What Practitioners Need To Know . . .

. . . About Commodity Futures Contracts

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During the past decade, institutional investors have sought to diversify their portfolios by investing in nontraditional assets such as foreign securities, real estate and venture capital. More recently, some institutions have considered commodities as a potential investment. Historically, commodities have had a negative correlation with traditional asset classes and have offered an effective hedge against inflation.

This column reviews the market and describes the sources of value for nonfinancial commodity futures contracts. These contracts fall into four broad categories—grains and oil seeds, livestock and meat, food and fiber, and metals and petroleum.[1]

Commodity Futures Markets

A commodity futures contract obligates the seller to deliver a particular quantity and grade of a commodity to the buyer at a predetermined date and location, for a price agreed upon at the time of the transaction. The terms of the contract are standardized. Only the price of the contract changes with the passage of time. This standardization distinguishes futures contracts from forward contracts, the terms of which must be negotiated privately between the buyer and the seller for each contract.

Although a commodity futures contract calls for delivery of the relevant commodity at the time of settlement, most futures contracts are liquidated by executing an offsetting transaction prior to the settlement date. If a seller is long 10 July 1993 cotton contracts, he simply enters an order to sell 10 July 1993 cotton contracts in order to close his position. If he were short the contracts, he would liquidate his position by entering an order to buy 10 July 1993 cotton contracts.

If a trader with a long position in commodity futures contracts neglects to liquidate his position by executing an offsetting transaction, he takes delivery of the physical commodity (unless the contract calls for cash settlement). Delivery does not mean that a trader might arrive home one evening from a stressful day at the office only to find live hogs collectively weighing in at 400,000 pounds roaming around his finely manicured suburban lawn. Each contract designates a location with suitable facilities for delivery. The trader might, however, be required to pay storage and insurance costs while he seeks a buyer for his hogs.

Many commodity futures contracts are entered into by suppliers and consumers of the commodity desiring to hedge their existing exposure. Consequently, some contracts are liquidated by a transaction called an exchange of futures for physicals. For example, a wheat farmer who has yet to harvest his crop may have sold wheat futures contracts to protect himself from a potential decline in the price of wheat. In the meantime, a miller may have purchased wheat futures contracts as a hedge against a price increase prior to the time he is ready to buy the wheat. These parties might agree to exchange wheat for their futures contracts, assuming the wheat can be harvested and delivered before the settlement date of the contract.

Some commodity futures contracts specify cash settlement. For these contracts, the gain or loss that results when the futures price converges to the spot price at the settlement date is simply transferred to the appropriate party.

Commodity futures contracts are traded by institutions called futures commission merchants. A futures commission merchant (FCM) essentially performs the same function as a brokerage house. It maintains trading accounts for its customers, executes trades at the exchanges, and collects margin deposits from its customers.

There are numerous exchanges in the United States and around the world on which commodity futures contracts are traded. They include the Chicago Board of Trade, the Chicago Mercantile Exchange and the New York Mercantile Exchange. In 1990, nearly 110 million nonfinancial commodity futures contracts were traded in the United States. More than 70% of these trades occurred on the three exchanges mentioned above.[2]

Exchanges, which are sometimes referred to as contract markets, set margin requirements for each contract. When a trader purchases a futures contract, he is not required to pay the value of the contract to the FMC at that time. Instead, he must deposit initial margin in the form of a Treasury bill or a bank letter of credit. The initial margin is, in effect, a performance bond, and the amount required varies from contract to contract, typically as a function of the volatility of the underlying commodity. The amount also depends on whether the trader is hedging an existing exposure to

Table I Trading Activity for Futures Contracts on Soybean Meal

	Open	High	Low	Settle	Change	Lifetime High	Lifetime Low	Open Interest
Soybean Meal (CBT) 100 tons: $ per ton								
Dec	188.30	188.30	187.40	188.20	−0.50	209.00	176.50	3,013
Ja93	185.70	185.70	184.50	185.60	−0.20	209.00	177.40	21,934
Mar	184.70	184.50	183.40	184.00	−0.60	210.00	178.30	23,230
May	184.00	184.00	183.10	183.70	−0.70	210.00	179.40	12,172
July	185.10	185.20	184.30	184.80	−0.70	208.00	181.30	9,840
Aug	185.70	186.00	185.20	185.50	−0.40	193.50	182.20	1,751
Sept	186.50	186.70	186.20	186.40	−0.50	193.50	183.10	1,217
Oct	188.00	188.00	187.50	188.00	−0.70	194.50	185.50	416
Dec	189.00	189.00	189.00	189.00	−1.00	191.50	187.20	207
Est vol 16,000: vol Tues 14,719; open int 73,780; 1,175								

Source: *Wall Street Journal*, December 17, 1992.

the underlying commodity or simply speculating in the commodity. The initial margin requirement is usually greater for speculators than it is for hedgers.

Once a trader establishes a position in a futures contract, he is also required to pay daily variation margin to cover trading losses as they occur. Suppose, for example, that a trader is long 10 contracts that, as of the previous close, were valued at $50,000 each. Now suppose that at the close of today's trading these contracts settle at a price of $49,500. The total position falls in value by $5000. The trader must therefore transfer $5000 from his account to the account of the FMC to cover this loss. If the contracts rise in value to $51,000 the next day, the FMC must transfer $15,000 to the trader's account to meet the required variation margin. Thus the gains and losses of futures contracts are settled on a daily basis, even though the position remains open.

Each exchange is affiliated with a clearinghouse that performs two functions. First, it provides a mechanism by which exchange members clear their positions. Second, it ensures the financial integrity of the exchange by monitoring the credit-worthiness of exchange members and by maintaining capital funds as protection against the potential insolvency of any of the members.

Trades are cleared through the following mechanism. The members of the exchange report all their trades to the associated clearinghouse. Once the clearinghouse accepts these trades, it replaces the exchange members as the buyers and the sellers of the contracts. It matches all the trades and computes the members' net gains and losses. The clearinghouse then collects the appropriate payments from the members with net losses and disburses them to the members with net gains.

The federal regulatory agency that oversees trading in commodity futures contracts is called the Commodity Futures Trading Commission (CFTC). It was established in 1974 and derives its authority from the Commodity Exchange Act. The CFTC fulfills a role that is analogous to the function of the Securities and Exchange Commission. Essentially, it is responsible for promoting fair and efficient pricing, trading integrity and financial soundness.

Reporting on Commodity Trading

Below we review an example of the type of information about commodity futures contracts that is reported in the financial press. The December 17, 1992 edition of the *Wall Street Journal* reported the information given in Table I for futures contracts on soybean meal. CBT refers to the Chicago Board of Trade, the exchange where futures contracts on soybean meal are traded. Each contract represents 100 tons of soybean meal, and the quoted prices are the dollars per ton for the contracts.

On December 16, 1992, the contract for May 1993 delivery opened at $184.00 per ton for a total price of $18,400.00, which was also its high for the day. It traded as low as $183.10 and settled for the day at $183.70, which was $0.70 below the prior day's closing price. The lifetime high for the May 1993 contract was $210.00, and its lifetime low was $179.40. As of the close of trading on December 16, 1992, 12,172 contracts remained open. This figure refers to either the long positions or the short positions, not to the sum of the long and short positions, because each long position is also a short position.

The estimated volume on Wednesday, December 16, 1992 was 17,000 contracts, compared with 14,719 contracts on the previous Tuesday. The open interest for all the soybean meal contracts traded on the Chicago Board of

Trade totaled 73,780 contracts, a reduction of 1175 contracts from the previous day.

Note the prices of the various contracts. The prices of the December 1992 through May 1993 contracts decrease with the time remaining to settlement. Beginning with the July 1993 contract, however, the prices of the contracts start to increase with further increases in the time remaining to settlement. The next section reviews the valuation of commodity futures contracts and explains why prices vary as a function of the time remaining to the settlement date.

Valuing Commodity Futures Contracts

The fair value of a commodity futures contract is based on the principle of arbitrage. Suppose we purchase 100 troy ounces of gold at $350.00 per ounce and finance this purchase by borrowing $35,000.00 at a total cost of $500.00 for three months. Suppose, at the end of three months, the price of a troy ounce of gold appreciates to $365.00, at which time we sell the 100 ounces and repay the loan. Our total profit from these transactions equals $1000 ($36,500 − $35,000 − $500).

Now suppose that, instead of purchasing 100 ounces of gold on margin, we purchase a futures contract for 100 ounces of gold for settlement in three months. The fair value of this contract equals the price that yields a $1000.00 profit if we hold this futures contract until the settlement date, when it will be worth $36,500.00. A purchase price of $35,500.00 yields a profit of $1000 under this scenario.[3]

If the futures contract sells for less than $35,500.00—say $35,200.00—we could sell 100 ounces of gold short and lend the proceeds of $35,000.00, earning interest income of $500.00. At the same time, we could purchase the futures contract at a price of $35,200.00 and hold it until the settlement date. By then we will have earned a profit of $1300.00 on the futures transaction, experienced a loss of $1500.00 on the short sale, and earned interest income of $500.00 for a net profit of $300.00 without any capital outlay or risk exposure.

If the futures contract sells for $36,000.00, we could sell the futures contract and borrow $35,000.00 to purchase 100 ounces of gold. By the settlement date, we will have earned a $1500.00 profit on our long position in the gold, suffered a loss of $500.00 on our short futures position, and incurred an interest expense of $500.00 for a net profit of $500.00, again without any capital outlay or exposure to risk.

Arbitragers monitor the prices of futures contracts and their underlying commodities and engage in arbitrage transactions whenever the opportunity arises. This activity prevents futures prices from deviating significantly from their fair values.

The pricing model used to determine the fair value of a commodity futures contract is called the cost-of-carry model. According to this model, the fair value of a commodity futures contract equals the spot price of the underlying commodity plus the cost of carrying the commodity, which in the previous example is the financing cost. If we assume that the cost of carrying the commodity is comprised entirely of the financing cost, the cost-of-carry model supposes that the profit or loss on a long futures position equals the profit or loss from acquiring the underlying commodity on margin. Table II summarizes this relationship.

Table II Equivalence of Futures Position and Leveraged Acquisition

	Underlying Commodity	*Futures Contract*
Beginning Price:	$ 350	$ 355
Financing Cost:	5	0
Spot Price Appreciates to:	365	365
Net Profit:	10	10
Spot Price Depreciates to:	340	340
Net Loss:	−15	−15

Thus far we have assumed that the cost of carry is comprised only of the financing cost of acquiring the commodity on margin. Although the financing cost accounts for the preponderance of the cost of carry for precious metals, a significant component of the cost of carrying other commodities consists of storage and transportation costs; for commodities for which the risk of spoilage or damage is a consideration, insurance costs can be significant. If we take all these costs into account, the fair value of a commodity futures contract equals the spot price of the underlying commodity plus the financing, insurance, storage and transportation costs.

Because the collective costs of carrying a commodity are positive, we might expect the price of a futures contract to exceed the spot price of the underlying commodity. Moreover, as the settlement date approaches, we might expect the difference between the price of the underlying commodity and the price of the futures contract to diminish, because the cost of carrying the commodity diminishes with the passage of time. The difference between the spot price and the futures price is called the basis. If the futures price exceeds the spot price, the relationship is referred to as *contango*.

Table I reveals that the prices of some of the longer-dated contracts are lower than the prices of some of the shorter-dated contracts. For example, the May 1993 contract settled at $183.70 per ton compared with $185.60 for the January 1993 contract. What's more, the spot price for soybean meal as of the close of trading on December 16, 1992 was $189.00

per ton based on the average of the bid-ask spread reported in the *Wall Street Journal* the next day.[4] This relationship seems to imply that the cost of carrying soybean meal is negative, a rather unlikely proposition.

When the spot price of the commodity exceeds the price of the futures contract, the futures contract is said to be in *backwardation*. Based on the arbitrage concept described earlier, backwardation would appear to offer a free lunch.

In theory, an owner of soybean meal could sell his supply at $18,900.00 per 100 tons, lend the proceeds of this sale at the available five-month interest rate of 1.4%, and thereby earn interest of $264.60. At the same time, he could purchase a May 1993 futures contract on soybean meal for $18,730.00. These transactions would guarantee a riskless profit of $434.60 per 100 tons of soybean meal relative to holding the current supply of soybean meal.[5]

To validate this result, suppose the price of soybean meal appreciates to $195.00 per ton. The futures position yields a gain of $770.00 per contract, which, together with the interest proceeds of $264.60, results in a total gain of $1034.60. This gain exceeds by $434.60 the forgone profit of $600.00 per 100 tons of soybean meal the owner would have realized had he kept his supply of soybean meal.

If, instead, the price of soybean meal declines to $185.00 per ton, the futures position produces a loss of $230.00 per contract, which is offset by interest proceeds of $264.60 per 100 tons. Had he kept his supply of soybean meal, the owner would have lost $400.00 per 100 tons. Thus his net advantage again equals $434.60.

To the extent the owners of soybean meal choose not to engage in these transactions, they agree to forgo $434.60 of profit per 100 tons of soybean meal. In theory, the price of the futures contract should equal $19,164.60—the sum of $18,900.00, the spot price of 100 tons of soybean meal, and the financing cost of $264.60. But the market price is only $18,730.00, $434.60 less than the theoretical value.

How can we explain this discrepancy? The owners of soybean meal are willing to forgo the gain of $434.60 in exchange for the convenience of having soybean meal readily accessible, because during certain times of the year (prior to a harvest, for example) soybean meal is scarce. Because they need soybean meal to meet their customers' demands or for their own consumption, they are unwilling to part with it, even for a profit. We can think of this forgone profit as the premium the owners pay for accessibility. Arbitragers are unable to engage in transactions to correct the theoretical mispricing of the futures contracts, because they are unable to borrow the commodity from the owners. The forgone profit as a percentage of the spot price is called a *convenience yield*.

In order to determine the fair value of a commodity futures contract, we must reduce the cost of carry expressed as a percentage of the spot price by the convenience yield:

$$F = S \cdot e^{[(r - y) \cdot n/365]}$$

where

- F = the fair value of a commodity futures contract;
- S = the spot price of the underlying commodity;
- e = the base of the natural logarithm (2.71828);
- r = the annualized rate of total cost of carry including financing cost, insurance cost, storage cost and transportation cost;
- y = the annualized convenience yield; and
- n = the number of days remaining until settlement date.

Investing in Commodity Futures Contracts

A commodity futures contract by itself is a highly leveraged investment. Purchasing a futures contract on a commodity is equivalent to acquiring the underlying commodity on margin. We can eliminate the inherent leverage of a futures position by collateralizing the position—that is, by investing an equivalent amount of funds in riskless securities. The lending implicit in a Treasury bill investment offsets the borrowing implicit in a futures contract investment.

The return on a collateralized futures portfolio consists of three components—the return on the underlying Treasury bill position, the return on the underlying commodity, and the *roll yield*, which is defined as the return from liquidating an existing futures position and establishing a new position in a contract with a more distant settlement date, controlling for the change in the spot price.

Should investors consider collateralized commodity futures positions as a potential investment?[6] The commodity component of the return on a collateralized futures portfolio offers superb diversification with respect to stocks and bonds. However, the long-run return from the underlying commodities may not be particularly appealing, because improvements in technology over time could increase the supply of commodities such as agricultural products and reduce the demand for commodities such as energy and industrial metals.

The roll yield component of the return on a commodity futures portfolio *may* offer an opportunity for investors to extract a premium by overweighting commodity futures contracts that are

Kritzman concluded on page 16.

Table I Present Value of Expected Loan Cash Flow

Assumptions

Loan Amount = $1 million;
Loan Type = unsecured, interest-only until maturity;
Maturity = three years;
Interest Rate = simple 11%, payable annually at end of year;
ZETA® Score = −1.8 (S&P B rating equivalent);
Cost of Funds = 8% (discount rate).

Period	Promised Cash Flow	Expected Loss Rate	Expected Cash Flow	Discount Factor	P.V. Expected Cash Flow
0	($1,000,000)	0.00%	($1,000,000)	0.0000	($1,000,000)
1	110,000	1.04%	108,856	0.9259	100,790
2	110,000	3.80%	105,820	0.8573	90,719
3	1,110,000	8.97%	1,010,433	0.7938	802,081
					($ 6,410)

$−6,410. The expected cash flow is determined by reducing each promised annual interest payment ($110,000) and the principal repayment ($1 million) by the relevant adjusted cumulative loss rate.[5] The negative net present value indicates that this loan is unacceptable, at least at the time of the initial analysis. Either charging a 1% fee up front or increasing the interest rate by 1% per year would result in a positive net present value and an acceptable investment.

Loss reserves would equal the sum of the present values of the annual loss rates multiplied by the promised cash flows. These reserves would be reduced if the loan performed as promised over time. If, after one year, the borrower's credit quality changed, for example to a BB bond-rating equivalent, then the analysis would change (data permitting) to one appropriate to a seasoned loan with two years of maturity remaining. An unsecured senior loan of uncertain recovery, however, would be assigned the average recovery based on the experience of senior bonds in the public marketplace. If the asset becomes non-performing or impaired, and the recovery amount can be determined from the specific attributes of the loan (i.e., from its security), then that amount should be used in the calculation.

Conclusion

The procedure set forth above provides a rigorous approach for the valuation of non-publicly-traded assets. Our approach is potentially useful for assets in liquid and illiquid markets but the payoff would seem to be especially great in the latter case. It provides financial institutions, for example, with a basis for estimating fair values of loans made to privately held firms, as well as to publicly held ones. It also facilitates pricing decisions. One can solve, for instance, for the nominal interest rate that would result in a net present value of zero on the investment—a type of break-even analysis.

Our valuation analysis takes implicit account of expected loss rates. As such, it provides a valid tool for estimating the capital reserves to be set aside for expected losses. Mortality estimates, based on loss experience in the public bond market, are already being used by high-yield fixed income investors, particularly insurance companies. Private placement valuations by insurance companies, commercial banks and other lending/investing institutions would seem to be a natural extension.

Footnotes

1. *For a discussion of the exposure drafts, see P. McConnell, "Mark-to-Market: The FASB Changes Direction Again," "Mark-to-Market Accounting Creeps a Step Closer to Completion," and "More Bad News for Financial Institutions: Measuring Loan Losses," in the* Accounting Issues *(Bear, Stearns & Co.) of July 16, October 2 and November 1, 1992.*
2. *E. Altman, "The Market for Distressed Securities and Bank Loans: Altman, Foothill Report II" (The Foothill Corporation, Los Angeles, October 1992).*
3. *E. Altman, "Revisiting the High Yield Debt Market,"* Financial Management, *Summer 1992.*
4. *E. Altman, R. Haldeman and P. Narayanan, "ZETA® Analysis: A New Model to Identify Bankruptcy Risk of Corporations,"* Journal of Banking and Finance, *June 1977.*
5. *Altman, "Revisiting,"* op. cit.

Kritzman *concluded from page 21.*

in backwardation (those that have positive roll yields) and underweighting commodity futures contracts that have negative roll yields.

As with most investment opportunities, commodity futures contracts present tradeoffs with respect to expected return and risk. Each investor should assess these within the context of his particular needs and attitude toward risk.[7]

Footnotes

1. *This article, of necessity, presents only a cursory description of commodity futures contracts. Those readers who wish a more detailed discussion of the topic are referred to F. Edwards and C. Ma,* Futures and Options *(New York: McGraw-Hill, Inc., 1992).*
2. Ibid., *6–9.*
3. *In this example and in those that follow, I ignore the effect of margin deposits.*
4. Wall Street Journal, *December 17, 1992.*
5. *This profit estimate assumes that the only cost of carrying soybean meal is the interest cost.*
6. *For an excellent discussion of the investment suitability of commodities, see J. Scott, "Managing Asset Classes" (Working paper, Prudential Investment Corporation).*
7. *I thank Jack Meyer for his helpful comments.*