The Oil Industry and Aggregate Economy:
An Analysis of the Effect of Oil Price Fluctuations

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Capstone Approval Page

Capstone Title: The Oil Industry and Aggregate Economy: An Analysis of the Effect of Oil Price Fluctuations

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ABSTRACT:

To better understand the components of volatility in oil-related industries, I examine the relationship between changes in crude oil prices and stock returns in the United States between 1987 and 2000. I find that the spot price of crude oil is statistically positive related to the stock returns of oil-related industries. In addition, changes in the aggregate level of oil reserves are only significant in explaining returns of firms in operation of oil distribution. I also analyze the relationship between oil price changes and aggregate market returns. The results of these tests indicate that oil price changes Grainger cause stock market returns (inversely), and there is a one-month lag in this relationship. In addition, there may be a pattern of stock market returns in the three months prior to an increase/decrease in oil prices.
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Abstract

To better understand the components of volatility in oil-related industries, I examine the relationship between changes in crude oil prices and stock returns in the United States between 1987 and 2000. I find that the spot price of crude oil is statistically positive related to the stock returns of oil-related industries. In addition, changes in the aggregate level of oil reserves are only significant in explaining returns of firms in operation of oil distribution. I also analyze the relationship between oil price changes and aggregate market returns. The results of these tests indicate that oil price changes Grainger cause stock market returns (inversely), and there is a one-month lag in this relationship. In addition, there may be a pattern of stock market returns in the three months prior to an increase/decrease in oil prices.

Key words: Oil prices; Stock returns; Economic factors

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1. Introduction

Oil-related industries in the United States have experienced a great deal of volatility during the end of the 20th century. The high coefficient of variation of oil stocks from 1987 to August of 2000, measuring the risk per unit of return at 5.73, best exemplifies this volatility. An industry with such poor risk-adjusted returns may not, at first glance, seem like an attractive investment opportunity. Understanding the economic factors contributing to the high volatility of returns should assist investors in performing security analysis. As a result, incorporating this information should lead investors to more successful portfolio allocation decisions.

To analyze the factors affecting oil stock returns, I examine stock returns of oil-related industries in the United States between 1987 and 2000. The focus of this analysis is to determine how changes in the spot price of crude oil effects these stocks’ returns. A review of prior research suggests that previous studies do not attempt to explain how oil price changes effects firms involved within oil operations. However, there have been numerous studies on oil’s effect on aggregate stock returns rather than the more specific oil sector. Most of the research available examined the period after World War II through the 1970’s or up to the early 1980’s. For example Hamilton (1983) examined oil’s effect on the economy from 1948 through 1972. Chen, Roll and Ross (1986) examined oil as a risk premium between 1958 and 1984. Kaul and Seyhun (1990) analyzed price variability in oil between 1947 and 1985, and Jones and Kaul (1996) examined the effects of oil shocks on real future cash flows from 1947 to 1991.

The time periods of these studies indicate that most analysis has not focused on latter part of the 1980’s through the 1990’s. I examine crude oil price changes over the
last 14 years to determine their effect on firms with oil operations as well as on returns for the aggregate market.

The remainder of the paper is organized as follows: the following section is a review of literature detailing previous works relating to oil's impact on the economy and stock market returns followed by my hypotheses. Section 3 describes the data I use in the analysis. Section 4 provides summary statistics, results and conclusions of the regressions. A conclusion is offered in section 5.

2. Literature Review and Theory

2.1 General literature

In order to examine the effect of oil prices changes on stock returns, I need to control for other potential explanatory variables, such as monetary policy, inflation, etc. In a study that analyzes the fed funds rate and changing monetary policy, Bernanke and Blinder (1992) suggest that the fed funds rate is a more appropriate measure as an interest rate variable than other open-market interest rates. The fed funds rate reflects Federal Reserve policy, which has been shown to have a significant impact on stock market returns. Jensen and Mercer (2001), and Becher, Jensen and Mercer (2001) expand upon this idea in their analysis of monetary policy and security markets. They use a fed funds premium, defined as the fed funds rate minus the three-month Treasury bill, as the variable that controls for changes in interest rates.

There is a substantial amount of conflicting research regarding oil prices and the aggregate market and economy. The following studies all contain varying aspects of oil's relationship to different economic measures relating to my analysis. I provide a brief
synopsis of their respective conclusions, and show how their results support or contradict one another.

2.2 Oil as a factor

James Hamilton (1983) analyzes the United States economy from 1948 through 1972 and finds that “seven of the eight postwar recessions in the United States have been preceded by a dramatic increase in the price of crude oil.” Hamilton (1983) extends his argument to propose that if there had not been such an increase in crude oil prices during the time periods prior to a recession, the timing, magnitude, and/or duration of these recessions would have been different.

Jones and Kaul (1996) investigate the effects of changes in oil prices on stock prices during the postwar period. The authors find that changes in stock returns are directly related to the impact that changing oil prices have on real cash flows alone, implying that investors account for oil shocks rationally. This conclusion, however, extended only to markets in the United States and Canada. Jones and Kaul (1996) find contrasting information in the United Kingdom and Japanese markets where oil price changes caused larger changes in stock prices.

2.3 Oil as a non-factor

Chen, Ross, and Roll (1986), in their analysis of the risks that are priced into the stock market, concluded oil price risk was not separately rewarded in the stock market. The author’s results suggest there is no risk premium for the volatility in oil prices. The lack of a risk premium may also help explain the high coefficient of variation (5.73) for oil firms in the United States. Assuming oil is a component that adds to the volatility of
stock returns, not including an additional risk premium for oil results in an “improper” proper risk/return tradeoff.

Kaul and Seyhun (1990) analyzed the period between 1947 and 1985 to test their hypotheses. The authors found evidence that “relative price variability ... has a significant negative effect on output and stock returns.” Their data indicates that oil shocks were not as significant a factor in the periods of economic recession prior to the early 1970’s as compared to other periods, contrary to evidence presented by Hamilton (1983).

However, Kaul and Seyhun (19990) find that oil shocks do have a significant impact on periods of economic recession during the late 1970’s and 1980’s. More specifically than the results of oil shocks examined by Hamilton (1983), Kaul and Seyhun (1990) discover that relative price variability is a more determining component of periods of economic recession. Their research found that oil price variability is highly significant (explaining 18.6% of the variation in output) when lagged one period. Therefore, in analyzing stock returns lagged oil prices may need to be included in regression analysis as well to fully capture the effect of oil price changes on stock market returns.

Raymond and Rich (1997) also found evidence contradictory to Hamilton (1983). The authors examine changes in the real price of oil, and its effect on the business cycle as measured by growth in GDP. Their results suggest that oil prices have contributed to the mean of low-growth phases of output (recessions), but they are generally not a principal determinant in the occurrence of those phases. These results suggest that oil prices are not a significant component of stock market returns.
2.4 Theory

I hypothesize that there is a positive correlation between changes in oil prices and the stock returns of oil firms. As oil prices increase, the profit margins for these firms should increase as firms sell oil purchased at lower prices, but charge customers the new higher prices. This increase in profit margins would then positively affect future cash flows and, in turn, stock returns.

Assuming the demand for oil is inelastic and price increases in oil can be passed on to consumers, the overall effect on these firms’ stock returns should be positive. I believe that the positive effect on the oil firms’ cash flows will be a function, in part, of the aggregate level of reserve oil held. In a period of rising prices, a greater level of reserves should allow oil firms to charge higher prices while using the lower cost oil on hand.

My second hypothesis examines the effect of changes in oil prices and total market returns. Consistent with the findings of Jones and Kaul (1996) I hypothesize that oil price changes are negatively correlated with aggregate stock returns. Oil is a commodity that is an input to many industries in the aggregate economy.

The effect on aggregate stock returns, however, should be converse to the effect on individual industry returns (hypothesis one). As the cost of this input increases, the margins for most firms should decrease, negatively effecting future cash flows and, in turn, stock returns. Consistent with Kaul and Seyhun (1990) I believe this relationship will occur in a lag/lead form, suggesting there is some period of delay between oil price changes and the inverse impact on stock market returns.
3. Data Sample

3.1 Firm Selection

In order to create a detailed sample of firms involved in oil operations, I choose all firms recorded from the Center for Research in Security Prices (CRSP) within any oil-related industry. The returns are recorded monthly from January 1987 to August 2008. A thorough search through the Federal Reserve, OPEC, Department of Energy, and various other energy or economic related databases revealed that monthly oil prices are usually available after 1990, but not prior to late 1986. Moreover, examining this period allows the opportunity to examine more recent time periods not studied in previous research.

To create this sample, I select firms based on their Standard Industry Classifications (SIC codes). However, firms involved in oil operations fall into many different SIC codes. Therefore, I segment these varying industries into four major groups, each composed of different areas along the supply chain. These groups are: Group 131, Crude Petroleum and Natural Gas; Group 138, Oil and Gas Field Services; Group 291, Petroleum Refining; and Group 517, Petroleum and Petroleum Products. These groups are further segmented into seven different industries arranged by SIC code. Table 1 presents the groups and specific SIC codes of the industries used in this analysis, as well as a brief description of the operations of those industries across the different segments of the supply chain of oil operations and representative example firms for each SIC code.

In order to ensure that the stock returns of these industries are not largely a function of the aggregate market, it is necessary to control for market returns. Therefore,
in all analyses, I use net-of-market return data. Net-of-market returns are calculated by subtracting market returns from each industry’s monthly returns. The combined value-weighted returns of the NYSE, NASDAQ and AMEX markets are used to obtain market returns (VWMRTN). Subtracting VWMRTN leaves a measure of excess return that I use throughout my regression analysis.1

It is important to point out that the number of firms in each SIC code changes over the years as firms are added or taken out of a given industry. While this change in number of firms may affect some of my results, particularly if there is an industry that is leading the overall results, the overall the number of firms is relatively constant over the 14-year period of analysis. In most cases, the number of firms in each industry varies by less than ten firms in 14-years. Nonetheless, I have reported the average number of firms listed under each SIC code, as well as the range in Table 2.

3.2 Variables

The main variable used in my analysis is the price of crude oil derived from the Goldman Sachs Commodity Index (GSCI) Crude Oil Subindex that measures the monthly crude oil spot price. From this indexed data, I calculate percentage change in monthly spot price (OIL). To determine if the OIL variable contains seasonal patterns or trends, I apply Spencer’s formulae to de-trend the data. Results indicate there is not a seasonal pattern to crude oil price changes.2

Next, to ensure that oil price changes and returns are not solely a function of rising prices throughout the aggregate market, I attempt to control for inflation. I control for

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1 I also have aggregate return data calculated equal-weighted, but use value-weighted due to the variance in the size of the firms.
2 For an additional explanation of Spencer’s formulae, see Kendall and Ord (1990).
inflation as measured by percentage change in the Consumer Price Index reported in the
Board of Governors Federal Reserve Statistical Releases (CPI).

Moreover, changes in return may be a function of changing interest rates rather than oil prices. As a result, I include a control variable based on changing monetary policy. Consistent with Jensen and Mercer (2001) and Becher, Jensen and Mercer (2001) I use the variable FFPREM to measure the premium of the Fed-Funds rate over the three-month Treasury bill.\(^3\) Both of these statistics can also be found in the Board of Governors Federal Reserve Statistical Releases.

Finally, my first hypothesis suggest that oil firms will perform better in periods of increasing crude oil prices, as a function of the level of reserve oil held. Therefore, I include a control for the level of oil reserves in my analysis. Change in global proven crude oil reserves as quoted in the 1999 OPEC Annual Statistical Bulletin are reported only on an annual basis (from 1986 to December 1999). Therefore, in all analyses, oil reserve data are on an annual basis (RESERVES).

4. Summary Statistics and Results

4.1 Summary statistics of oil firms

I examine monthly returns for firms in seven different oil related industries from January 1987 to August 2000. The combined return of the seven different industries, or ALL, is the aggregate measure of oil stock returns. Though ALL is the most comprehensive measure to test my hypothesis that changes in oil prices affect oil stock returns, I also analyze each individual component included in ALL to determine if one

\(^3\) Analysis was also conducted using a dummy variable increasing/decreasing monetary policy. Results are qualitatively the same and the tables are therefore omitted.
particular industry reacts differently from other industries along the oil value chain or is driving the overall results. The variables: SIC 1311, SIC 1381, SIC 1382, SIC 1389, SIC 2911, SIC 5171, and SIC 5172 represent stock return data for each of those seven industries examined (a description of the operations of those industries is presented in Table 1).

The summary statistics reported for these eight return variables include mean, median, minimum and maximum, and first and third quartile returns as well as standard deviation and coefficient of variation (all reported monthly). During the time period studied, SIC 2911 was the only industry to actually have a negative average return. Otherwise the industry with the highest coefficient of variation (risk per unit of return), 15.03, was SIC 1382. Given that this industry is composed of field exploration firms and does not have a method of protecting its cash flows from high variability, this result seems logical. On the other hand, SIC 1389 had a coefficient of variation of 3.38, the lowest of all the industries.

As previously mentioned, the number of firms that operate during a given month varies as firms enter or exit the industries. For this reason, I also report the mean number of firms in each industry as well as the minimum and maximum. The industry with the greatest number of firms was SIC 1311, with a mean of 198 firms. In contrast, the industries with the smallest number of firms were SIC 5171 and SIC 5172, each with a mean of three firms. These statistics are further detailed in Table 2.

4.2 Summary statistics of other variables

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4 In order not to create survivorship bias, I include the returns of all firms available in a given month regardless of whether they survive the entire sample period.
The mean monthly change in the spot price of crude oil (OIL) over the 1987-2000 time period was 0.78%. The change in oil prices range from as low as a minimum of -24.3% to a maximum of 44.6%, resulting in a standard deviation of 9.4%. The mean monthly inflation is 0.27% as measured by change in the CPI, ranging from a minimum of -0.1% to a maximum of 1.0%, resulting in a standard deviation of 0.2%. The variable FFPREM, the premium of the fed-funds rate over the three-month Treasury bill, has a mean change of 0.45%, ranging from a minimum of -0.3% to a maximum of 1.38%. The standard deviation during the period examined was 0.37%. The level of reserves, measured on a yearly basis, had a mean change of 1.45%, and ranged from a minimum of -1.5% to a maximum of 10.6%. The standard deviation during the period examined was 2.9%. Table 2 provides full summary statistics for all of these variables on a monthly basis except for reserves, which are reported on an annual basis.

4.3 Methodology

4.3.1 Hypothesis one

To test hypothesis one, I regress changes in oil prices, inflation, the interest rate premium and reserve levels on oil stock returns:

\[
\text{ALL} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 1311} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 1381} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 1382} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 1389} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 2911} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 5171} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 5171} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1 \\
\text{SIC 5172} = \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1
\]
4.3.2 Methods – hypothesis two

To test hypothesis two I implement several regressions. First, I regress:

\[ VWMRTN = \beta_0 + \beta_1 OIL + \beta_2 CPI + \beta_3 FFREM + \beta_4 RESERVES + \epsilon_i \]  

(2)

To help in the analysis of which variable explains the other, I also run the regression:

\[ OIL = \beta_0 + \beta_1 VWMRTN + \beta_2 CPI + \beta_3 FFREM + \beta_4 RESERVES + \epsilon_i \]  

(3)

To determine lead/lag relationship between VWMRTN and OIL, I test Grainger causality of these variables using up to 12 lags to determine what variables determine each role. Regressions results and statistical analysis, however, find little explanatory power in lags beyond three months. As a result, while all Grainger causality regressions were run using lags up to 12 months prior, I only report three-month lags in this analysis. To test for Grainger causality, I use the regressions stated below, where OILL1 is OIL lagged one month, OILL2 is OIL lagged two months, OILL3 is OIL lagged three months, VWRL1 is the VWMRTN lagged one month, VWRL2 is the VWMRTN lagged two months and VWRL3 is the VWMRTN lagged three months.

\[ VWMRTN = \beta_0 + \beta_1 VWRL1 + \beta_2 OILL1 + \beta_3 OILL2 + \beta_4 OILL3 + \epsilon_i \]  

(4)

\[ VWMRTN = \beta_0 + \beta_1 VWRL1 + \beta_2 VWRL2 + \beta_3 OILL1 + \beta_4 OILL2 + \beta_5 OILL3 + \epsilon_i \]  

(5)

\[ OIL = \beta_0 + \beta_1 OILL1 + \beta_2 VWRL1 + \beta_3 VWRL2 + \beta_4 VWRL3 + \epsilon_i \]  

(6)

\[ OIL = \beta_0 + \beta_1 OILL1 + \beta_2 OILL2 + \beta_3 OILL3 + \beta_4 VWRL1 + \beta_5 VWRL2 + \beta_6 VWRL3 + \epsilon_i \]  

(7)

In all of the regression tests run, I perform a Durbin-Watson test to determine whether there are other variables that are positively serially correlated. According to standard tests based on the number of independent variables and the number of observations, the results of these tests always fell within a reasonable range, implying that the error terms are serially correlated.
4.4 Hypothesis one tests

4.4.1 Results of hypothesis one tests

Calculating the correlation among the variables used in regression analysis, I find a statistically significant relationship between OIL and returns for each of the SIC codes. The variable with the highest correlation to oil was ALL, the combination of the seven individual industries (55.81% correlation and significant at the 0.00 level). Not surprisingly, the industry with the greatest correlation to ALL was SIC 1311 (98.14% correlation and significant at the 0.00 level). This relationship is most likely because SIC 1311 is the largest industry of the seven, making up on average 112 of the 198 total firms. Table three contains the correlation statistics in greater detail.

The variable CPI (inflation) is significantly positively correlated to every variable except for SIC 5172. There is a 30.48% highly significant positive correlation between CPI and FFPREM as would be expected based on the Federal Reserve Board’s monetary policy. A statistically significant negative correlation exists between RESERVES and ALL (-18.26% and significant at the 0.03 level). This relationship suggests that oil returns increase as reserves decrease, which contrasts my hypothesis.

Regressing the dependent variable ALL on OIL, CPI, FFPREM and RESERVES (regression 1a), I find that OIL and CPI are statistically significant (at the 0.00 level and 0.03 level respectively). These four variables are able to explain a substantial amount of the variation, measured by an adjusted $R^2$ of 32.62%.

For each individual SIC code, OIL is statistically significant in all seven regressions. However, the only SIC code in which RESERVES is statistically significant
is 5171, Petroleum Bulk Stations and Terminals (significant at the 0.04 level). The results of the regressions are further detailed in Table 4.

When using the variable OILL1 in addition to the other variables, the only industry in which there is statistical significance in explaining industry returns is SIC 5171 (p-value of 0.09). Moreover, CPI and RESERVES are also statistically significant (p-values of 0.08 and 0.05 respectively). These findings are only significant within this industry.

4.4.2 Conclusions of hypothesis one test

After controlling for CPI, FFPREM and RESERVES, it appears that oil is a statistically significant factor in explaining the stock returns of oil-related firms. This is important in making investment decisions in the within the oil industry. As stated before, the seven SIC codes I examined had a coefficient of variation of 5.73. With such a high level of risk for every unit of return, this industry does not appear to be a prudent investment. Analyzing the relationship OIL has on these stocks’ returns helps to increase the understanding of the economic components affecting those returns, so that an investor can make more informed portfolio allocation decisions.

The initial rationale I presented regarding the effects the level of reserves would have on oil firms was rejected in all but one of the SIC codes. SIC 5171 is the only industry in which the levels of reserves are significant (p-value of 0.04). This industry, which contains firms mostly engaged in wholesale distribution of petroleum, is the most sensitive to the level of reserves because the firms are storing the product for a greater length of time than firms in other industries. Therefore, the returns are more sensitive to reserve levels and may explain the significant correlation between returns and reserve
levels. In conclusion, these firms benefit from a greater level of reserves, perhaps because of the increasing profit margins that result in periods of increasing prices.

The significance of the variables OILL1, CPI and RESERVES in regression 1g2 can possibly be explained by the nature of the industry. SIC 5171 contains firms involved in the wholesale distribution of oil. Since these firms are more likely to have higher inventory levels, it makes sense that inflation and reserve levels are significant in explaining stock returns.

4.5 Hypothesis two tests

4.5.1 Results of hypothesis two tests

The results of the first regression for my second hypothesis (regression 2) regarding oil price changes effect on aggregate stock returns, indicate that none of the variables included have any statistical significance. This lack of significance in the current period is expected, since I proposed there is a lead/lag relationship between crude oil prices and market returns. The results of the lagged oil regression analyses do not have the same insignificant findings.

In regression three the variables VWMRTN and OIL are switched where OIL is the dependent variable. Results indicate that VWMRTN is statistically significant in explaining OIL, and that there is an inverse relationship. CPI is also significant as an independent variable in this regression. The results from the two regressions suggest that OIL and VWMRTN affect one another. The next regression, using tests for Grainger causality, will attempt to determine if changes in oil prices causes changes in market returns, or vice-versa.
Regression four and five both demonstrate that OILL1 is statistically significant in explaining VWMRTN, and that these two variables are inversely related. This evidence suggests that last month’s oil price movement affects this month’s aggregate stock returns inversely.

Upon finding that OILL1 was significant in explaining VWMRTN, I add two additional regressions to further test this relationship:

\[
\begin{align*}
\text{VWMRTN} &= \beta_0 + \beta_1 \text{OIL} + \beta_2 \text{OILL1} + \beta_3 \text{CPI} + \beta_4 \text{FFPREM} + \beta_5 \text{RESERVES} + \epsilon_1 \\
\text{VWMRTN} &= \beta_0 + \beta_1 \text{OILL1} + \beta_2 \text{CPI} + \beta_3 \text{FFPREM} + \beta_4 \text{RESERVES} + \epsilon_1
\end{align*}
\]

(8) (9)

Under both of these regression models, OILL1 was statistically significant in explaining aggregate market returns.

In explaining oil, regression six and seven both find that VWRL1 and VWRL3 are both statistically significant, while VWRL2 is marginally significant. However, there is an inverse relationship between VWRL1 and OIL, while the relationship between VWRL3 and OIL is positive.

4.5.2 Conclusions of hypothesis two test

As expected, the relationship between OIL and VWMRTN is not statistically significant. However, evidence indicates that OILL1 Grainger causes VWMRTN. These conclusions are similar to the findings presented by Hamilton (1983), which suggests that there is a relationship between oil shocks and contractionary economic environments. My analysis builds upon this result, and suggests that the relationship does not exist only during periods of economic downturns.

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5 Regressions were also run using a lag period of up to six months. In these regressions, VWRL2 is statistically significant in explaining OIL.
Kaul and Seyhun (1990) suggest the existence of a one-period lag of oil price variability to periods of economic recession. My conclusions find that this relationship also exists outside of these extreme economic environments. In particular, results indicate that this relationship exists consistently throughout the 1987 to 2000 time period.

The results from regressions six and seven suggest that oil price movements in a given month are explained partially by the returns of the aggregate market in the prior months. For the sake of simplicity in further explaining the results, I will use the example of oil prices increasing at time zero (the relationship also exists in its inverse). Three months prior to an increase in oil prices, the aggregate market is experiencing significantly increasing returns. Two months prior there also are increasing returns, but only marginally significant (p-value of 0.12; again, this variable becomes highly significant in six-month lag analysis). As the market is increasing, one of the side effects of a strong economy begins to occur in the form of rising oil prices at time zero. As a result, one month prior to the actual increase in oil prices, the market anticipates the effects of inflation by pricing it into the expected cash flows. Thus, the market experiences decreasing returns, which is found by the statistically significant negative coefficient of VWRL1 on OIL. The timeline below further illustrates this relationship.

Another potential explanation for the relationship between changes in oil prices and market returns is based on more simple economic factors, supply and demand. As the
economy expands, market returns increase and individual wealth grows, the demand for products such as oil increases. However as demand increases, the price of oil is likely to increase, which the market anticipates one month prior to its occurrence.\textsuperscript{6} Expectation of future price changes may be incorporated in the days prior to an increase in oil prices, however, as this analysis employs monthly data, the relationship appears one month prior.

These results are not meant to suggest that OIL is a factor unto itself in explaining stock market returns. Rather, I propose that OIL is yet another variable in which a relationship exists with market returns, and should not be overlooked in the investment decision when performing an analysis of the economic environment. Further research needs to examine the cycle between oil prices and stock market returns to better explain the cause and effect relationship.

5. Conclusion

This paper analyzes the effects of changes in crude oil prices on the returns of oil-related stocks and aggregate market returns from 1987 to 2000. I find that the spot price of crude oil is statistically positive related to changes in the stock returns of seven different oil-related industries, as well as these industry’s combined returns. In addition, contrary to my initial hypothesis, changes in the aggregate level of reserves are not significantly related to the returns of oil-related stocks, except firms in operation of oil distribution. This positive relationship may be due to the nature of these firms’ operations, which, by definition, often require a large inventory of crude oil.

\textsuperscript{6} This is consistent with the rational-expectations hypothesis in that expected future price changes are built into today’s economic decisions.
With regards to oil and the aggregate economy, I find that oil price changes Grainger cause stock market returns (inversely), and there is a one-month lag in this relationship. This suggests, similar to the findings of Kaul and Seyhun (1990), the existence of a one-period lag of oil price variability to periods of economic recession. My conclusions find that this relationship also exists outside of these extreme economic environments. In particular, results indicate that this relationship exists consistently throughout the 1987 to 2000 time period.

Moreover, there appears to be a pattern of stock market returns in the three months prior to an increase/decrease in oil prices. These results are consistent with the rational-expectations hypothesis, explaining the effects of inflationary pressures on inputs to the aggregate economy.
References


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<th>SIC CODE</th>
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| Group 131 | Crude Petroleum and Natural Gas | -firms primarily engaged in operating oil and gas field properties  
-firms who produce oil through mining and extraction  
-firms operating oil and gas wells on a contract basis  
i.e. Andarko Petroleum, Apache Corporation, Chesapeake Energy, Brigham Exploration Company |
| 1311 | Crude Petroleum and Natural Gas | -firms primarily engaged in operating oil and gas field properties  
-firms who produce oil through mining and extraction  
-firms operating oil and gas wells on a contract basis  
i.e. Andarko Petroleum, Apache Corporation, Chesapeake Energy, Brigham Exploration Company |
| Group 138 | Oil and Gas Field Services | -firms primarily engaged in drilling for others on a contract basis  
i.e. Diamond Offshore Drilling, Helmerich & Payne, Petroleum Development Corporation |
| 1381 | Drilling Oil and Gas Wells | -firms primarily engaged in drilling for others on a contract basis  
i.e. Diamond Offshore Drilling, Helmerich & Payne, Petroleum Development Corporation |
| 1382 | Oil and Gas Field Exploration Services | -firms contracted out in the exploration of oil  
i.e. Petrocorp, U.S. Energy Corporation |
| 1389 | Oil and Gas Field Services, Not Elsewhere Classified | -any other contracted out oil service  
-excavations, surveying, etc.  
i.e. Halliburton Company, Oceaneering International, Ramco Energy |
| Group 291 | Petroleum Refining | -firms primarily engaged in producing gasoline through alteration of crude oil  
-many of the large conglomerates  
i.e. Chevron Corporation, Exxon Mobil Corporation, Pennzoil-Quaker State Company, Conoco, Phillips Petroleum, Shell Oil Company |
| 2911 | Petroleum Refining | -firms primarily engaged in producing gasoline through alteration of crude oil  
-many of the large conglomerates  
i.e. Chevron Corporation, Exxon Mobil Corporation, Pennzoil-Quaker State Company, Conoco, Phillips Petroleum, Shell Oil Company |
| Group 517 | Petroleum and Petroleum Products | -firms engaged in the wholesale distribution of crude petroleum and petroleum products  
-petroleum bulk stations and wholesale terminals  
i.e. Aectra Refining and Marketing, EOTT Energy Partners, Penn Octane Corporation |
| 5171 | Petroleum Bulk stations and Terminals | -firms engaged in the wholesale distribution of crude petroleum and petroleum products  
-petroleum bulk stations and wholesale terminals  
i.e. Aectra Refining and Marketing, EOTT Energy Partners, Penn Octane Corporation |
| 5172 | Petroleum and Petroleum Products Wholesalers, Except Bulk Stations | -packaged and bottled products distributors  
for crude oil, fuel oil, gasoline, kerosene, petroleum and more  
i.e. Castle Energy Corporation, Sun Coast Resources, Ultramar Diamond Shamrock Corporation |
| 5172 | Petroleum and Petroleum Products Wholesalers, Except Bulk Stations | -packaged and bottled products distributors  
for crude oil, fuel oil, gasoline, kerosene, petroleum and more  
i.e. Castle Energy Corporation, Sun Coast Resources, Ultramar Diamond Shamrock Corporation |

Source: www.OSHA.gov
### TABLE 2
SUMMARY STATISTICS

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ALL = combined indexed net of market (excess) returns for each of the seven SIC codes examined; SIC #### = each industry examined by Standard Industrial Classification (see table 1 for further detail); OIL = change in crude oil spot price; CPI = change in Consumer Price Index; FFPREM = premium of fed funds rate over the 3-month Treasury bill; Reserves = change in level of global oil reserves. All data reported on a monthly basis except reserve levels, in which the percentage change for the twelve months within a given year will be constant.

1. Source: Center for Research in Security Prices (CRSP)
2. Source: Goldman Sachs Commodity Index (GSCI) Crude Oil Subindex
3. Source: Board of Governors Federal Reserve Statistical Releases
4. Source: Board of Governors Federal Reserve Statistical Releases
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The data reported include the parameter estimate for each independent variable in each of the nine regressions, with the p-value underneath. 

ALL = combined indexed net of market (excess) returns for each of the seven SIC codes examined; SIC 1311 = each industry examined by Standard Industrial Classification (see Table 1 for further detail); OIL = change in crude oil spot price; CPI = change in Consumer Price Index; FFPREM = premium of fed funds rate over the 3-month Treasury bill; Reserves = change in level of global oil reserves. All data reported on a monthly basis except reserve levels, in which the percentage change for the twelve months within a given year will be constant.

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4. Source: Board of Governors Federal Reserve Statistical Releases
**TABLE 4**

**CHANGES IN OIL PRICES AND STOCK RETURNS**

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3. Source: Board of Governors Federal Reserve Statistical Releases
4. Source: Board of Governors Federal Reserve Statistical Releases
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<td>0.04</td>
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<td></td>
<td>(0.22)</td>
<td>(0.55)</td>
<td>(0.23)</td>
<td>(0.13)</td>
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<tr>
<td>VWMRTN (9)</td>
<td></td>
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<td></td>
<td></td>
<td>1.13</td>
<td>0.01</td>
<td>-1.70</td>
<td>-0.08</td>
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<td>(0.62)</td>
<td>(0.19)</td>
<td>(0.15)</td>
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</table>

The data reported include the parameter estimate for each independent variable in each of the nine regressions, with the p-value underneath.  
OIL = change in crude oil spot price; OILL1, OILL2, OILL3 = OIL lagged by 1, 2, and 3 months respectively; VWRL1, VWRL2, VWRL3 = VWMRTN lagged by 1, 2, and 3 months respectively; CPI = change in Consumer Price Index; FFREMP = premium of fed funds rate over the 3-month Treasury bill; Reserves = change in level of global oil reserves. All data reported on a monthly basis except reserve levels, in which the percentage change for the twelve months within a given year will be constant.

1. Source: Center for Research in Security Prices (CRSP)
2. Source: Goldman Sachs Commodity Index (GSCI) Crude Oil Subindex
3. Source: Board of Governors Federal Reserve Statistical Releases
4. Source: Board of Governors Federal Reserve Statistical Releases