85/\text{bu.} - \$3.89/\text{bu.})(5,000 \text{ bu.}) = \$772.50$$

$$Y: \text{Account Value} = \$972.50 + (\$3.89/\text{bu.} - \$3.85/\text{bu.})(5,000 \text{ bu.}) = \$1,172.50$$

With the lower futures price, X's long position decreased in value by \$200 and Y's short position increased by \$200. When there is a decrease in the account value, the futures trader's broker has to exchange money through the clearing firm equal to the loss on the position to the broker and clearinghouse with the gain. This process is known as *marking to market*. Thus, in our case, X's broker and clearing firm would pass on \$200 to Y's broker and clearing firm.

To ensure that the balance in the trader's account does not become negative, the brokerage firm requires a *maintenance margin* (or *variation margin*) be maintained by the futures traders. The maintenance margin is the amount of additional cash or cash equivalents that futures traders must deposit to keep the equity in their commodity account equal to a certain percentage (e.g., 75%) of the initial margin value. If the maintenance margin requirement were set at 100% of the initial margin, then the equity value of X's and Y's accounts would each have to be at least \$972.50. If Speculator X did not deposit the \$200 required margin, then she would receive a *margin call* from the broker instructing her to post the required amount of funds. If Speculator X did not comply with the margin call, the broker would close the position.

It should be noted that the margin requirements and clearinghouse mechanism that characterize futures exchanges also serve to differentiate them from customized forward contract positions written by banks and investment companies. Forward contracts are more tailor-made contracts, usually do not require margins, and the underlying asset is typically delivered at maturity instead of closed; they are, however, less marketable than exchange-traded futures.

Transaction Costs

Maintaining margin accounts can be viewed as part of the cost of trading futures. In addition to margin requirements, transaction costs are also involved in establishing futures positions. Such costs include broker commissions, clearinghouse fees, and the bid-ask spread. On futures contracts, commission fees usually are charged on a per contract basis and for a round lot, and the fees are negotiable. The clearinghouse fee is relatively small and is collected along with the commission fee by the broker. The bid-ask spreads are set by dealers and represent an indirect cost of trading.

A Note on Taxes

In the United States, futures positions are treated as capital gains and losses for tax purposes. For speculators, a marked-to-market rule applies in which the profits on a futures position are taxed in the year the contract is established. That is, at the end of

the year, all futures contracts are marked to the market to determine any unrealized gain or loss for tax purposes. For example, suppose in September a futures speculator takes a long position on a March contract at a contract price of \$1,000. If the position were still open at the end of the year, the speculator's taxes on the position would be based on the settlement price at year's end. If the contract were marked to market at \$1,200 at the end of the year, then a \$200 capital gain would need to be added to the speculator's net capital gains to determine her tax liability. If the speculator's position were later closed in March of the following year at a contract price of \$1,100, then she would realize an actual capital gain of \$100. For tax purposes, though, the speculator would report a loss equal to the difference in the settlement price at the end of the year (\$1,200) and the position's closing price (\$1,100): that is, a \$100 loss. Both realized and unrealized capital losses, in turn, are deductibles that are subtracted from the investor's capital gains.

Note: The end-of-the-year marked-to-market rule on futures applies only to speculative positions and not to hedging positions. Gains or losses from hedges are treated as ordinary income with the time of the recognition occurring at the time of the gain or loss of income from the hedged item. Also note that when delivery on a futures contract takes place, taxes are applied when the asset actually is sold.

Commodity Futures Hedging

Exchange futures and OTC forward contracts provide investors, businesses, and other economic entities a means for hedging their particular spot positions against adverse price movements. Two hedging positions exist: long hedge and short hedge. In a *long hedge* (or hedge purchase), a hedger takes a long position in a futures contract to protect against an increase in the price of the underlying asset or commodity. Long hedge positions are used, for example, by manufacturers to lock in their future costs of purchasing raw materials, by portfolio managers to fix the price they will pay for securities in the future, or by US multinational corporations that want to lock in the dollar costs of buying foreign currency at some future date. In a *short hedge*, the hedger takes a short futures position to protect against a decrease in the price of the underlying asset. In contrast to long hedging, short hedge positions are used, for example, by farmers who want to lock in the price they will sell their crops for at harvest, by portfolio managers and investment bankers who are planning to sell securities in the future and want to minimize price risk, or by US multinational corporations who have to convert future foreign currency cash flows into dollars and want to immunize the future exchange against adverse changes in exchange rates.

Long Commodity Hedge Example

To illustrate a long hedge position, consider the case of an oil refinery that, in January, anticipates purchasing 100,000 barrels of crude oil in July. Suppose the refinery wants to avoid the price risk associated with buying crude oil on the spot market in July.

In the absence of a forward contract or futures markets for crude oil, the only way the refining company could avoid price risk would be to buy the crude oil in January and store it until July. With crude oil futures contracts listed on the NYMEX, however, the refinery alternatively can minimize price risk by taking a long position in the July crude oil contract (see Exhibit 1.6). With the standard size on crude oil futures of 1,000 barrels, the company would need to go long in 100 July crude oil contracts to hedge its July spot purchase. To this end, suppose the refinery goes long in 100 July contracts at $f_T = \$32.54/\text{barrel}$; that is, agrees to buy 100,000 barrels of crude oil (100 contracts with each contract 1,000 barrels) at $\$32.54/\text{barrel}$ at the expiration date on the July contract). At expiration, the company would probably find it advantageous (lower transportation costs) to purchase its 100,000 barrels of crude oil on the spot market at the spot price, then close its futures position by going short in the expiring July crude oil futures contract. Given that the spot and expiring futures prices must be equal (or approximately equal), the refinery will find that any additional costs of buying crude oil above the $\$32.54/\text{barrel}$ price on the spot market will be offset by a profit from its futures position; while on the other hand, any benefits from the costs of crude oil being less than the $\$32.54/\text{barrel}$ price would be negated by losses on the refinery's futures position. As a result, the refining company's costs of buying crude oil on the spot and closing its futures position would be $\$32.54/\text{barrel}$, which is the initial July crude oil contract price they obtained in January.

EXHIBIT 1.6 Prices on NYMEX July 2016 Crude Oil Futures Contract and West Texas Spot Index, 7/17/15 to 7/1/16 Bloomberg GP Screens (CLQ6 <Comdty>, USCRWTIC <Index>)



EXHIBIT 1.7 Long Hedge Example**Initial Position:**

Long in July crude oil futures contracts at \$32.54/barrel to hedge crude oil purchases in July.

At Delivery:

Close July crude oil contract at $f_T = S_T$ and purchase crude oil on the spot market at S_T .

Positions	Costs		
(1) July Spot Price	\$25.00	\$32.54	\$50.00
(2) Cost of 100,000 Barrels	\$2,500,000	\$3,254,000	\$5,000,000
(3) Profit on Futures	−\$754,000	0	\$1,746,000
(4) Net Costs: Row (2) − Row (3)	\$3,254,000	\$3,254,000	\$3,254,000

(Profit on futures)/barrel = $100 (f_T - \$32.54)/\text{barrel}(1,000 \text{ barrels})$

The refining company's long hedge position is shown in Exhibit 1.7. In the exhibit, the first row shows three possible spot prices at the July delivery date of \$25.00, \$32.54, and \$50.00. The second row shows the cost of buying 100,000 barrels of crude oil on the spot markets, and the third row shows the profits and losses from the long futures position, in which the offset position has a contract price (f_T) equal to the spot price (S_T). The last row shows the net costs of buying 100,000 barrels of \$3,254,000 resulting from purchasing the crude and closing the futures position. Thus, if the price of crude oil on the spot market were \$25.00 at the July delivery date, the refinery would pay \$2,500,000 for 100,000 barrels of crude oil and \$754,000 to the clearinghouse to close its futures positions (i.e., the agreement to buy 100,000 barrels at \$32.54 and the offsetting agreement to sell 100,000 barrels at \$25.00 means the refining company must pay the clearinghouse \$754,000). By contrast, if the spot crude oil price were \$50.00, the company would have to pay \$5,000,000 for 100,000 barrels of crude oil, but could finance part of that expenditure with the \$1,746,000 receipt from the clearinghouse from closing (i.e., agreement to buy at 100,000 barrels at \$32.54 and the offsetting agreement to sell 100,000 barrels at \$50.00, means the clearinghouse will pay the refining company \$1,746,000).

Note: As shown in Exhibit 1.6, the July 2016 futures price of crude oil contracts trading on the MYMEX was \$32.54/barrel on 1/20/16. A long hedger with 100 contracts on the July contract would agree to buy 100,000 barrels of light crude oil at \$32.54/barrel (\$3,254,000 cost). From January to July 2016, the price of crude oil increased. On 6/20/16, the spot price of West Texas crude oil was \$49.37 and the July 2016 futures price was \$48.85. If the hedger bought 100,000 barrels of crude oil on the spot, the cost would be \$4,937,000. However, the hedger would receive \$1,631,000 from closing the 100 futures contracts. That is, to close on July 20, 2016, the hedger would have had to go short in 100 July 2016 futures contracts at \$48.85 per barrel (i.e., agree to sell 100,000 barrels at \$48.85) in order to close the 100 long July contracts at \$32.54/barrel that was set up in January (i.e., the agreement to buy 100,000 barrels at \$32.54); thus, the hedger would receive \$1,631,000 from the clearinghouse.

EXHIBIT 1.8 Long Crude Oil Hedge of July 2016 Crude Oil Purchase

Clearinghouse Records for Long Crude Oil Hedger:	
1/20/16	Hedger agrees to <i>buy</i> July crude oil at \$32.54/barrel; 100 contracts; 1,000 barrels per contract.
6/20/16	Hedger agrees to <i>sell</i> July crude oil at \$48.85/barrel; 100 contracts; 1,000 barrels per contract.
Close	Clearinghouse pays the hedger \$16.31/barrel Total Receipt: $(100)(\$16.31/\text{barrel})(1,000 \text{ barrels}) = \$1,631,000$
6/20/16	Cost of Crude Oil: $\$4,937,000 = (100,000 \text{ barrels}) (\$49.37/\text{barrel})$ Hedged Cost = Cost of Crude – Futures Profit Hedged Cost = $\$4,937,000 - \$1,631,000 = \$3,306,000$

In this case, the hedger's hedged cost on July 20, 2016, of buying crude oil on the spot at \$4,937,000 and receiving \$1,631,000 from the clearinghouse would have been \$3,306,000 (see Exhibit 1.8). In retrospect, the hedger would have been pleased by having set up the hedge.

Short Commodity Hedge Example

To illustrate how a short hedge works, consider the case of a corn farmer who, in December, wants to lock in the price he will receive for his estimated 100,000 bushels of corn expected to be harvested in July. If the farmer goes short in 20 July corn futures contracts (contract size is 5,000 bushels) priced at \$3.90/bu. on 12/14/16, he would be able to receive approximately \$3.89/bu. in revenue at the delivery date in July from selling the corn on the spot market and closing the futures contracts by going long in the expiring July contracts trading at the spot price. This can be seen in Exhibit 1.9. In the exhibit, the first row shows three possible spot prices of \$4.10, \$3.90, and \$3.70, the second row shows revenues from selling 100,000 bushels on the spot market, the third row shows the profits and losses from the futures position, and the fourth row shows the constant hedged revenue \$390,000 from aggregating both positions. If the farmer receives \$3.70 per bushel for his corn and therefore only \$370,000 from selling his 100,000 bushels, he also realizes a \$20,000 profit from futures position (the agreement to sell 100,000 bushels of July corn for \$3.90 is closed with an agreement to buy 100,000 bushels of July corn for \$3.70, resulting in a \$20,000 receipt from the clearinghouse). On the other hand, if the farmer is able to sell his corn for \$4.10 per bushel and therefore \$410,000, he also will have to pay the clearinghouse \$20,000 (the agreement to sell 100,000 bushels of July corn for \$3.90 is closed with an agreement to buy 100,000 bushels of July corn for \$4.10), resulting in a \$20,000 receipt from the clearinghouse. Thus, regardless of the spot price, the farmer receives \$390,000.

Exhibit 1.3 shows the prices on the July 2016 corn futures contract listed on the CBT from 7/1/15 to 7/14/16 and the spot prices on yellow corn. On 12/14/15, a

EXHIBIT 1.9 Short Corn Hedge Example**Initial Position:**

Short in 20 July corn futures contracts at \$3.90/bu. to hedge corn sale in July.

At Delivery:

Close corn futures contracts at $f_T = S_T$ and sell the harvested corn on the spot market at S_T .

Positions	Revenue per Bushel		
(1) Spot Corn Price	\$4.10	\$3.90	\$3.70
(2) Revenue: S_T (5,000 bu)	\$410,00	\$390,000	\$370,000
(3) Profit from Futures	−\$20,000	0	\$20,000
(4) Net Revenue = Row (2) + (3)	\$390,000	\$390,000	\$390,000

(Profit from Futures) = (5,000 bu.)(($\$3.90 - f_T$)/bu.)

farmer wanting to hedge 100,000 bushels of corn to be harvested and sold on 7/15/16 would have been able to go short in 20 July 2016 corn futures contracts at \$3.89 per bushel; a contract value of \$389,000 (= (20)(5,000 bushes)($\$3.89/\text{bu.}$)). From 12/14/15 to 7/14/16, the spot price of corn decreased approximately 8.00% from \$3.67 to \$3.375. On 7/15/16, the spot price of yellow corn was \$3.375/bu. and the July 2016 corn futures price was \$3.6225. If the farmer sold his 100,000 bushels on the spot on 7/14/16, he would have received \$337,500 for his corn. However, he would also have received \$26,750 when he closed his 20 corn futures contracts. That is, to close on 7/15/16, the hedger would have had to go long in 20 July 2016 futures contracts at \$3.6225 (i.e., agree to buy 100,000 bushels at \$3.6225) in order to close the 20 short July contracts at \$3.89/bu. that was set up on 12/14/16 (i.e., the agreement to sell 100,000 bushels at \$3.89); thus, the farmer would receive \$26,750 from the clearinghouse. In this case, the farmer's hedged revenue on July 15, 2016, of selling corn on the spot for \$337,500 and receiving \$26,750 from the clearinghouse would have been \$364,250 (see Exhibit 1.10). In retrospect, the farmer would have been pleased by having set up the short hedge.

EXHIBIT 1.10 Short Corn Hedge of July 2016 Corn

Clearinghouse Records for Short Corn Futures Hedger:	
12/14/16	Hedger agrees to <i>sell</i> July corn at \$3.89/bu.; 20 contracts; 5,000 bushels per contract.
7/14/16	Hedger agrees to <i>buy</i> July corn at \$3.6225/bu.; 20 contracts; 5,000 bushels per contract.
Close	Clearinghouse pays the hedger \$0.2675 Total Receipt: (20)($\$0.2675/\text{barrel}$)(5,000 bushels) = \$26,750
7/14/16	Sale of Corn on the spot at \$3.375: \$337,500 = (100,000 bushels) ($\$3.375/\text{bu.}$) Hedged Revenue = Corn Sale + Futures Profit Hedged Revenue = \$337,500 + \$26,750 = \$364,250

Hedging Risk

These examples in which the hedger closed the futures position at an expiring futures price equal to the spot represent perfect hedging cases in which certain revenues or costs can be locked in at a future date. In practice, perfect hedges are the exception and not the rule. This was seen in the case in which the farmer sold his corn at \$3.375 on the spot and closed his futures at \$3.6225. There are three types of hedging risk that preclude one from obtaining a zero risk position: *quality risk*, *timing risk*, and *quantity risk*.

Quality risk exists when the commodity or asset being hedged is not identical to the one underlying the futures contract. The oil refinery in our first hedging example, for instance, may need to purchase a different grade or quality of crude oil than the one specified in the futures contract. In our corn example, the price difference between the spot and futures can be explained in the differences in types of corn on the spot and futures and the hauling cost. In certain hedging cases, futures contracts written on a different underlying asset are used to hedge the spot asset. For example, a portfolio manager planning to buy corporate bonds in the future might hedge the acquisition by going long in T-bond futures. This type of hedge is known as a *cross hedge*. Different from *direct hedges* in which the futures' underlying assets is the same as the asset being hedged, cross-hedging cannot eliminate risk, but can minimize it.

Timing risk occurs when the delivery date on the futures contract does not coincide with the date the hedged assets or liabilities need to be purchased or sold. For example, timing risk would exist in our second hedging example if the corn farmer expected to harvest his corn in late June instead of mid-July. If the spot asset or commodity is purchased or sold at a date t that differs from the expiration date on the futures contract, then the price on the futures (f_t) and the spot price (S_t) will not necessarily be equal. The difference between the futures and spot price is called the *basis* (B_t). The basis tends to narrow as expiration nears, converging to zero at expiration ($B_T = 0$). Prior to expiration, the basis can vary, with greater variability usually observed the longer the time is to expiration. Given this *basis risk*, the greater the time difference between buying or selling the hedged asset and the futures' expiration date, the less perfect the hedge. To minimize timing risk or basis risk, hedgers often select futures contracts that mature before the hedged asset is to be bought or sold but as close as possible to that date. For very distant horizon dates, though, hedgers sometimes follow a strategy known as *rolling the hedge forward*. This hedging strategy involves taking a futures position, then at expiration closing the position and taking a new one.

Finally, because of the standardization of futures contracts, futures hedging also is subject to quantity risk. Quantity risk would have been present in our second hedging example if the farmer had expected a harvest of 102,000 bushels instead of 100,000 bushels. With the contract size on the corn futures contract being 5,000 bushels, 100,000 bushels of the farmer's harvest could be hedged, but 2,000 would be subject to price risk.

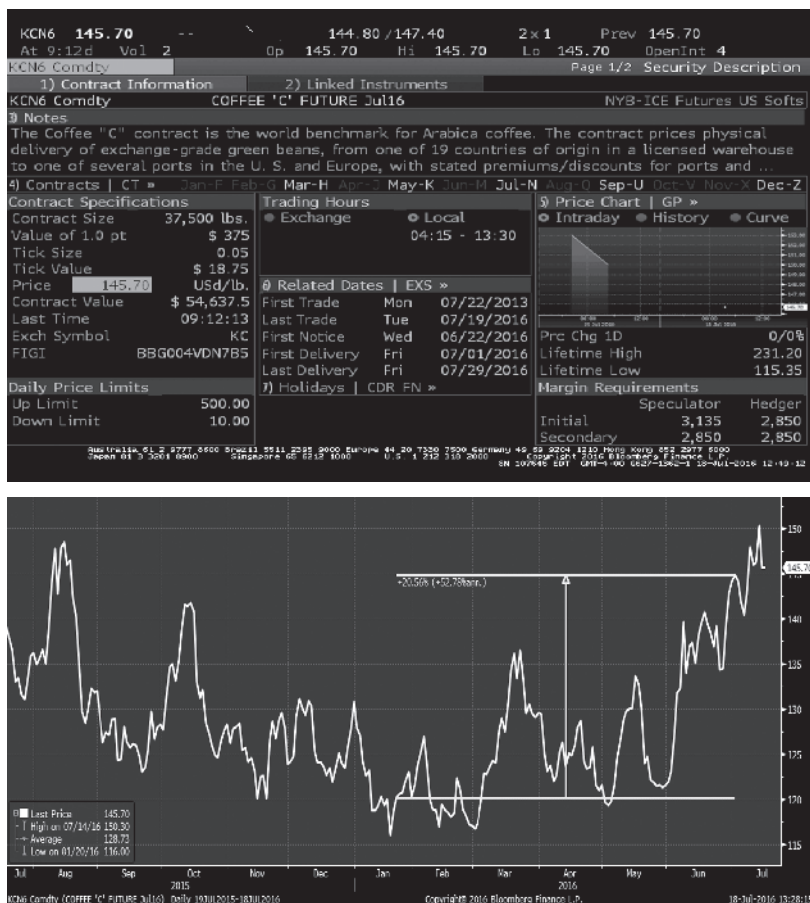
Hedging Models

The presence of quality, timing, and quantity risk means that pricing risk cannot be eliminated totally by hedging with futures contracts. As a result, the objective in hedging is to try to minimize risk. Several hedging models try to achieve this objective: price-sensitivity model, minimum variance model, naive-hedge model, and utility-based hedging model. These models have as their common objective the determination of a *hedge ratio*: the optimal number of futures contracts needed to hedge a position. In later chapters, we will define and examine how some of these models can be used to hedge stock portfolios, debt securities, and foreign currency positions.

Commodity Speculating with Futures

Although futures are used quite extensively for hedging, they are also used to speculate on expected price changes. A long futures position is taken when the price of the underlying asset is expected to rise and a short position is taken when the price is expected to fall. Such positions are referred to as *outright futures positions*. For example, consider coffee speculators tracking the July 2016 coffee futures prices shown in Exhibit 1.11. On 1/22/16, financial news reported coffee crop declines in Brazil and expectant doubling of Starbucks in China. Based on these reports, suppose a bullish coffee speculator took a long position on 1/22/16 in one July 2016 coffee contract at 120.15 cents (\$1.2015). The contract would require the speculator to buy 37,500 pounds of coffee at \$1.2015 in July with the first delivery date being July 1, 2016 (see Bloomberg Description page in Exhibit 1.11). As shown in the graph in Exhibit 1.11, if the long speculator closed her position on 7/1/16 when the July futures contract was trading at \$1.4485, she would have realized a profit of \$9,262.50. By contrast, a bearish speculator who took a short position in the July coffee futures on 1/22/16, perhaps after observing recent price decline, would have lost \$9,262.50 by taking a short position on 1/22/16 at \$1.2015 and closing it at \$1.4485 on 7/1/16 (see Exhibit 1.12).

Speculating on a change in the price of an asset or commodity by taking such outright or naked futures positions represents an alternative to buying or short selling an asset or commodity on the spot market. Because of the risk inherent in such outright futures positions, some speculators form spreads instead of taking a naked position. A futures spread is formed by taking long and short positions on different futures contracts simultaneously. There are two general types of spreads: intracommodity and intercommodity. An *intracommodity spread* is formed with futures contracts on the same asset but with different expiration dates; an *intercommodity spread* is formed with two futures contracts with the same expiration but on different assets.

EXHIBIT 1.11 2016 July Coffee Futures Contract Bloomberg Description Screen**EXHIBIT 1.12** Outright Positions in July 2016 Coffee Futures Positions

Clearinghouse Records for Long Coffee Speculator:	
1/22/16	Speculator agrees to buy 37,500 pounds of coffee in July for \$1.2015 per lb.
7/1/16	Speculator agrees to sell 37,500 pounds of coffee in July at \$1.4485 per lb.
Close	Clearinghouse pays Speculator \$9,262.50
	Closing receipt from clearinghouse: 37,500 lbs. $(\$1.4485/\text{lb.} - \$1.2015/\text{lb.}) = \$9,262.50$
Clearinghouse Records for Short Coffee Speculator:	
1/22/16	Speculator agrees to sell 37,500 pounds of coffee in July for \$1.2015 per lb.
7/1/16	Speculator agrees to buy 37,500 pounds of coffee in July at \$1.4485 per lb.
Close	Speculator pays clearinghouse Speculator \$9,262.50
	Closing payment to clearinghouse: 37,500 lbs. $(\$1.2015 - \$1.4485/\text{lb.}) = -\$9,262.50$

Intracommodity Spread

An intracommodity spread is often used to reduce the risk associated with a pure outright position. More distant futures contracts (T_2) are sometimes more price sensitive to changes in the spot price, S , than near-term futures contracts (T_1):

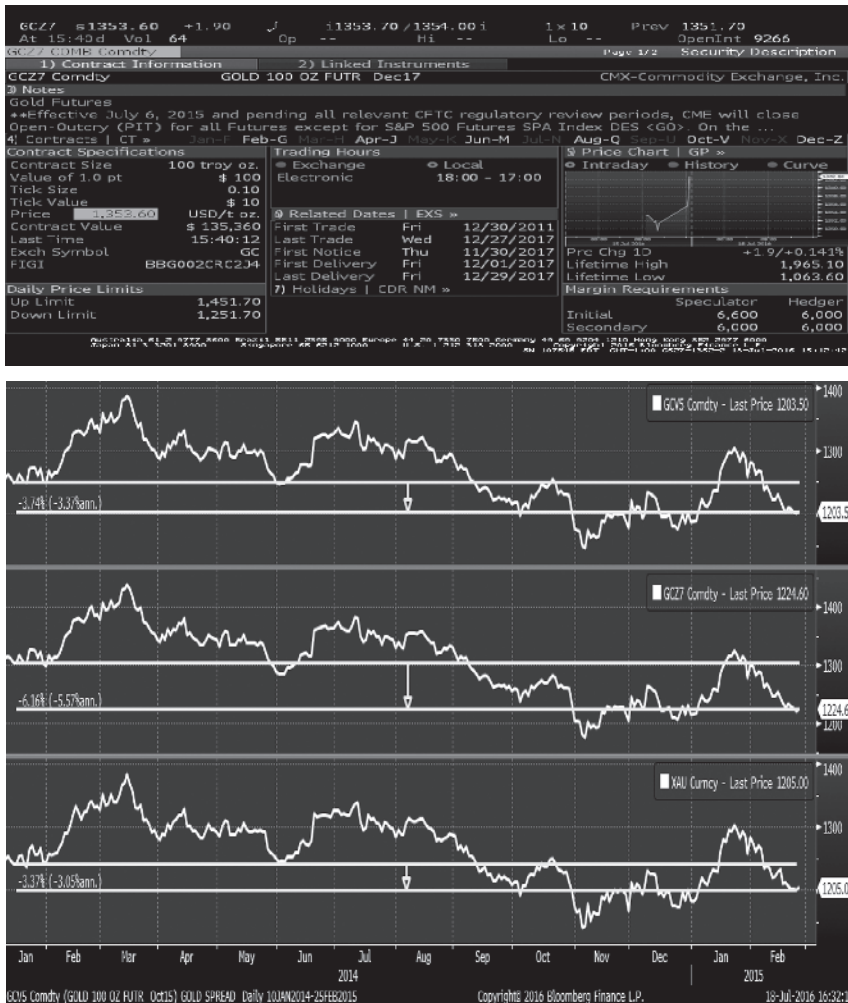
$$\frac{\% \Delta f_{T_2}}{\% \Delta S} > \frac{\% \Delta f_{T_1}}{\% \Delta S}$$

Thus, a speculator who expects the price of a commodity or asset to increase in the future could form an intracommodity spread by going long in the asset's or commodity's longer-term futures contract and short in a shorter-term one. This type of intracommodity spread will be profitable if the expectation of the price increasing occurs. That is, the increase in the commodity or asset price will cause the price on the longer-term futures to increase more than the shorter-term one. As a result, a speculator's gains from his long position in the longer-term futures will exceed his losses from his short position. If the spot price falls, though, losses will occur on the long position; these losses will be partially offset by profits realized from the short position on the shorter-term contract. On the other hand, if a speculator believes the spot price will decrease but did not want to assume the risk inherent in an outright short position, he could form a spread with a short position in a longer-term contract and a long position in the shorter-term one. Note that in forming a spread, the speculator does not have to keep the ratio of long-to-short positions one-to-one, but instead could use any ratio (2-to-1, 3-to-2, etc.) to obtain her desired return-risk combination.

Exhibit 1.13 shows the prices from 1/10/2014 to 2/25/15 for a COMEX October 2015 gold futures contract (GCV5) and a December 2017 gold futures contract (GCZ7), along with gold spot prices (XAU) (COMEXC is a division of the NYMEX). Suppose a speculator bullish on gold formed an intracommodity spread on 1/16/14 by going long in one COMEX December 2017 gold contract (100 troy ounces) at \$1,305.00/oz. and short in one October 2015 gold contract at \$1,250.20. From 1/16/2014 to 2/25/2015, spot gold prices decreased 3.37% from \$1,242.39 to \$1,200.53, the longer-term December 2017 contract decreased 6.16% to \$1,224.66, and the shorter-term October 2015 contract decreased 3.74% to \$1,203.56. If the bullish spreader closed his position on 2/25/2015, he would have realized a loss of \$8,034 on the December 2017 contract and a gain of \$4,670 on the October 2015 contract, for a net loss of \$3,364 (see Exhibit 1.14).

In retrospect, the spreader would have wished he had taken an outright short position in the longer-term December 2017 contract where he would have realized a profit of \$8,034. The bullish spreader's short position, however, was used to give him protection if gold prices decreased, which was the case for this time period. In contrast, a bearish speculator who took a bearish intracommodity spread on 1/16/14 by going short in the December 2017 contract and long in the October 2015 contract would have gained \$3,364 if she closed the positions on 1/23/2015. Thus, the intracommodity spread provides the speculator with a lower return opportunity but also lower risk than the outright position.

EXHIBIT 1.13 Bloomberg Description Screen for December 2017 Gold Futures Contract and Prices on October 2015 Gold Futures, December 2017 Gold Futures, and Gold Spot 1/10/2014 to 2/16/2105



It should be noted that differences in futures price with different expiations depend, in part, on interest rates and difference in the expiration period. When interest rates are low, the price differences with contracts with different expiration may be small, and as a result, the applicability of using intracommodity spreads to provide different return-risk may be only minimal.

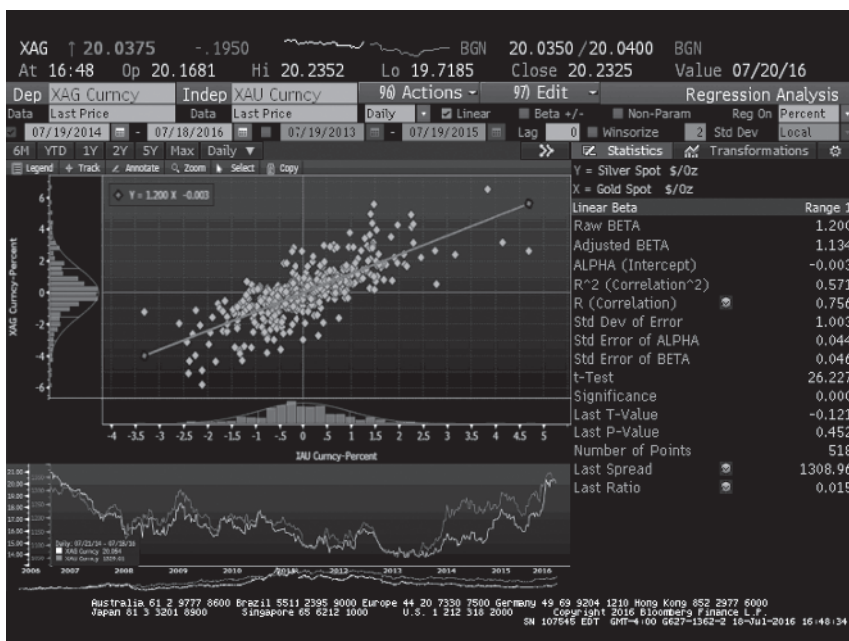
Intercommodity Spread

An inter-commodity spread is formed with two futures contracts with the same expiration dates but on different commodities (e.g., opposite positions on a July gold futures contract and a July silver contract). In constructing intercommodity spreads, a spreader

EXHIBIT 1.14 Intracommodity Spread: Long in One December 2017 Gold Futures Contract and Short in One October 2015 Futures Contracts

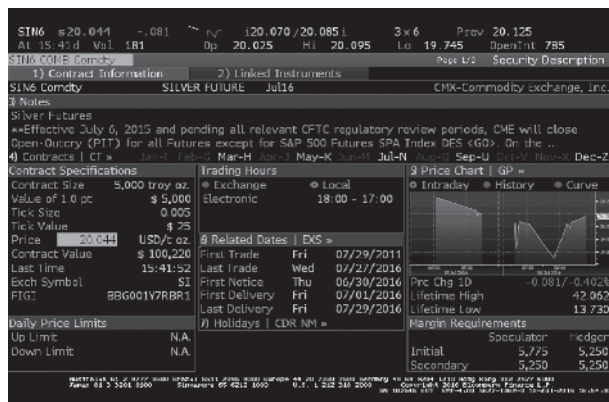
1/16/14	Clearinghouse Records for Long December 2017 Position
to 2/25/15	
1/16/14	Speculator agrees to buy 100 troy ounces of gold in December 2017 for \$1,305.00/oz.
2/25/15	Speculator agrees to sell 100 troy ounces of gold in December 2017 for \$1,224.66/oz.
Close	Speculators pays \$8,034 to the clearinghouse: 100 oz. $(\$1,224.66/\text{oz.} - \$1,305.00/\text{oz.}) = -\$8,034$
	Clearinghouse Records for Short October 2015 Position
1/16/14	Speculator agrees to sell 100 troy ounces of gold in October of 2015 for \$1,250.20/oz.
2/25/15	Speculator agrees to buy 100 troy ounces gold in October 2015 for \$1,203.50/oz.
Close	Speculators receives \$4,670 from the clearinghouse: 100 oz. $(\$1,250.20/\text{oz.} - \$1,203.50/\text{oz.}) = \$4,670$
	Net Position
2/25/15	$\$4,670 - \$8,034 = -\$3,364$

often makes use of the correlation between the underlying assets. Exhibit 1.15 shows an estimated regression relation between the percent change in the spot price of silver per troy ounce and the percent change in the spot price of gold per troy ounce.

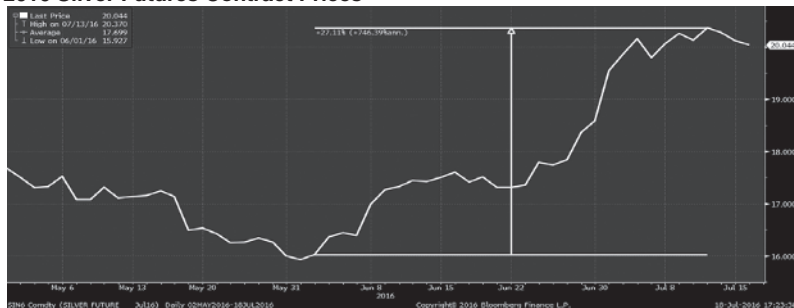
EXHIBIT 1.15 Regression Relation between Percentage Change in Gold Prices (XAU) and Silver Prices (XAG), 7/19/2014 to 7/18/16

The slope of the regression line is $\% \text{ Change Silver} / \% \text{ Change Gold} = 1.134$. A mildly bullish precious metals speculator who wanted a lower return-risk combination than implied by either metal could form an intercommodity spread by going long in one COMEX silver futures contract and short in one gold futures contract. Based on the regression relationship, there would be an 11.34% increase (decrease) in silver prices for a 10% increase (decrease) in gold prices. Thus, for a 10% increase in gold prices, the bullish spreader would, in turn, realize a 1.34% gain, and for a 10% decrease in gold price, the spreader would lose 1.34%.

EXHIBIT 1.16 Bloomberg Description Screen for Prices on July 2016 Silver Futures and July 2016 Gold Futures, 5/2/16 to 7/18/16



July 2016 Silver Futures Contract Prices



July 2016 Gold Futures Contract Prices

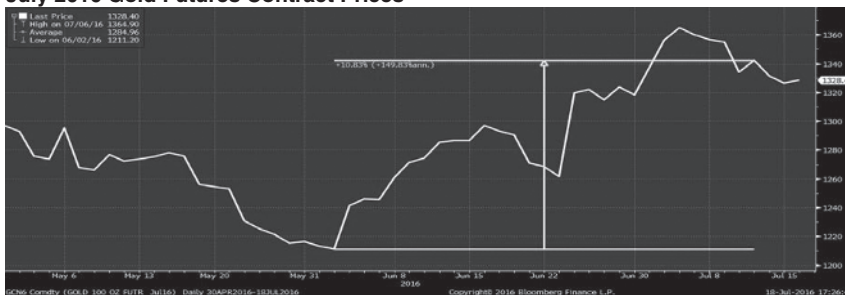


Exhibit 1.16 shows the prices for a July 2016 silver futures contract and a July 2016 gold contract. As shown in the Bloomberg Description screen in the exhibit, the contract on silver calls for the delivery or purchase of 5,000 troy ounces of silver in July. The gold contract (see Exhibit 1.13), in turn, calls for the delivery or purchase of 100 troy ounces of gold in July. Suppose a speculator, expecting the price of precious metal to increase in the near future, formed an intercommodity spread on 5/2/16 by going long in one July silver contract at \$16.025 and short in one July gold contract at \$1,211.20. From 5/2/16 to 6/2/16, precious metal prices did increase, resulting in a 27.11% increase in July silver futures to \$20.37 and a 10.83% increase in July gold futures prices to \$1,342.40. If the spreader closed her intercommodity spread on 6/2/16, she would have realized a profit of \$21,725 on her long July silver futures contract and a loss of \$13,120 on her short July gold futures contract, resulting in a net gain of \$8,605 (see Exhibit 1.17).

The spreader probably regretted that she did not take an outright long position in the silver contract where she would have realized a \$21,725 gain. Her short position in gold, however, was taken to give her some protection in case the price of precious metals decreased.

EXHIBIT 1.17 Intercommodity Spread: Long in July 2016 Silver Futures Contract and Short in July 2016 Gold Futures Contract

5/2/16	Clearinghouse Records for Long July 2016 Silver Futures Position
to 6/2/16	
5/2/16	Opening Position: Long in one July silver futures contract (contract size = 5,000 oz.): Speculator agrees to buy 5,000 troy ounces of silver in July for \$16.025/oz.
6/2/16	Closing Position: Short in one July silver futures contract: Speculator agrees to sell 5,000 troy ounces in July for \$20.37/oz.
Close	Speculator receives \$21,725 from the clearinghouse: $(\$20.37/\text{oz.} - \$16.025/\text{oz.})(5,000 \text{ oz.}) = \$21,725$
	Clearinghouse Records for Short July 2016 Gold Futures Position
5/2/16	Opening Position: Short in one July gold futures contract (contract size = 100 troy ounces): Speculator agrees to sell 100 troy ounces in July for \$1,211.20
6/2/16	Closing Position: Long in one July gold futures contract: Speculator agrees to buy 100 troy ounces in July for \$1,342.40
	Speculators pays clearinghouse \$13,120:
Close	$(\$1,211.20/\text{oz.} - \$1,342.40/\text{oz.})(100 \text{ oz.}) = -\$13,120$
	Net Position
6/2/16	$\$21,725 - \$13,120 = \$8,605$

Pricing Futures and Forward Contracts: Carrying-Cost Model

Basis

As a derivative security, the price on a futures contract depends on the price of the underlying asset. The difference between the futures price and the spot price is called the basis (B_t):

$$\text{Basis} = B_t = f_t - S_t$$

(The basis also can be expressed as $S_t - f_t$.) For most futures contracts, the futures price exceeds the spot price before expiration and approaches the spot price as expiration nears. Thus, the basis usually is positive and decreasing over time, equaling zero at expiration ($B_T = 0$). Futures and spot prices also tend to be highly correlated with each other, increasing and decreasing together. Their correlation, though, is not perfect. As a result, the basis tends to be relatively stable along its declining trend, even when futures and spot prices vacillate.

By definition, a normal market is one in which the futures price exceeds the spot price and is referred to as a *contango*. In contrast, if the market is inverted with the futures price less than the spot price (a negative basis), the costs of carrying the asset is said to have a *convenience yield* in which the benefits from holding the asset exceed the costs. An inverted market in which the basis is negative is referred to as *backwardation*.

Carrying-Cost Model for a Commodity

The relation between the futures (or forward) price and the spot price is governed by an arbitrage relation that is explained by the *carrying-cost model* (or *cost-of-carry model*). This model determines the equilibrium futures price by solving for that price that is equal to the cost of carrying the underlying asset for the time period from the present to the expiration on the contract (i.e., the net cost of buying the underlying asset and holding it for the period). If the futures price does not equal the cost of carrying the underlying asset, then an arbitrage opportunity exists by taking a position in futures and an opposite position in the underlying asset. Thus, in the absence of arbitrage, the price on the futures contract is equal to the cost of carrying the asset. The model is used to explain what determines the equilibrium price on a forward contract. If short-term interest rates are relatively constant, futures and forward prices will be equal, and thus the carrying-cost model can be extended to price futures contracts as well.

For financial futures, the carrying costs include the financing costs of holding the underlying asset to expiration minus the benefits from coupon interest or dividends earned from holding the asset. For commodities, the carrying costs include not only financing costs but also storage and transportation costs, and generally there are no benefits. The carrying-cost model for a typical commodity forward contract is:

$$f_0^* = S_0 (1 + R_f)^T + (K)(T) + TRC$$

where:

- K = storage costs per unit of the commodity per period
- TRC = transportation costs
- T = time to delivery as a proportion of a year

To illustrate, suppose on April 15 the spot price of a bushel of corn is \$3.66 (see Exhibit 1.3), the annual storage costs is \$0.35 per/bushel, the risk-free rate is 3%, and the costs of hauling corn from the destination point specified on the futures contract to a local grain elevator, or vice versa, is \$0.035/bu. By the cost of carry model, the equilibrium price of a futures contract on the July corn (expiration of $T = 0.25$) would be \$3.81/bu.:

$$f_0^* = (\$3.66/\text{bu.})(1.03)^{0.25} + (0.35/\text{bu.})(0.25) + \$0.035/\text{bu.} = \$3.81/\text{bu.}$$

If the futures price in the market, f^M , was \$3.85/bu. (above the equilibrium price), an arbitrageur could:

1. Take a short position in the futures contract: agree to sell a July bushel of corn for \$3.85.
2. Borrow \$3.66 at 3% interest.
3. Use the loan proceeds to buy a bushel of corn for \$3.66, and then store it for three months.
4. At expiration: (1) pay the financing costs of \$3.687/bu. ($= \$3.66(1.03)^{0.25}$), (2) pay the storage costs of $(\$0.35/\text{bu.})(0.25) = \$0.0875/\text{bu.}$, (3) transport the corn from the grain elevator to the specified destination point on the futures contract for \$0.035/bu., and (4) sell the bushel of corn on the futures contract at \$3.85/bu.

From this cash-and-carry strategy, the arbitrageur would earn a riskless return of \$0.04/bu.

$$f_0^M - f_0^* = \$3.85 - [\$3.66(1.03)^{0.25} + (0.35)(0.25) + \$0.035] = \$0.04$$

If the futures price on a commodity is below the equilibrium price, the strategy would need to be reversed. This would entail taking a short position in the spot commodity and a long position in the futures contract. In our corn example, such an opportunity might be available, for example, to a mill company maintaining an inventory of corn. Instead of holding all of its corn, the company might sell some of it on the spot market and invest the proceeds in a risk-free security for the period, then go long in a futures contract to buy the corn back. For many commodities, though, this reverse strategy may not be practical. For those commodities in which the reverse cash-and-carry arbitrage strategy does not apply, the equilibrium condition for the futures contract needs to be specified as an inequality:

$$f_0^* \leq S_0 (1 + R_f)^T + (K)(T) + TRC$$

For commodity futures, an inverted market in which the spot price exceeds the futures price often exists for unstorable commodities (e.g., eggs) or can occur in certain situations in which the existing supplies of a commodity (e.g., corn) are limited, but future supplies (e.g., the next corn harvest) are expected to be abundant.

Pricing the CBT September 2016 Corn Futures Contract

Exhibit 1.18 shows the futures price on the CBT September 2016 contract, the spot prices on yellow corn, and Bloomberg's GRCC screen (grain cash and carry analysis). On 7/14/16, the spot price of yellow corn was \$3.3759/bu., short-term interest rates were approximately 1%, the storage cost for Iowa yellow corn for three months was 0.03/bu, the cost of hauling corn 60 miles from River Gulf Grain Elevator in Bettendorf, Iowa, was \$0.15/bu, and the time to the September contract was $T = 0.25$ per year. Using these numbers, the carrying-cost price on the September CBT corn futures on 7/14/16 would have been \$3.5643/bu.

$$f_0^* = S_0(1 + R_f)^T + (K)(T) + TRC$$

$$f_0^* = (\$3.3759/\text{bu.})(1.01)^{0.25} + (0.03/\text{bu.}) + \$0.15/\text{bu.}] = \$3.5643/\text{bu.}$$

EXHIBIT 1.18 Bloomberg Grain and Cash and Carry Analysis Screen (GRCC) for Yellow Corn on 7/15/16 and Prices on September 2016 CBT Corn Futures Contracts and Yellow Corn Spot Prices, 7/20/15 to 7/14/16

Enter #<GO> to chart forward period net return for a given buyer

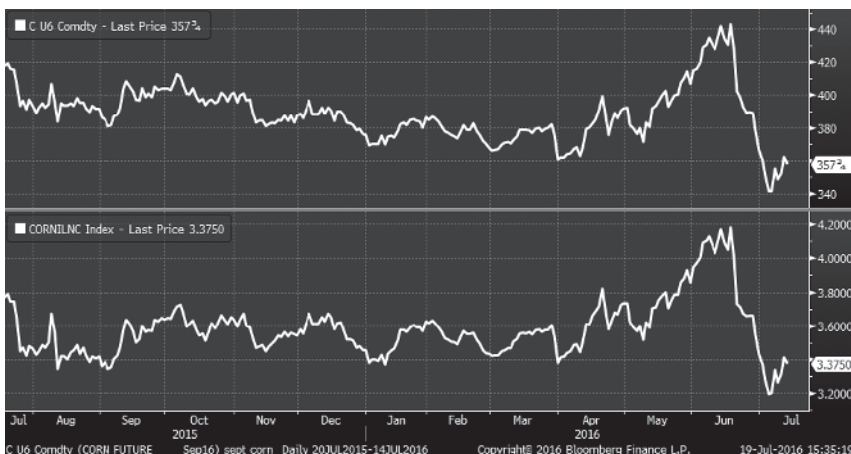
US Grains Cash and Carry Analysis

Find Buyers around: Consumers Coop Within 50 Miles
Commodity: Corn (Yellow) - bushel (56 lb.) Hauling Rate: .25 USD per 100 Miles
Source: CGB Storage Cost: .01 USD per Month
Period: March 2017

Local Spot Bid Price: 3.71 USD from Consumers Coop as of 05-26-16
Storage Cost: 0.09 USD from July 2016 to March 2017

Net Return = Buyer's price - local spot bid price - storage cost - hauling cost

Buyer	Updated	Bid Price	Basis	Distance	Hauling Cost	Net Return
1) Adm Growmark	05-26-16	4.16	-0.07	30	.08	.28
2) Cargill	05-26-16	4.10	-0.07	30	.08	.22
3) Tri Oak Foods	05-26-16	3.93	-0.24	39	.10	.03
4) River Valley Coop	05-26-16	3.90	-0.21	34	.09	.01
5) Eichelberger Milling Inc	05-26-16	3.87	-0.30	43	.11	-.03
6) River Valley Coop	05-26-16	3.85	-0.26	43	.11	-.05
7) Farmers Coop	05-26-16	3.83	-0.34	39	.10	-.06
8) Penford	05-26-16	3.54	-0.10	30	.08	-.33



This price, in turn, is close to the actual futures price on the September contract on 7/14/16 where the September corn's last price was \$3.5775, the bid was \$3.5675, and the ask was \$3.56.

Price Relationship Between Futures Contracts with Different Expirations

The same arbitrage arguments governing the futures and spot price relation also can be extended to establish the equilibrium relationship between futures prices with different expirations. Specifically, given a distant futures contract expiring in T_2 and a nearby contract on the same asset expiring in T_1 , the equilibrium relationship between the futures prices on the two contracts (f_{T_2} and f_{T_1}) is:

$$f_{T_2}^* = f_{T_1} (1 + R_{T_1})^{T_2 - T_1} + (K)(T_2 - T_1) + TRC$$

where:

R_{T_1} = risk-free rate or repo rate at time T_1 . This rate can be locked in with a forward contract to borrow funds at R_{T_1} (see Chapter 4).

If the market price of the forward contract with T_2 expiration ($f_{T_2}^M$) exceeded the equilibrium price, an arbitrageur could profit by forming an intracommodity spread by:

1. Taking a long position in the T_1 futures contract
2. Taking a short position in the T_2 futures contract
3. Entering a forward contract to borrow at time T_1 , f_{T_1} dollars at rate R_{T_1} for the period from T_1 to T_2

At T_1 expiration, the arbitrageur would:

1. Borrow f_{T_1} dollars at a rate of R_{T_1} on the forward contract.
2. Buy the commodity on the T_1 futures contract for f_{T_1} .
3. Transport and store the commodity for the period at a costs of $K(T_2 - T_1) + TRC$.

At the T_2 expiration, the arbitrageur would:

1. Sell the asset on the T_2 futures contract for f_{T_2} .
2. Repay the loan of $f_{T_1}(1 + R_{T_1})^{T_2 - T_1}$.
3. Pay the transportation and storage costs of $K(T_2 - T_1) + TRC$.
4. Transport the commodity to the specified destination point on the futures contract.

The arbitrageur's actions would result in a riskless CF of

$$CF = f_{T_2}^M - [f_{T_1}(1 + R_{T_1})^{T_2 - T_1} + (K)(T_2 - T_1) + TRC]$$

Such actions, in turn, would continue until the equilibrium condition is satisfied.

To illustrate, consider the forward price relationship for October and July corn contracts. Suppose the following conditions are present:

1. The future price on the July corn contract is $f_{T_1} = \$3.81/\text{bu.}$
2. The July forward interest rate on a three-month loan is 3% (annual).
3. The storage costs for corn is \$0.35/bu. per year.
4. The costs of transporting are \$0.035/bu.

If the time period between the expiration on the July corn contract and the October contract is $T_2 - T_1 = 0.25/\text{year}$, then the equilibrium price on the October contract would be \$3.96/bu.

$$f_{T_2}^* = \$3.81(1.03)^{0.50-0.25} + (\$0.35)(0.50 - 0.25) + \$0.035/\text{bu.} = \$3.96/\text{bu.}$$

If the October corn futures contract is \$4.00, then an arbitrageur could earn a \$0.04/bu. profit by:

1. Entering a July forward contract to borrow \$3.81 at $R_{T_1} = 3\%$
2. Going long in the July corn contract at $f_{T_1} = \$3.81/\text{bu.}$
3. Taking a short position on the October corn contract at $f_{T_2} = \$4.00$

In July, the arbitrageur would:

1. Borrow \$3.81 at 3% interest on the forward contract.
2. Purchase the corn on the July contract at \$3.81.
3. Store the corn at an annual rate of \$0.35/bu. for 0.25 of a year.

At the October expiration the arbitrageur would realize a \$0.04/bu. profit. by:

1. Selling the corn on the October contract for \$4.00/bu.
2. Repaying the loan of \$3.838 ($= \$3.81(1.03)^{0.25}$)
3. Paying the storage costs of \$0.0875 ($= (\$0.35/\text{bu.})(0.25)$)
4. Transporting the corn from the grain elevator to the specified destination point on the futures contract for \$0.035/bu.

$$CF = f_{T_2}^M - f_{T_2}^*$$

$$CF = \$4.00 - [\$3.81(1.03)^{0.50-0.25} + (0.35)(0.50 - 0.25) + \$0.035]$$

$$CF = \$0.04$$

If the October corn contract is less than the equilibrium price, the above intracommodity spread strategy would need to be reversed. This would require taking a short position in the July contract, a long position in the October contract, and entering a forward contract to invest f_{T_1} funds at rate R_{T_1} for $T_2 - T_1$. The implementation of this reverse strategy may or may not be practical. For financial futures, for example, this reverse strategy generally can be applied. However, as noted for some commodity futures contracts, the reverse strategy does not hold. For such commodity futures, the carry-cost, in turn, needs to be expressed as an inequality.

The Value of Futures and Forward Contracts

The carrying-cost model determines the forward or futures price. A separate question is whether there is any value to the futures or forward contract. A futures or forward contract is simply an agreement that has no inherent value when it is introduced. In the case of forward contracts, there is a value to an existing contract. After its introduction, the value of a forward contract at time t should be equal to the present value of the difference between its initial contract price (F_0) and the contract price on a new forward contract with the same expiration date and underlying asset (F_t). That is, the value of a long position on the initial forward contract at time t (V_t) is:

$$V_t = \frac{F_t - F_0}{(1 + R)^t}$$

For example, if the forward contract price on September corn is \$3.83 (F_t) when there is one month to expiration ($t = 1/12$ of a year) and the annual risk-free rate is 3%, then the value of a long position on a September wheat forward contract initiated earlier at \$3.81 would be \$0.01995:

$$V_t = \frac{F_t - F_0}{(1 + R)^t} = \frac{\$3.83 - \$3.81}{(1.03)^{1/12}} = \$0.01995$$

With one month to delivery, the \$0.01995 value of the earlier contract reflects the \$0.02 riskless return that can be realized at the end of one month by the holder of the earlier contract forming an intracommodity spread by taking a short position in the new contract. At the expiration, the spreader would be able to buy the corn at \$3.81 and sell it at \$3.83.

Like forward contracts, futures contracts also can have values after their inceptions, but only until they are marked to market. Once a futures contract is marked to market, its value reverts to zero.

The Relation between Futures and Forward Prices

The price relationships we've described thus far hold strictly for forward contracts that have no initial or maintenance margin requirements. As noted, if short-term interest rates are relatively constant over time, it can be shown that the prices of futures and forward contracts on the same underlying asset are the same. The proof of this relation, as well as the relation between futures prices and expected spot prices, is presented in many derivative texts.

Conclusion

In this chapter, we have provided an overview of futures and forward contracts. These derivatives can be used as speculative tools to profit from changes in asset prices and as hedging tools to minimize price risk. Futures contracts are traded on organized exchanges that establish trading rules and procedures for buying and selling contracts. In this chapter, we examined the speculative and hedging uses of physical commodities. In the next chapter, we examine the hedging and speculative uses of currency futures

and forward contracts. In Chapters 3 and 4, we respectively examine equity index and interest rate contracts.

BLOOMBERG: COMMODITY FUTURES AND RELATED SCREENS

Appendix A at the end of this book presents an overview and guide to the Bloomberg system. In this section, we identify screens and functions related to commodity futures. In subsequent chapters, we identify Bloomberg screens and functions applicable to that chapter's subject.

BLOOMBERG CTM SCREEN AND UPLOADING

Bloomberg Commodity Screens, CTM

Exchange-listed commodity futures contracts can be found by accessing the CTM screen shown in Exhibit 1.1: CTM <Enter>. Contracts can be found by category, exchange, and region. For example, to find the corn contract offered by the CBT, use the CBT Exchange screen and click "Corn" from the dropdown menu in the "Category" column. Alternatively, click "Categories" and "Commodities" and then type the name of the exchange (e.g., CBT) in the amber Exchange box and find the contract of interest.

Uploading a Futures Contract

To upload a futures contract's menu screen enter: Ticker <Comdty> (e.g., C A <Comdty> for the CBT's corn futures contract menu), and then use the Expiration screen (EXS) on the contract's menu page to find the ticker for the contract with the expiration month you want to analyze: Ticker <Comdty> (e.g., C H7 <Comdty> for the March 2017 contract). View screens to examine:

- CT: Contract Table
- EXS: Expiration Schedule
- GP: Price Graph
- GIP: Intraday Graph
- COSY: Commodity Studies

SECF for Finding and Uploading Futures, Forward, and Spot Contracts

The SECF screen can be used to find the tickers for a select commodity's futures, forward, and spot contracts: SECF <Enter>; select "Commodities" from the Category dropdown, select type from the tabs (e.g., Agriculture), select subtype from "Category" dropdown (e.g., corn), select type of contract from the "Instrument" dropdown (e.g., futures, forward, and spot. To upload the menu screens, enter: Ticker <Comdty> or <Index> (e.g., CORNILNC <Index> for North Central Illinois No. 2 Corn Spot Prices.

The menu includes:

- Des: Description
- GP: Price Graph

- GIP: Intraday Graph
- COSY: Commodity Studies

COST OF CARRY

Grain Cash and Carry Analysis (GRCC)

The GRCC screen can be used to search for the best grain prices. The screen monitors real-time prices from over 10,000 US grain elevators (combined with road networks and trucking rates) to pinpoint cheapest-to-deliver grain prices within a certain radius. You can also compare spot and forward delivery prices when buying from a specific grain elevator. See Exhibit 1.18.

Commodity Price Forecast (CPFC)

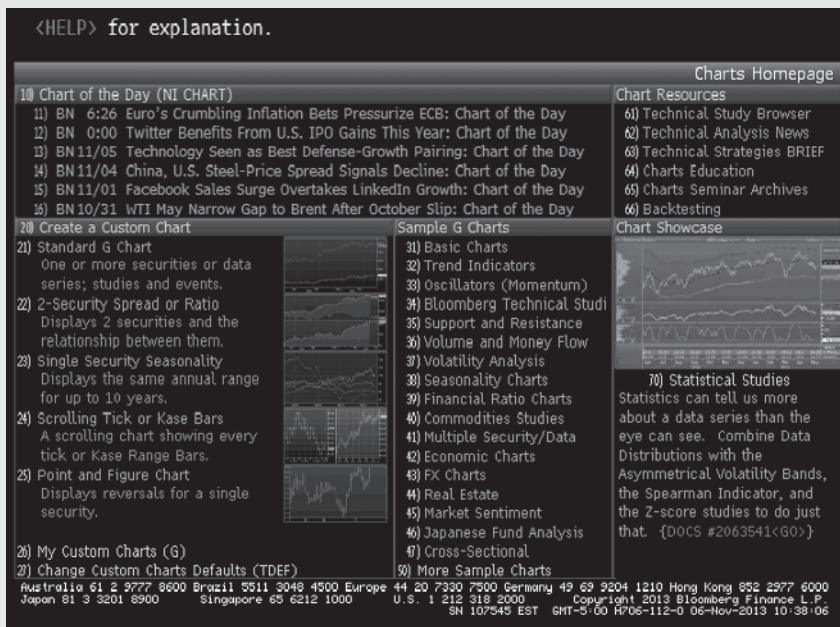
CPFC allows you to compare price forecasts for major commodity products, such as crude oil, natural gas, and metals. The screen displays analysts' estimates. CPFC also allows you to compare forecasts against the current forwards.

BLOOMBERG CHARTS AND ANNOTATIONS TOOLS

Charts Homepage: Chart <Enter>

The chart homepage has five box areas: Custom charts, sample charts, new charting analytics, chart resources, and chart of the day newswire (See Exhibit 1.19).

EXHIBIT 1.19 Bloomberg Custom Chart Screen



(Continued)

Custom Chart (G <Enter>)

On the Custom Chart screen, you can create and customize charts representing different relationships, showing various technical studies. Charts created on other screens, such as GP, can also be saved to the Custom Chart screen by clicking the “Save as” tab on that screen. To create a new chart, click “Create Chart” tab and then select type. On the graph screens, you can edit the graph by going to the “Edit” dropdown tab. From the “Edit” dropdown, you can place graphs in separate panels (Securities and Data) and change colors and lines (Chart Colors and Lines).

Annotations

Lines, regression lines, bands, and other drawings can be included on a graph by clicking the “Annotate” button on the gray toolbar at the top of the price chart. Clicking the button will bring up an annotations palette showing all of the tools for drawing on the chart, editing, and deleting.

News: Also on the gray toolbar is the “News” button. Clicking this button will bring up an orange vertical bar. You can move the bar to a date of interest and then click to bring up a news box of stories related to your loaded security or index.

Selected References

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- Hardy, C. *Risk and Risk Bearing*. Chicago: University of Chicago Press, 1940, 67–69.
- Hardy, C., and Lyon, L. “The Theory of Hedging.” *Journal of Political Economy*, 31 (1923): 271–287.
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Problems and Questions

1. Explain the differences between forward, futures, and options contracts.
2. Define and explain the functions provided by futures exchanges.
3. Explain how the clearinghouse would record the following:
 - a. Mr. A buys a September wheat futures contract from Ms. B for \$4.00/bu. on July 20.
 - b. Mr. D buys a September wheat futures contract from Mr. E for \$3.95 on July 25.
 - c. Ms. B buys a September wheat futures contract from Mr. D for \$4.01 on July 30.
 - d. Mr. E buys a September wheat futures contract from Mr. A for \$4.06 on August 3.

Show the clearinghouse’s payments and receipts needed to close each position.

4. Explain why the price on an expiring futures contract must be equal or approximately equal to the spot price on the contract’s underlying asset.

5. Suppose on March 1 you take a long position in a June crude oil futures contract at \$50/barrel (contract size = 1,000 barrels).
 - a. How much cash or risk-free securities would you have to deposit to satisfy an initial margin requirement of 5%?
 - b. Calculate the values of your commodity account on the following days, given the following settlement prices:

3/2	\$50.50
3/3	50.75
3/4	50.25
3/5	49.50
3/8	49.00
3/9	50.00
 - c. If the maintenance margin requirement specifies keeping the value of the commodity account equal to 100% of the initial margin requirement each day, how much cash would you need to deposit in your commodity account each day?
6. What is the major economic justification of the futures market?
7. Ms. Hunter is the chief financial officer for Atlanta Developers. In January, she estimates that the company will need to purchase 300,000 square feet of plywood in June to meet its material needs on one of its office construction jobs.
 - a. Suppose there is a June plywood contract trading at $f_0 = \$0.20/\text{sq. ft.}$ (contract size is 5,000 square feet). Explain how Ms. Hunter could hedge the company's June plywood costs with a position in the June plywood contract.
 - b. Show in a table Ms. Hunter's net costs at the futures' expiration date of buying plywood on the spot market at possible spot prices of 0.18/sq. ft., 0.20/sq. ft., 0.22/sq. ft., and 0.24/sq. ft. and closing the futures position. Assume no quality, quantity, and timing risk.
 - c. Define the three types of hedging risk and give an example of each in the context of this problem.
 - d. How much cash or risk-free securities would Ms. Hunter have to deposit to satisfy an initial margin requirement of 5%?
8. In May, Mr. Smith planted a wheat crop, which he expects to harvest in September. He anticipates the September harvest to be 10,000 bushels and would like to hedge the price he can get for his wheat by taking a position in a September wheat futures contract.
 - a. Explain how Mr. Smith could lock in the price he sells his wheat with a September wheat futures contract trading in May at $f_0 = \$4.50/\text{bu.}$ (contract size of 5,000 bushels).
 - b. Show in a table Mr. Smith's revenue at the futures' expiration date from closing the futures position and selling 10,000 bushels of wheat on the spot market at possible spot prices of \$4.00/bu., \$4.50/bu., and \$5.00/bu. Assume no quality, quantity, or timing risk.
 - c. Give examples of the three types of hedging risk in the context of problem b.
 - d. How much cash or risk-free securities would Mr. Smith have to deposit to satisfy an initial margin requirement of 5%?

9. What spread positions would you form in the following cases:
 - a. In July, you expect the spot price of wheat to increase, and September and October wheat futures contracts are available.
 - b. The estimated relationship between the price of copper (P_c) and the price of lead (P_L) is $\% \Delta P_c = 0.9(\% \Delta P_L)$. You expect a decrease in the price of metals and futures contracts are available on both metals.
10. Define the basis and its relationship to the time to expiration.
11. Suppose the spot price of a bushel of wheat is \$2.00, the annual storage cost is \$0.30 per/bushel, the risk-free rate is 8%, and the costs of transporting wheat from the destination point specified on the futures contract to a local grain elevator, or vice versa, is \$0.01/bu.
 - a. Use the cost-of-carry model to determine the equilibrium price of a September wheat futures contract (expiration of $T = 0.25$).
 - b. Explain the arbitrage strategy an arbitrageur would pursue if the September wheat contract is trading at \$2.16/bu.
12. Suppose the following conditions are present:
 - The forward price on the March lumber contract is $f_{T_1} = \$0.24/\text{sq. ft.}$
 - The March forward interest rate on a three-month loan is 8% (annual).
 - The storage costs for lumber is \$0.06/sq. ft. per year.
 - The carrying-costs benefits and the costs of transporting lumber are zero (assume there is a storage facility at the location point specified on the lumber forward contract).
 - The time period between the expiration on a June lumber contract and the March contract is $T_2 - T_1 = 0.25/\text{year}$.
 - a. Using the carrying-cost model, determine the equilibrium price on the June contract.
 - b. Explain the arbitrage strategy an arbitrageur would pursue if the June contract were trading at \$0.30/sq. ft.
13. What would be the July 1 value of a September forward contract initiated on June 1 to purchase crude oil for \$50/barrel on September 1, if the same contract were available on July 1, but with a contract price of \$55/barrel? Assume on July 1 there are exactly two months to expiration, the risk-free rate is 6% (annual), and the forward contracts are not marked to market. What arbitrage strategy could the June 1 holder of the September contract employ if the contract price in July is not correctly priced?
14. Briefly comment on the following:
 - a. The importance of the delivery procedure on futures contracts, even though most futures contracts are closed by offsetting positions.
 - b. The advantages and disadvantages of price limits.
 - c. The marked-to-market tax rule on speculative futures positions.
 - d. Rolling the hedge.

15. Short-answer questions:

- a. What was the primary factor that contributed to the dramatic growth in the futures trading over the last 30 years?
- b. What is a hedge called in which the asset underlying the futures contract is not the same as the asset being hedged?
- c. A farmer who hedged his expected sale of 7,000 bushels in early September with CBT wheat futures contracts would be subject to what types of hedging risks?
- d. Who ensures that the price on an expiring futures contract is equal or approximately equal to its spot price?
- e. What is the number of futures contracts outstanding at a given point in time called?
- f. How does a futures market provide continuous trading without market makers or specialists?

Bloomberg Exercises

1. Access Bloomberg information on a CBT futures contract on an agriculture commodity such as wheat or corn contracts using the CTM screen: Type CTM to bring up the “Contract Table Menu,” click “Categories,” select the commodity (such as “Corn,” search for CBT on the Menu (type CBT in the amber Exchange box), find the CBT contract of interest, and bring up the contract’s menu screen (Ticker <Comdty>; e.g., C A <Comdty> for corn). Then use the Expiration screen (EXS) on the contract’s menu page to find the ticker for the contract with the expiration month you want to analyze (Ticker <Comdty>; e.g., C H7 <Comdty> for the March 2017 contract). View screens to examine: DES, GP, and COSY.
2. Access Bloomberg information on a futures contract on energy, such as crude oil, coal, or natural gas contracts, using the CTM screen: Type CTM to bring up the “Contract Table Menu,” click “Categories,” select the commodity (such as “Crude Oil,” search for Exchange (e.g., NYMEX) on the Menu (type NYMEX in the amber Exchange box), find the NYMEX contract of interest, bring up the contract’s menu screen (Ticker <Comdty>; e.g., CLA <Comdty> for crude oil), and then use the Expiration screen (EXS) on the contract’s menu page to find the ticker for the contract with the expiration month you want to analyze (Ticker <Comdty>; e.g., CLH7 <Comdty> for the March 2017 contract). View screens to examine: DES, GP, and COSY.
3. Use the SECF screen to find the tickers for a select futures contracts and the spot prices related to the contract: SECF <Enter>; select “Commodities” from the “Category” dropdown, select the type of contract from the tabs (e.g., Agriculture), select subtype from “Category” dropdown (e.g., corn), and select type of contract from the “Instrument” dropdown (e.g., futures or spot). To upload the menu screens, enter: Ticker <Comdty> or Ticker <Index> (e.g., C A <Comdty> for corn futures and CORNILNC <Index> for North Central Illinois No. 2 Corn

- Spot Prices). On each of the menu screens, analyze some of its screens (e.g., DES and GP).
4. Following the steps similar to the ones identified in Exercises 1 and 3, access Bloomberg information from the CTM or SECF screens and the menu screens for the following types of futures contract:
 - a. Precious Metals
 - b. Foodstuff
 - c. Livestock
 - d. Base Metals
 5. Using the GP screen, examine the historical prices of the agriculture futures contract you selected in Exercise 1. Select a time period that the contract was active.
 - a. Select a period in which you would have taken a long position and calculate the profit from opening and closing at the futures price at the beginning and ending dates for your selected period. Calculate the losses if you had taken a short position.
 - b. Select a period in which you would have taken a short position and calculate the profits from opening and closing at the futures price at the beginning and ending dates for your selected period. Calculate the losses if you had taken a long position.
 - c. Using the annotation bar, apply the “% Change” tool to calculate the percentage change for your select periods, and then click the “News” icon on the annotation bar to find relevant news events on or preceding the opening date.
 - d. Examine the spot index for the period that your futures contract was active. The ticker for the index can be found using SECF. Use the “Chart” screen (Chart <Enter>) to create multigraphs for the prices on the futures contract and the spot price. On the Chart Menu screen, select Standard G chart; once you have loaded your securities, go to “Edit” to put your graphs in separate panels.
 6. Using the GP screen, examine the historical prices of the energy futures contract you selected in Exercise 2. Select a time period that the contract was active.
 - a. Select a period in which you would have taken a long position and calculate the profit from opening and closing at the futures price at the beginning and ending dates for your selected period. Calculate the losses if you had taken a short position.
 - b. Select a period in which you would have taken a short position and calculate the profits from opening and closing at the futures price at the beginning and ending dates for your selected period. Calculate the losses if you had taken a long position.
 - c. Using the annotation bar, apply the “% Change” tool to calculate the percentage change for your select periods, and then click the “News” icon on the annotation bar to find relevant news events on or preceding the opening date.
 - d. Examine the spot price for the period that your futures contract was active. The ticker for spot prices can be found using SECF. Use the “Chart” screen (Chart <Enter>) to create multigraphs for the prices on the futures contract

- and the spot price. On the Chart Menu screen, select Standard G chart; once you have loaded your securities, go to “Edit” to put your graphs in separate panels.
7. Using the GP screen, examine the historical prices of one or more of the contracts you selected in Exercise 4. Select a time period that the contract was active.
 - a. Select a period in which you would have taken a long position and calculate the profit from opening and closing at the futures price at the beginning and ending dates for your selected period. Calculate the losses if you had taken a short position.
 - b. Select a period in which you would have taken a short position and calculate the profits from opening and closing at the futures price at the beginning and ending dates for your selected period. Calculate the losses if you had taken a long position.
 - c. Using the annotation bar, apply the “% Change” tool to calculate the percentage change for your select periods, and then click the “News” icon on the annotation bar to find relevant news events on or preceding the opening date.
 - d. Examine the spot price for the period that your futures contract was active. The ticker for spot prices can be found using SECF. Use the “Chart” screen (Chart <Enter>) to create multigraphs for the prices on the futures contract and the spot price. On the Chart Menu screen, select Standard G chart; once you have loaded your securities, go to “Edit” to put your graphs in separate panels.
 8. Examine an ex-post long hedging position for a futures commodity purchase.
 - a. Select a futures contract and use the expiration date on the futures contract as the date of your purchase.
 - b. Use the “Chart” screen (Chart <Enter>) to create multigraphs for the prices on the futures and spot price (use SECF to find the spot prices on the commodity). On the Chart Menu screen, select Standard G chart; once you have loaded your futures and commodity, go to “Edit” to put your graphs in separate panels.
 - c. Select a beginning date that you would have implemented your hedge and a closing date near the futures expiration as the date for purchasing the commodity and closing your hedge. Calculate the profit or loss on the futures position from opening and closing at the futures prices at the beginning and ending dates, the cost of purchasing the commodity on the closing date, and the hedged cost (commodity purchase minus futures profit). Compare your hedged cost to the unhedged cost. In retrospect, was the hedge a good strategy?
 9. Examine an ex-post short hedging position for a future commodity sale.
 - a. Select a futures contract and use the expiration date on the futures as the date of your sale.
 - b. Use the “Chart” screen (Chart <Enter>) to create multigraphs for the prices on futures and spot (use SECF to find the spot prices on the commodity). On the Chart Menu screen, select Standard G chart; once you have loaded your futures and commodity, go to “Edit” to put your graphs in separate panels.

- c. Select a beginning date that you would have implemented your hedge and a closing date near the futures expiration as the date for the commodity sale and closing your hedge. Calculate the profit or loss on the futures position from opening and closing at the futures prices at the beginning and ending dates, the revenue from selling the commodity on the closing date, and the hedged revenue (sales revenue plus futures profit). Compare your hedged revenue to the unhedged revenue. In retrospect, was the hedge a good strategy?
 10. Using the Bloomberg HRA Regression screen, estimate the relation between two commodities in the same category (e.g., precious metal). Load your selected spot prices (e.g., SLVR <Index> for the silver), and then go to the HRA screen for the regression. On the HRA screen, enter the other commodity as the independent variable in the amber box (e.g., XAU <Index> for gold) and select the time period and periodicity (e.g., daily).
 - a. Comment on the regression results and the relation (beta).
 - b. Explain how you would form a bullish and bearish intercommodity spreads with the futures contracts on the underlying commodities.
 11. Using the Chart screen (Chart <Enter>), examine the intercommodity spread you identified in Exercise 10. Note that the contracts have to have the same expiration and may need to be adjusted for possible differences in the size of their contracts.
 - a. Use the “Chart” screen (Chart <Enter>) to create multigraphs for the futures contracts. On the Chart Menu screen, select Standard G chart; once you have loaded your securities, go to “Edit” to put your graphs in separate panels.
 - b. Select a period in which you would have taken a bullish spread position and calculate the profit you would have realized from opening and closing at the futures prices at the beginning and ending dates for your selected period. Calculate the losses if you had taken a bearish intercommodity position.
 - c. Select a period in which you would have taken a bearish spread position and calculate the profit you would have realized from opening and closing at the futures prices at the beginning and ending dates for your selected period. Calculate the losses if you had taken a bullish position.
 - d. Using the annotation bar, apply the “% Change” tool to calculate the percentage change for your select periods, and then click the “News” icon on the annotation bar to find relevant news events on or preceding the opening date.
 12. Examine the cost of carrying corn or soybeans for different periods using Bloomberg’s Grain Cash and Carry Analysis (GRCC) screen.
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