Long-Short Strategies involving Oil Futures and Shares of Firms that depend on Oil

Finance 925

Sponsor
Eric Tavel, Goldman Sachs

Advisor
Ravi Jagannathan, Northwestern University

Project Team
Sergey Korshunov

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Executive Summary

In this paper, we analyze the relationship between the performance of the broad stock market, oil futures, and oil industry stocks. The expected cash flows for both the general market and oil industry stocks depend on the future prices of oil, even though in a different fashion. It is reasonable to assume that expected oil price changes are reflected in asset prices as well as in the futures markets. We use statistical tools to analyze the dynamics of the variables as it relates to the near future.

The mainstream approach of getting information about the future prices of oil is to look at the futures market. However, recent research indicates that the stock market also could be used in predicting future oil prices. Pollet (2002) showed that Norwegian stock market and US oil index along with oil futures data can be important predictors of the next month oil price change. Our approach was to concentrate exclusively on the information from the stock market as an input for our statistical model. We used two indexes which expected to have the opposite reactions to any expected change in oil prices. S&P 500 is dominated by consumers of oil and for these companies oil is a significant cost center. Therefore, S&P 500 index is expected to have lower returns if an increase in oil prices is anticipated. AMEX oil index is dominated by producers of oil which are expected to experience an increase in their profits when oil prices rise. By using both indexes in the regression we expected to make a more precise estimate about the stock market's appraisal of the anticipated oil price changes.

To summarize, the four variables used in our analysis are:

- American Exchange Oil Index (XOI) prices for a proxy of oil companies

- S&P 500 index (S&P) prices for a proxy of the overall market
- Western Texas Intermediate (WTI) for a proxy of spot oil prices
- WTI oil futures to be utilized as our trading vehicle.

We utilized monthly prices for S&P, XOI, and WTI from January 1986 through May 2004. It is important to note that this period of time has a good representation of different economic conditions including the stock market crash of 1987, the early 1990's war in Iraq with its high oil prices and following recession, the economic boom of the late 1990s and the subsequent early 2000's bear market and recession.

Regressions were run in an attempt to establish the historical relationship between the WTI spot rate change for month t+1 and the returns from the XOI and the S&P for month t. The results were used to make predictions for the oil price change one month ahead. Our study predicted 204 oil price changes for the entire period of time that we have examined. The regression equation used is as follows:

$$\mathbf{Ln(WTI_2 / WTI_1) = \alpha + \beta_1(Ln(S\&P_1 / S\&P_0) + \beta_2(Ln(XOI_1 / XOI_0) + \varepsilon}$$

The comparison of the predicted returns with the actual oil price changes showed that this is a well-performing strategy for predicting oil prices in the near future (one month). This information, however, could already be priced in the futures market and therefore be not tradable there. Below we try to resolve this doubt by reviewing a simple trading strategy:

- If the regression predicts a positive change in the price of oil over the next month, a long position should be taken in WTI two-month futures for one month.

- If the regression predicts a negative change in the price of oil over the next month, a short position should be taken in WTI two-month futures for one month.

We analyzed the performance of this strategy over the 18 year horizon. The presence of abnormally high returns serves as evidence that the information received from the stock market was not completely priced in by the oil futures market.

1 Introduction

There is much speculation that returns in certain industries or commodity markets may predict future excess returns in the overall stock market, Hong, Torous, Valkanov (2002). Their team concludes that oil is one of certain commodity markets that may play a role in predicting overall equity market returns. Opposing viewpoints exist regarding the predictive ability oil price changes have on anticipating future excess market returns. For instance, Pollet (2003) and Chen, Roll and Ross (1986) agree and disagree, respectively, about the ability of oil returns to forecast equity market returns. Our analysis takes the inverse approach of these research projects and attempts to determine if equity market returns can predict future oil returns.

We feel it is important to focus upon oil spot and futures prices versus consumer oil prices. Consumer oil prices are subject to governmental control contributing to the fact that they are not entirely correlated to the spot price of oil, which we feel is the true free-market price. In the research projects cited above Pollet utilized oil futures returns while Chen, Roll and Ross utilized fluctuations in consumer oil prices to predict future overall market returns. This may partially explain the disparity in their findings.

Our predictive model starts with the generally accepted notion that current month's market returns are typically negatively correlated with next month's spot oil returns. We take this trend further and incorporate the positively correlated returns of oil companies. By combining oil equities with the overall market we attempt to eliminate much of the systematic market risk embedded in oil equities and focus mainly upon fluctuations driven by oil prices. The net coefficient could potentially provide insight into information contained in oil equities that has not yet been incorporated into the price of oil futures.

It is equally important to understand how the commodities markets operate to determine if a tradable arbitrage opportunity exists. We have investigated various aspects of the New York Mercantile Exchange (NYMEX) to determine what degree of returns must be generated to exceed trading costs. Consideration must be given to minimum contract sizes, margin requirements, and trading timeframes. If the excess returns predicted by our model are statistically significant and exceed the costs of trading on an exchange similar to the NYMEX there is potential that our model may provide a profitable opportunity for a properly funded entity.

The rest of this paper is structured in the following manner. Section 2 provides a general overview of the oil futures market. Section 3 describes the empirical methodology including our assumptions and variables. Section 4 discusses the results of our regression analysis. Section 5 presents a simple trading strategy based upon our results. Finally, Section 6 presents our conclusion regarding the ability of oil equities combined with the overall market to predict returns in the oil futures market.

2 Oil Futures Market Overview

According to the NYMEX website, crude oil is the world's most actively traded commodity and is typically traded in the US on the NYMEX and in the UK on the International Petroleum Exchange (IPE). US spot oil prices are referred to as WTI Cushing (WTI) in reference to West Texas Intermediate oil delivered to Cushing, Oklahoma. UK spot oil prices are referred to as North Sea Brent (Brent) in reference to North Sea oil delivered to Sullom Voe in the Shetland Islands. Nearly all oil sold outside the US is priced using the UK spot oil price of Brent crude as a benchmark. WTI oil is primarily produced near US shores while Brent oil is generated from the North Sea. On the NYMEX, WTI futures trade under the ticker CL and Brent futures trade under the ticker SC. WTI was selected instead of Brent as the primary dependent variable and trading vehicle for this project for reasons described in section 3.2.

WTI oil futures are the most heavily traded and liquid oil futures in the world. The WTI futures contracts trade in units of 1,000 barrels and the delivery point is Cushing, Oklahoma, which is the origin of a major US oil pipeline. See Exhibit A for contract specifics. The contract provides for delivery of several grades of domestic and internationally traded foreign crudes, and serves the diverse needs of the oil consuming market. The varying grades of crude oil are priced according to a benchmark versus the WTI spot rate (i.e. 95% of WTI price). Light, sweet crudes similar to WTI are preferred by refiners because of their low sulfur content and relatively high yields of high-value products such as gasoline, diesel fuel, heating oil, and jet fuel. Risk management and trading opportunities are offered through options on WTI futures contracts; calendar spread options; crack spread options on the pricing differential of heating oil futures, crude oil futures, gasoline futures, crude oil futures and average price options.

The *e-miNY* crude oil futures contract, designed for investment portfolios, is the equivalent of 500 barrels of crude, 50% of the size of a standard futures contract. The contract is available for trading on the Chicago Mercantile Exchange (CME) GLOBEX electronic trading platform and clears through the New York Mercantile Exchange clearinghouse.

The Brent futures contract is based on a light, sweet North Sea crude oil that also serves as a benchmark grade and widely trades as a differential to the NYMEX Division's bellwether light, sweet crude oil futures contract. Most of the crude oil is refined in Northwest Europe, but significant volumes move to the U.S. Gulf and East Coasts. Complementing the Brent crude oil futures contract are options contracts, calendar spread options contracts, and an options contracts on the Brent/West Texas Intermediate crude oil spread.

Several other oil derivatives are exchange traded such as:

- A financially settled futures contract for Dubai crude oil
- A futures contract on the differential between the light, sweet crude oil futures contract and Canadian Bow River crude at Hardisty, Alberta
- A futures contract on the differentials of the light, sweet crude oil futures contract and four domestic grades of crude oil: Light Louisiana Sweet, West Texas Intermediate-Midland, West Texas Sour, and Mars Blend.

3 Empirical Methodology

3.1 Theoretical Assumptions

The theoretical claim that expected future cash flows determine stock prices should lead to the conclusion that the expected price of important inputs needs to be monitored by investors and reflected in the valuation of stocks. The future price of oil is an important variable for many firms' expected future cash flows. The broad stock market is sensitive to the future prices of oil and should accommodate these in its valuation of firms. The companies within the oil industry are sensitive to future oil prices which make a significant impact on their profits. Hence, it is reasonable to expect that these future prices should be reflected in their valuation as well.

Because future prices of oil change the current valuation of stocks, it should be possible to extract this information and compare it with the actual oil prices. We tested these assumptions by analyzing historical data described in section 4.0. From the historical analysis we felt it may be possible to predict the next month oil price change based upon the prior month S&P and XOI returns.

3.2 Data: Oil Futures and Spot Rates selected for Analysis

Our project focused on US WTI oil prices instead of Brent oil prices because they are the most heavily traded and liquid oil futures in the world and the Brent market was exposed to documented price squeeze arbitrage during the periods of our analysis.

Price squeezes occur when a trader buys all available cargoes for a particular month hoping to take advantage of sellers with commitments to deliver oil who will pay a premium price when

they can't find a cargo. A successful squeeze increases the price of the one-month future relative to the spot, when the two are typically 99% correlated. Research showed that on 23 occasions from 1989 to 2002 the price of Brent one-month futures rose more than one dollar against the price of the Brent spot. Two weeks later, 82% of the time the price of the one-month future had fallen back by nearly 50 cents a barrel. With cargoes of 500,000 barrels this translates into substantial price swings in only a matter of days (Fielden, 2003).

This arbitrage resulted in fundamental changes to the definition of Brent in 2002. Prior to July 2002, Brent oil referred to oil produced from the North Sea comprising of approximately 25 cargoes per month, or 12.5 million barrels. Subsequent to July 2002, Brent oil was expanded to include oil produced in Forties (Norwegian Sea) and Oseberg (UK North Sea). This change expanded monthly Brent cargoes to approximately 100 to prevent the likelihood of future price squeezes.

The potential volatility in Brent one-month futures versus spot during the 1990's could adversely affect the results of this analysis because our regression model utilizes the predicted percent change in spot prices to determine whether to go long or short two-month futures contracts. The larger cargo volumes of WTI and the fact that in the 1990's one-month futures were 99.9% correlated to the spot price provided sufficient justification to only utilize WTI futures and spot rates for our analysis.

3.3 Data: Oil Equities Selected for Analysis

The equity indexes selected for our regression analysis were the S&P 500 and the American Exchange Oil Index (XOI). The reasons we chose these indexes were the broad exposure to the market the S&P 500 provided and the specific oil industry exposure (and consequently oil

specific exposure) and long historic data the XOI presented. Although a number of oil indexes could have been used, including the CBOE Oil Index (OIX), Morgan Stanley's Oil Services Index (MGO) and the Philadelphia Stock Exchange Oil Services Index (OSX), the short historic data these indexes have compared to XOI's 20 years of existence did not allow us to perform an analysis that could have included all the significant equities and oil market corrections that have occurred in the years covering our study.

- ***Standard & Poor 500 (S&P 500)***: The S&P 500 is widely regarded as the best single gauge of the overall U.S. equities market. This index includes a representative sample of 500 leading companies in leading industries of the U.S. economy. Although the S&P 500 focuses on the large-cap segment of the market, covering over 80% of U.S. equity market capitalization, it is also an ideal proxy for the total market.
- ***American Exchange Oil Index (XOI)***: The American Exchange Oil Index is a price-weighted index of the leading companies involved in the exploration, production, and development of petroleum. The index was established in August 27, 1984 and has become a well known index for those interested in exposure to the oil industry. As of 05/21/04 the XOI was composed of:

Company Name	Symbol	% Weighting
Total 'b' ADS	TOT	12.88%
Chevrontexaco Corp	CVX	12.75%
Conocophillips	COP	10.03%
Amerada Hess	AHC	9.93%
Sunoco Inc	SUN	8.33%
BP p.l.c. ADS	BP	7.33%
Kerr-Mcgee	KMG	6.96%
Royal Dutch Petrol ADR	RD	6.88%
Occidental Petroleum	OXY	6.37%
Exxon Mobil	XOM	6.06%
Unocal Corp	UCL	4.99%
Marathon Oil	MRO	4.62%
Repsol Ypf S.A. ADS	REP	2.87%

4 Regression Analysis Results

An Ordinary Least Squares (OLS) regression was used to perform our analysis whereby next month's WTI spot oil returns were regressed on the current month's S&P and XOI returns. We used a 12 month rolling regression in order to have a model that adjusts rapidly to current economic conditions in the oil market while still utilizing historical data as a guide. We considered simply having one regression that added a data point each month for the most current returns. We concluded that this would not accurately reflect current economic conditions because as time goes by one month would not impact the regression model due to its immaterial impact on the large number of previous monthly results. Our regression model is as follows:

$$Ln(WTI_2 / WTI_1) = \alpha + \beta_1(Ln(S\&P_1 / S\&P_0) + \beta_2(Ln(XOI_1 / XOI_0) + \varepsilon$$

We used monthly prices for S&P, XOI, and WTI from January 1986 through May 2004. As we mentioned before, this period of time represents a variety of diverse economic conditions including the stock market crash of 1987, the early 1990's war in Iraq with its high oil prices and following recession, the economic boom of the late 1990s and the subsequent early 2000's bear market and recession. Our study predicted 204 oil price changes utilizing the same 12 month rolling regression methodology for the entire period of time that we have examined.

Our model generated promising results when predicting the direction of next month's oil price change. However, the magnitude of that change is often understated. The sign of the return is usually right, but the absolute value is typically less than the actual one. The most common approach to predicting future oil prices is to simply look at the futures market. While the futures market is certainly an important indicator of the expected future prices of oil, our research shows that the S&P and XOI indexes can also be useful in predicting future prices of oil. The

knowledge of the direction and the timing of the oil price change could be a useful tool for trading in the oil market. Our research indicates that the stock market reflects the information about the expected changes in the oil prices, and that information is a good predictor of the actual changes for the coming month.

5 Trading Strategy

As our model appears to enable us to predict the change in next month's price of oil, we considered a possibility that the oil future market might already accommodate this information. We tested this assumption by analyzing a simple trading strategy. This strategy makes directional bets on one month changes in the oil prices trying to capitalize on the high volatility of oil prices and can be summarized as follows:

- If the predicted one-month WTI spot price change is positive, a long position should be taken in WTI two-month futures for one month.
- If the predicted one-month WTI spot price change is negative, a short position should be taken in WTI two-month futures for one month.

For example, let us say that today is May 1st 2004, and we predict that on June 1st 2004 the price will be 7 percent higher. We are going to buy a futures contract with the delivery month of July 2004, hold it until June 1st and sell it. If on June 1st the price of the contract is higher than the one we agreed upon a month earlier, we make money; otherwise we lose.

During our study we made 204 predictions utilizing this strategy for every month starting with February 1987 and ending with April 2004. When calculating returns, we assumed margin requirements equal a 100% of the initial price of the contract. This approach eliminates much of the impact of leverage. As a result, this methodology provides very conservative results. In real life a typical margin requirement is approximately ten percent so the realized returns would be magnified by approximately 10 times. Figure 1 below graphically represents strategy returns over time. Table 1 and Figure 2 summarize the performance results and present a histogram of returns.

Figure 1: Strategy returns (February 1987 to April 2004)

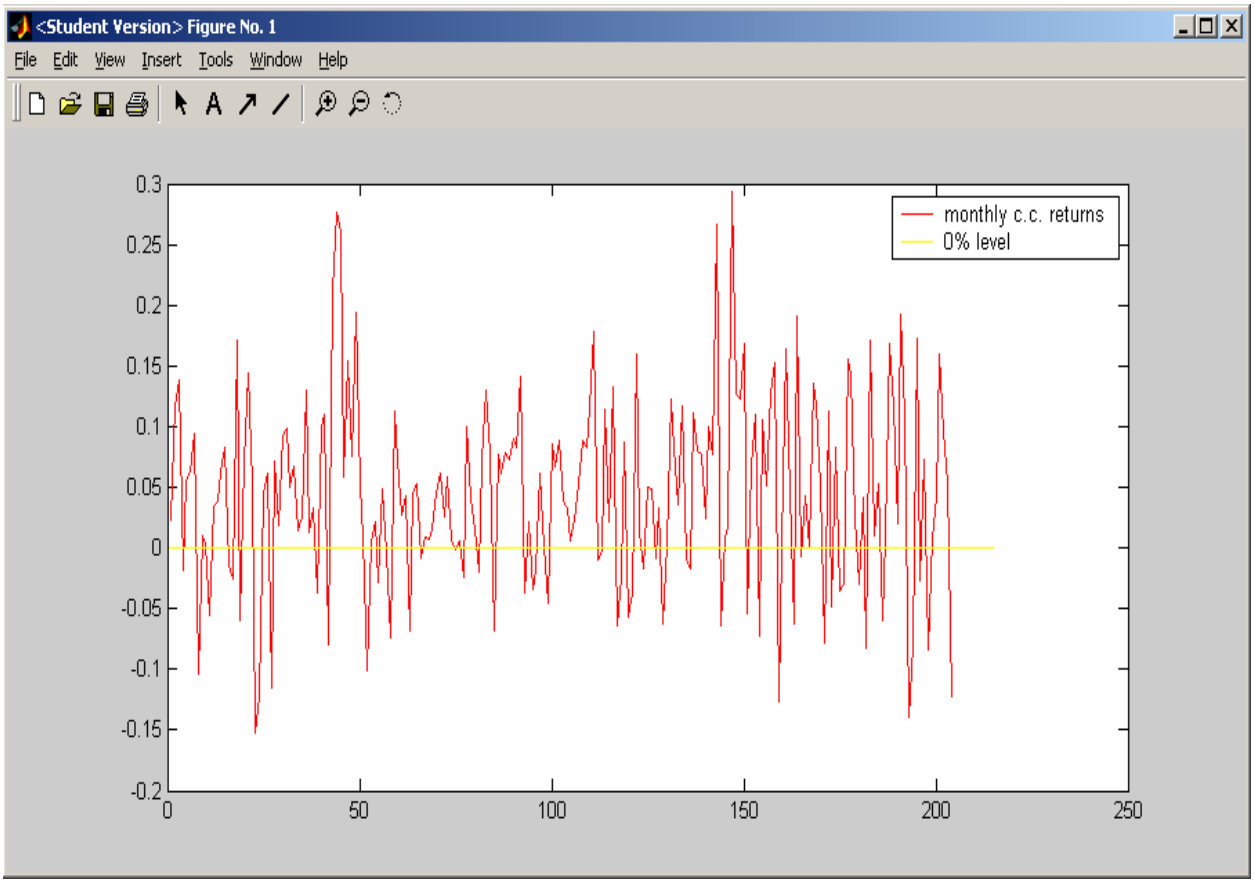
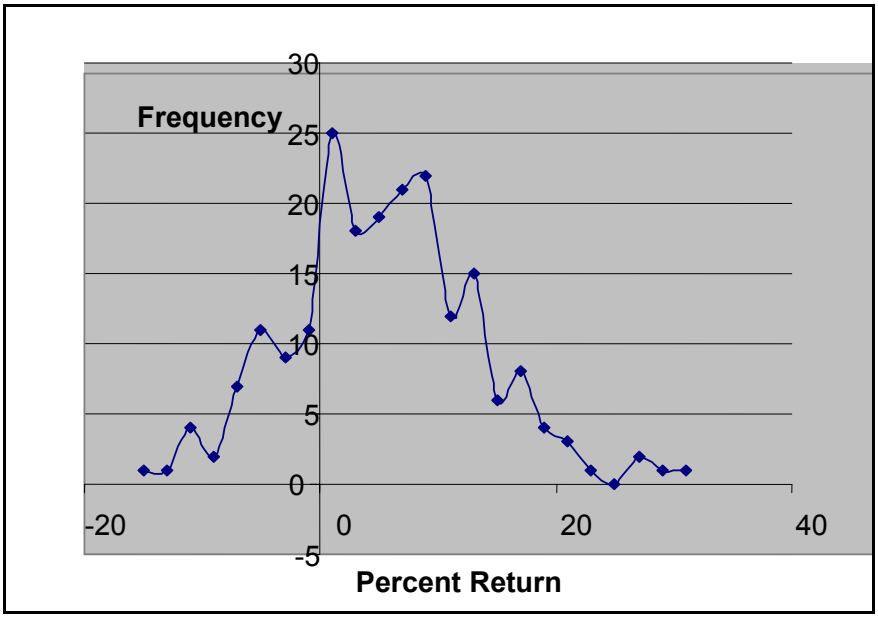


Table 1: Summary of Performance Results (February 1987 to April 2004)

Average Monthly Returns	4.45%
Standard Deviation of Monthly Returns	8.03%
Minimum Monthly Return	-15.19%
Maximum Monthly Return	29.41%
Average Return for a 12 Month Period	54.11%
Minimum Return for a 12 Month Period	5.55%
Maximum Return for a 12 Month Period	142.29%

Figure 2: Frequency of Returns (January 1987 to April 2004)



During the examined period of time, the investor would be long oil futures approximately 50% of the time and short futures the other half the time. The correlation of the monthly returns with S&P returns was 0.11 and had an insignificant t-ratio of 0.90. However, at a given point in time the investor is either long or short so average beta does not properly measure the risk of this investment strategy. To adjust our risk assessment we grouped the months when the investor would be long and grouped the months when the investor would be short. After the regrouping we recalculated the correlation with market returns. The result was a correlation value with S&P returns of (.02) and an insignificant t-ratio of (0.11) during months when the investor would have held a long position. For all months when the investor would have held a short position, the correlation of the returns with S&P returns was 0.28 and an insignificant t-ratio of 1.55. At a 90% confidence level the t-statistic was not significantly different from zero enabling us to conclude that the strategy has very low market risk.

To put our results into perspective, a portfolio that was always long a two-month futures contract and sold one month later would have had a mean monthly continuously compounded return of 0.87% and standard deviation of continuously compounded monthly returns of 10.08% for the period covered in our study. The S&P index over the same period has a mean monthly continuously compounded return of 0.78% and standard deviation of continuously compounded monthly returns of 4.50%.

From the information described above, it is clear that our trading strategy would have generated very high returns. Therefore, we have concluded that there appears to be significant information regarding next month's oil price changes embedded in the S&P and XOI indexes that was not reflected in oil futures prices.

6 Conclusion

The public information about the coming changes in the price of oil has a significant impact on numerous markets. It is traditional to look at the futures market for information about the expected changes in the price of oil, as well as many other commodities. However, stocks of the publicly traded companies also react to the expected changes in oil price. Using statistical analysis, it is possible to extract this information and compare it with the information from the futures markets.

As we illustrated in this paper, the information about the future oil price changes is accommodated in the stock market. Our analysis shows that there are two important characteristics of the prediction based on the data from the stock market: the quality of the short-term forecast of a direction of oil price change and the possibility to make predictions for a specific time in the future. By reviewing the simple trading strategy we have showed that much of this information was not reflected in futures prices. It is an important insight and can be used by practitioners to improve their assessment of the short-term oil spot prices forecast. The additional information from stocks which is not available from the futures market adds to the precision of the oil price change forecasts made solely based on the futures market analysis.

Exhibit A: Light, Sweet Crude Oil Futures Contract

Specifications

Trading Unit
1,000 U.S. barrels (42,000 gallons).

Price Quotation
U.S. dollars and cents per barrel.

Trading Hours (All times are New York time)
Open outcry trading is conducted from 10:00 AM until 2:30 PM.

After-hours futures trading is conducted via the NYMEX ACCESS® internet-based trading platform beginning at 3:15 PM on Mondays through Thursdays and concluding at 9:30 AM the following day. On Sundays, the session begins at 7:00 PM.

Trading Months
Thirty (30) consecutive months plus long-dated futures initially listed 36, 48, 60, 72, and 84 months prior to delivery.

Additionally, trading can be executed at an average differential to the previous day's settlement prices for periods of two to 30 consecutive months in a single transaction. These calendar strips are executed during open outcry trading hours.

Minimum Price Fluctuation
$0.01 (1¢) per barrel ($10.00 per contract).

Maximum Daily Price Fluctuation
$10.00 per barrel ($10,000 per contract) for all months. If any contract is traded, bid, or offered at the limit for five minutes, trading is halted for five minutes. When trading resumes, the limit is expanded by $10.00 per barrel in either direction. If another halt were triggered, the market would continue to be expanded by $10.00 per barrel in either direction after each successive five-minute trading halt. There will be no maximum price fluctuation limits during any one trading session.

Last Trading Day
Trading terminates at the close of business on the third business day prior to the 25th calendar day of the month preceding the delivery month. If the 25th calendar day of the month is a non-business day, trading shall cease on the third business day prior to the business day preceding the 25th calendar day.

Settlement Type
Physical.

Delivery
F.O.B. seller's facility, Cushing, Oklahoma, at any pipeline or storage facility with pipeline access to TEPPCO, Cushing storage, or Equilon Pipeline Co., by in-tank transfer, in-line transfer, book-out, or inter-facility transfer (pumpover).

Delivery Period
All deliveries are ratable over the course of the month and must be initiated on or after the first calendar day and completed by the last calendar day of the delivery month.

Alternate Delivery Procedure (ADP)
An alternate delivery procedure is available to buyers and sellers who have been matched by the Exchange subsequent to the termination of trading in the spot month contract. If buyer and seller agree to consummate delivery under terms different from those prescribed in the contract specifications, they may proceed on that basis after submitting a notice of their intention to the Exchange.

Exchange of Futures for Physicals (EFP)
The commercial buyer or seller may exchange a futures position for a physical position of equal quantity by submitting a notice to the Exchange. EFPs may be used to either initiate or liquidate a futures position.

Deliverable Grades
Specific domestic crudes with 0.42% sulfur by weight or less, not less than 37° API gravity nor more than 42° API gravity. The following domestic crude streams are deliverable: West Texas Intermediate, Low Sweet Mix, New Mexican Sweet, North Texas Sweet, Oklahoma Sweet, South Texas Sweet.

Specific foreign crudes of not less than 34° API nor more than 42° API. The following foreign streams are deliverable: U.K. Brent and Forties, and Norwegian Oseberg Blend, for which the seller shall receive a 55¢-per-barrel discount below the final settlement price; Nigerian Bonny Light and Colombian Cusiana are delivered at 15¢ premiums; and Nigerian Qua Iboe is delivered at a 5¢ premium.

Inspection
Inspection shall be conducted in accordance with pipeline practices. A buyer or seller may appoint an inspector to inspect the quality of oil delivered. However, the buyer or seller who requests the inspection will bear its costs and will notify the other party of the transaction that the inspection will occur.

Position Accountability Levels and Limits
Any one month/all months: 20,000 net futures, but not to exceed 1,000 in the last three days of trading in the spot month.

Margin Requirements
Margins are required for open futures positions.

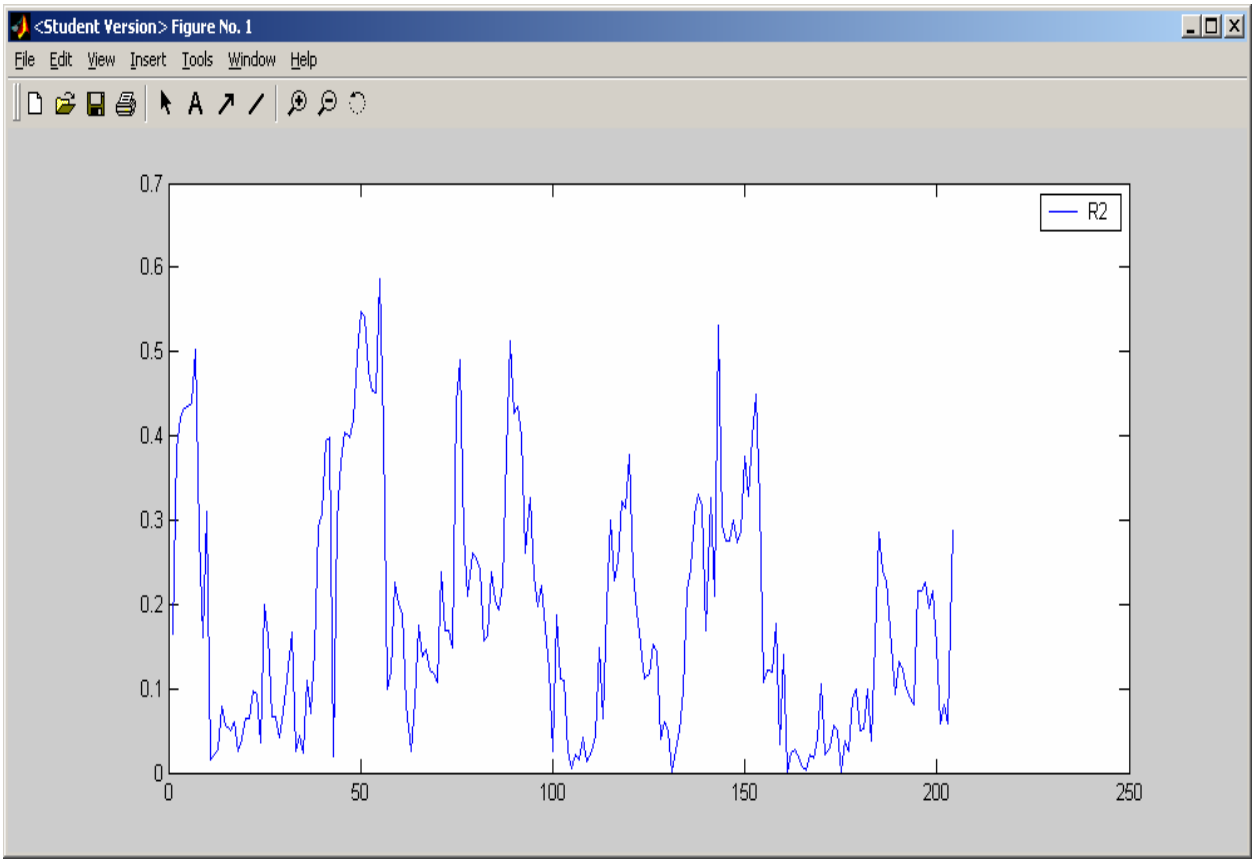
Trading Symbol
CL

Margins

Non-Member Customer Initial	Member Customer Initial	Clearing Member and Customer Maintenance
$3,375	**$2,750**	**$2,500**

Non-Member Customer Initial	Member Customer Initial	Clearing Member and Customer Maintenance					Assessments Spot Month
		Group 1	Group 2	Group 3	Group 4	Group 5	
135%	**110%**	$400*	$250*	$150*	$100*	N/A	**$3,000†**

Exhibit B: R-squared measures of the regressions.



References

Chen, Nai-Fu, Richard Roll, and Stephen A. Ross, 1986 “Economic Forces and the Stock Market”, *Journal of Business*, Vol. 59, 383-403.

Fielden, Sandy, 2002, “Brent Changes Promise Stability”, *Energy Power Risk Management,* September 2002 pp S15-S16

Hong, Harrison, Walter Torous and Torous Valkanov, 2002, “Do Industries Lead the Stock Market? Inattention, Delayed Reaction and Cross-Asset Return Predictability”, *Stanford University and UCLA Research Paper.*

Pollet, Joshua M., 2003 “Predicting Asset Returns with Expected Oil Price Changes”, *Harvard University Research Paper.*