Economics of Energy Futures Markets

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Introduction

The development of a successful futures market in crude oil, petroleum products, propane, and, most recently, natural gas has been one of the most fundamental changes to occur in oil and gas markets in recent years. The availability of futures trading not only provides a means of managing risk for traditional participants in markets for these commodities, but it enables entry into the marketplace of entirely new groups, without the high barriers to entry that have significantly restricted participation in the past.

The futures market is a paper market dealing in contracts for future delivery of a specified commodity. Unlike contract and spot markets, all trading is executed on an exchange, in a strictly prescribed manner, under government regulation. While physical delivery takes place on some futures contracts, most contracts are liquidated by offsetting transactions because they normally are entered into for risk-shifting or speculative purposes. The standardization of futures contracts facilitates their exchange, and all bidding focuses on price, thereby maximizing market liquidity and minimizing transaction costs. Contractual periods are usually specified by months, for up to 36 months into the future.

History of Energy Futures Contracts

There were at least 20 exchanges in the United States on which crude oil was traded in the 19th century. Those exchanges failed as the oil industry became increasingly dominated by the Standard Oil Trust and later by a few large, vertically integrated companies (see Weiner (1991) for details). Prior to the current era, the most recent unsuccessful crude oil futures contract was listed on the Commodity Exchange (also called COMEX) in New York from 1935 to 1942.

Recent attempts to establish trading in petroleum futures contracts began in 1971, with the introduction of a propane futures contract for Rotterdam delivery by the New York Cotton Exchange (Prast and Lax 1983). In 1974, the New York Cotton Exchange introduced a crude oil futures contract, also for Rotterdam delivery. Both of those contracts failed, largely because the relatively small price fluctuations, or "volatility" of the cash markets at that time did not make the futures markets attractive to commercial users. Academic studies of futures markets have often attempted to determine the effects of futures markets on cash markets by comparing the volatility of the cash markets before and after the advent of futures trading and have concluded that futures markets cause increased cash market volatility. Such studies ignore the effect of volatility on the decision to establish futures markets. Futures markets don't create volatility; volatility creates futures markets.

Historically, futures contracts have only succeeded when they met all of the following requirements (Jachimczyk 1983):

- A large number of buyers and sellers participating in the market
- A standardized product
- A certain amount of price volatility that makes it desirable for producers and users of the commodity to use the market to minimize price risk
- Market participants have a need to arrange for purchase or sale of the product in advance of the time it is actually distributed and consumed.

Added to this list should be:

- A suitable delivery point (or points) which is considered a reliable benchmark for the industry and which can readily accommodate delivery of the commodity when the futures contract expires
- An adequate deliverable supply of the commodity being traded.

[1]The author is grateful to the Commodity Futures Trading Commission, Office of Market Surveillance, for their assistance. The views expressed in this article are solely those of the author.

This list is important, because it shows that futures contracts will be viable only if they have commercial uses, which is an important economic purpose.

In 1978, the New York Mercantile Exchange (NYMEX) introduced futures contracts on both No. 2 heating oil and No. 6 fuel oil. The No. 6 fuel oil contract failed, because it did not meet the above criteria. The largest purchasers of No. 6 fuel oil are utilities, who are able to pass the risk of escalating prices on to their customers by means of fuel adjustment clauses and therefore, do not need to use the futures market to minimize price risk. The No. 2 heating oil contract, however, has been extremely successful, because:

- Heating oil is bought and sold by a very large number of market participants.
- Despite seasonal variations in demand, heating oil moves in commerce throughout the year, and inventories are built up in the off season to accommodate demand in peak periods.
- Refiners and marketers are subject to price risk because of the length of time between production and sale.

Trading volume in the NYMEX No. 2 heating oil contract grew explosively, from 25,910 contracts during its first year in 1978 to over 932,000 contracts in 1980 and to 5.7 million contracts in 1989.

The NYMEX has become the dominant market for energy futures trading. In 1981, the NYMEX began trading in leaded gasoline (which was gradually superseded by the unleaded gasoline contracts that began in 1984), and trading in crude oil futures began in 1983. Less heavily traded NYMEX futures contracts in propane began in 1987, residual fuel oil in 1989, and natural gas in 1990 - the contract specifications are listed in Gerald, Inc. (1991) and NYMEX (1990). The NYMEX is today by far the largest energy futures market.

Other exchanges have also traded oil and gas futures, e.g., the Chicago Board of Trade listed energy futures for a few years in the 1980's (Hirschfeld 1983). The International Petroleum Exchange (IPE) in London opened in 1981 for trading gas oil futures. They have since begun trading futures contracts in heavy (residual) fuel oil, Brent crude oil, Dubai crude oil, and naphtha. The Singapore International Monetary Exchange (SIMEX) recently began trading futures in Dubai crude oil and high sulfur (residual) fuel oil. The Rotterdam Energy Futures Exchange (ROEFEX) started trading crude oil futures and heavy (residual) fuel oil futures in 1989, but that exchange failed in less than a year (*Petroleum Economist* 1990). The ROEFEX competed with the IPE, and Dale (1981b) has shown that duplicative futures contracts have a high failure rate, as newcomers have a difficult time competing with an established high level of trading volume.

The Evolution of Spot Markets and Futures Markets

Energy futures markets have evolved in tandem with rapidly changing oil markets. In the early 1970's, the Organization of Petroleum Exporting Countries (OPEC) controlled oil prices, typically by adjusting their output levels (Verleger 1982a, b; Lowinger and Ram 1984; Draper 1984; Hall 1989). Their very high price levels proved unsustainable, partly due to a recession in the 1970's but also due to conservation and to dramatically increased supplies from non-cartel members. Refiners must commit to lifting crude oil from distant producers weeks in advance, forcing them to forecast their future demand. These forecasts left the refiners with small shortages or surpluses of crude, which were traded internationally.

Buying oil under term contracts exposes the buyer to significant price risks. During the early 1980's, producers wishing to increase their market share assumed this price risk to ensure its sale. During this period, large volumes of crude oil also found their way into the spot market when buyers and sellers could not agree on a term contract price. As a result, in the early 1980's, spot quotations gradually developed for several key grades of oil: West Texas Intermediate (WTI), Alaskan North Slope (ANS), North Sea Brent Blend (Brent), Indonesian Minas, Oman, Nigerian Bonny Light, and Dubai Fateh Blend. When oil prices collapsed in 1986, the volatility of world oil markets became so large that few buyers would accept the risk of a term contract except at a large discount to spot prices. Refiners were increasingly hedging their transactions, using the crude oil futures contract that was introduced in 1983, which resulted in large increases in futures market trading volume (Energy Information Administration 1990a).

The increase in spot market trading served three important functions for the petroleum industry (Razavi 1989):

- **Price discovery.** Spot market prices provide information about market clearing prices of crude oil and products.
- **Risk transfer.** Oil companies that fear a drop in oil prices can sell inventory in the spot market.
- **A channel for oil deliveries.** As noted above, the volume of spot market oil trade has increased considerably in recent years.

The futures markets can perform the first two of those three functions more efficiently than the spot market. In contrast to spot market transactions, which may be privileged information, futures prices are immediately available to everyone. Futures markets are also more efficient than spot markets for risk transferral. Since spot market transactions may require substantial capital, there may not be enough speculators willing and able to absorb price risk. Futures markets, on the other hand, have relatively small margin requirements, typically less than 10 percent of the value of the contract, and are much more likely to be able to supply enough speculators for hedgers to be able to transfer their risk. Finally, although particular futures contracts may not be large, direct channels for oil deliveries, their existence facilitates spot market trading by providing instantaneous price information.[2]

The wide availability and immediacy of NYMEX WTI crude oil prices have dramatically changed the way oil and, increasingly, products are marketed. Rather than contract for oil at fixed prices, contracts are priced at differentials negotiated with respect to one of the reference grades. For example, West African crude oil would no longer be contracted at a fixed price at the loading port but might be contracted for delivery at a negotiated discount to the WTI cash price at *delivery* several weeks later.

Since Brent and ANS are priced relative to WTI, and Dubai is typically priced relative to Brent, NYMEX price quotes directly or indirectly determine the price of most crude oil and, increasingly, of products (Razavi 1984; Fesharaki and Razavi 1986; Verleger 1987, 1988; Hall 1989; *Petroleum Intelligence Weekly* 1990; *Oil Marketing Bulletin* 1990b). Thus, sudden changes in the world supply picture now can be rapidly transmitted through NYMEX price changes to spot markets everywhere.

The question naturally arises as to whether the NYMEX will be able to maintain its preeminent position in the face of competition from markets in London and Singapore. WTI crude, for example, sometimes varies in price from similar internationally traded crude oils because its landlocked mid-continent status can cause variations in its associated transportation costs. But the tremendous liquidity and trading volume already existing on the NYMEX will make it difficult for competitors to keep up, in spite of the inherent risk involved in using WTI contracts to hedge foreign positions. In any case, all energy futures markets are likely to continue to have a profound effect on the way oil and products are marketed.[4]

Futures Market Terminology

Futures markets have an associated terminology that describes their functions. Those markets have been especially useful for fulfilling two specific needs--risk transfer and price discovery:

- **Risk Transfer.** Futures trading provides a means for transfer of the risk inherent in price volatility from the producers and consumers of a commodity, for whom price may determine profitability, to those parties most willing to bear risk (speculators) as a financial strategy. Thus, by taking price risk away from hedgers, speculators may perform a useful economic function.

- **Price Discovery.** Because of the free flow of information across the broad spectrum of energy suppliers, consumers, traders, and speculators involved, as well as the sheer number of participants, futures markets provide a very efficient means of determining the free market value, or "market clearing price," of a commodity. Additionally, because of the regulated and observable nature of trading activity, reported prices are objective and verifiable.

Market participation can be grouped into two types, according to the participant's physical market position (ownership or anticipated ownership of product):

- **Hedging.** Where a futures position is taken to offset an existing or anticipated physical position, attempting to lock in cost or profit margin.

- **Speculation.** No corresponding or anticipated physical position exists, and the trader will incur profit or loss on any price movement.

Commodity exchanges emphasize the difference between "gambling," which involves the artificial creation of risk, and "speculation," which involves the assumption of existing risk inherent in the markets. "Hedging" can sometimes be difficult to define, because a large commercial trader may temporarily have a futures market position that is not completely offset in the cash market (Working 1953). Examples of hedging are given below.

Purchase or sale of a futures contract requires posting a "margin," or good faith deposit, to guarantee fulfillment of contract obligations. Because most futures contracts are liquidated before their delivery dates, the margin requirements need to be large enough only to cover possible price changes, not the full value of the

[2]Futures contract prices are also more useful than prices from "forward contracts," which are informal, non-exchange commodity contracts in which the buyers and sellers determine delivery times and amounts, because futures contracts represent standardized contract specifications and time periods (Dew 1981).

[3]Mabro (1990) asserts that producers will readily abandon futures market-pricing formulas in a crisis if they think that those prices don't reflect "the levels of bids that hungry buyers are willing to make."

[4]The NYMEX currently has an application pending with the Commodity Futures Trading Commission to begin trading in a sour crude oil contract.

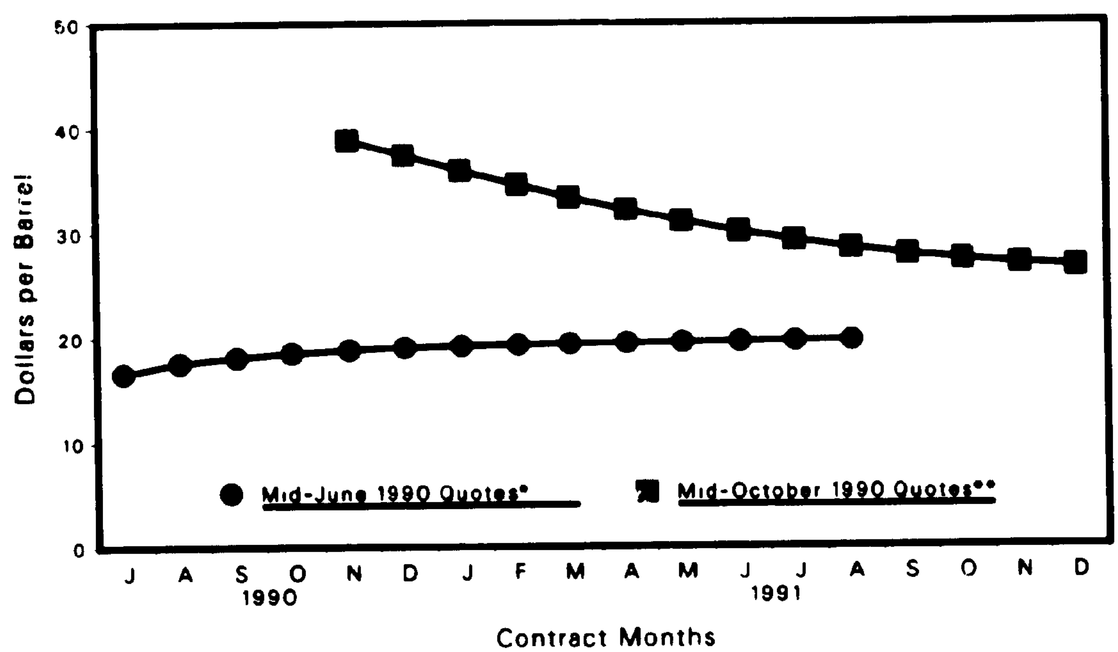
contract. Thus, commodity futures margins are normally much smaller than stock market margins, which represent downpayments on the purchase of stocks. For example, a customer might have to make a margin deposit of only $1,500 to buy a 1,000 barrel contract of crude oil that is quoted at $20 per barrel, and which thus represents $20,000 worth of crude oil. A buyer would have to deposit a minimum of $10,000 to purchase an equivalent amount of stock. Futures market positions are also "marked-to-the-market" on a daily basis, a term which means that a customer's paper profits or losses are recorded by their brokers daily, which changes their equity in their futures position. If prices move against a commodity futures trader and decrease his equity position to less than a "maintenance margin" level, the customer must post additional margin money to restore his equity.

A major factor underlying the credibility of a futures market is the concept of "cash convergence." As a futures contract approaches its expiration date, the futures price and cash price converge. This is because of the "arbitrage," or ability to profit from a price discrepancy, permitted by the contract's delivery provisions. Traders may purchase the spot product and sell the futures contract, or vice versa, to take advantage of the price differential.

Another important concept in commodity futures trading is the "basis," which in its simplest form is the difference between the spot price and a given futures contract price (Brown and Errera 1987). The concept of basis is important because hedgers frequently may not be able to complete a transaction at the exact time and place corresponding to the expiration of a futures contract. The hedger may still use the futures market to minimize price risk of a future cash market transaction by, for example, taking an immediate position in the futures contract that will eventually expire next (called the "nearby," "first nearby," "prompt," or "spot" contract) after the consummation of his cash market transaction and then eventually liquidating his futures contract upon completion of that cash market transaction. Illustrations of this procedure are given below.

It is important to note, however, that the hedger will have eliminated his price change risk *only if the basis is the same at the time he bought his futures contract and the time he liquidated his futures contract.* If the basis changes unfavorably, the hedger will take a loss on his position. If the basis changes favorably, the hedger will have a profit from his futures market transaction, which may be substantial. Since only a stable basis will ensure that the hedger will have neither a net gain nor loss from his futures market transactions, tests of

Figure FE1. NYMEX Crude Oil Contracts



*An upward slope means a contango market (see text on page 9)
**A downward slope means a backwardation market
Source: New York Mercantile Exchange (NYMEX) daily price quotations

the economic effectiveness of futures markets typically measure basis stability (Cicchetti, Dale, and Vignola 1981; Dale 1981a; Chen, Sears, and Tzang 1987). The results generally showed that futures markets are very effective for minimizing price risk and that hedging effectiveness increases with the hedger's holding period and the nearer the futures contract's time to delivery. Illustrations of "basis risk" are given below. Other types of basis risk, i.e., "locational basis risk," which arises from transportation costs between the futures market delivery point and the actual delivery point, and "product basis risk," which arises from the difference between the quality of the futures contract product and the desired physical product, can also be important. They are omitted from the examples below for simplicity.

The Pricing of Futures Contracts

Conventional understanding of commodity futures market pricing is based on the "cost of storage," or "carrying charge," concept developed by Holbrook Working (1948, 1949, 1958) and Brennan (1958) for agricultural commodities. Subsequently, it has been shown that the cost of storage concept has wide applicability in nonagricultural futures markets, such as financial futures (Vignola and Dale 1979, 1980) and energy futures (Williams 1986; Wright and Williams 1989; Verleger 1990b).

Theoretically, the price of a futures contract will never be higher than the cash market price of that commodity, plus the cost of storage of the commodity until the contract expiration. If the futures price were to rise higher than that, a trader could ensure himself a profit by buying and storing the cash commodity, simultaneously selling the overpriced futures contract and delivering the cash commodity when the futures contract expires. Thus, on a given day, the price of a nearby futures contract might be less than the price of a more distant futures contract by the carrying charge between the expiration of those contracts. The carrying charge is sometimes called a "contango." Figure FE1 shows the "contango market" that existed in mid-June 1990 in crude oil futures, when the expiring July 1990 contract traded near $16 per barrel and the price of more distant contracts rose gradually to near $20 per barrel in the distant August 1991 contract.

While there is a limit to how much *higher* a distant futures contract price may be with respect to the cash price, there is no theoretical restriction as to how much *lower* a distant futures price may be. At a time of tight oil supplies in the cash market, nearby futures contracts are often priced much higher than more distant contracts. For example, after Iraq invaded Kuwait on August 2, 1990, the futures market reflected concerns about the real and potential loss of supply in the near term. Nearby futures contracts became higher priced than more distant ones, a situation known as "backwardation," or an "inverse carrying charge market." Figure FE1 shows the crude oil futures market backwardation in mid-October 1990. The implied negative carrying charge is sometimes referred to as a "convenience yield," because it shows that industry participants, particularly refiners, apparently did not want to risk being caught short of oil in the event of further supply disruptions resulting from hostilities in the Persian Gulf. Consequently, their collective but independent buying activity in international spot and

Table FE1. Three Applications of a Sample Long Hedge in Crude Oil

June 1	Short 1,000 barrels of crude oil at $25/barrel		Buy one December crude oil contract at $26/barrel
		Basis = $1.00	
Case I: Basis Unchanged - Cash and Futures Rise Equally			
November 15	Cash market = $28/barrel		Sell one December crude oil contract at $29/barrel
	Loss in cash market = $3,000		Gain in futures market = $3,000
		Net Gain or Loss = $0	
Case II: Cash Rises More than Futures			
November 15	Cash market = $27.50/barrel		Sell one December crude oil contract at $28/barrel
	Loss in cash market = $2,500		Gain in futures market = $2,000
		Net Loss = $500	
Case III: Cash Rises Less than Futures			
November 15	Cash market = $30/barrel		Sell one December crude oil contract at $33/barrel
	Loss in cash market = $5,000		Gain in futures market = $7,000
		Net Gain = $2,000	

futures markets bid up the price of near term oil. *In the case of backwardation, futures markets clearly reflect external developments.*

Commercial Uses of the Futures Markets

As noted above, futures contracts do not survive unless there is significant use of the markets for commercial purposes. This section describes some possible commercial uses of the futures markets. The hedging examples are adapted from the *NYMEX Energy Hedging Manual* (1986), Jachimczyk (1983), and Prast and Lax (1983). The examples here are greatly oversimplified, but they illustrate the concepts involved.

A Sample Long Hedge

Suppose, in June an oil trader commits to sell 1,000 barrels of crude oil in late November at the November market price. He has no oil in inventory (i.e., is "short" in the cash market), and decides to hedge his position. Suppose, spot oil is currently selling at $25 per barrel and December futures (which is the contract that expires in November) are trading at $26 per barrel. The trader attempts to fix his oil cost by buying (putting on a "long hedge") one December futures contract, worth 1,000 barrels of oil. Whether or not the trader succeeds in fixing his price depends upon whether or not the "basis," the $1.00 difference between the futures price and cash price, is the same when he removes his hedge in November.

Three possibilities are shown in Table FE1. In Case I, both cash and futures rise by equal amounts, the gain in futures exactly offsets the rise in spot prices, so the trader has succeeded in fixing his purchase cost at $25 per barrel. It is possible, however, that cash prices may rise more than futures, as shown in Case II. In that example, cash prices rose by $2.50 to $27.50 per barrel, while futures prices rose only $2.00 per barrel, so that the trader will pay $500 more than he would have if he had succeeded in fixing his purchase price at $25 per barrel.

Finally, consider what happens if cash prices rise less than futures, as shown in Case III. Suppose, the cash price rose by $5.00 to $30 per barrel, while the futures price rose by $7.00 to $33 per barrel. The trader will not only have fixed his purchase price at $25 per barrel, he will also have an additional profit of $2,000 from his futures contract.

These very simple examples illustrate an important point: Large refiners, who may be short in the cash market and who attempt to fix their costs by using the futures markets, will succeed only if the basis between cash and futures is exactly the same when they put on their hedges as it is when they remove their hedges. If the basis changes because cash and futures prices move up or down by different amounts, then the refiners will have net gains or losses from their futures markets transactions, and those gains or losses are potentially enormous.

A Sample Short Hedge

Suppose a jobber buys 42,000 gallons of No. 2 heating oil for 60 cents per gallon on June 1 and puts them into storage. He expects to sell it to customers during the winter and wants to protect himself from inventory devaluation. He sells (puts on a "short hedge") one December heating oil contract for 63 cents per gallon. The basis in this example is 3 cents. Again, consider three cases, as shown in Table FE2.

In Case I, between June and December, both cash and futures prices drop by 2 cents per gallon, so the basis remains unchanged at 3 cents, and the $840 loss in the cash market is exactly offset by the $840 gain in the futures market, and the jobber has ended up with a "perfect hedge." If cash falls less than futures, as in Case II, his futures gain will more than offset his cash market loss, and he will have an additional profit from his futures market transactions. Finally, if cash falls more than futures, as in Case III, his gain in the futures market will not be enough to offset his loss in the cash market. Note, however, that in Case III his net loss ($420) after hedging is still less than it would have been if he had not hedged at all ($1,260).

There are two conclusions from these examples. First, assuming that futures markets can be used to eliminate price risk completely is a myth. This is an especially important point that has been learned by "cross-hedgers," which are companies that attempt to use futures contracts to hedge against price movements in different commodities. For example, some airlines and fuel suppliers have reportedly used the No. 2 heating oil futures contract to hedge against price movements in jet fuel, for which no futures market exists. This practice will only be effective if the price differential between heating oil and jet fuel remains stable *(Oil Marketing Bulletin* 1990a). In recent months, however, jet fuel has fluctuated from a few cents per gallon over heating oil to over 38 cents in some cases, making heating oil futures a very risky hedging tool for jet fuel. Since heating oil futures are not even a perfect hedge for the heating oil spot market, it is not surprising that they have been a faulty hedge for the jet fuel market.

Second, the fact that commercial traders show large profits or losses from futures market transactions does not automatically mean that they have been engaging in speculation in the futures markets. Their profits or losses may have been largely due to basis changes in hedges.

Table FE2. Three Applications of a Sample Short Hedge in Heating Oil

June 1	Buy 42,000 gallons of heating oil at $0.60/gallon	Sell one December heating oil contract at $0.63/gallon
	Basis = $0.63 - $0.60 = $0.03	
Case I: Basis Unchanged - Cash and Futures Rise Equally		
November 15	Inventory value = $0.58/gallon	Sell one December heating oil contract at $0.61/gallon
	Loss in cash market = $840	Gain in futures market = $840
	Net Gain or Loss = $0	
Case II: Cash Falls Less than Futures		
November 15	Inventory value = $0.59/gallon	Buy one December heating oil contract at $0.61/gallon
	Loss in cash market = $420	Gain in futures market = $840
	Net Gain = $420	
Case III: Cash Falls More than Futures		
November 15	Inventory value = $0.57/gallon	Buy one December heating oil contract at $0.61/gallon
	Loss in cash market = $1,260	Gain in futures market = $840
	Net Loss = $420	

An Example of an Exchange of Futures for Physicals (EFP)

There is seemingly an endless number of possibilities for commercial uses of the futures markets. Traders who think prices in 2 contract months will change at different rates may put on an "intramarket spread" by simultaneously buying 1 month and selling another month. Or, traders who want to take advantage of the price differential between crude oil, heating oil, and unleaded gasoline might simultaneously buy oil and sell products, putting on an "intermarket spread" or "crack spread."

There are also various possibilities available in the delivery area. When delivery notices are issued and received at the expiration of a contract, the buyer and seller can mutually agree to waive the exact terms of the futures contract and use an Alternative Delivery Procedure (ADP). But the most popular delivery mechanism on the New York Mercantile Exchange is the Exchange of Futures for Physicals (EFP). In 1989, over a billion barrels of crude oil and products were exchanged by using the EFP mechanism, the equivalent of 150 days of U.S. crude oil production, 44 days of OPEC crude oil production, and up to 20 days of free world crude oil consumption (Hill 1990).

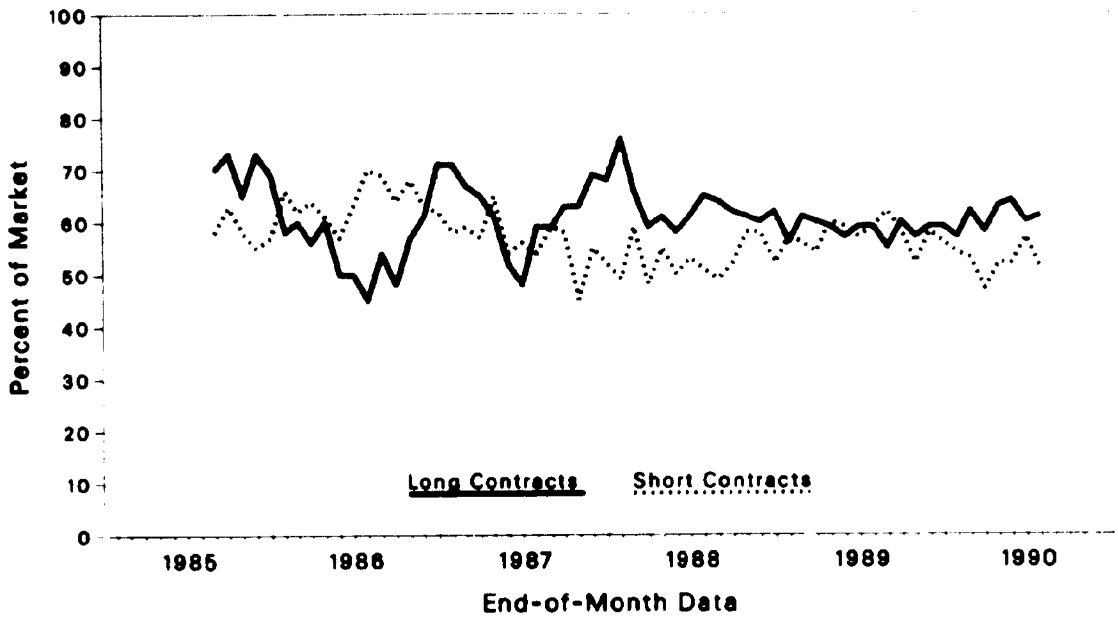
In a standard delivery procedure, the buyer and seller do not know in advance who the company is on the other side of the trade, because they are matched by the futures market exchange. In an EFP, however, the buyer and seller know in advance whom they are trading with. An example of an EFP is shown in Table FE3 (NYMEX 1986).

As Table FE3 shows, the supplier and user may initiate their futures markets positions at different times. The supplier sells 30 August heating oil futures contracts

Table FE3. An Example of an Exchange of Futures for Physicals

Date	Action
July 1	Supplier A sells 30 August No. 2 heating oil futures contracts at $0.80/gallon.
July 15	User B buys 30 August No. 2 heating oil futures contracts at $0.75/gallon.
July 23	Supplier A and User B agree to transact 1.26 million gallons (30 contracts) of No. 2 heating oil for August NYMEX's EFP delivery mechanism. Supplier A tells his broker to buy 30 contracts from User B's broker, which will liquidate both futures market positions. August No. 2 heating oil closes at $0.78/gallon.
Result:	Supplier A receives $0.78/gallon from User B and $0.02/gallon profit from futures market $0.80/gallon sale price. User B pays $0.78/gallon to Company A and receives $0.03/gallon profit from futures market $0.75/gallon purchase price.

Figure FE2. NYMEX Crude Oil Futures Commercial Open Interest



Source: Commodity Futures Trading Commission (1990).

on July 1, and the user buys 30 contracts on July 15. As the contract nears expiration, an informal network of companies and brokers might be used to locate opposite parties. When the two sides agree, the supplier tells his broker to buy 30 heating oil futures contracts from the user's broker, and the NYMEX is notified of the transaction, which did not take place on the exchange floor. The two sides may have very different gains and losses from their futures market transactions.

Issues Surrounding the Futures Markets

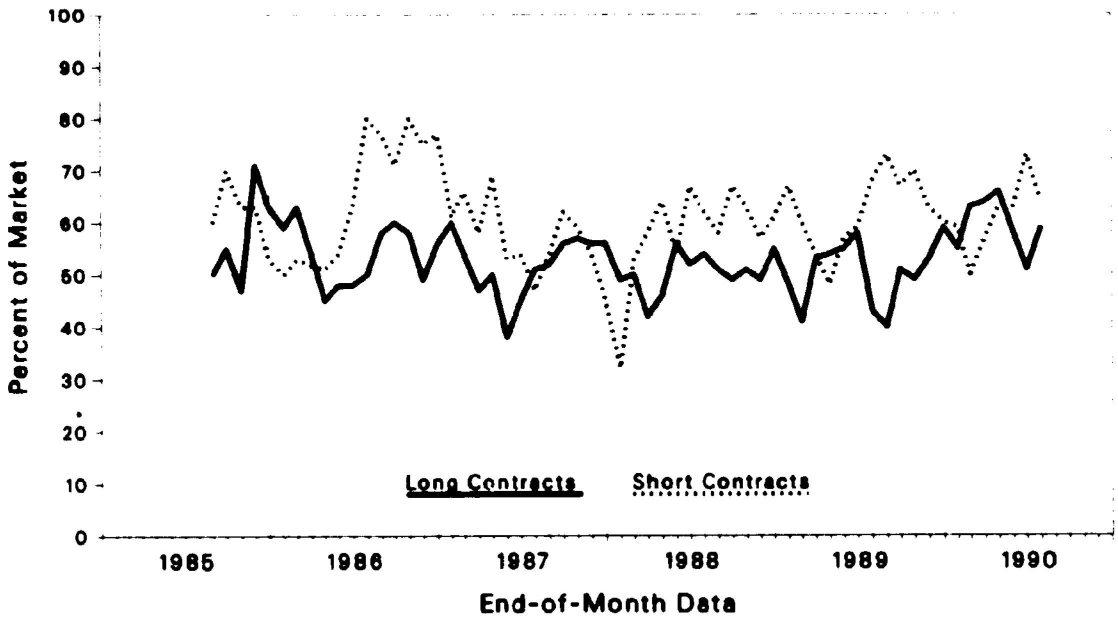
Futures markets have frequently been embroiled in controversy ever since they began over 100 years ago, and energy futures have followed this pattern. The arcane nature of the markets adds to the confusion surrounding their economic functions. In this section are described some of the issues related to energy futures markets.

Do Speculators Destabilize Prices?

Two recurring issues in futures markets are whether or not futures markets increase price volatility in the underlying cash markets (Baumol 1957; Dale 1991) and whether or not their existence can lead to sudden upward price spikes, or "bubbles" (Flood and Hodrick 1990). The issue is complicated by the history of the oil markets. Prices posted by OPEC certainly had little day-to-day volatility, and today's more competitive markets have more volatility. Increased volatility is sometimes blamed on speculators. Yet, if increasing restrictions are placed on speculators (e.g., by increasing margin requirements or by lowering the number of contracts they are permitted to hold), the result might be fewer traders, less liquidity available for hedges, and more actual volatility.

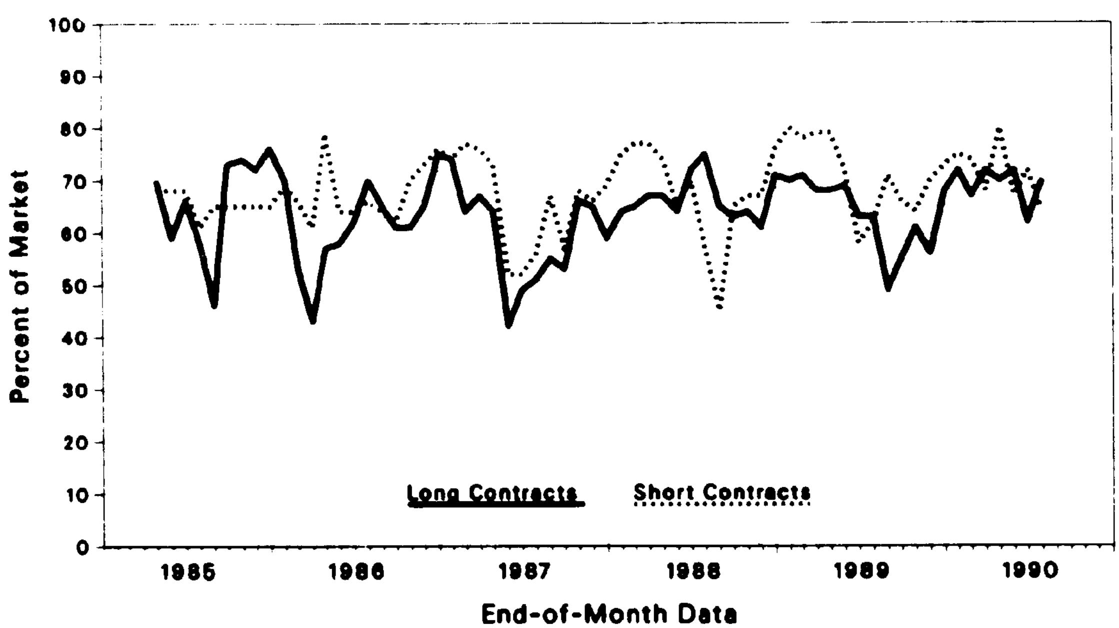
Since speculators frequently rely on mechanical trading rules, which are trading methods they develop using historical prices rather than economic fundamentals, to try to determine buy and sell points (Dale and Workman 1980, 1981; Brock 1991), a large amount of speculative activity can cause concern that the markets are producing incorrect prices. One way to look for undue speculative activity is to examine the types of traders involved in the markets (Verleger 1990a; Energy Information Administration 1990b). All traders who hold more than 250 contracts of crude oil futures must have their positions reported by their brokers to

Figure FE3. NYMEX Heating Oil Futures Commercial Open Interest



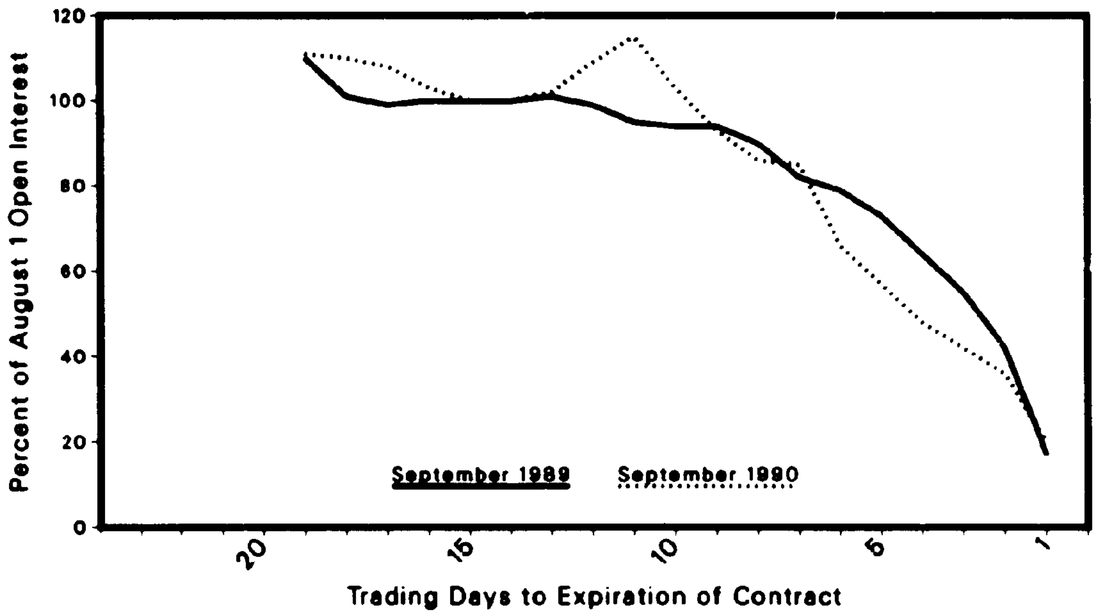
Source: Commodity Futures Trading Commission (1990).

Figure FE4. NYMEX Unleaded Gasoline Futures Commercial Open Interest



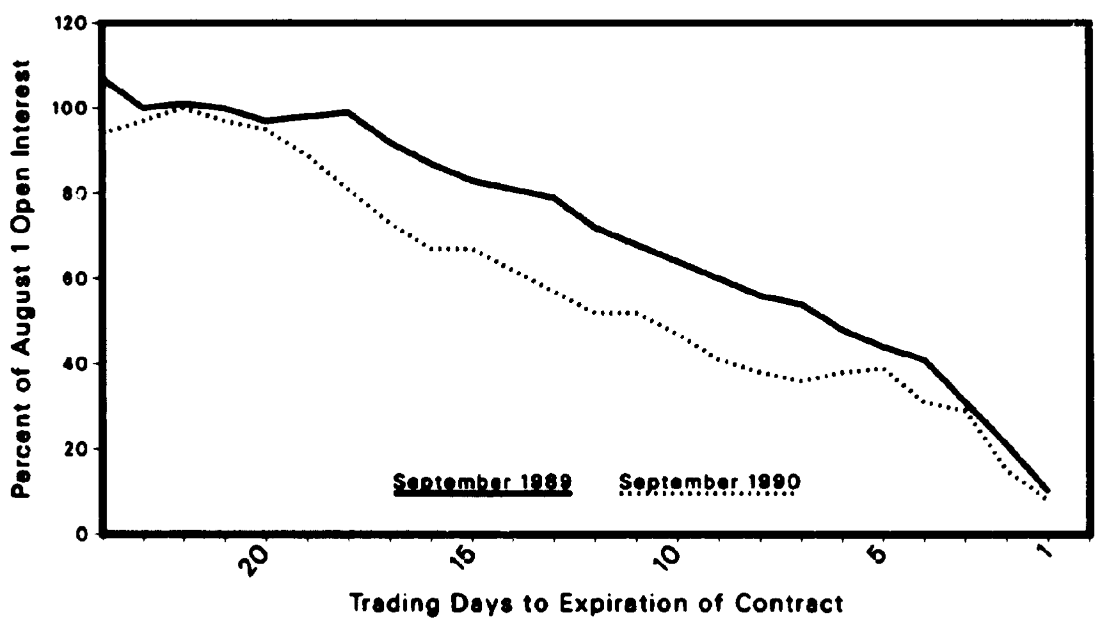
Source: Commodity Futures Trading Commission (1990).

Figure FE5. NYMEX Crude Oil Contract Liquidation Patterns



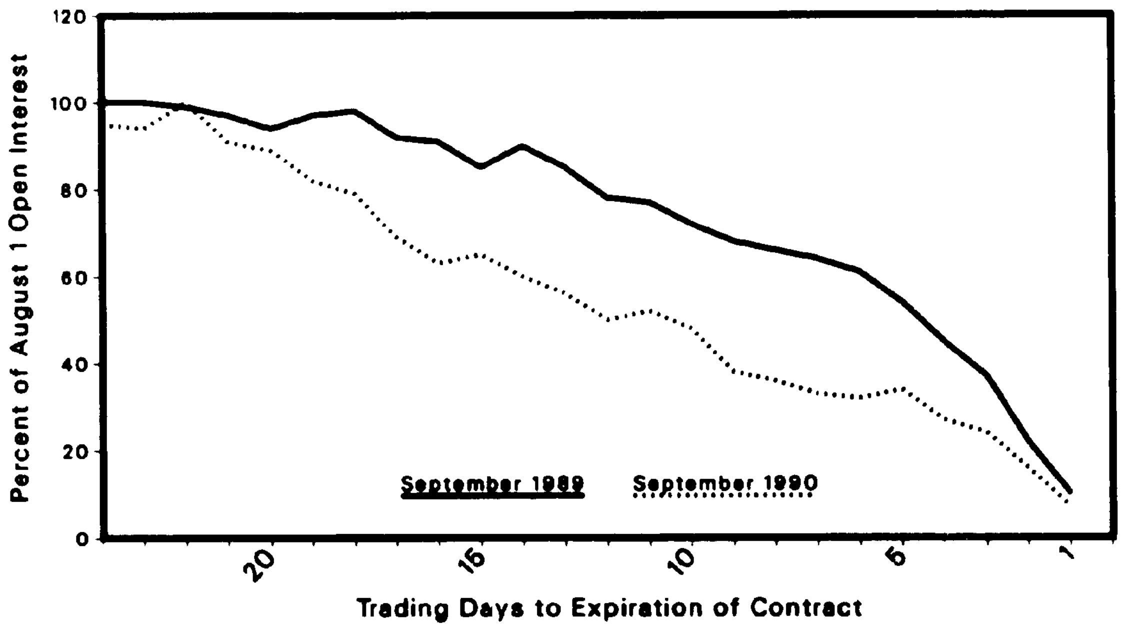
Source: New York Mercantile Exchange (NYMEX) daily price quotations.

Figure FE6. NYMEX Heating Oil Contract Liquidation Patterns



Source: New York Mercantile Exchange (NYMEX) daily price quotations.

Figure FE7. NYMEX Unleaded Gasoline Contract Liquidation Patterns



Source: New York Mercantile Exchange (NYMEX) daily price quotations.

the Commodity Futures Trading Commission (CFTC 1990). The CFTC thus knows the percentage of total contracts outstanding, or "open interest," held by large commercial traders and the percentages that are held by large noncommercials (i.e., speculators) and by nonreporting traders (who might be either small commercial traders or small speculators).[5]

Figures FE2 through FE4 show the monthly commitments of large commercial traders over the last 5 years. No sudden anomalous changes are seen, even in the turbulent August 1990 period, for crude oil or crude oil products. The percent of large commercial traders typically fluctuated between about 40 percent and 70 percent, indicating the markets were dominated by commercial traders, not speculators. Since there was not a sharp rise in speculative holdings in August 1990, there is no evidence from the commitment graphs that speculators magnified price movements in oil or oil products.[6]

Another way to look for evidence of potential market destabilization is to examine the liquidation patterns of expiring contracts. Figures FE5 through FE7 show the liquidation patterns of the expiring September 1990 contracts (which expired in August 1990) of oil and oil products, compared to the patterns of their 1989 counterparts. The open interest declined steadily in all of the contracts for both years, showing no sharp spikes in open interest that could indicate abnormal trading activity and destabilization of the futures markets. In both years, the number of deliveries against the contracts were relatively small.

Hedging Accompanied Increased Oil Production

Many oil companies responded to the Gulf crisis in August 1990 by increasing their production of domestic crude oil.[7] The Energy Information Administration (1991) collects data on Domestic Crude Oil First Purchases, which represent purchases at the production site and, as such, are a reliable proxy for trends in oil production. The volume of first purchases nationwide[8] in August 1990 was at a rate of 5,548,000 barrels per

[5]As noted above, there is not always a clear distinction between speculation and hedging. The definition used here conforms to the classification system used by the Commodity Futures Trading Commission.

[6]In fact, Verleger (1988) and Abken (1989) argue that the high volume of commercial activity indicates that there are *not enough speculators* in energy futures to ensure correct commodity pricing.

[7]The Mexican Government also hedged much of its 1991 oil production in the futures market (*Oil Marketing Bulletin* 1991).

[8]The following data do not include those of Alaska, which was subject to erratic production in 1990 because of pipeline repairs.

Table FE4. NYMEX Crude Oil Futures Market Commercial Activity, August 1990

Company Type	Total Number of Companies	Number of Companies Increasing Their Net Short Positions
Major oil companies with substantial crude	5	4
Major oil companies that purchase substantial crude	8	5
Large independents and nonrefiners	10	7

Source: Commodity Futures Trading Commission.

day, up 2.23 percent from the July level of 5,427,000 barrels per day.

The increase in crude oil first purchases in August 1990 over purchases in July was a deviation from the recent historical pattern, in which August volume declined relative to July. Using a 5-year average to eliminate any exceptional variations in the month-to-month changes, from 1985 through 1989 first purchases actually dropped an average of 1.45 percent from July to August, compared to the 2.23 percent increase in 1990. If historical patterns had held in 1990, instead of increasing in August, first purchases would have fallen to 5,348,000 barrels per day, and production would probably have fallen as well.

A preliminary analysis of data from the Commodity Futures Trading Commission shows that, while there may be numerous possible reasons for increased oil production, one possible scenario for the increased oil production in August is that oil companies made substantial use of the NYMEX crude oil futures market to hedge the price risk arising from their increased production, purchases, and processing. Table FE4 groups oil companies into three categories: (1) major oil companies that own substantial amounts of their own crude, (2) major oil companies that must purchase large quantities of their own crude, and (3) large independents and nonrefiners. The table shows the number of companies that were net sellers of crude oil futures contracts in August 1990, i.e., companies that either decreased long positions or increased short positions during the month.

All three groups were net sellers on balance. Higher oil prices apparently induced higher oil production, and producers used short sales of oil futures to hedge price risk from their increased production. Refiners could put on "reverse crack spreads" (selling crude oil futures and buying product futures) to hedge against possible shutdowns for unexpected repairs, while operating near full capacity. This would enable refiners to fulfill their product commitments and hedge against price risk of selling crude for which they might not have storage capacity during the unexpected repairs. Since commercial traders comprise the majority of futures market participants, in late August their heavy volume of short sales at relatively low prices helped to slow the bidding up of oil futures prices by buyers.

Conclusions

The following conclusions are based on the analysis in this article:

- Energy futures have significantly altered the way in which crude oil and products are marketed by causing contracts to be priced relative to futures market prices.
- Energy futures have been used increasingly by companies in the oil industry to transfer price risk.
- There is no evidence that speculators in futures markets destabilized spot crude oil and product markets since the invasion of Kuwait by Iraq. The relative amount of speculative activity did not increase.
- Most activity in the energy futures markets involves users and suppliers of oil who are using futures contracts as a means of guaranteeing price and availability.

References

Abken, P. A. 1989. "An Analysis of Intra-Market Spreads in Heating Oil Futures." *The Journal of Futures Markets* 9, No. 1: pp.77-86.

Baumol, W. August 1957. "Speculation, Profitability, and Stability." *The Review of Economics and Statistics* 39: pp. 263-271.

Brennan, M. J. 1958. "The Supply of Storage." *American Economic Review* 48: pp. 50-72.

Brock, W. A. 1991. "Causality, Chaos, Explanation and Prediction in Economics and Finance." SSRI Reprint Series No. 387. University of Wisconsin, Madison.

Brown, S. L., and S. Errera. 1987. *Trading Energy Futures: A Manual for Energy Industry Professionals.* New York: Quorum Books.

CFTC. 1990. *Commitments of Traders in Commodity Futures.* Various months. Washington, DC. Commodity Futures Trading Commission.

Chen, K. C., R.S. Sears and D-N. Tzang. 1987. "Oil Prices and Energy Futures." *The Journal of Futures Markets* 7, No. 5. pp. 501-518.

Cicchetti, P., C. Dale and A. J. Vignola. 1981. "Usefulness of Treasury Bill Futures as Hedging Instruments." *The Journal of Futures Markets* 1, No. 3: pp. 379-387.

Dale, C. Spring 1981a. "The Hedging Effectiveness of Currency Futures Markets." *The Journal of Futures Markets* 1, No. 1: pp. 77-88.

Dale, C. May 1981b. "Brownian Motion in the Treasury Bill Futures Market." *Business Economics,* pp. 47-54.

Dale, C. July 1991. "The Effects of Energy Futures Markets on the Worldwide Marketing of Oil." *Proceedings of the International Association for Energy Economics.* Honolulu, HI, pp. 786-795.

Dale, C., and R. Workman. Nov/Dec 1980. "The Arc Sine Law and the Treasury Bill Futures Market." *Financial Analysts Journal,* pp. 71-74.

Dale, C., and R. Workman, Winter 1981. "Measuring Patterns of Price Movements in the Treasury Bill Futures Market." *Journal of Economics and Business,* pp. 81-87.

Dew, J. K. 1981. "Comment on 'Usefulness of Treasury Bill Futures as Hedging Instruments'." *The Journal of Futures Markets* 1, No. 3: pp. 389-391.

Draper, D. W. 1984. "The Behavior of Event-Related Returns on Oil Futures Contracts." *The Journal of Futures Markets* 4, No. 2: pp. 125-132.

Energy Information Administration. October 11, 1990a. Office of Oil and Gas. *The U.S. Petroleum Refining Industry in the 1980's.* DOE/EIA-0536. Washington, DC.

Energy Information Administration. November 1990b. *Petroleum Prices and Profits in the 90 Days Following the Invasion of Kuwait.* Service Report SR/OA/90-01. Washington, DC.

Energy Information Administration. 1991. Office of Oil and Gas. *Domestic Crude Oil First Purchase Report.* Form 182. Unpublished.

Fesharaki, F., and H. Razavi. 1986. *Spot Oil, Netbacks, and Petroleum Futures.* The Economist Intelligence Unit, Economist Publications Limited. New York.

Flood, R. P., and R. J. Hodrick. 1990. "On Testing For Speculative Bubbles." *Journal of Economic Perspectives* 4, No. 2: pp. 85-101.

Gay, G. D., and R. W. Kolb. (eds.) 1982. *Interest Rate Futures: Concepts and Issues. Richmond,* VA: Robert F. Dame, Inc.

Gerald, Incorporated. 1991. "Futures Calendar and Reference Guide." 10 South Wacker Drive, Suite 2200, Chicago, IL 60606

Hall, A. J. January 23, 1989. "How Price Linkage Ties World Oil Markets." *Oil & Gas Journal,* pp. 33.1-33.4.

Hill, J. Summer 1990. "EFPs and the Crude Oil Market." *Energy in the News,* pp. 17-20.

Hirschfeld, D. J. 1983. "A Fundamental Overview of the Energy Futures Market." *The Journal of Futures Markets* 3, No. 1: 75-100.

Jachimczyk, J. 1983. *Energy Futures.* Washington, DC: McGraw-Hill Publications Co.

Lowinger, T. C., and R. Ram. 1984. "Product Value as a Determinant of OPEC's Official Crude Oil Prices." *The Review of Economics and Statistics* 66: pp. 691-695.

Mabro, R. August 27, 1990. "Politics, Economics of First Oil War." *Petroleum Intelligence Weekly,* pp. 7-8.

NYMEX. 1986. *NYMEX Energy Hedging Manual.* 4 World Trade Center, Suite 744, New York, NY 10048.

NYMEX. March 1990. *NYMEX Energy Complex.* 4 World Trade Center, Suite 744, New York, NY 10048.

Oil Marketing Bulletin. October 29, 1990a. "New Jet Fuel Contract Needed as No. 2 Hedge Proves Faulty," p. 1.

Oil Marketing Bulletin. December 24, 1990b. "1990: The Year of NYMEX-Related Pricing," p. 1.

Oil Marketing Bulletin. April 1, 1991. "Mexico Locks in Forward Sales Via Futures, Swaps Markets," p. 4.

Petroleum Economist. November 1990 "ROEFEX, RIP," p. 55.

Petroleum Intelligence Weekly. November 26, 1990. "U.S. Refiners Turning to NYMEX Average in Posted Pricing," p. 4.

Prast, W. G., and H. L. Lax. 1983. *Oil-Futures Markets.* Lexington, MA: Lexington Books.

Razavi, H. 1984. *Oil Futures Trading.* London. Financial Times Business Information Limited.

Razavi, H. 1989. *The New Era of Petroleum Trading.* Technical Paper No. 76. Washington, DC: The World Bank.

Verleger, P. K., Jr. 1982a. *Oil Markets in Turmoil.* Cambridge, MA. Ballinger Publishing Co.

Verleger, P. K., Jr. 1982b. "The Determinants of Official OPEC Crude Prices." *The Review of Economics and Statistics* 64: pp. 177-183.

Verleger, P. K., Jr. 1987. "The Evolution of Oil as a Commodity." In *Energy: Markets and Regulation. Essays in Honor of M. A. Adelman.* Cambridge, MA: MIT Press.

Verleger, P. K., Jr. 1988. "The Role and Impact of Commodity Market Institutions in the Determination of Oil Prices." *Annual Review of Energy* 13: pp. 359-382.

Verleger, P. K., Jr. 1990a. "The Impact of Cold Weather in December 1989 on Heating Oil Prices." Statement before the Governmental Affairs Committee of the United States Senate. Washington, DC.

Verleger, P. K., Jr. 1990b. "Understanding the 1990 Oil Crisis." *The Energy Journal* 11, No. 4: pp. 15-33.

Vignola, A. J., and C. Dale. Winter 1979. "Is the Futures Market for Treasury Bills Efficient?" *Journal of Portfolio Management,* pp. 78-81. Reprinted in Gay and Kolb (1982, pp. 115-122).

Vignola, A. J., and C. Dale. Fall 1980. "The Efficiency of the Treasury Bill Futures Market: An Analysis of Alternative Specifications." *Journal of Financial Research,* pp. 169-188. Reprinted in Gay and Kolb (1982, pp. 213-235).

Weiner, R. 1991. "Origins of Futures Trading: The Oil Exchanges in the Nineteenth Century." Working Paper, Department of Economics, Brandeis University. Waltham, MA.

Williams, J. C. 1986. *The Economic Function of Futures Markets,* Cambridge, MA: Cambridge University Press.

Working, H. 1948. "Theory of the Inverse Carrying Charge in Futures Markets." *Journal of Farm Economics* 30: pp. 1-28.

Working, H. December 1949. "The Theory of Price of Storage." *American Economic Review* 39: pp. 1254-1262.

Working, H. 1953. "Hedging Reconsidered." *Journal of Farm Economics* 35: pp. 544-561.

Working, H. May 1958. "A Theory of Anticipatory Prices." *American Economic Review* 48: pp. 188-199.

Wright, B. D., and J. C. Williams. 1989. "A Theory of Negative Prices for Storage." *The Journal of Futures Markets* 9, No. 1: pp. 1-13.