PETROLEUM FUTURES TRADING AND PRICE VOLATILITY

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(ABSTRACT)

This study investigates the effects of futures trading on petroleum price variability. Though a number of critics from various quarters claim futures markets have made petroleum prices more volatile, economic reasoning does not support this viewpoint.

A review of theoretical studies and empirical investigations of other commodities shows general support for the hypothesis that futures markets do not destabilize prices and may, in fact, add to price stability. In this study, regression analysis is used to explain the price variability of heating oil and gasoline in terms of factors that may affect this variability, including the existence of futures markets. Though the empirical tests performed are biased towards finding destabilizing effects of futures markets, no statistically significant increase in price volatility is found, and in the case of gasoline,

indications of stabilizing effects are found. Thus, neither the results of other studies of futures markets nor examination of petroleum futures trading support the critics' contention that futures trading has destabilized petroleum prices.

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INTRODUCTION

The first petroleum futures contract to achieve relative success, for home heating oil, began trading on the New York Mercantile Exchange in 1978. It was followed by gasoline in 1981 and crude oil in 1983. As with other commodities, there are critics who claim that these futures markets have added to petroleum price volatility. Many economists, on the other hand, believe that these markets do not destabilize prices and may even add to price stability.

The purpose of this thesis is to investigate these competing claims. Chapter 1 reviews the elements of futures trading in general and the essence of the arguments for and against price destabilization. Chapter 2 investigates what can be learned about the possible effect of futures markets on petroleum price stability from previous theoretical studies and from empirical investigations of other commodities. In Chapter 3, developments in petroleum markets during the 1970s and 1980s, including a short history of petroleum futures trading in the U.S., are briefly reviewed in order to provide the proper background for the empirical tests presented in Chapter 4. Chapter 5 summarizes and concludes the study.

CHAPTER 1

This chapter will review the operations of futures markets in general and some of the criticisms that have been made of futures markets, including those for petroleum. The essence of the economic argument against destabilizing effects also will be presented.

Futures Markets

A buyer of a futures contract enters into an agreement with a commodity exchange (or, more likely, with a broker who is a member of the exchange) to buy a certain amount of the commodity at a certain price at a certain future date.[1] He typically is required to deposit funds in a margin account so that at the end of each trading day, the exchange can "mark to market" his account--that is, add or subtract from his account the amount by which the value of his contract changed that day. A seller enters a similar agreement with the exchange (or broker).

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[1]Much of the general material on the operations of futures markets in this section is inspired by Carlton (1984), Goss and Yamey (1976), and Telser (1981).

All contracts are standardized in terms of grade, location and means of delivery, quantity, and other terms. Because of standardization and centralization, the exchange can act as a clearinghouse to balance the number of contracts bought and sold without buyers and sellers having to seek out and transact with each other directly. Buyers and sellers of futures contracts can easily close out their positions by entering an offsetting contract to respectively sell or buy an equal amount of the commodity.

The futures market provides an opportunity for those who deal in the physical commodity--producers and users of the commodity who hold inventory or have entered fixed-price contracts to deliver products manufactured from the commodity, for example--to reduce the risk stemming from price uncertainty. Such agents may hedge in this way either regularly or selectively. An inventory holder may hedge selectively, for example, by selling futures contracts only when he believes there is a possibility of a large price decline.

The futures market also provides an opportunity for those who do not necessarily deal in the physical commodity but nevertheless hold beliefs about future prices to speculate on those beliefs.

It is unreasonable for futures prices to depart substantially from expected future cash prices, since this creates a perceived opportunity for knowledgeable participants to profit from the discrepancy and by their trading to cause the futures price to move back into line. For example, if a higher cash price is expected next period but the futures price does not reflect it, individuals could buy futures contracts now and expect to make a profit selling them next period. Thus, futures prices can be expected to reflect in some way the available information about future cash prices. This means that since futures prices are publicly available and easy to obtain, the futures market provides price information even to those who do not participate in futures trading.[2]

Though it is true that hedging can be accomplished by means of forward contracts rather than with futures (Telser 1981, p. 5), compared to forward contracts, futures trading has numerous advantages because of standardization and centralization. Futures markets lower

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[2]Whether or not futures prices at a particular point in time are unbiased reflections of price expectations is a question that has received much attention in the economic literature.

transaction costs by making it easier for a buyer or seller to find a trading partner (in effect, the exchange is the other partner to each transaction) and greatly reducing participants' cost of evaluating the creditworthiness of the other party to the contract. Futures markets may also enhance liquidity, since holders of futures positions can easily close them out with the offsetting contract. This is unlike many holders of forward contracts, who must search for another party requiring similar volumes, timing, and point of delivery.

Criticisms of Futures Markets

Criticism of futures markets and their alleged destabilizing effects has probably persisted for as long as there have been futures markets. For example, in 1922 Congress passed the Grain Futures Act which included the statement that ". . . such fluctuations in prices are an obstruction to and a burden upon interstate commerce. . . .", and in 1958 went so far as to ban the trading of onion futures altogether (Working 1960, in Working 1977 p. 45). In the 1963 Congressional hearings on potato futures, complaints were heard that farmers were being placed at the mercy of gambling speculators (Gray 1964, p. 105).

In more recent times, there has been no shortage of critics who maintain that futures trading has destabilized petroleum prices. Some criticism has come from within the industry:

> "The futures market has contributed greatly to volatility." [Industry executive quoted in Oil and Gas Journal 1984, p. 43].

> As oilmen searched for an explanation to the severe contraseasonal swings, most placed the blame on an "unpredictable" futures market. . . . [Waterman 1984, supplement p. 1].

> Many feel the growth of futures trading represents no real improvement in the traditional market since it responds with great volatility to factors that often seem irrelevant to the "real" physical oil business. [Petroleum Intelligence Weekly 1985, supplement p. 2].

> There is particular concern in oil circles that futures are too much of a "gambling forum" for speculators. There is concern futures trading adds too many non-oil commodity influences to the pricing equation, sometimes running contrary to physical market patterns. [Petroleum Intelligence Weekly 1986, p. 4].

Despite criticism from some parts of the industry, clearly opinions vary greatly--it is reported that about two-thirds of petroleum futures trading activity is for or by the industry (Taylor 1986, p. 26). Furthermore, numerous articles have appeared from time to time in the trade literature on the benefits of futures trading.[3]

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[3]For only one of many examples, see Petroleum Economist (1985).

At least one independent producer hedged most of its crude oil production against a potential 1986 price decline (Pickens 1986).

> Some analysts and traders think futures markets can stabilize the physical spot markets. Cash market price movements, they say, are moderated. . . .[*Oil and Gas Journal* 1984, p. 41].

A mixture of opinions may also be found in the government sector. At one point during the winter of 1983-84, extremely cold weather in the Northeast caused a rapid price increase for heating oil (followed by a rapid decrease). This spurred numerous government investigations of factors affecting heating oil prices. Several state investigations implicated petroleum futures trading as one potential cause of the price increase.[4] Interestingly enough, the Connecticut investigation took a different approach, recommending that

> Connecticut, in both its roles as a purchaser of millions of gallons of fuel oil and as a provider of funds for the Low Income Energy Assistance Program, should study the feasibility of stabilizing its energy costs through the use of . . . distillate commodity futures contracts. . . . [Connecticut 1984, p. 3].

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[4]For example, see Massachusetts (1984) and New York (1984).

<u>The Stabilizing Effect of Futures Markets</u>

Contrary to the critics' assertions, there is reason to believe that futures markets do not destabilize prices and, in fact, have potentially stabilizing effects.

One reason this is not always apparent may be due to a confusion between cause and effect. Telser's observation that futures markets should be expected to flourish when prices are less stable and languish when prices are more stable suggests that the direction of causation is the reverse of what critics perceive (Telser 1981, pp. 21-22).

The potentially stabilizing effect of futures markets has to do with the information the futures price conveys about price expectations. This information enables producers and users of the commodity to adjust their plans more effectively, thus helping to stabilize prices. For example, if futures markets participants' information leads them to believe that prices will rise, futures prices are bid up and producers, basing their decisions on this information, increase output. This higher output helps to dampen the spot price increase in the next period. Without the increased information from futures markets, producers may not have increased output and the spot price increase may have been greater.

Cox (1976, p. 1218) summarized how futures markets increase the flow of information:[5]

> Without futures trading, individuals' expectations may differ widely, but often it is not worthwhile to communicate that information. A formal futures market reduces the cost of transacting because trading is completely centralized. Relative to dispersed trading and private negotiation, it is cheaper to identify potential traders, search for the best bid or offer, and negotiate a contract in a futures market. It becomes worthwhile for more individuals to trade and thereby communicate their information. The dispersed information on supply and demand is concentrated in one place and is all reflected in a single futures price. . . . Because futures prices are widely publicized, the information incorporated in a futures price can be acquired cheaply by individuals who do not trade in futures markets.

Futures markets could be destabilizing if a large number of speculators were generally uninformed and brought erroneous information into the market. However, as Carlton (1984, p. 13) states,

> If a futures market attracts uninformed traders, it is conceivable that price predictions could become less accurate. However, this seems unlikely because any deterioration in the accuracy of price predictions would attract informed investors who would have an

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[5]Cox distinguishes between information from speculators and information from those who deal in the physical commodity. Though in what follows, Cox is referring to the second group, the quotation aptly describes the communication of market information as a whole.

incentive to use their knowledge to earn high profits and thereby drive the poorly informed from the market by inflicting losses on them.

Thus, economic arguments tend not to support a destabilizing effect of futures markets.

CHAPTER 2

The essential economic argument against destabilizing effects of futures markets has already been stated--that futures markets make information on price expectations more easily available, enabling producers and users of the commodity to make plans that more accurately reflect future conditions, and thus potentially helping to stabilize prices. In investigating the possible effects of futures trading on petroleum markets, a further exploration of theoretical results is in order, as well as a review of what has been found in empirical studies of other commodities. This review will provide a better idea of what might be expected to be the case with petroleum futures markets.

The Effects of Futures Trading--Theoretical Studies

Danthine (1978) developed a rational expectations model of futures trading in which only speculators have information about future spot prices. Since, in his model, production occurs at a lag and demand in the next period is subject to random disturbances, producers would stand to benefit from increased information about these disturbances but can only acquire this information from futures prices. Given the assumptions about the distribution of information in the model, it is not surprising that Danthine found that the introduction of futures trading helped to stabilize prices.

The assumption that producers are uninformed about the future is a questionable one in many cases. Kawai (1983) did away with this assumption while adding a number of other changes as well. Kawai could not solve his model for the general rational expectations case, but examined several extreme cases and numerical examples. He concluded that the source of random disturbances (i.e., supply, consumption demand, or inventory demand) was an important factor in determining the effect of futures trading on prices, and that while in some cases futures trading had a stabilizing effect, in other cases futures trading was destabilizing.

However, Kawai's model may not necessarily imply that actual futures markets are in some cases destabilizing. The effects derived mathematically by Kawai are conclusive only for cases of extreme differences in disturbances among sources. Furthermore, his numerical examples involve differences among disturbances from different sources of one hundred to one. In fact, for his cases in which the variances of all three disturbances are the same (the only other numerical cases shown), futures trading is either stabilizing or has essentially no effect.

Turnovsky (1983) presented a model similar to Kawai's and again could not achieve a general solution despite the elimination of inventory demand disturbances. However, examination of a number of polar cases led Turnovsky to conclude that, since in all cases examined, futures markets either stabilized prices or had no effect, cases between the extremes might be expected to have the same result.

Turnovsky and Campbell (1985) explored Turnovsky's model further by using numerical methods to solve the model under assumptions of various plausible values for the parameters. In all cases, the variance of the spot price was reduced, though the degree of stabilization varied from substantial to minimal. Futures markets had a greater stabilizing effect for demand disturbances than for supply disturbances of equal magnitude.[1]

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[1]Interestingly enough, the nonexistence of a solution occurred only in cases without futures markets and very inelastic demand. In these cases, the introduction of futures trading always brought about a feasible solution.

Theoretical studies thus do not generally support the hypothesis that petroleum futures markets destabilize prices.

The Effects of Futures Trading--Empirical Studies

Numerous empirical studies of the effect of futures markets on spot prices have been performed in the past several decades, including Working (1960), Gray (1963), Gray (1964), Powers (1970), Tomek (1971), Taylor and Leuthold (1974), Cox (1976), and Tomek (1979) in commodity markets and Froewiss (1978), Figlewski (1981), Corgel and Gay (1984), and Simpson and Ireland (1985) in financial markets. Friedman, Harrison, and Salmon (1983) and Forsythe, Palfrey, and Plott (1984) simulated futures markets with human participants in a laboratory setting.

Markets for which either stabilizing or neutral effects were found include onions, potatoes, live cattle, pork bellies, wheat, hogs, frozen concentrated orange juice, and securities of the Government National Mortgage Association (GNMA). Two studies found destabilizing effects for GNMA futures and for Treasury bill futures, respectively.[2]

Both market simulations found that futures markets increased the speed with which new information was incorporated into market prices. Friedman, et al. (1983) found that futures markets tended to stabilize spot prices; Forsythe, et al. (1984) found that though futures markets increased the variance of spot market prices initially, equilibrium was reached more rapidly, reflecting efficiency gains because information was more rapidly incorporated into spot prices.

Thus, most empirical studies suggest that futures trading in petroleum should likely not destabilize prices.

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[2]Figlewski (1981) included futures trading volume and open interest as explanatory variables in a regression model of GNMA price volatility. As Corgel and Gay (1984, p. 179) point out, it seems much more probable that cash price variability caused the increase in futures trading rather than the reverse. Corgel and Gay found futures trading to have a stabilizing effect on GNMA prices.

The conclusion of Simpson and Ireland (1985) that Treasury bill futures trading added to volatility is based on an apparent increase in the responsiveness of Treasury bill rates to changes in the rate on bankers' acceptances. However, this could easily be used to support the opposite conclusion--for example, that Treasury bill markets became more integrated with other markets because of futures trading.

Implications for Analysis of Petroleum Futures

Both theoretical and empirical studies suggest that futures markets likely should not destabilize prices. However, as the theoretically derived results of Turnovsky and Campbell show, it is possible that any stabilizing effect could be too small to detect in some cases.

The empirical methodologies used vary widely. A number of authors, for example, Working (1960), Gray (1963, 1964), and Taylor and Leuthold (1974), implicitly assume that no other factors affecting price volatility changed between periods with and without futures trading. This is not always likely to be true, especially in light of Telser's (1981) observation that futures markets have a greater chance of success when prices are highly variable than when they are not. The *ceteris paribus* assumption is especially questionable for petroleum markets, which have changed dramatically over the 1970s and 1980s.

Other authors have implicitly or explicitly gone beyond this *ceteris paribus* assumption. Some, such as Powers (1970) and Cox (1976), did not explicitly model the other sources of price variability but allowed the model structure to change between the two periods. Others, such as Figlewski (1981) and Corgel and Gay (1984), explicitly modelled price variability as a function of known factors and the existence of futures markets.

The *ceteris paribus* assumption is clearly unwarranted for petroleum markets over the past decade-and-a-half. In addition to the waxing and waning role of OPEC, supply disruptions, and various degrees of government intervention experienced, the structure of domestic supply and demand has changed as well. Higher real price levels and other factors reduced consumption in relation to refining capacity, altered relative proportions of petroleum products consumed, changed seasonal consumption patterns, and affected the cost of and demand for inventory. It therefore appears wise, in the case of modelling the effects of futures markets on petroleum price variability, to account for the possible effects of these factors. This is the goal of the next chapter.

CHAPTER 3

In this chapter, the developments of the 1970s and 1980s in petroleum markets and how they may affect a test of the effect of futures markets on price volatility will be discussed. The first section will deal with supply disruptions and price controls, the second with shifts in domestic supply and demand. The third will briefly review the history of futures trading in petroleum, while the fourth will examine the implications of the first three for empirical analysis.

Supply Disruptions and Price Controls

The supply disruptions linked with the Arab oil embargo of 1973-74 and the Iranian revolution in late 1978 are familiar to many. Less well-remembered by some is how government price and allocation controls exacerbated these disruptions.[1]

Petroleum price controls were an outgrowth of President Nixon's general wage and price freeze of August

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[1] Much of the material here on supply disruptions and government controls is based on Lane (1981) and Kalt (1980).

1971 under the authority of the Economic Stabilization Act of 1970. The price control program went through several stages in the following years. Phase IV controls had been scheduled to terminate by the spring of 1974, but after the beginning of the Arab oil embargo of the U.S. and Netherlands (October 1973-March 1974), controls were extended for petroleum.

For petroleum products, the controls did not consist of specified prices, but rather were designed to preserve a fixed margin for refiners and marketers. Thus, refiners were allowed to "pass through" the cost of spot purchases of crude oil and products (Lane 1981, p. 21). Except in periods of disruption, product price controls were generally not binding (Kalt 1980, p. 4).[2]

Crude oil controls did set specific price ceilings, well below world levels, for most domestic crude oil. Because of the large price difference between domestic and imported oil, the Entitlements Program was created in an effort to equalize (broadly speaking) the price of crude

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[2]But, for example, there is evidence that margin controls at the retail level on full-service gasoline tended to be binding. This distorted the relative shares of full-service and self-service sales (Fenili and Lane, 1985, p. 8).

oil among all refiners.[3] This meant that a refiner could import a barrel of oil at the world price but, through the Entitlements formula, pay in effect only the lower, average cost of domestic and imported crude oil combined.

In addition to price controls, allocation controls affected petroleum markets in the 1970s, particularly during disruptions. One of the features of these controls was that, particularly during disruptions, petroleum products could not be moved to areas of strongest demand, but were instead allocated to resellers and a limited class of end users based on historical sales patterns. As a result of this inflexible system, the disruptions of 1973-74 and 1979 were exacerbated.[4]

Regulatory uncertainty was created during disruptions by continually-shifting government positions on "desirable" actions for the industry. For example, during the 1979 disruption, government policy was at one

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[3]However, special advantages were developed for "small" refiners.

[4]For a more detailed description of the effects of the controls during disruptions, see Lane (1981).

Though the Iranian Revolution began in late 1978, the associated disruption's effects were not felt in the U.S. until 1979; gasoline lines, for example, began forming in the spring of 1979 and largely disappeared by late summer.

point discouraging and at another encouraging spot market purchases; at one point federal policy was aimed at pushing refiners to produce gasoline at the expense of distillates and at another, to do the reverse (Lane, pp. 65-67 and 76-77). These governmental vacillations can be expected to have added to spot price volatility.

The various controls ended at different times. Controls on heating oil were discontinued in 1976, though similar margin controls lasting from late 1978 through 1980 were reinstituted under the guidelines of the Council of Wage and Price Stability. Gasoline and crude oil controls were ended in January 1981.

Other Domestic Supply and Demand Developments

The petroleum price increases of the 1970s, in combination with other factors, affected several aspects of the domestic supply and demand situation for petroleum products. Higher prices reduced consumption levels, with a resulting impact on refinery utilization. While throughout most of the 1970s the utilization rate of operable U.S. refinery capacity was in the 85 to 90 percent range, in the first half of the 1980s it was typically in the 60s and 70s. Over the years, refining capacity gradually fell as a result, but at a substantial lag. The proportion of light products (such as gasoline and distillates) to total consumption rose, as residual fuel oil consumption fell largely because of fuel switching. Seasonal patterns of consumption were altered by price levels,[5] storage costs were generally higher because of higher petroleum price levels and "real" interest rates, and spare refinery capacity was greater, all altering the supply of and demand for inventory.

Petroleum Futures Markets

The petroleum futures contracts that were introduced in 1978 and following years were not the first. The New York Cotton Exchange (NYCE) introduced a crude oil futures contract in September 1974; the New York Mercantile Exchange (NYMEX) introduced heating oil and industrial fuel oil contracts in October of that year. These contracts were never very successful and had fallen into inactivity by mid-1976 (*Petroleum Intelligence Weekly* 1976, pp. 6-7).

Later, NYMEX redesigned the heating oil contract and initiated trading in mid-November 1978. Leaded gasoline followed in October 1981 and crude oil at the end of March

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[5]See Planting (1982).

1983. A contract in unleaded gasoline began trading in 1984, but due to the high correlation between leaded and unleaded prices, it has never achieved the volumes of the leaded contract. The Chicago Board of Trade has also entered the petroleum futures arena, but these contracts have been relatively unsuccessful (Petroleum Intelligence Weekly 1984).

As with most commodity contracts that eventually succeeded, the NYMEX petroleum futures began at lower volumes that grew over time. Month-end open interest did not reach 5,000 contracts until 1980:III, 1983:I, and 1983:III, respectively for heating oil, leaded gasoline, and crude oil.

Implications for Analysis of Petroleum Futures

What implications do the developments of the 1970s and 1980s have for petroleum price volatility? First, because of the special nature of the disruption periods, it appears wise to treat them separately. Though the question of price volatility during disruptions is of great interest in other contexts, for the purpose of this study more "normal" periods are of first concern. Especially because of the exacerbating effects of allocation controls combined with regulatory uncertainty during the disruptions of the 1970s, one would expect price volatility on the spot market to have been increased above levels that would have otherwise occurred during these periods.

Second, for nondisrupted periods, price controls, if they had any effect on spot price volatility, may have reduced it. However, since refiners and others could pass through the cost of products acquired on the spot market, it is unclear whether the effect of product price controls on spot price volatility, if it existed, was very large.

However, crude oil price controls, combined with the Entitlements Program, effectively reduced the cost of a <u>marginal</u> barrel of crude oil to refiners to the (lower) combined domestic-imported <u>average</u> price. It may well be that for this reason, price volatility on world crude oil markets was not fully reflected in U.S. spot product prices. On the other hand, product imports continued throughout the 1970s and 1980s, and if foreign sources are the marginal suppliers of products, then U.S. spot prices should reflect world crude oil price volatility.

In any event, in the empirical tests performed in this study, adjustments are not made for the effects of crude or product price controls. This, if anything, biases the conclusions against the hypothesis that futures markets do not add to price volatility. Nevertheless, this approach is taken because futures trading for the products examined began not long after each was decontrolled, thus making it difficult to statistically test the separate effects of controls and futures markets.

In the absence of such a test, one answer to criticisms of any increase in price volatility would then be that it is a result of decontrol. Though this is a plausible assertion, it is only an assertion. A more persuasive argument can be made against destabilizing effects of futures markets if a test biased towards finding greater volatility does not, in fact, find it.

Third, changes in refinery utilization rates, product market shares, and inventory levels may all be relevant to product price volatility, both in terms of varying seasonal patterns and in terms of the long-run shifts of the 1970s and 1980s.

Fourth, because it took time for petroleum futures markets to gain acceptance, it may be advisable to test both for "immediate effects" and "lagged effects", as some other authors have.

CHAPTER 4

In this chapter, empirical tests of the effects of futures trading on petroleum markets will be presented. These tests are biased in at least two ways against the hypothesis that futures markets have no destabilizing effects. Thus, a finding of no destabilizing effects will actually be stronger than the statistical tests indicate.

The first and most important bias is that no allowance is made for the possibility that decontrol of petroleum markets increased price volatility. The reason for this approach is that periods of decontrol and futures trading are almost the same and do not allow for useful statistical tests separating the effects of futures trading and price controls. Rather than simply state that any increase in price volatility has to do with petroleum price decontrol, the approach taken here will make the conclusion stronger, if indeed no destabilizing effects are found.

The second reason the tests are biased against finding no destabilizing effects has to do with the measurement of price volatility, and is probably less important. It will be discussed in the next section.

Because little data are available on spot crude oil prices in the U.S. before futures trading began in early 1983, a direct test for crude oil markets would be difficult. Therefore, the tests performed will focus on spot price volatility for heating oil and motor gasoline. However, the effect of the crude oil futures market on the price volatility of products will be tested.

Unless otherwise noted, the years 1974 and 1979 will be excluded from the analysis, since there is reason to believe data from these years may be quite different from those of other periods. This supposition will be confirmed later in this chapter when price volatility in these excluded periods is projected from the estimated regression equations.

First, the approach will be explained. Then, the data will be described. Then follows the regression analyses and a summary of the results.

The Approach

The approach taken here is similar to that of those authors who attempted to explain price volatility as a function of factors that may affect this volatility, including futures trading. Specifically, a regression approach is taken, with the dependent variables being the volatility of the spot price for heating oil and gasoline. The effect of futures trading will be tested by means of an indicator variable for the existence of futures markets. This approach is quite similar to that of Corgel and Gay (1984).[1]

Many different measures of price volatility have been used in the literature, ranging from day-to-day price changes to variations around an eight-year mean. Period-to-period changes emphasize short-range volatility, while variance-type measures give a broader indication of price variability. All the theoretical studies and a number of the empirical studies discussed in this study use the variance or coefficient of variation of spot prices within a specified period as the measure of price volatility. In this study, the variation of daily prices around a quarterly mean will be used. Because of large differences in price levels over the period examined, these variations normalized by their respective means--

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[1]Corgel and Gay use intervention analysis, a form of ARIMA modelling, rather than regression, but otherwise the approach is conceptually the same.

that is, coefficients of variation--will be used to give a truer indication of price variability.

The use of daily prices ensures that volatility in heating oil and gasoline prices is not lost through aggregation over longer periods. Since theory suggests that any stabilizing effect of futures trading probably occurs over longer than daily periods, and that short-range volatility may even be increased due to the more rapid flow of information (Forsythe, et al., 1984), this has the effect of biasing the tests against finding no destabilizing effect. However, critics do not always specify whether it is short-range or long-range volatility that is the complaint, so this specification, if no destabilizing effects are found, will broaden the argument against the ill effects of futures markets.

Quarterly data are used because the data on crude oil spot prices, discussed below, are available at best on a monthly basis, and at least two observations are required to calculate a variance or coefficient of variation.

A few other comments on the regressions are in order. Since there is no *a priori* reason to specify the model in logs or the original variables, both are presented. Also, as noted above, observations for 1974 and 1979 are excluded from most of the analysis because there is reason to believe that price volatility in these years may be quite different from that of other periods. Thus, excluding these years, there are forty observations.

The Data

A description of the data used follows.

Heating oil and gasoline price volatility. Coefficients of variation of daily New York Harbor spot prices for heating oil and leaded regular gasoline are calculated over quarters to provide the dependent variables.[2]

Indicator variables for futures trading in heating oil, gasoline, and crude oil. In the "immediate effects" cases, these variables are equal to one beginning with 1979:I, 1982:I, and 1983:II, respectively, and zero otherwise. These are the first full quarters of trading in the respective commodities. A second specification is also tested in which the indicator variables are equal to one beginning in the quarter in which month-end open interest first exceeded 5,000 contracts--1980:III, 1983:I,

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[2]Spot price data are from Platt's Oil Price Handbook and Platt's Oilgram Price Report.

and 1983:III, respectively. This is to recognize that it may take time for trading to become active and for market participants to adjust to the new situation. Crude oil trading is included as an independent variable because it may potentially affect product price volatility. However, in the lagged effects cases for gasoline, this variable is identical with the gasoline trading variable except for two observations and so is omitted. In these cases, the gasoline trading variable actually may be measuring the effects of both contracts.

Crude oil price volatility. Price variability in world crude oil markets can be expected to reflect world supply uncertainties, which, in turn, may affect product price variability. In the regressions, this world crude oil price variability is represented by the coefficient of variation of world crude oil monthly spot prices around their quarterly means.[3]

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[3]The data used are for African/North Sea crudes and were collected, for the most part, by Petroleum Intelligence Weekly (PIW). Because the PIW data are only quarterly prior to 1978, data from another source (see Energy Economics Research Ltd. and Middle East Economic Survey in the list of references) were used to construct a monthly series back to 1976. For 1974 and 1975, coefficients of variation are based on quarterly PIW data and are adjusted to be comparable to the rest of the series.

(Footnote continued)

Weather. Unusually cold or warm weather affects heating oil demand and thus should influence spot prices for heating oil. The data used, based on U.S. Department of Commerce (1985), are absolute deviations from the fifty-year mean of heating degree days. Heating degree days are an approximate indicator of the demand for heating fuels. The data are geographically weighted by 1980 heating oil demand.

Refinery capacity utilization. This is essentially crude oil input to refineries as a fraction of capacity.[4] When utilization rates are high, refiners have less flexibility to respond to random shocks in demand or supply, so high utilization rates might be expected to

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[3](continued)
Though Saudi Light has at times been regarded as a benchmark crude, it has fallen out of currency in spot markets in recent years and for some recent periods spot price quotations are rarely encountered. The choice probably has little effect on the results.

[4]Though "input to crude oil distillation units" as a percent of "operable capacity" is the official calculation used by the Department of Energy, a significant portion of this capacity has not been in active use in recent years. A more realistic measure of capacity for the purpose of this study is "operating capacity", also available from the Deparment of Energy sources listed in the references. The next two data series are also calculated from the same sources.

bring about greater price volatility. High utilization rates correspond to a steep portion of the refining industry's supply curve; a shift in the demand curve thus results in a greater price change than when the initial equilibrium is at a lower, less steep part of the supply curve.

Stocks/demand ratio. This is referred to as "days of supply" in the oil industry and as "inventory/sales ratio" elsewhere. Again, low stocks in relation to demand should make prices more susceptible to the effects of random shocks.

Market share. Petroleum refining is a joint product industry. Thus, changes in the relative demand for one product may affect the prices of other products. The direction of the effect is ambiguous. For example, particularly high demand for one product relative to others may make its price more volatile as refineries stretch available facilities in an attempt to meet that demand. That is, price becomes more volatile because supply is less elastic at this higher point on the supply curve. This might be expected for a product which accounts for a large share of total output such as gasoline. On the other hand, demand-induced increases in the output of one product may also increase the output of other products, depressing their prices. For these other products, the resulting lower-than-average market share thus corresponds with higher price volatility. This might be expected for products with smaller market shares, such as distillate fuel oil.

Seasonal indicators. Anderson (1982) found seasonal variations in the volatility of futures prices for many commodities. It is quite likely that this is true for spot market prices as well. Seasonal indicators are included for the first three quarters of the year, with the fourth quarter being implicitly identified when the indicators for the first three quarters are all zero.

Regression Analyses

Tables 1 through 4 display a total of 16 regressions.[5] The number of variations is the result of three sets of alternatives applied to the two products--original variables versus logs, immediate futures market impact versus a lagged effect, and inclusion or exclusion of domestic supply/demand

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[5]For interested readers, the means of the variables and the simple correlations among them are displayed in the Appendix.

TABLE 1

HEATING OIL REGRESSIONS, ORIGINAL VARIABLES

	(1)	(2)	(3)	(4)
Constant	0.182 (1.10)	-0.005 (-0.49)	0.237 (1.41)	-0.003 (-0.30)
Heating oil trading	0.018 (1.18)	0.009 (1.24)	0.011 (0.78)	0.010 (1.42)
Crude oil volatility	0.268 (2.12)*	0.312 (2.31)*	0.254 (1.96)*	0.282 (2.01)*
Weather (x 1,000)	0.128 (3.61)*	0.117 (3.29)*	0.121 (3.30)*	0.109 (3.14)*
Capacity utilization	0.083 (0.76)		0.039 (0.37)	
Stocks/demand (x 1,000)	-0.926 (-2.06)*		-0.940 (-1.90)*	
Market share	-1.081 (-2.41)*		-1.145 (-2.50)*	
Crude oil trading	-0.010 (-0.93)	0.007 (1.01)	-0.008 (-0.81)	0.005 (0.74)
Seasonal I	0.004 (0.37)	-0.001 (-0.07)	0.006 (0.48)	0.001 (0.13)
Seasonal II	-0.029 (-1.99)*	0.001 (0.07)	-0.032 (-2.02)*	0.001 (0.14)
Seasonal III	-0.009 (-0.68)	0.016 (1.64)	-0.012 (-0.89)	0.014 (1.47)
F statistic	4.87* (10,29)	4.81* (7,32)	4.72* (10,29)	4.75* (7,32)
Durbin-Watson	2.00	1.85	1.96	1.87
R squared	0.63	0.51	0.62	0.51
R bar squared	0.50	0.41	0.49	0.40
Standard error of estimate	0.015	0.016	0.015	0.016

*Significant at the .10 level (see text).

TABLE 2

HEATING OIL REGRESSIONS, LOG FORM

	(1)	(2)	(3)	(4)
Constant	-3.876 (-1.12)	-5.844 (-4.98)*	-3.647 (-1.04)	-5.979 (-5.34)*
Heating oil trading	0.160 (0.29)	0.091 (0.35)	-0.064 (-0.11)	0.230 (0.88)
Crude oil volatility	0.241 (2.11)*	0.307 (2.63)*	0.256 (2.29)*	0.269 (2.27)*
Weather	0.589 (3.08)*	0.645 (3.26)*	0.590 (3.03)*	0.633 (3.18)*
Capacity utilization	-0.486 (-0.15)		-1.678 (-0.47)	
Stocks/ demand	-2.448 (-2.29)*		-2.761 (-2.19)*	
Market share	-4.891 (-1.67)*		-5.508 (-1.81)*	
Crude oil trading	-0.334 (-0.87)	0.318 (1.36)	-0.339 (-1.05)	0.201 (0.83)
Seasonal I	-0.330 (-0.85)	0.117 (0.45)	-0.421 (-0.86)	0.128 (0.49)
Seasonal II	-1.089 (-1.82)*	-0.006 (-0.02)	-1.263 (-1.90)*	0.011 (0.04)
Seasonal III	0.293 (0.45)	1.035 (2.24)*	0.243 (0.38)	0.991 (2.11)*
F statistic	5.37* (10,29)	6.16* (7,32)	5.50* (10,29)	6.06* (7,32)
Durbin-Watson	1.91	1.85	1.88	1.83
R squared	0.65	0.57	0.65	0.57
R bar squared	0.53	0.48	0.54	0.48
Standard error of estimate	0.518	0.543	0.514	0.546

*Significant at the .10 level (see text).

TABLE 3

MOTOR GASOLINE REGRESSIONS, ORIGINAL VARIABLES

	(1)	(2)	(3)	(4)
Constant	-0.349 (-1.51)	0.025 (3.22)*	-0.363 (-1.71)*	0.025 (3.17)*
Gasoline trading	-0.011 (-0.89)	0.012 (1.11)	-0.020 (-2.31)*	0.003 (0.48)
Crude oil volatility	0.048 (0.30)	0.040 (0.24)	-0.016 (-0.11)	0.123 (0.83)
Capacity utilization	0.051 (0.58)		0.056 (0.67)	
Stocks/demand (x 1,000)	-0.822 (-0.49)		-0.833 (-0.52)	
Market share	0.906 (2.65)*		0.933 (3.12)*	
Crude oil trading	-0.007 (-0.69)	-0.007 (-0.63)		
Seasonal I	0.031 (2.58)*	0.001 (0.07)	0.033 (2.96)*	0.001 (0.14)
Seasonal II	-0.017 (-1.35)	0.010 (1.13)	-0.018 (-1.58)	0.011 (1.22)
Seasonal III	-0.034 (-2.79)*	-0.007 (-0.79)	-0.036 (-3.12)*	-0.006 (-0.69)
F statistic	2.09* (9,30)	1.00 (6,33)	2.73* (8,31)	0.96 (5,34)
Durbin-Watson	2.16	1.99	2.05	2.02
R squared	0.38	0.15	0.41	0.12
R bar squared	0.20	0.00	0.26	-0.01
Standard error of estimate	0.018	0.020	0.017	0.020

*Significant at the .10 level (see text).

TABLE 4

MOTOR GASOLINE REGRESSIONS, LOG FORM

	(1)	(2)	(3)	(4)
Constant	10.640 (1.62)	-3.912 (-6.18)*	10.867 (1.74)*	-3.569 (-6.46)*
Gasoline trading	-0.191 (-0.40)	0.478 (1.18)	-0.384 (-1.18)	0.216 (0.85)
Crude oil volatility	0.000 (0.00)	0.011 (0.08)	-0.017 (-0.12)	0.080 (0.66)
Capacity utilization	-0.069 (-0.02)		0.105 (0.04)	
Stocks/ demand	-1.687 (-0.78)		-1.646 (-0.78)	
Market share	9.316 (1.85)*		9.780 (2.19)*	
Crude oil trading	-0.151 (-0.38)	-0.190 (-0.46)		
Seasonal I	0.999 (2.14)*	0.109 (0.33)	1.046 (2.42)*	0.138 (0.43)
Seasonal II	-0.348 (-0.78)	0.352 (1.07)	-0.387 (-0.91)	0.387 (1.18)
Seasonal III	-0.786 (-1.75)*	-0.086 (-0.26)	-0.827 (-1.94)*	-0.050 (-0.15)
F statistic	1.37 (9,30)	0.78 (6,33)	1.69 (8,31)	0.69 (5,34)
Durbin-Watson	1.87	1.92	1.82	1.94
R squared	0.29	0.12	0.30	0.09
R bar squared	0.08	-0.03	0.12	-0.04
Standard error of estimate	0.680	0.721	0.663	0.723

*Significant at the .10 level (see text).

variables. The omission of these variables excludes the possibility that domestic supply and demand, in some unspecified way, might react to price volatility as well as cause it. Specifically, in each set of four regressions, the numbered columns represent:

(1) All variables included, no lag in the effects of futures trading.

(2) Same as (1) but domestic supply/demand variables excluded.

(3) Same as (1) but with lagged trading effects.

(4) Same as (2) but with lagged trading effects.

Because the coefficients on the weather and stock variables are very small in the "original variables" versions, they are multiplied by 1,000 in the tables.

The t-tests are two-tailed on futures trading and seasonal indicator variables, since the proper signs for their coefficients are either unknown or at issue. All other t-tests are one-tailed.

Table 5 shows the distribution of residuals for each of the four versions of equation (1). For statistical tests of significance to be valid, the error term should be approximately normally distributed. As the residuals show, the one model that clearly does not fulfill this criterion is the gasoline equation in logs. Therefore,

TABLE 5

DISTRIBUTION OF REGRESSION RESIDUALS

HEATING OIL, ORIGINAL VARIABLES

Range		Frequency
-0.03 - -0.02	1	XX
-0.02 - -0.01	8	XXXXXXXXXXXXX
-0.01 - 0	12	XXXXXXXXXXXXXXXXXXXX
0 - 0.01	11	XXXXXXXXXXXXXXXXXX
0.01 - 0.02	5	XXXXXXXX
0.02 - 0.03	3	XXXXX
0.03 - 0.04	0	

HEATING OIL, LOG FORM

Range		Frequency
-2 - -1.6	0	
-1.6 - -1.2	1	X
-1.2 - -0.8	1	X
-0.8 - -0.4	6	XXXXXXXX
-0.4 - 0	11	XXXXXXXXXXXXXX
0 - 0.4	16	XXXXXXXXXXXXXXXXXXXX
0.4 - 0.8	4	XXXXX
0.8 - 1.2	1	X
1.2 - 1.6	0	

GASOLINE, ORIGINAL VARIABLES

Range		Frequency
-0.04 - -0.03	1	XX
-0.03 - -0.02	4	XXXXXXX
-0.02 - -0.01	5	XXXXXXXX
-0.01 - 0	9	XXXXXXXXXXXXXXX
0 - 0.01	12	XXXXXXXXXXXXXXXXXXXX
0.01 - 0.02	5	XXXXXXXX
0.02 - 0.03	3	XXXXX
0.03 - 0.04	1	XX
0.04 - 0.05	0	

GASOLINE, LOG FORM

Range		Frequency
-2 - -1.75	0	
-1.75 - -1.5	1	XX
-1.5 - -1.25	1	XX
-1.25 - -1	1	XX
-1 - -0.75	2	XXXX
-0.75 - -0.5	5	XXXXXXXXX
-0.5 - -0.25	1	XX
-0.25 - 0	2	XXXX
0 - 0.25	11	XXXXXXXXXXXXXXXXXXXX
0.25 - 0.5	8	XXXXXXXXXXXXXXX
0.5 - 0.75	7	XXXXXXXXXXXXX
0.75 - 1	1	XX
1 - 1.25	0	

the t-statistics in Table 4 are the least likely to be valid.

Proceeding to the estimated coefficients, those of primary interest are those of the futures trading variables. In no case is there a statistically significant increase in volatility due to futures trading (.10 level, two-tailed test). In one case, equation (3) for gasoline, original variables (Table 3), a statistically significant reduction in price volatility is found. This result, though in accord with economic theory, must be tempered by the fact that the regression diagnostics discussed below indicate problems with the gasoline equations.

As for the other estimated coefficients, the statistically significant variables in the heating oil equations are crude oil price volatility, weather, inventory, market share, and seasonals (one-tailed tests except for seasonals). For the gasoline equations, only the market share variables and seasonals are significant (in addition to the futures trading variable in equation (3), Table 3). All statistically significant variables are of the expected sign (more precisely, if two-tailed tests had been used, no significant, unexpected signs would have been found).

The coefficients of significant variables are relatively stable over the four equations in each table. As might be expected, the coefficients on the seasonal indicators do vary when some of the variables are dropped since the seasonal indicators' role is to explain seasonal variation not explained by other variables. For the same reason, little interpretation can safely be attached to the signs of the seasonals.

Overall, the heating oil equations explain more about price volatility than do the gasoline equations. The heating oil equations explain from 51 to 65 percent of the variation in heating oil price volatility, while the gasoline equations explain 9 to 41 percent. Most of the Durbin-Watson statistics are close to two and none fall within the rejection region (.10 level, two-tail).

The correlations among estimated coefficients displayed in Tables 6 and 7 indicate some degree of multicollinearity exists among some variables, so that the individual significance of each of these variables is made less certain.[6] Specifically, the tables show higher-than-average correlations in the heating oil equations among

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[6]Tables 6 and 7 are for equations (1) in original variables. The results from the log form equations are quite similar and add little to the discussion.

TABLE 6

HEATING OIL REGRESSION DIAGNOSTICS

CORRELATION MATRIX FOR ESTIMATED PARAMETERS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Constant	1.00	-0.74	-0.19	0.11	-0.79	-0.77	-0.77	0.07	-0.19	-0.77	-0.48
(2) Heating oil trading	-0.74	1.00	-0.09	0.00	0.90	0.35	0.28	-0.53	0.23	0.33	0.08
(3) Crude oil volatility	-0.19	-0.09	1.00	0.12	0.11	0.20	0.14	0.25	0.04	0.26	0.23
(4) Weather	0.11	0.00	0.12	1.00	-0.06	0.03	-0.26	0.07	-0.08	0.07	0.18
(5) Capacity utilization	-0.79	0.90	0.11	-0.06	1.00	0.39	0.26	-0.39	0.34	0.35	0.03
(6) Stocks/demand	-0.77	0.35	0.20	0.03	0.39	1.00	0.70	0.43	0.34	0.78	0.39
(7) Market share	-0.77	0.28	0.14	-0.26	0.26	0.70	1.00	0.15	-0.16	0.81	0.73
(8) Crude oil trading	0.07	-0.53	0.25	0.07	-0.39	0.43	0.15	1.00	0.20	0.22	0.09
(9) Seasonal I	-0.19	0.23	0.04	-0.08	0.34	0.34	-0.16	0.20	1.00	0.15	-0.23
(10) Seasonal II	-0.77	0.33	0.26	0.07	0.35	0.78	0.81	0.22	0.15	1.00	0.74
(11) Seasonal III	-0.48	0.08	0.23	0.18	0.03	0.39	0.73	0.09	-0.23	0.74	1.00

PLOT OF RESIDUALS BY QUARTER

```
                   First Qtr           Second Qtr            Third Qtr             Fourth Qtr
1974-------------------------------------------------------------------------------------------
1975            |XXXXXX             |                     |XXXXXXXXX            |
1976      XXXXXX|                 XX|                XXXXX|                     |X
1977            |XXXXX          XXXX|                   XX|                     |XXX
1978    XXXXXXXX|                  X|                     |XX                   |X
1979-------------------------------------------------------------------------------------------
1980          XX|                  X|                   XX|                     |XXXXXXX
1981         XXX|                   |                   XX|                  XXX|
1982            |XX                X|                    X|                     |XXXXX
1983            |X                  |XX              XXXXX|                 XXXX|
1984            |XXXXX              |XX                 XX|                XXXXX|
1985            |X                  |XXXXX                |XXXXXXX        XXXXXX|
```

Note: Values to the right of the axis are underestimates, values to the left overestimates. Observations for 1974 and 1979 were excluded from the regressions.

TABLE 7

GASOLINE REGRESSION DIAGNOSTICS

CORRELATION MATRIX FOR ESTIMATED PARAMETERS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Constant	1.00	0.41	-0.18	-0.84	-0.78	-0.89	0.02	-0.40	0.57	0.60
(2) Gasoline trading	0.41	1.00	-0.29	-0.12	-0.12	-0.58	-0.65	-0.46	0.42	0.40
(3) Crude oil volatility	-0.18	-0.29	1.00	0.31	0.12	0.06	0.33	0.04	0.12	0.10
(4) Capacity utilization	-0.84	-0.12	0.31	1.00	0.74	0.56	-0.08	0.17	-0.28	-0.35
(5) Stocks/demand	-0.78	-0.12	0.12	0.74	1.00	0.49	-0.01	-0.08	-0.25	-0.26
(6) Market share	-0.89	-0.58	0.06	0.56	0.49	1.00	0.01	0.61	-0.73	-0.74
(7) Crude oil trading	0.02	-0.65	0.33	-0.08	-0.01	0.01	1.00	0.08	0.03	0.05
(8) Seasonal I	-0.40	-0.46	0.04	0.17	-0.08	0.61	0.08	1.00	-0.28	-0.29
(9) Seasonal II	0.57	0.42	0.12	-0.28	-0.25	-0.73	0.03	-0.28	1.00	0.79
(10) Seasonal III	0.60	0.40	0.10	-0.35	-0.26	-0.74	0.05	-0.29	0.79	1.00

PLOT OF RESIDUALS BY QUARTER

```
           First Qtr         Second Qtr          Third Qtr         Fourth Qtr
1974-----------------------------------------------------------------------------
1975      XXX|                  |XXXXXXXX          |            XXXXXX|
1976   XXXXXX|                  |XXXXXXXXX       XX|                  |X
1977         |XXX              X|                  |                XX|
1978         |XX               X|                  |              XXXX|
1979-----------------------------------------------------------------------------
1980         |XXXX              |XXX               |XX                |XX
1981         |X          XXXXXXX|                 X|                XX|
1982         |XXXXXX            |XX            XXXX|                  |XX
1983   XXXXXX|             XXXXX|                  |XX               X|
1984     XXXX|                  |                  |XX                |XXX
1985         |XXXX      XXXXXXXX|                  |X                 |XXXXXX
```

Note: Values to the right of the axis are underestimates, values to the left overestimates. Observations for 1974 and 1979 were excluded from the regressions.

the coefficients for stocks, market share, and seasonals, and in the gasoline equations for market share and seasonals. This may affect only the interpretation of individual coefficients and does not, in itself, invalidate tests of other variables.

Also, according to Table 6, the coefficient on heating oil trading is highly positively correlated with that of refinery utilization. However, omission of the utilization variable has no predictable effect on the heating oil trading coefficient and in any event it does not become statistically significant.[7]

For the gasoline equations, the residual plot in Table 7 shows noticeable seasonal trends in the error terms. This is a sign that the equation has not adequately accounted for factors that affect seasonal patterns. Thus, though in the case of a lagged impact of futures markets (equation (3), Table 3), futures markets were found to have stabilizing effects, a stronger case would be made if a better model could be found.

Finally, Table 8 shows the residuals from equations (1) (original variables) when these equations are used to

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[7]Omission of the heating oil trading variable does not cause refinery utilization to become significant, either.

TABLE 8

RESIDUALS WHEN 1974 AND 1979 DEPENDENT VARIABLES
ARE ESTIMATED FROM REGRESSIONS EXCLUDING THOSE PERIODS

HEATING OIL

```
            First Qtr             Second Qtr             Third Qtr             Fourth Qtr
1974           |XXXXXXXXXX        XXX|                      X|                     |XXX
1975           |XXXX                 |X                      |XXXXX                |X
1976        XXX|                     |                XXXXXXX|                     |XX
1977           |XX                 XX|                      X|                     |X
1978      XXXXX|                  XXX|                       |XXXX                 |XX
1979          X|                     |XXXXXXXXXX             |XXXXXXXXX            |
1980           |X                   X|                       |                     |XX
1981          X|                     |X                    XX|                  XXX|
1982           |                    X|                       |X                    |XX
1983           |X                    |XX                   XX|                  XXX|
1984           |XX                   |X                     X|                    X|
1985           |                     |XX                     |XXXX              XXX|
```

GASOLINE

```
            First Qtr             Second Qtr             Third Qtr             Fourth Qtr
1974           |XXXXXX               |XXXXXX                 |XXXXXXXXX            |XXXX
1975        XXX|                     |XXX                    |X            XXXXXXXX|
1976       XXXX|                     |XXXX                   |                     |
1977           |XXX                  |X                      |                  XXX|
1978           |XX                   |X                      |X                   X|
1979           |XXXXXXX              |XXXXXXXXX              |XXXXXXXX             |XXXXXXXX
1980           |XXX                  |XXX                    |XX                   |XX
1981           |X              XXXXXX|                     XX|                     |
1982           |XXX                  |X                  XXXX|                     |XX
1983        XXX|                  XXX|                       |X                    |
1984        XXX|                     |X                      |X                    |XXX
1985           |X               XXXXX|                       |                     |XXX
```

project price volatility during the disruption periods of 1974 and 1979. The heating oil equation greatly underestimates price volatility in 1974:I, 1979:II, and 1979:III, while the gasoline equation underestimates significantly for most of 1974 and all of 1979.[8] Though a number of explanations are possible, one is that government allocation controls combined with the great uncertainty as to government policies in those periods increased price volatility beyond what the equation projects.

Summary of Results

To summarize,

(1) In all cases, no statistically significant destabilizing effect of futures markets was found.

(2) In one case, for gasoline, a statistically significant stabilizing effect was found, though regression diagnostics suggest the estimated equation should be treated with skepticism.

(3) Other variables, when statistically significant, were of the correct sign.

(4) Price volatility in disruptive periods was much

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[8]The size of these deviations is well over two standard errors of the regression.

greater than would be expected based on the estimated relationship for other periods. The effects of allocation controls and regulatory uncertainty are possible explanations.

CHAPTER 5

This study has investigated the effects of futures trading on petroleum price stability. Though a number of critics from various quarters claim futures markets have made petroleum prices more volatile, economic reasoning does not support this viewpoint.

A review of theoretical studies and empirical investigations of other commodities found general support for the alternative hypothesis, that futures markets do not destabilize prices and may, in fact, add to price stability. The empirical tests in Chapter 4 were biased towards finding destabilizing effects of futures markets. Nevertheless, no statistically significant increase in price volatility was found, and in the case of gasoline, indications of stabilizing effects were found.

Thus, neither the results of other studies nor examination of petroleum futures markets' effects on price volatility support the critics' contention that futures trading has destabilized petroleum prices.

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APPENDIX

The tables that follow display the means for the variables used in the regressions (Table 9) as well as correlation matrices (Table 10). In all cases, observations from 1974 and 1979 are excluded from the calculations. Indicator variables are for the "immediate effects" cases.

TABLE 9

TABLE OF MEANS

	Original Variables	Log of Variables
HEATING OIL		
Heating oil volatility	0.032	-3.683
Heating oil trading	0.600	0.600
Crude oil volatility	0.023	-4.245
Weather	162.754	4.705
Capacity utilization	0.836	-0.181
Stocks/demand	58.236	4.025
Market share	0.178	-1.736
Crude oil trading	0.275	0.275
Seasonal I	0.250	0.250
Seasonal II	0.250	0.250
Seasonal III	0.250	0.250
MOTOR GASOLINE		
Gasoline volatility	0.030	-3.727
Gasoline trading	0.400	0.400
Crude oil volatility	0.023	-4.245
Capacity utilization	0.836	-0.181
Stocks/demand	35.063	3.552
Market share	0.414	-0.884
Crude oil trading	0.275	0.275
Seasonal I	0.250	0.250
Seasonal II	0.250	0.250
Seasonal III	0.250	0.250

TABLE 10

CORRELATION MATRICES

HEATING OIL (original variables)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Heating oil volatility	1.00	0.31	0.38	0.48	-0.18	-0.39	0.37	0.21	0.36	-0.29	-0.15
(2) Heating oil trading	0.31	1.00	0.38	-0.15	-0.80	-0.20	-0.03	0.50	0.00	0.00	0.00
(3) Crude oil volatility	0.38	0.38	1.00	0.05	-0.47	-0.07	0.16	-0.08	0.16	-0.13	-0.17
(4) Weather	0.48	-0.15	0.05	1.00	0.03	-0.56	0.84	-0.05	0.63	-0.22	-0.61
(5) Capacity utilization	-0.18	-0.80	-0.47	0.03	1.00	0.05	-0.07	-0.03	-0.18	-0.04	0.16
(6) Stocks/demand	-0.39	-0.20	-0.07	-0.56	0.05	1.00	-0.69	-0.47	-0.52	-0.18	0.57
(7) Market share	0.37	-0.03	0.16	0.84	-0.07	-0.69	1.00	0.04	0.75	-0.32	-0.66
(8) Crude oil trading	0.21	0.50	-0.08	-0.05	-0.03	-0.47	0.04	1.00	-0.10	0.03	0.03
(9) Seasonal I	0.36	0.00	0.16	0.63	-0.18	-0.52	0.75	-0.10	1.00	-0.33	-0.33
(10) Seasonal II	-0.29	0.00	-0.13	-0.22	-0.04	-0.18	-0.32	0.03	-0.33	1.00	-0.33
(11) Seasonal III	-0.15	0.00	-0.17	-0.61	0.16	0.57	-0.66	0.03	-0.33	-0.33	1.00

HEATING OIL (log form)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Heating oil volatility	1.00	0.37	0.49	0.45	-0.23	-0.45	0.42	0.27	0.35	-0.29	-0.18
(2) Heating oil trading	0.37	1.00	0.58	-0.03	-0.79	-0.18	0.00	0.50	0.00	0.00	0.00
(3) Crude oil volatility	0.49	0.58	1.00	0.12	-0.53	-0.12	0.17	0.12	0.09	-0.13	-0.13
(4) Weather	0.45	-0.03	0.12	1.00	-0.11	-0.57	0.81	-0.01	0.54	-0.02	-0.83
(5) Capacity utilization	-0.23	-0.79	-0.53	-0.11	1.00	0.01	-0.09	-0.01	-0.18	-0.04	0.16
(6) Stocks/demand	-0.45	-0.18	-0.12	-0.57	0.01	1.00	-0.70	-0.47	-0.56	-0.17	0.53
(7) Market share	0.42	0.00	0.17	0.81	-0.09	-0.70	1.00	0.06	0.73	-0.29	-0.68
(8) Crude oil trading	0.27	0.50	0.12	-0.01	-0.01	-0.47	0.06	1.00	-0.10	0.03	0.03
(9) Seasonal I	0.35	0.00	0.09	0.54	-0.18	-0.56	0.73	-0.10	1.00	-0.33	-0.33
(10) Seasonal II	-0.29	0.00	-0.13	-0.02	-0.04	-0.17	-0.29	0.03	-0.33	1.00	-0.33
(11) Seasonal III	-0.18	0.00	-0.13	-0.83	0.16	0.53	-0.68	0.03	-0.33	-0.33	1.00

TABLE 10--Continued

GASOLINE (original variables)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Gasoline volatility	1.00	0.19	0.13	-0.10	-0.16	0.24	0.06	0.02	0.26	-0.25
(2) Gasoline trading	0.19	1.00	0.24	-0.28	-0.08	0.46	0.75	0.00	0.00	0.00
(3) Crude oil volatility	0.13	0.24	1.00	-0.47	0.25	-0.03	-0.08	0.16	-0.13	-0.17
(4) Capacity utilization	-0.10	-0.28	-0.47	1.00	-0.56	-0.12	-0.03	-0.18	-0.04	0.16
(5) Stocks/demand	-0.16	-0.08	0.25	-0.56	1.00	-0.56	-0.19	0.64	-0.22	-0.31
(6) Market share	0.24	0.46	-0.03	-0.12	-0.56	1.00	0.39	-0.71	0.44	0.42
(7) Crude oil trading	0.06	0.75	-0.08	-0.03	-0.19	0.39	1.00	-0.10	0.03	0.03
(8) Seasonal I	0.02	0.00	0.16	-0.18	0.64	-0.71	-0.10	1.00	-0.33	-0.33
(9) Seasonal II	0.26	0.00	-0.13	-0.04	-0.22	0.44	0.03	-0.33	1.00	-0.33
(10) Seasonal III	-0.25	0.00	-0.17	0.16	-0.31	0.42	0.03	-0.33	-0.33	1.00

GASOLINE (log form)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Gasoline volatility	1.00	0.25	0.12	-0.14	-0.15	0.26	0.13	0.03	0.21	-0.15
(2) Gasoline trading	0.25	1.00	0.39	-0.26	-0.06	0.45	0.75	0.00	0.00	0.00
(3) Crude oil volatility	0.12	0.39	1.00	-0.53	0.21	0.08	0.12	0.09	-0.13	-0.13
(4) Capacity utilization	-0.14	-0.26	-0.53	1.00	-0.57	-0.12	-0.01	-0.18	-0.04	0.16
(5) Stocks/demand	-0.15	-0.06	0.21	-0.57	1.00	-0.55	-0.17	0.62	-0.21	-0.31
(6) Market share	0.26	0.45	0.08	-0.12	-0.55	1.00	0.38	-0.71	0.43	0.41
(7) Crude oil trading	0.13	0.75	0.12	-0.01	-0.17	0.38	1.00	-0.10	0.03	0.03
(8) Seasonal I	0.03	0.00	0.09	-0.18	0.62	-0.71	-0.10	1.00	-0.33	-0.33
(9) Seasonal II	0.21	0.00	-0.13	-0.04	-0.21	0.43	0.03	-0.33	1.00	-0.33
(10) Seasonal III	-0.15	0.00	-0.13	0.16	-0.31	0.41	0.03	-0.33	-0.33	1.00

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