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Volatility of Oil Prices

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Abstract

This paper examines the behavior of crude oil prices since 1980, and in particular the volatility of these prices. The empirical analysis covers "spot" prices for one of the key internationally traded crudes, namely Dated Brent Blend. A GARCH (generalized autoregressive conditional heteroscedastic) model, which allows the conditional variance to be time-variant, is estimated for the period which includes the oil price slump of 1986 and the surge in prices in 1990 as a result of the Iraqi invasion of Kuwait. The paper also discusses the growth of futures and derivative markets and the dynamic links between spot and futures markets.

JEL Classification Numbers:
G13, Q4

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[1]I am grateful to Thomas Enger, Zuliu Hu, Mohsin S. Khan, and Blair Rourke for comments. Errors remain the responsibility of the author. The usual disclaimer applies.

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Summary

This paper examines crude oil prices from 1980 to mid-1996, focusing specifically on two episodes of high volatility: the oil price slump in 1986 linked to the changeover to market-determined pricing from the system of administered prices, and the surge in prices in 1990 resulting from the Iraqi invasion of Kuwait. To help examine certain aspects of oil price volatility, a generalized autoregressive conditional heteroscedastic model (GARCH), which allows the conditional variance to be time-variant, is estimated.

The difference between the two oil price situations was reflected in prices for spot oil and oil futures on the New York Mercantile Exchange. The 1986 price slump, associated with uncertainty over how long increasing supplies and ample stocks would persist, resulted in early 1986 in a price path for futures contracts that was positively sloped, with contracts further into the future commanding a premium.

In contrast, the 1990 episode of exceptionally high prices, reflecting the disruption of supplies and pressure on crude oil stocks outside the Middle East, caused spot and prompt supplies to trade at a premium, with further out contracts trading at a significant discount as traders expected resolution of the Kuwaiti conflict and regularization of supplies.

The analysis brings out several important features about the dynamic behavior of oil markets and oil prices. First, it is possible to carry forward current supplies in the form of stocks, but only to a limited extent in the short run is it possible to shift or bring forward large volumes of supply from the future. Second, except for physical limits in the short run, it is possible (at a cost) to carry forward supplies, (hold stocks) without being otherwise constrained. On the other hand, because stocks cannot effectively be negative, prices can rise very sharply for spot and prompt deliveries when supply disruptions occur and stocks are relatively low, even if the supply disturbance is not viewed as long term.

I. Introduction

Early 1986 saw the beginning of the demise of the posted or administered oil pricing system for shipments which had been the norm since the wave of nationalizations of foreign oil companies in the Middle East and in other key oil producing nations in the early and mid-1970s. At that earlier time, the administration of oil prices was passed from the major multinational oil companies to the national oil companies of the producing countries, with a major share of decision making being conducted within the confines of OPEC (the Organization of Petroleum Exporting Countries). As the 1980s progressed, the oil supply management strategy came under increasing strain as the low-cost producer with the largest proven crude reserves, Saudi Arabia, found that its role as **de facto** "swing" producer within OPEC was becoming increasingly burdensome with respect to matching demand and supply to achieve price targets. Production outside OPEC, in the North Sea, Alaska, and elsewhere, was adding increasing amounts to supply at a time of relatively modest demand increases. Decreased demand for supplies from OPEC countries as a group which were trying to maintain an administered price system was principally absorbed by Saudi Arabia which suffered a significant erosion in market share. Without accommodation from other OPEC producers, the increased supplies from Saudi Arabia as it attempted to regain market share increased competitive pressures for sales and resulted in a sharp decline in oil prices. The pricing system for oil shipments became much more dependent on direct market signals, whether in the form of netback formulae or the basing of prices for OPEC crudes on key marker market-determined crudes, notably Brent, Dubai, West Texas Intermediate (WTI), and Alaska North Slope (ANS, c.i.f. United States Gulf Coast).

As market-determined and market-linked pricing began to cover much larger proportions of international trade in crude oil, oil producers who had previously adhered to administered or posted pricing methods voiced concerns that market-determined prices were "too" volatile, which had adverse effects on income streams needed for development and made investment decisions or planning much more difficult. For consuming countries, especially oil importing developing countries, oil price volatility was similarly seen as contributing to economic management and stabilization problems, against which they had little protection. Private oil companies were also concerned about the management of risk in their operations and the impact on investment decisions (see, for example, the discussion in Verleger (1995)). On a number of occasions, there have been calls for dialogue between the oil-consuming and oil-producing countries to consider ways and means for addressing the issue of "excessive" volatility in oil prices and various voices have advocated forms of intervention by governments to reduce oil price volatility.

It is not the purpose of this paper to present a viewpoint on the pros and cons of various proposals for greater government intervention in the crude oil markets. The much more limited objective is to provide information on the volatility of crude oil prices over recent periods.

II. The Behavior of Oil Prices, 1980-96

Volatility is in the eye of the beholder; that is, the frequency of observation for price changes depends on the interests of the various parties engaged in transactions. For traders and brokers in futures markets, intraday and interday price changes may be central to their profit realizations. For oil producers setting prices on the basis of a marker crude, revisions to formulae are often decided month-by-month and may be changed on such a basis if conditions warrant.[2] For macroeconomists, such data may be less important and more interest may be focused on quarter-to-quarter changes in oil prices in assessing the impact of oil price changes on the economy subject to analysis. In this paper, a choice has been made to focus on a month-to-month measure of price changes, in the belief that this represents a horizon of general interest and which provides potentially useful information to various parties on oil price volatility.

The data observations in this paper are the average monthly price for Dated Brent Blend Crude, the price indicated by price reporting agencies for notified shipments within a specific three day loading window in the next fifteen days from the Sullom Voe terminal in the Scottish Shetland Islands.[3] This is the nearest equivalent to a true "spot" price for North Sea crude. It is also the basis for spread pricing for other North Sea crudes and for shipments from elsewhere (e.g., Saudi Arabia) to Europe. As an indicator of volatility, the first difference of the logarithm of the monthly reported price for Dated Brent Blend Crude is shown in Figure 1. As can be seen from the graph, the oil price series has shown considerable variability, with relative quietude demonstrated in the period 1982 through late 1985, an explosion of volatility in 1986, and a further explosion associated with the invasion of Kuwait and its aftermath, affecting oil prices from mid-1990 through March-April 1991.

The univariate properties of the time series for the first differences of the log of monthly Dated Brent Crude are presented in Table 1. The sample is January 1980 through June 1996 and the table shows the first and higher order moments of the monthly price change series. The tests on the time series reject the null hypothesis of log-normality at the 99 percent confidence level. That is, month-to-month changes in the log of crude oil prices are not normally distributed; in particular, changes in the log of prices are characterized by excess kurtosis (fat tails). This is consistent with the findings of studies with respect to other commodity prices.

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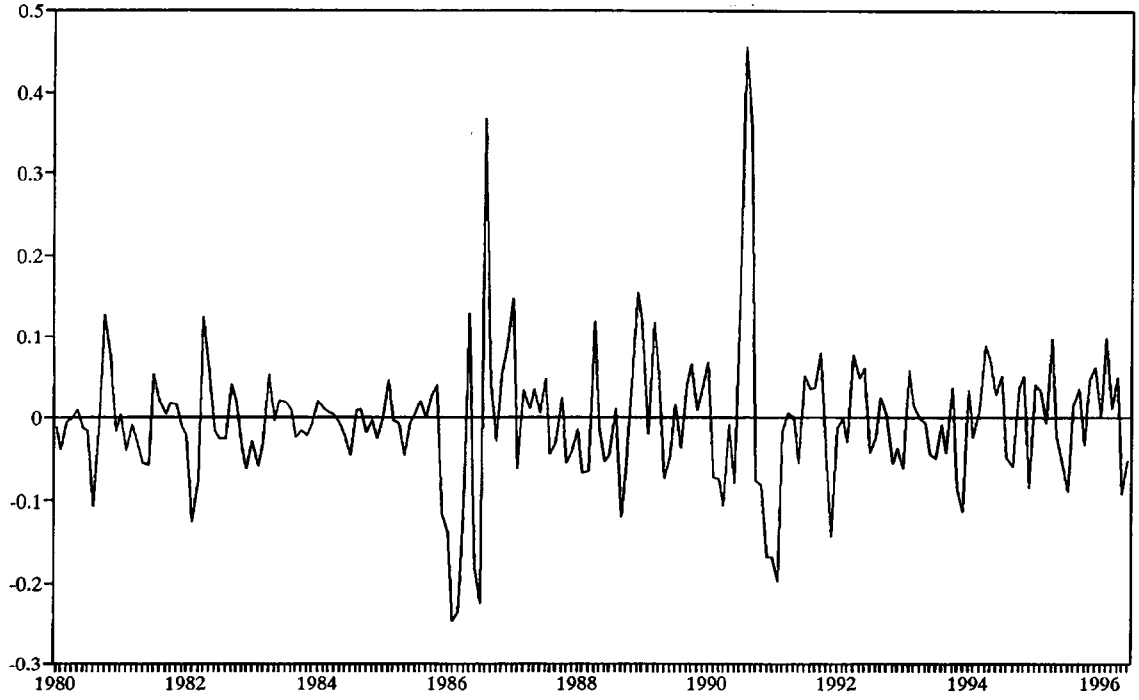
[2]The oil producers have often expressed the desire to maintain the mean level of prices stable over time. Hence, OPEC's declaration of a target price around which they would prefer to see less volatility at relatively high frequencies (quarterly, monthly).

[3]Prior to August 1990, the price data are for oil from the Brent system only. In August 1990, it was decided to commingle oil from the Brent system and the Ninian system at Sullom Voe to reduce specific gravity variations of the oil; the oil is known as Brent Blend. For a detailed account of the emergence and importance of the Brent market, see Horsnell and Mabro (1993).

Figure 1.

First Difference of the Log of monthly Crude Oil prices, Jan 1980-Jun 1996. 1/

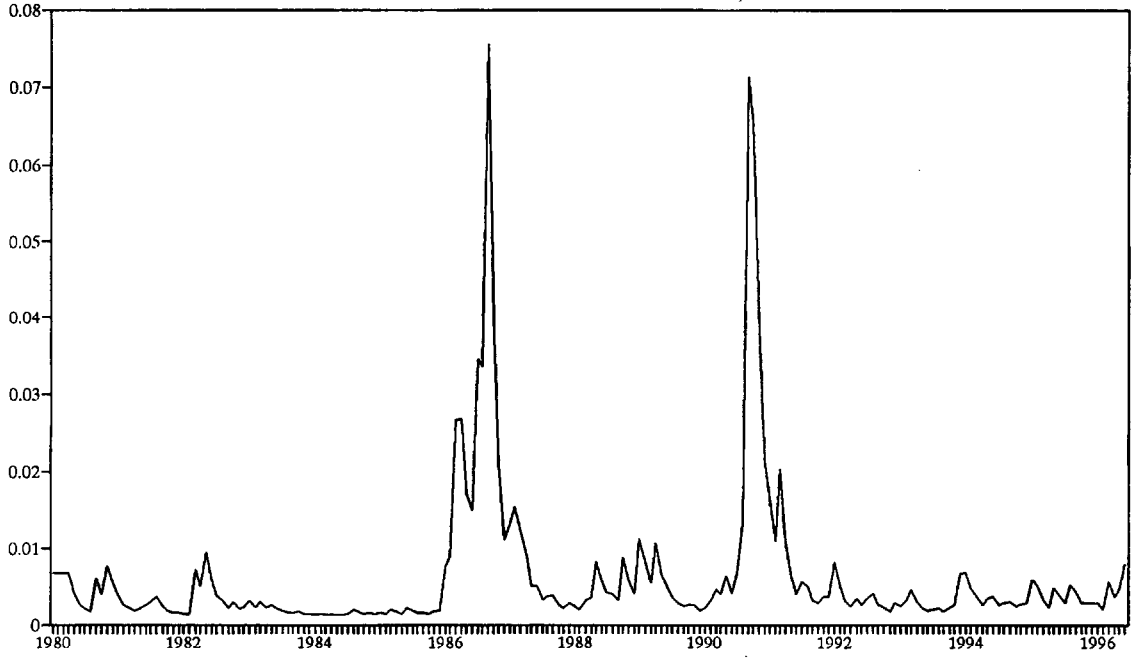


Source: Platt's Oilgram Price Report

1/ Dated Brent Blend.. f.o.b. Sullom Voe Terminal in the Shetlands (see footnote in text, on page 2).

Figure 2.

Estimated Conditional Variance of Oil Prices, Jan 1980-Jun 1996.



Source: Author's regression.

Table 1. Univariate Statistical Properties

Variable	First difference of the average monthly price of Dated Brent Blend in logarithms.
Period	January 1980 to June 1996.
Sample size	198 observations.
Mean	-0.004040
Std. deviation	0.082965
Skewness	1.276507
Excess kurtosis	7.601425
Minimum	-0.248460
Maximum	0.455405
Normality Chi sq.(2)	70.662 (0.0000)**

III. Modeling Price Volatility

In analyses of volatility, there have been major advances in the last few years. In modeling the variance of a stochastic process, ARCH (autoregressive heteroscedastic models) have been supplemented by GARCH, (generalized autoregressive heteroscedastic models), and variants thereof.[4] The basic idea behind these types of models is that volatility can be broken down into predictable and unpredictable elements, and it is the difference which determines potential risk exposure. The predictable element is the conditional variance of the time series in question.

The conditional mean η_t and the conditional variance σ^2_t (i.e., the predictable part of volatility) of a time series depend on the information set Γ_{t-1}; thus, $\eta_t = E(dp_t \mid \Gamma_{t-1})$ and $\sigma^2_t = Var(dp_t \mid \Gamma_{t-1})$ where dp_t is the first difference of the logarithm of the oil price. The innovations or disturbances μ_t from a model explaining the rate of return (i.e., dp_t) are specified as:

$$\mu_t | \Gamma t\text{-}1 \sim N(0,\sigma^2_t) \qquad (1)$$

[4]ARCH models were introduced by Engle (1982) and GARCH models by Bollerslev (1986).

The conditional variance in the GARCH (p,q) takes the form of:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_i \mu_{t-i}^2 + \sum_{i=1}^{q} \beta_i \sigma_{t-i}^2 \qquad (2)$$

where:

$$\begin{aligned} & p > 0 \qquad q \geq 0 \\ > 0, \quad & \alpha_i \geq 0, \qquad i=1,0\ldots,q \\ & \beta_i \geq 0, \qquad i=1,\ldots..,p \end{aligned} \qquad (3)$$

For q=0, the model becomes ARCH(p) and the σ^2_t depend only on the past squared residuals. The GARCH(p,q) model permits lagged conditional variances also to influence the present conditional variance.

In modeling other volatile time series, such as stock returns, it has often been argued that the mean should exhibit relatively little predictability from the past, except perhaps for the presence of moving average error terms due to seasonality or data irregularities and possibly some serial correlation. As a first step, therefore, the time series on the first difference of the log of oil prices was regressed against seasonal dummy variables. For the period as a whole, no significant seasonality was found in the data at the monthly frequency, although it is possible that some seasonality may be present in the subperiod after the Gulf War, but it is not significant at traditional significance levels.

The next question to be raised is how in fact the conditional mean of changes in the log of oil prices can be modeled and the innovations (the μ_t) obtained. It has been argued, as suggested above, that market efficiency (in its weak form) implies that returns on financial assets under the assumption of risk neutrality should follow a random walk, in which case it is not possible to forecast future price changes using past changes in prices. Nevertheless, and despite low transactions costs, it has frequently been found with data at various frequencies (daily, weekly, monthly) that equity and foreign currency returns exhibit serial correlation. The oil price data used here is at a monthly frequency and it can be argued that barriers to arbitrage and transaction costs for oil are likely to be considerably higher than is the case for financial instruments. Preliminary econometric investigation also suggested that an autoregressive model for oil price changes might be appropriate. Thus, in estimating the model, the innovations μ_t would be obtained from an equation of the form:

$$\mu_t = dp_t - \sum_{i=1}^{n} \beta_i \, dp_{t-i} \qquad (4)$$

The model for the conditional mean and a GARCH process for the conditional variance were jointly estimated by quasi-maximum likelihood. The most robust model based on log-likelihood values was where the conditional mean was specified as an AR(4) process without a constant and where the conditional variance was specified as a GARCH(1,1) process. The model together with the test statistics is given in Table 2. The robust standard errors and robust T-statistics reflect adjustments for conditional non-normality of the dependent variable (see Table 1 for unconditional normality tests for the period as a whole).[5] Summary statistics for the normalized residual ($\mu/\sqrt{\sigma^2}$) and the square of the normalized residual ($\mu.\mu/\sigma^2$) are also given in the table along with the Ljung-Box statistics for serial correlation (Q(12)). The latter statistics have a Chi-square distribution with 12 degrees of freedom [$\chi^2(12)$]; the null of no serial correlation is accepted at conventional confidence levels.

The conditional variance (i.e., the predictable element of volatility) of the first differences in the log of oil prices is given in Figure 2 (compare with actual volatility in Figure 1). As can be inferred, the unpredictable element of volatility is predominant, but some informational content of the model is suggested by flares in the conditional variance in the early 1980s associated with increased measured volatility. In the period from 1983 through late 1985, the estimated conditional variance was very low and provides little information on volatility which was in any event somewhat lower than experienced earlier in the decade. Figure 2 indicates that there was a predictable part of volatility associated with both the oil price slump of late 1985 and 1986 and the price surge experienced at the time of the Iraqi invasion of Kuwait and the subsequent liberation. Thereafter volatility declined although not to the levels experienced from 1983 through late 1985 and appears somewhat more predictable than in the earlier period.

IV. Volatility and the Use of Hedging Instruments

Under the impact of oil market deregulation in the U.S. market and the growth of crude oil production by the private sector in the North Sea, Alaska and elsewhere, market-based spot trading for crude oil gained in importance in the late 1970s and early 1980s. At the same time, and in response to largely unpredictable spot price volatility for market-based crudes, forward markets were increasingly used by producers and refiners for hedging price risk. Spot and forward trades are bilateral deals (contracts) not conducted on formal exchanges, and prices are assessed by price reporting agencies who canvas oil market traders and brokers for details of trades taking place. Price assessments are provided daily (also intraday by online screen

[5]See Bollerslev and Wooldridge (1992). The program used for estimation was EZARCH 4.0X written by Ng (1991).

services) for spot trades for a variety of crudes, as well as for forward trades, principally for Brent, Dubai, and (through spread data) other crudes.[6]

Table 2. GARCH(1,1) Model
Endogenous variable: dp; No. of observations: 198
Period: January 1980 to June 1996

Parameters	Est.Value	Std.Error	T-stat	Robust-SE	Robust T-stat
Mean equation					
dp_{t-1}	.260766	.070948	3.675461	.100484	2.595102
dp_{t-2}	-.141890	.080647	-1.759409	.090476	-1.568268
dp_{t-3}	.084812	.074236	1.142467	.080437	1.054394
dp_{t-4}	-.170696	.065529	-2.604914	.065814	-2.593612
Variance equation					
Constant	.000553	.000206	2.683491	.000264	2.095912
σ^2_{t-1}	.505345	.111108	4.548218	.124988	4.043134
μ^2_{t-1}	.418557	.096885	4.320131	.192016	2.179804
Test statistics	Mean	Variance	Skewness	Kurtosis	Q(12)
$\mu/\sqrt{\sigma^2}$	-.08573	.99029	-.00255	3.82089	11.75532
$\mu.\mu/\sigma^2$	.99764	2.79636	3.37765	17.27710	9.26202

[6]Once the key marker price in levels is known, the spread to the marker permits determination of the outright price for other crudes.

While forward markets can be used for hedging purposes, these markets lack some of the advantages made possible by trading futures contracts on a formal and regulated exchange with a clearing house in operation. In such markets, open bidding and selling is featured, the contracts are tightly specified, margin requirements are determined in advance, and positions are priced to market. Having successfully launched a futures contract for heating oil in late 1978, the New York Mercantile Exchange (NYMEX) started trading a futures contract for light sweet crude oil in March 1983.[7] After a modest start, the market grew very rapidly, in large part due to the increasing proportion of spot trading in crude oil being conducted at market-based or market-linked prices. Data on open interest and volume for crude oil contracts on NYMEX are shown in Figure 3.

Attempts were made in the early- and mid-1980s to launch a futures contract for Brent crude on the International Petroleum Exchange in London, but these were not successful. A redesigned contract was, however, launched in June 1988 and trading grew rapidly, particularly after Iraq invaded Kuwait in 1990 and the spot market tightened and prices became very volatile in the highly uncertain supply environment. Figure 4 shows volume and open interest on the IPE in recent years.

Recently, in efforts to provide more hours of trading available to those outside the New York and London time zones, the IPE entered into an agreement with the Singapore International Monetary Exchange (SIMEX) during 1995 allowing trade to take place there in Brent futures, while NYMEX made arrangements to permit computer trading of its futures on the Sydney Futures Exchange. Both NYMEX and the IPE also trade crude oil options contracts. Furthermore, apart from trade in such derivatives on formal exchanges, over-the-counter markets allow purchase and sale of financial instruments such as options and swaps; the size of the market is difficult to gauge as most transactions are kept confidential, but it is believed to be substantial.[8]

Some critics of the performance of oil markets have argued that "excessive" volatility has resulted from the emergence and growing importance of market-determined spot and futures prices. In part this viewpoint may reflect observance of the historically atypical behavior of oil prices in the 1950s and 1960s under the administered price system of the major international oil companies. It may also reflect the fact that, despite the upheavals of 1973-74 and 1979-80, the major oil producing countries managed to achieve relatively smooth prices for their own oil

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[7]The basic trading unit or contract is 1,000 barrels and the physical base for the contract is the delivery of West Texas Intermediate **or** substitute domestic or imported crudes by pipeline at Cushing, Oklahoma.

[8]One of the most-widely reported uses of OTC markets was Mexico's purchase of put options to protect against a decline in oil prices for its exports below $17 a barrel in 1991. The cost of the put options was reportedly $200 million to ensure that oil export earnings did not fall below $8.5 billion.

exports through the use of term contracts and supply management in the period until late 1985.[9] However, once the administered pricing system of the major oil producers broke down it subsequently proved infeasible to resurrect it even with an extant common interest in supply management. With many players in the markets with differing interests, it also seems inevitable that the largely unpredictable volatility of prices on spot markets, subject as they are to short-run supply disturbances and demand shocks, would lead to the further development of markets for hedging (including futures markets) to allow scope for economic agents to manage price risk. And, it is generally argued in the literature that the presence of futures markets for commodities should, other things being equal, have a stabilizing impact on spot prices.[10] Given the information presently available to agents, spot and futures and forward markets provide the dynamic link between current and future demands and supplies, and thus perform an effective intertemporal role in processing the available information.[11]

V. Episodes of Crude Oil Price Volatility

The interesting feature of the picture drawn of oil price volatility over the period was that the first very large outburst (1985-86) was associated with marked uncertainty over how long an increase in supplies associated with the breakdown in the OPEC production-sharing agreement was going to persist, while the second large outburst (1990-91) was associated how long supplies were likely to be disrupted and how much pressure was likely to be exerted on crude oil stocks outside the Middle East. The difference between the two situations was reflected in prices for spot oil and oil futures on the New York Mercantile Exchange (NYMEX) and for the latter episode also on the International Petroleum Exchange (IPE).[12]

In 1985, the price curve started out very flat and generally moved into mild backwardation between spot and the fourth month futures contract with futures prices further out essentially flat (Figure 5, upper left panel). By November the backwardation became more marked and the price curve was negatively sloped throughout the range of futures contracts,

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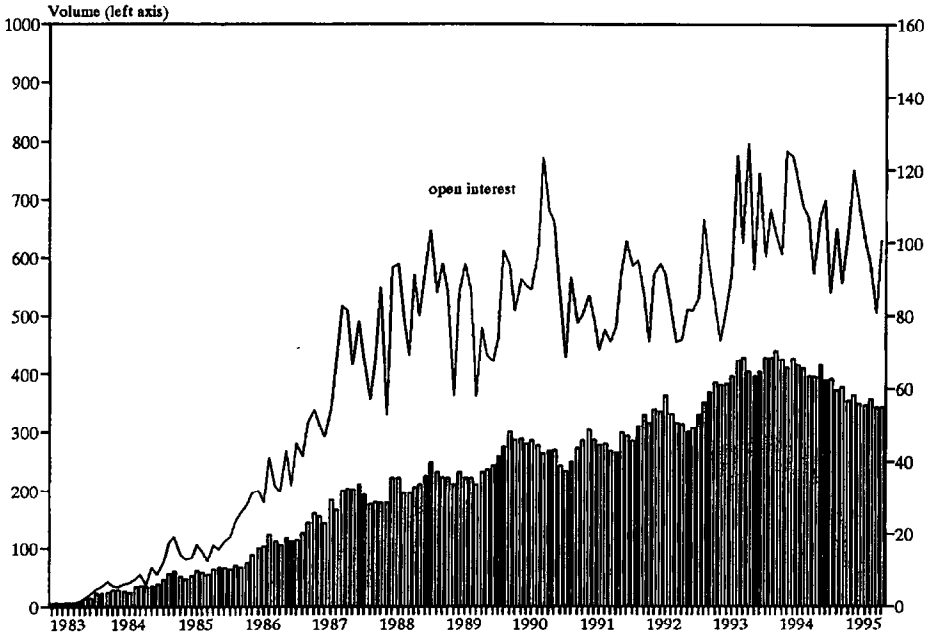
[9]In earlier years, since the first development of oil fields in Pennsylvania and Texas until the outbreak of World War II, oil prices exhibited much greater volatility than was subsequently observed in the 1950s and 1960s.

[10]See, for example, the discussion in Newbery and Stiglitz (1981). There are, however, a number of theoretical specifications with results contrary to this prior.

[11]This is not to argue that there may be reasons why, as in other asset markets, there may seem to be undershooting and overshooting (from an **ex-post** standpoint) as markets react to changes in the information set. The probabilities attached to the likelihood of certain events occurring can change over time as the information set is affected by "news".

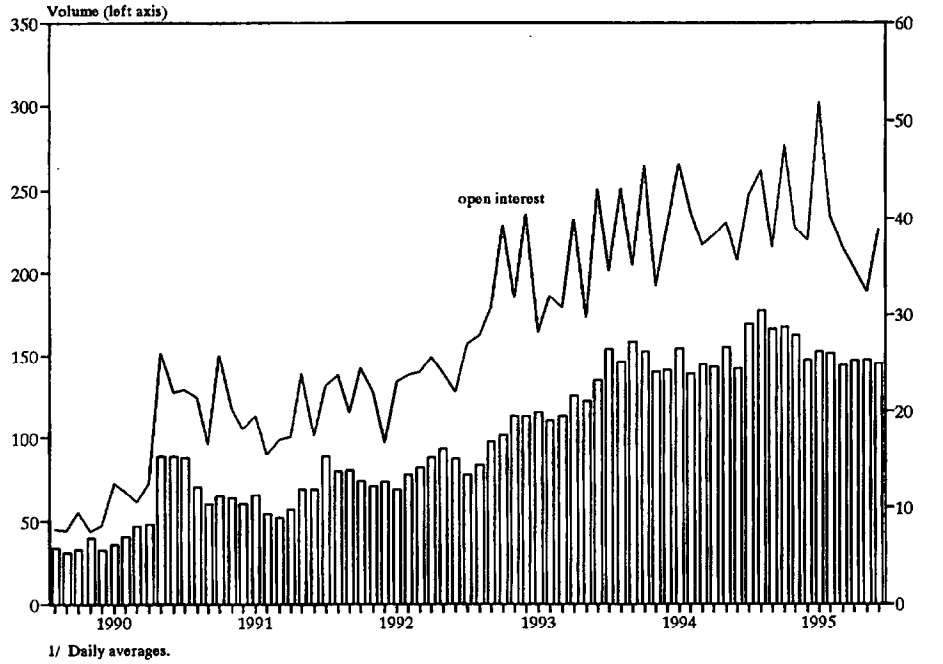
[12]Brent crude futures trading on the IPE started on June 23, 1988.

Figure 3. NYMEX: West Texas Intermediate volumes and open interest 1/
(in thousand contracts)



1/ Daily averages.

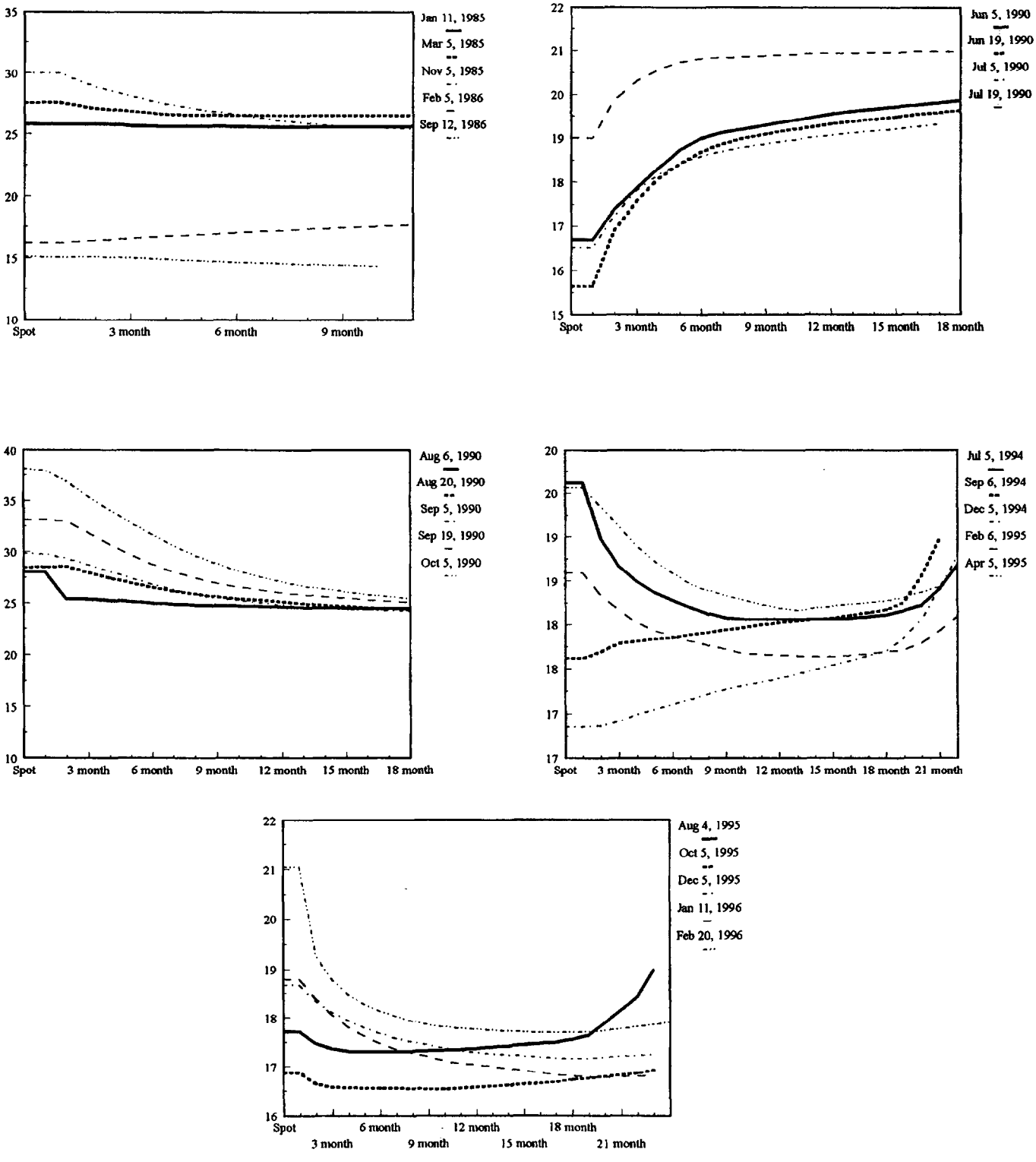
Figure 4. IPE: U.K. Brent volumes and open interest 1/
(in thousand contracts)



1/ Daily averages.

Figure 5. Oil Futures 1/

In U.S. Dollars per Barrel



1/ New York Mercantile Exchange.

Source: Wall Street Journal.

possibly reflecting doubts about the cohesiveness of OPEC producers with spot prices approaching $30 a barrel in light of the erosion of Saudi market share. As prices slumped in early 1986 as increased supplies were being shipped from Saudi Arabia and no accompanying reduction by other OPEC members seemingly likely, the market moved into modest contango (i.e., the slope of the price curve is positive).[13] With uncertainty about how OPEC might react to the slump, spot prices and price curves became even more volatile in May through August into early September, and it was only in late September 1986 with evidence that cuts in output agreed by OPEC were being implemented that volatility decreased and price curves flattened out into mild backwardation. Thereafter until the Kuwait crisis, crude oil prices displayed a cyclical pattern with relative tightness in the market being associated with upsurges in volatility and sharper backwardation in the price curve, while relative ease in the market was reflected in contango or relatively modest backwardation.

The second episode of exceptionally high volatility was associated with the Iraqi invasion of Kuwait. Prior to this event, the market had been associated with contango (Figure 5, upper right panel). With the invasion of Kuwait on August 2, 1990 and with two major players out of the market, the market moved into backwardation with spot and prompt supplies commanding a premium with further out contracts trading at a discount. The backwardation became sharper as 1990 progressed and the short-term supply situation remained highly uncertain as Saudi and other Middle East suppliers' oil installations were believed to be under threat. Nevertheless, traders seemed to expect beyond the short term a resolution to the Kuwaiti conflict, the regularization of supplies (from Kuwait if not Iraq), and a decrease in pressure on stocks; hence the flattening out of the price curve at more distant maturities. The "backwardation" associated with the uncertainty about spot and prompt supplies but not further out is illustrated in Figure 5 (middle left panel).

These two episodes bring out several important features about the dynamic behavior of oil markets and oil prices. First, while it is possible to carry forward current supplies in the form of stocks, it is only possible to a limited extent in the short run to "borrow" or bring forward significant volumes of supply from the future. Second, except for physical limits in the short run it is possible (at a pecuniary cost) to carry forward supplies (i.e., hold stocks) without being otherwise constrained. Arbitrage possibilities imply that the extent of contango will be limited and will depend on storage and interest costs. On the other hand, the fact that stocks cannot effectively be negative means that prices can rise very sharply for spot and prompt deliveries when supply disruptions occur and when stocks are relatively low, even if the supply disturbance is not viewed as likely to be persistent. Thus, backwardation can be quite pronounced in such circumstances as agents place very high values on existing stocks.

In the aftermath of the Middle East War, considerable uncertainty has persisted about whether or not supplies from Iraq would return to the market and intermittent negotiations have

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[13]In fact some other OPEC producers increased their output at the same time as Saudi Arabia was increasing its supplies.

taken place between the Iraqi authorities and the UN on possible sales of Iraqi crude to finance purchase of supplies for humanitarian purposes under U.N. Resolution 986. The mixed picture during the latter half of 1994 and early 1995, for example, is shown in Figure 5 (middle right panel). In July the market was in a state of backwardation, but in the latter part of 1994 as hopes dimmed for a United Nations agreement with Iraq, the market moved into contango; however in early 1995 a quite pronounced backwardation again emerged as demand surged due to cold weather in North America and northern Europe. Despite the uncertainties concerning Iraqi supplies, the response of OPEC, and the role of non-OPEC suppliers, considerable pressures on profit margins have faced refiners in key regions. Such pressures and the belief that prices were likely to fall in the future if and when Iraqi sales were permitted are believed to have placed a premium on "just-in-time" deliveries to refineries, with the result that incentives to hold crude stocks have been somewhat eroded over time, and U.S. crude stocks (relative to consumption) were by end-March 1996 much reduced compared to the norm of recent years. The implication has been that "bad news" on the demand side (i.e., higher than expected demand) and on the supply side (i.e., lower than expected supply) have recently (notably in early 1995 and again in late 1995 and early 1996) been having a pronounced effect on the short-term behavior of crude oil prices. In particular, the market has been affected by refiners and other market participants reaction to such "news" or shocks, with tightness in spot and prompt supplies resulting in extensive backwardation for contracts unto twelve months out, with modest contango for contracts further out (see Figure 5, middle right panel and bottom panel).

VI. Concluding Remarks

This paper has examined the volatility of crude oil prices over the last decade and a half. This period saw the end of the system of administered pricing followed by the national oil companies of major oil producing countries, and the spread of market-determined or market-linked pricing based on key marker cruces. The conditional volatility of crude oil price changes was estimated using a GARCH model. Two episodes of particular volatility stand out, that associated with price slump in 1986 and that associated with the Iraqi invasion of Kuwait and the military aftermath thereof. It was also noted oil price volatility for market-determined crudes after the Kuwait-Iraq crisis continued at levels somewhat above that experienced in the early 1980s. Spot price volatility gives rise to risk, and markets for forward, futures, and derivative instruments have emerged to protect against such risk. Oil futures markets in particular have grown rapidly. The paper reviewed the link between spot and futures markets for crude oil by examining situations where the price curve, which shows the relationship between spot and futures prices, changed between backwardation and contango. Examining such situations brings to the fore the necessity of analyzing price developments in such an important commodity market from an intertemporal standpoint.

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