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# FINANCIAL PERFORMANCE IN UPSTREAM, DOWNSTREAM, AND INTEGRATED OIL COMPANIES IN RESPONSE TO OIL PRICE VOLATILITY 

GRADUATION THESIS

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## Executive Summary

This paper investigates the relation between crude oil price volatility and stock returns among oil companies using a three-part methodology, by using the West Texas Intermediate (WTI) as oil price benchmark. I asses the various indicators that set signals for oil price volatility and the interpretation of each (PMI, S\&P500, DJIA, and World Crude Oil Output). This research also focuses on the relation between different types of companies in the oil industry (integrated, upstream, and downstream) and how each type of company will be assessed in a particular way to predict abnormal returns, based on market data and statistical analyses results and interpretation.

## 1. Introduction

An investor's objective will always be to maximize risk-adjusted return in a manner consistent with their goals, time horizon, risk tolerance, liquidity needs, and tax status. Taking that premise as a starting point to formulate an effective strategy, you should be weary of over-investing in the oil industry owing to the high commodity price volatility and thus risk that has been associated with this industry over time. However, it would make sense for each investor to include some portion of their portfolio in assets closely linked to the industry in order to maintain diversification in their portfolios, and thus to reduce overall portfolio risk. The price of crude oil has been broadly analyzed, but factors that affect crude and related markets over time remain somewhat mysterious.

In this paper, I investigate the relation between crude oil price volatility and stock returns among oil companies using a three-part methodology. First, I measure crude oil price volatility, using West Texas Intermediate (WTI) as the most appropriate U.S. oil price benchmark, versus different indicators that will set signals for periods of price reversals and high volatility (PMI, S\&P500, DJIA, and World Crude Oil Output). Second, I assess how oil company financial performance is related to crude oil price volatility, including differences between upstream, downstream, and integrated oil companies. Third, I assess how oil price volatility is related to the total returns of different types of oil companies. I report univariate summary statistics, bivariate correlation analysis, and multivariate regression results.

Many direct and indirect factors determine oil prices and volatility. These factors include intra-industry (production and consumption, operational costs, logistics and transportation, etc.) variables that directly affect oil prices, and external (political affairs, currency strength, economic growth, etc.) variables whose effect is indirect. Given that many factors are in play, it is difficult to predict how oil prices will fluctuate during a given period of time. This means that as an investor, one will need an "optimal" analysis of the market to prepare a healthy portfolio with a strong risk-adjusted return on investment.

There are three major findings in this paper. First, it proves the validity of trend signals for oil price movements, and that these relations follow a particular fashion depending on the type of analysis being made. Second, it demonstrates the action-reaction movements that exist between crude oil prices and integrated, upstream, and downstream companies. Third, it finds the most statistically significant variables to be considered as effective indicators for oil stocks performance.

With this research I expect to find different market signals that will give investors a real and optimal methodology that can serve as a guide on how to allocate their investments
during a certain period of time, considering historical trends on the market. Since there are many direct and indirect factors that play an important role into defining the price for which oil is traded in the market, this paper will not try to predict future prices or forecast for great volatility periods, but instead will try to prove that the market itself has the same trends characteristics and these trends are fractal as explained in Kirkpatrick \& Dahlquist "Technical Analysis" book (2007).

This paper makes three contributions to the literature on the determinants of oil company performance. First, it gives a trend analysis methodology that serves as a first indicator of both oil prices, and oil company's stock return levels. Second, it provides a guide on understanding the oil industry and its different reactions to crude oil volatility. Finally, this paper demonstrates the timely movements and the significance of these fluctuations on oil stock returns. With this paper I expect to give the reader a clear explanation of the relation between oil price volatility and the financial and stock return performance of different types of oil companies during different time periods. I also anticipate highlighting findings that suggest signals to look for when interpreting data or searching for relevant variables for predicting investment performance.

The rest of the paper proceeds as follows. Section II describes the relevant literature and test the proposed hypothesis. Section III discusses sample selection and methodology. In Section IV I report the empirical results from my findings. Finally, Section V is a brief discussion and final conclusions of this paper.

## 2. Literature Review

When crude oil prices began to decline in July of 2014, nobody expected them to go into freefall from a price that broke the $\$ 100$ mark per barrel to less than $\$ 30$, severely affecting the energy sector in particular and equity and debt markets in general. Now we know how prices were driven down is such fashion due to Chinese economic slowdown and lower (unexpected) oil consumption, and the non-slowdown in production from OPEC countries and the US which has damaged many of the players in the oil industry.

Analyst Matt Egan (2016) wrote in his article for CNN Money, "When economies are booming, they consume lots of oil - and vice versa. That's why Wall Street is worried that the drop in energy prices suggests the global economy is slowing down". Oil commodity has shown the same downfall trend when it fell roughly by the same amount during the '07'09 recession. It also showed the same behavior during the early 1980's downturn. For these periods, Glassman (2015) suggests previous declines were triggered by significant global slowdowns and thus a considerable decrease in demand.

As shown in Fig. 2.1, the oversupply of oil that flooded the market has been a determining factor in the reverse of oil prices. Moreover, it is readily apparent that this trend of economic slowdown/low consumption resembles that of 2007-2009. This analysis becomes even more important when we consider Murphy (2004)'s statement that three of four recent downturns in the U.S. (1974, 1980, and 1990) were accompanied by surging oil prices.


Figure 2.1 WTI historical price compared to total world's production and consumption of oil. Source: EIA.

The association of increasing oil prices and thus growing oil price volatility with macroeconomic slowdowns can be further explored by comparing spot oil prices to the Purchasing Managers' Index (PMI), as oil prices have historically trailed index performance based on the five major macroeconomic indicators of new orders, inventory levels, production, deliveries, and the employment environment. Figure 2.2 shows how the PMI moves in tandem with oil prices.


Figure 2.2 WTI historical price compared to PMI levels form April 2006 to March 2016.

Oil price also has a great impact on financial markets globally as it has historically trended in an opposite fashion from the market, which means that an oil price rise is correlated to a market tumble (and vice versa). Murphy (2004) analyzed this situation by
studying the rise in oil prices during the summer of 1990 and found that the inflationary impact of rising oil took a bearish toll on equity prices around the globe. After this increased volatility period "oil became the dominant commodity during that year and demonstrated in dramatic fashion how sensitive bond and stock markets are to action in the commodity sector."

Figure 2.3 illustrates how the WTI trends in opposite direction with the market and trails changes in direction of index levels depending on the oil price swing. This paradigm is criticized in Jones and Kaul (1996) when they state: "given the importance of oil to the world economy, it is surprising that little research has been conducted on the effects of oil shocks on the stock market."


Figure 2.3 WTI historical price compared to S\&P500 and the Dow Jones Industrial Average levels form April 2006 to March 2016.

Oil-related stocks are also largely dependent on the trend of oil. It has been studied that a sharp rise in the price of the commodity sends an early warning to stock traders. When oil-related stocks and WTI prices start to diverge, this is usually an early signal of a trend change. Murphy (2004) adds that "stocks usually change direction ahead of their commodity. This makes energy shares a leading indicator for oil."

In this paper, I analyze the three types of oil companies (upstream, downstream, and integrated), but each type responds differently to swings in oil prices. For example, upstream company's stock prices are especially vulnerable to oil price changes, and move in tandem with the trend of the commodity. Conversely, downstream company's stock prices move in an opposite way in response to changes in oil price. Integrated companies react differently since they make money from both types of operations - these types of companies would have higher upstream and lower downstream profits if oil prices experiment a rise.

Figures 2.4, 2.5, and 2.6 show a comparison between WTI historical daily prices compared to a stratified selected sample of companies for each type of business operation
within the industry. The sample selection will be covered in Section III of this paper. The graphics show how each type of company reacts to changes in oil prices, which affects stock returns directly. This different reactions among industry companies demonstrate the relation between oil price volatility and stock returns among oil companies, which validates the main focus of this research of finding an optimal methodology to approach risk-adjusted investments in the oil industry that accounts for volatility factors as the ones already presented previously.


Figure 2.4 WTI historical price compared to historical stock prices of Integrated oil companies for the April 2006 - March 2016 period.


Figure 2.5 WTI historical price compared to historical stock prices of Upstream oil companies for the April 2006 - March 2016 period.


Figure 2.6 WTI historical price compared to historical stock prices of Downstream oil companies for the April 2006 - March 2016 period.

This approach of studying oil-related portions of the stock market is relevant if we accept that security prices do not always reflect all available information. It is known that there exists an equilibrium degree of disequilibrium in the market - think an efficient amount of inefficiency - as demonstrated by Grossman and Stiglitz (1980), whose research of market inefficiencies concludes that prices reflect the information of the informed individuals (arbitrageurs) but only partially, so that those who expend resources to obtain information do receive compensation.

To study oil prices historically stating that past behavior can be a good indicator for oil stock company's returns, and that price divergences exist due to market inefficiencies, would suggest a departure from Fama's Efficient Market Hypothesis (1970). Even though my research focuses on a technical approach to identify market trends in different time periods, it does not mean that the market should be approached in one solely particular way, because in finance one indicator is not enough to identify optimal performance. Instead it is important to revisit Lo (2005)'s Adaptive Market Hypothesis (AMH), that states investment strategies undergo cycles of profitability and loss in response to changing business conditions, competitors, and available profitable opportunities in the market.

Finally, Jones and Kaul (1996) research on oil and the stock markets supports the case built in this paper by stating that "Any correlation between stock returns, long real stock returns, and lagged oil price variables would be direct evidence of market inefficiency," and "The evidence of statistically significant lagged effects of oil prices on stock returns suggests that either (a) oil shocks induce some variation in expected stock returns, or (b) the stock markets are inefficient."

## 3. Sample Selection and Methodology

To evaluate the relation between oil price volatility and oil company's stock returns, I will report univariate summary statistics, bivariate correlation analysis, and multivariate regression results. I will focus my study on the period between April 2006 and December 2015. This 10-year period of representative data, where global economies experienced big fluctuations between economic recessions and expansions. The companies selected include
a balanced stratified sample by market capitalization levels, and type of company within the industry of Integrated, Exploration and Production (upstream), and Refining (downstream) oil companies, as evidenced by Figures 3.1, 3.2, and 3.3.


Figure 3.5 Integrated sample companies' market capitalization.


Figure 3.6 Upstream sample companies' market capitalization levels.


Figure 3.7 Downstream sample companies' market capitalization levels.
I follow a three-part methodology. First, I measure crude oil price volatility, using West Texas Intermediate (WTI) as my oil price benchmark compared to the different trend indicators studied in Section II, by performing descriptive statistics and correlation analyses to historical data. I have divided these analyses in two parts:

1. Correlation and descriptive data analyses of the WTI's prices vs. production indexes, world output (production \& consumption), and major financial indexes (DJIA and S\&P 500).
2. Descriptive statistics and correlation analysis of a 12 -month trailing standard deviation of WTI daily prices, market risk premium, including Fama and French (1993) Small-Big (SMB and High-Low (HML).

Second, I assess oil company historical stock price daily data related to WTI price volatility, including differences between upstream, downstream, and integrated oil companies. For this analysis I selected a number of companies from each sector, varying in their capitalization levels to get the full spectrum of small, medium, and large companies. To establish this relationship I will compare the different trends in daily stock prices for each type of company, to the movements in WTI daily price data using descriptive statistics and correlation analyses. The purpose of this analysis is to evidence that each type of company behaves in a different manner depending on the movement of oil prices, and that divergences between oil prices and stock of oil companies can trigger early signals for oil price reversals, thus future financial performance of stock returns.

Third, I assess how oil price volatility is related to the total returns of oil companies, including upstream, downstream, and integrated. In doing so, I report multivariate regression results using variables and results selected from previous test performed. I also analyze the robustness of stock returns using daily price data for each stock, and calculating the level of "abnormal returns" by comparing these returns to indicators of value-weighted returns for large-cap companies, and equal-weighted returns for small-cap companies.

## 4. Empirical Results

In this section, I report results of univariate and bivariate statistics and multivariate regressions. Table 4.1 shows descriptive statistics of test and control variables. Variables WTI, PMI, Production and Consumption (and thus Output Production minus Consumption), and the mean value of the S\&P 500 are not normally distributed, but I will assume normal distribution throughout the rest of my analysis and leave non-parametric analysis for further research.

|  | WTI | PMI | Production | Consumption | Differential (P-C) | S\&P 500 | DJIA |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  |  |  |  |  |  |  |  |  |
| Mean | 80.384 | 51.992 | 89.160 | 89.015 | 0.146 | 1452.921 | 13072.582 |  |
| Standard Error | 2.005 | 0.468 | 0.329 | 0.295 | 0.135 | 32.296 | 252.081 |  |
| Median | 84.250 | 52.600 | 88.550 | 88.920 | -0.050 | 1397.910 | 12631.480 |  |
| Mode | 94.510 | 51.400 | 85.310 | 87.270 | -0.270 | \#N/A | \#N/A |  |
| Standard Deviation | 21.873 | 5.109 | 3.587 | 3.222 | 1.472 | 352.309 | 2749.884 |  |
| Sample Variance | 478.414 | 26.104 | 12.869 | 10.378 | 2.167 | 124121.683 | 7561859.842 |  |
| Kurtosis | -0.391 | 3.607 | -0.771 | -0.968 | -0.616 | -0.711 | -0.747 |  |
| Skewness | -0.204 | -1.644 | 0.545 | -0.068 | 0.223 | 0.341 | 0.182 |  |
| Range | 103.560 | 26.800 | 12.600 | 12.530 | 6.770 | 1372.300 | 10889.240 |  |
| Minimum | 30.320 | 33.100 | 84.150 | 82.470 | -2.630 | 735.090 | 7235.470 |  |
| Maximum | 133.880 | 59.900 | 96.750 | 95.000 | 4.140 | 2107.390 | 18124.710 |  |
| Sum | 9565.730 | 6187.100 | 10610.060 | 10592.740 | 17.320 | 172897.549 | 1555637.210 |  |
| Count | 119 | 119 | 119 | 119 | 119 | 119 | 119 |  |

Table 4.1 Descriptive statistics for the WTI vs. selected indicators.

Correlation analysis results shown in Table 4.2 shows a strong but less than perfect correlation between WTI and PMI, reflecting a positive but relatively low ( $38.0 \%$ ) relation between Producer Manufacturing (think industrial demand) and WTI prices. These results suggest an association between oil prices volatility and industrial performance, as the index move in tandem with the WTI. Also, noteworthy is a positive but low relation between the Dow and WTI, likely related to the concentration of large energy companies in the Dow, but the negative low correlation with the S\&P500 supports the claim that the markets move in a different fashion than oil prices.

|  | WTI | PMI | Production | Consumption | Differential (P-C) | S\&P 500 | DJIA |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| WTI | 1 |  |  |  |  |  |  |
| PMI | 0.380 | 1 |  |  |  |  |  |
| Production | -0.086 | 0.265 | 1 |  |  |  |  |
| Consumption | 0.044 | 0.386 | 0.912 | 1 |  |  |  |
| Differential | -0.304 | -0.198 | 0.441 | 0.034 | 1 |  |  |
| S\&P 500 | -0.062 | 0.324 | 0.814 | 0.807 | 0.219 | 1 |  |
| DJIA | 0.006 | 0.343 | 0.829 | 0.834 | 0.195 | 0.990 |  |

Table 4.2 Correlation analysis for the WTI vs. selected indicators.
Descriptive statistics for variables used in Fama French (1993) analysis are reported in Table 4.3. They also show that none of the variables used in this paper are perfectly normally distributed.

|  | WTI Price | WTI StDev | Mkt Ret | RF | Mkt-RF | SMB | HML | Mom |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  |  |  |  |  |  |  |  |  |
| Mean | 80.531 | 10.889 | 0.033 | 0.004 | 0.029 | 0.000 | -0.003 | 0.003 |
| Standard Error | 0.439 | 0.155 | 0.027 | 0.000 | 0.027 | 0.012 | 0.012 | 0.021 |
| Median | 82.860 | 7.793 | 0.089 | 0.000 | 0.080 | 0.010 | -0.010 | 0.060 |
| Mode | 74.380 | 5.454 | 0.280 | 0.000 | -0.100 | 0.030 | 0.030 | 0.160 |
| Standard Deviation | 21.934 | 7.720 | 1.324 | 0.007 | 1.324 | 0.598 | 0.615 | 1.049 |
| Sample Variance | 481.103 | 59.600 | 1.753 | 0.000 | 1.753 | 0.358 | 0.378 | 1.100 |
| Kurtosis | -0.360 | 2.990 | 8.884 | 0.562 | 8.880 | 4.232 | 7.668 | 9.715 |
| Skewness | -0.177 | 1.823 | -0.134 | 1.504 | -0.132 | 0.067 | 0.355 | -0.818 |
| Range | 119.120 | 34.224 | 20.304 | 0.022 | 20.300 | 8.110 | 7.580 | 15.270 |
| Minimum | 26.190 | 3.813 | -8.950 | 0.000 | -8.950 | -3.760 | -3.590 | -8.220 |
| Maximum | 145.310 | 38.037 | 11.354 | 0.022 | 11.350 | 4.350 | 3.990 | 7.050 |
| Sum | 200764.810 | 27145.552 | 82.730 | 10.090 | 72.640 | 0.390 | -6.410 | 6.730 |
| Count | 2493 | 2493 | 2493 | 2493 | 2493 | 2493 | 2493 | 2493 |

Table 4.3 Descriptive statistics for the WTI, standard deviation, risk premium (Expected Return on the Market - Risk Free Rate), and Fama French (1993) Small - Big (SMB) \& High - Low (HML).

Correlation analysis for Fama French (1993) variables is shown in Table 4.4. None of these variables are highly correlated with WTI Price, but are of necessary study to construct a proper oil industry company's analysis.

|  | WTI Price | WTI StDev | Mkt Ret | RF | Mkt-RF | SMB | HML | Mom |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| WTI Price | 1 |  |  |  |  |  |  |  |
| WTI StDev | -0.339 |  | 1 |  |  |  |  |  |
| Mkt Ret | 0.008 | -0.004 | 1 |  |  |  |  |  |
| RF | -0.128 | -0.207 | -0.009 | 1 | 1 |  |  |  |
| Mkt-RF | 0.009 | -0.003 | 1.000 | -0.014 | 1 |  |  |  |
| SMB | 0.010 | 0.028 | 0.199 | -0.020 | 0.199 | 1 |  |  |
| HML | 0.028 | 0.000 | 0.384 | 0.012 | 0.384 | -0.048 | 1 |  |
| Mom | 0.045 | -0.077 | -0.386 | 0.011 | -0.386 | -0.007 | -0.582 |  |

Table 4.4 Correlation analysis for the WTI, standard deviation, risk premium, and FamaFrench SMB \& HML.

Descriptive statistics and correlation analyses for individual Integrated, Upstream, and Downstream oil companies are reported in Tables 4.5-4.7. Again, variables are less than perfectly normally distributed as shown in each descriptive statistics analysis. Correlation analyses performed to the different sectors in the industry validate the initial claim that each type of company moves in a particular way in relation to crude oil prices. As shown in Table 4.5 integrated companies would move in tandem and trailing a movement in oil prices. Table 4.6 shows higher positive correlation values for upstream companies evidencing their vulnerability to oil price changes and movement in the direction of the trend of crude oil. Conversely, downstream company's stock prices move in an opposite way in response to changes in oil price as shown in Table 4.7.

|  | WTI Price | XOM | CVX | RDS.B | PTR | PBR | BP | TOT | E | SU |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Mean | 80.188 | 80.904 | 93.178 | 66.279 | 120.461 | 26.889 | 49.525 | 58.641 | 49.205 | 35.422 |
| Standard Error | 0.442 | 0.213 | 0.388 | 0.212 | 0.504 | 0.297 | 0.240 | 0.213 | 0.236 | 0.171 |
| Median | 82.660 | 82.390 | 92.120 | 68.390 | 120.520 | 24.220 | 45.650 | 55.920 | 46.820 | 33.800 |
| Mode | 60.010 | 84.220 | 111.730 | 72.030 | 111.300 | 22.400 | 42.020 | 49.740 | 45.230 | 31.590 |
| Standard Deviation | 22.181 | 10.688 | 19.432 | 10.641 | 25.274 | 14.896 | 12.034 | 10.680 | 11.811 | 8.548 |
| Sample Variance | 492.002 | 114.242 | 377.593 | 113.239 | 638.756 | 221.886 | 144.825 | 114.060 | 139.490 | 73.072 |
| Kurtosis | -0.393 | -0.753 | -1.141 | -0.428 | 4.431 | -0.085 | -0.681 | -0.342 | -0.136 | 1.781 |
| Skewness | -0.182 | -0.165 | 0.097 | -0.385 | 0.689 | 0.601 | 0.629 | 0.718 | 0.674 | 1.019 |
| Range | 119.120 | 47.810 | 78.390 | 50.960 | 209.650 | 72.290 | 52.680 | 49.730 | 59.140 | 58.290 |
| Minimum | 26.190 | 56.570 | 56.460 | 36.960 | 54.050 | 2.900 | 27.020 | 40.210 | 25.000 | 14.660 |
| Maximum | 145.310 | 104.380 | 134.850 | 87.920 | 263.700 | 75.190 | 79.700 | 89.940 | 84.140 | 72.950 |
| Sum | 201512.810 | 203311.700 | 234155.970 | 166558.790 | 302719.560 | 67571.590 | 124455.090 | 147364.050 | 123652.680 | 89016.380 |
| Count | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 |
|  | WTI Price | XOM | CVX | RDS.B | PTR | PBR | $B P$ | TOT | E | SU |
| WTI Price | 1 |  |  |  |  |  |  |  |  |  |
| XOM | 0.429 | 1 |  |  |  |  |  |  |  |  |
| CVX | 0.525 | 0.864 | 1 |  |  |  |  |  |  |  |
| RDS.B | 0.657 | 0.652 | 0.553 | 1 |  |  |  |  |  |  |
| PTR | 0.588 | 0.342 | 0.268 | 0.712 | 1 |  |  |  |  |  |
| PBR | 0.446 | -0.258 | -0.366 | 0.097 | 0.477 | 1 |  |  |  |  |
| BP | 0.225 | -0.047 | -0.349 | 0.490 | 0.486 | 0.547 | 1 |  |  |  |
| TOT | 0.360 | 0.228 | -0.101 | 0.624 | 0.525 | 0.530 | 0.895 | 1 |  |  |
| E | 0.403 | 0.111 | -0.190 | 0.587 | 0.577 | 0.605 | 0.925 | 0.931 | 1 |  |
| SU | 0.607 | 0.253 | 0.057 | 0.666 | 0.655 | 0.636 | 0.732 | 0.862 | 0.833 | 1 |

Table 4.5 Descriptive statistics (top) and correlation analyses (bottom) between WTI daily prices and integrated oil companies daily stock prices.

|  | WTI Price | COP | CEO | OXY | EOG | APC | HES | DVN | COG | NBL |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Mean | 80.188 | 54.682 | 156.142 | 74.692 | 57.739 | 66.889 | 66.155 | 66.966 | 17.709 | 42.003 |
| Standard Error | 0.442 | 0.245 | 0.919 | 0.314 | 0.434 | 0.367 | 0.341 | 0.322 | 0.211 | 0.276 |
| Median | 82.660 | 55.270 | 162.440 | 77.140 | 51.940 | 67.750 | 61.190 | 64.640 | 14.690 | 39.750 |
| Mode | 60.010 | 51.190 | 203.000 | 81.550 | 46.100 | 73.370 | 58.780 | 60.710 | 8.460 | 47.230 |
| Standard Deviation | 22.181 | 12.270 | 46.084 | 15.732 | 21.749 | 18.415 | 17.098 | 16.138 | 10.585 | 13.848 |
| Sample Variance | 492.002 | 150.559 | 2123.700 | 247.491 | 473.011 | 339.103 | 292.337 | 260.448 | 112.044 | 191.755 |
| Kurtosis | -0.393 | -0.393 | -0.898 | -0.727 | -0.376 | -0.722 | 1.037 | 1.999 | -1.027 | -0.256 |
| Skewness | -0.182 | 0.015 | -0.125 | -0.414 | 0.779 | 0.139 | 1.039 | 0.557 | 0.642 | 0.671 |
| Range | 119.120 | 59.980 | 214.600 | 71.960 | 95.180 | 85.520 | 99.420 | 105.710 | 37.070 | 61.270 |
| Minimum | 26.190 | 26.780 | 56.040 | 39.060 | 22.800 | 27.170 | 34.380 | 18.650 | 4.540 | 17.960 |
| Maximum | 145.310 | 86.760 | 270.640 | 111.020 | 117.980 | 112.690 | 133.800 | 124.360 | 41.610 | 79.230 |
| Sum | 201512.810 | 137416.270 | 392384.150 | 187700.240 | 145096.990 | 168091.590 | 166247.600 | 168286.290 | 44503.820 | 105554.500 |
| Count | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 | 2513 |
|  | WTI Price | COP | CEO | OXY | EOG | APC | HES | DVN | COG | NBL |
| WTI Price | 1 |  |  |  |  |  |  |  |  |  |
| COP | 0.549 | 1 |  |  |  |  |  |  |  |  |
| CEO | 0.685 | 0.390 | 1 |  |  |  |  |  |  |  |
| OXY | 0.623 | 0.506 | 0.866 | 1 |  |  |  |  |  |  |
| EOG | 0.176 | 0.705 | 0.311 | 0.618 | 1 |  |  |  |  |  |
| APC | 0.551 | 0.765 | 0.668 | 0.830 | 0.797 | 1 |  |  |  |  |
| HES | 0.652 | 0.696 | 0.404 | 0.540 | 0.522 | 0.593 | 1 |  |  |  |
| DVN | 0.636 | 0.360 | 0.271 | 0.181 | -0.108 | 0.131 | 0.678 | 1 |  |  |
| COG | 0.249 | 0.691 | 0.364 | 0.590 | 0.876 | 0.816 | 0.377 | -0.243 | 1 |  |
| NBL | 0.590 | 0.773 | 0.648 | 0.801 | 0.796 | 0.918 | 0.596 | 0.082 | 0.861 | 1 |

Table 4.6 Descriptive statistics (top) and correlation analyses (bottom) between WTI daily prices and upstream oil companies daily stock prices.

|  | WTI Price | PSX | VLO | MPC | TSO | HFC | UGP | INT | WNR |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Mean | 80.188 | 68.037 | 40.727 | 36.600 | 40.749 | 30.151 | 15.022 | 31.654 | 24.547 |
| Standard Error | 0.442 | 0.501 | 0.367 | 0.343 | 0.514 | 0.262 | 0.138 | 0.234 | 0.284 |
| Median | 82.660 | 74.160 | 38.970 | 39.620 | 35.140 | 30.370 | 15.830 | 35.100 | 23.410 |
| Mode | 60.010 | 86.090 | 18.000 | 42.850 | 13.200 | 10.940 | 22.180 | 40.010 | 6.700 |
| Standard Deviation | 22.181 | 15.824 | 18.400 | 11.864 | 25.744 | 13.140 | 6.902 | 11.707 | 14.229 |
| Sample Variance | 492.002 | 250.403 | 338.567 | 140.749 | 662.770 | 172.652 | 47.635 | 137.051 | 202.473 |
| Kurtosis | -0.393 | -0.323 | -1.385 | -1.120 | 0.052 | -1.222 | -1.360 | -1.111 | -1.024 |
| Skewness | -0.182 | -0.809 | 0.200 | -0.310 | 0.890 | 0.001 | -0.023 | -0.070 | 0.273 |
| Range | 119.120 | 64.330 | 63.660 | 45.810 | 111.440 | 52.920 | 24.170 | 50.470 | 61.050 |
| Minimum | 26.190 | 29.350 | 14.050 | 13.530 | 6.800 | 5.510 | 3.560 | 7.810 | 4.110 |
| Maximum | 145.310 | 93.680 | 77.710 | 59.340 | 118.240 | 58.430 | 27.730 | 58.280 | 65.160 |
| Sum | 201512.810 | 67833.200 | 102347.450 | 43846.970 | 102402.900 | 75770.460 | 37750.310 | 79547.180 | 61685.540 |
| Count | 2513 | 997 | 2513 | 1198 | 2513 | 2513 | 2513 | 2513 | 2513 |
|  | WTI Price | PSX | VLO | MPC | TSO | HFC | UGP | INT | WNR |
| WTI Price | 1 |  |  |  |  |  |  |  |  |
| PSX | -0.430 | 1 |  |  |  |  |  |  |  |
| VLO | -0.229 | 0.924 | 1 |  |  |  |  |  |  |
| MPC | -0.506 | 0.891 | 0.931 | 1 |  |  |  |  |  |
| TSO | -0.346 | 0.797 | 0.771 | 0.900 | 1 |  |  |  |  |
| HFC | 0.129 | 0.457 | 0.517 | 0.719 | 0.768 | 1 |  |  |  |
| UGP | 0.332 | -0.229 | -0.045 | 0.152 | 0.422 | 0.776 | 1 |  |  |
| INT | 0.000 | 0.544 | 0.102 | 0.526 | 0.573 | 0.738 | 0.863 | 1 |  |
| WNR | -0.166 | 0.862 | 0.795 | 0.958 | 0.866 | 0.832 | 0.419 | 0.502 | 1 |

Table 4.7 Descriptive statistics (top) and correlation analyses (bottom) between WTI daily prices and downstream oil companies daily stock prices.

Multivariate regression analyses results of total monthly returns data for the three different types of oil companies in the industry (dependent variable) versus WTI price standard deviation, market premium, SMB, HML, and UMD (independent variables) are reported in Tables 4.8-4.10 for integrated, upstream, and downstream oil companies respectively. It is important to mention that two different regressions were performed for downstream oil companies, in which MPC, PSX, and UGP's data was taken from June 2012.

| Intercept | $-0.008^{* *}$ |
| :--- | ---: |
| WTI Std Dev | 0.001 |
| Excess Return on the Market | $1.219^{* * *}$ |
| Small-Minus-Big Return | $-0.637^{* * *}$ |
| High-Minus-Low Return | -0.067 |
| Up-Minus-Down Return | 0.016 |
| Adjusted R Square | 0.328 |
| Observations | 1053 |
| F | 103.583 |
| Significance $\boldsymbol{F}$ | $7.317 \mathrm{E}-89$ |

Table 4.8 Multivariate regression analysis results of total returns of integrated oil companies sample selection vs. WTI Std. Dev., Mkt-Rf, SMB, HML, and UMD. *, **, *** indicates significance at the $90 \%, 95 \%$, and $99 \%$ level, respectively.

| Intercept | 0.002 |
| :--- | ---: |
| WTI Std Dev | $-4.041 \mathrm{E}-05$ |
| Excess Return on the Market | $1.173^{* * *}$ |
| Small-Minus-Big Return | -0.175 |
| High-Minus-Low Return | 0.075 |
| Up-Minus-Down Return | 0.062 |
| Adjusted R Square | 0.280 |
| Observations | 1053 |
| F | 82.675 |
| Significance $\boldsymbol{F}$ | $3.036 \mathrm{E}-73$ |

Table 4.9 Multivariate regression analysis results of total returns of upstream (E\&P) oil companies sample selection vs. WTI Std. Dev., Mkt-Rf, SMB, HML, and UMD. *, **, *** indicates significance at the $90 \%, 95 \%$, and $99 \%$ level, respectively.

| Intercept | $0.026^{* * *}$ | Intercept | 0.003 |
| :--- | ---: | :--- | ---: |
| WTI Std Dev | $-0.002^{* *}$ | WTI Std Dev | 0.001 |
| Excess Return on the Market | $1.056^{* * *}$ | Excess Return on the Market | $0.917079^{* * *}$ |
| Small-Minus-Big Return | $0.505^{* *}$ | Small-Minus-Big Return | 0.001132 |
| High-Minus-Low Return | $-0.818^{* * *}$ | High-Minus-Low Return | 0.297552 |
| Up-Minus-Down Return | $-0.322^{* * *}$ | Up-Minus-Down Return | -0.48325 |
| Adjusted R Square | 0.186 | Adjusted R Square | 0.150885 |
| Observations | 585 | Observations | 129 |
| F | 82.675 | F | 5.549053 |
| Significance $\boldsymbol{F}$ | $3.04 E-73$ | Significance $\boldsymbol{F}$ | 0.000121 |
| Table |  |  |  |

Table 4.10 Multivariate regression analysis results of total returns of downstream (refining) oil companies sample selection vs. WTI Std. Dev., Mkt-Rf, SMB, HML, and UMD. *, **, *** indicates significance at the $90 \%, 95 \%$, and $99 \%$ level, respectively.

Every analysis performed show a weak adjusted R-Square value, meaning a poor fit to the data. This event can also be explained to the claim presented in Section 2 of this paper, in which explicates that oil company's stocks trail WTI and market price changes. It is noteworthy also that every small Significance F confirms the validity of the regression output. It is important to notice that downstream companies returns resulted to be a great predictor for volatility in WTI's standard deviation, most likely due to its opposite movement to the benchmark.

## 5. Robustness Tests

To assess the validity of the analyses performed in Section IV, I perform a robustness test by using the Brent Crude standard deviation as my benchmark. To perform this analysis, I will test the same sample selection to get a significant representation of every sector in the industry and to give a higher validity degree to the analysis

This robustness analysis looks to support the empirical findings reported in Section IV, by comparing re-examining the same variables to another crude oil benchmark. The Brent Crude is highly correlated to the WTI, as they both measure sweet light crude oil, with the difference that the Brent crude is the leading global price benchmark for Atlantic basin crude oils, and the WTI is listed in Cushing, Oklahoma. The WTI is said to also be "lighter" and "sweeter" than the Brent crude, referring to specific gravity and sulfur content respectively. Tables 5.1-5.3 shows the results for the multivariate regression analysis using the Brent crude as robustness benchmark.

| Intercept | -0.008 |
| :--- | ---: |
| WTI Std Dev | 0.000 |
| Excess Return on the Market | $1.219^{* * *}$ |
| Small-Minus-Big Return | $-0.635^{* * *}$ |
| High-Minus-Low Return | -0.063 |
| Up-Minus-Down Return | 0.015 |
| Adjusted R Square | 0.328 |
| Observations | 1053 |
| F | 103.498 |
| Significance F | $8.427 \mathrm{E}-89$ |

Table 5.1 Multivariate regression analysis results of total returns of downstream (refining) oil companies sample selection vs. Brent Crude Std. Dev., Mkt-Rf, SMB, HML, UMD. *, $* *,{ }^{* * *}$ indicates significance at the $90 \%, 95 \%$, and $99 \%$ level, respectively.

| Intercept | 0.002 |
| :--- | ---: |
| WTI Std Dev | 0.000 |
| Excess Return on the Market | $1.173^{* * *}$ |
| Small-Minus-Big Return | -0.175 |
| High-Minus-Low Return | 0.075 |
| Up-Minus-Down Return | 0.062 |
| Adjusted R Square | 0.280 |
| Observations | 1053 |
| F | 82.675 |
| Significance F | $3.04 \mathrm{E}-73$ |

Table 5.2 Multivariate regression analysis results of total returns of upstream (E\&P) oil companies sample selection vs. Brent Crude Std. Dev., Mkt-Rf, SMB, HML, UMD. *, **, *** indicates significance at the $90 \%, 95 \%$, and $99 \%$ level, respectively.

| Intercept | $0.025^{* * *}$ |
| :--- | ---: |
| WTI Std Dev | $-0.002^{* *}$ |
| Excess Return on the Market | $1.056^{* * *}$ |
| Small-Minus-Big Return | $0.498^{* *}$ |
| High-Minus-Low Return | $-0.833^{* * *}$ |
| Up-Minus-Down Return | $-0.316^{* * *}$ |
| Adjusted R Square | 0.184 |
| Observations | 585 |
| F | 27.363 |
| Significance $\boldsymbol{F}$ | $6.82 \mathrm{E}-25$ |

Table 5.3 Multivariate regression analysis results of total returns of downstream (refining) oil companies sample selection vs. Brent Crude Std. Dev., Mkt-Rf, SMB, HML, UMD. *, **, ${ }^{* * *}$ indicates significance at the $90 \%, 95 \%$, and $99 \%$ level, respectively.

The results obtained from the multivariate regression analyses support the findings on Section IV by confirming a low R-Square value, thus supporting the claim that stocks trail crude oil prices, and react in different ways depending on the type of company. The analysis also shows a very small Significance F which confirms the validity of the regression analysis practiced. Finally, downstream companies confirm their significance as a reliable predictor for benchmark volatility due to the statistical significance of the results obtained in Table 5.3.

## 6. Discussion and Conclusion

With the analyses performed and the methodology and sample selection used in this paper, I evidence and explain the relation between oil price volatility and the financial and stock return performance of different types of oil companies during different time periods. I also recommend signals to look for when interpreting data or searching for relevant variables for predicting investment performance such as the Purchasing Manager's Index (PMI), market indexes (S\&P500 and DJIA), world's crude oil output, and oil stock movements depending on the type of company being evaluated.

This paper makes three contributions to the literature on the determinants of oil company performance. First, it gives a trend analysis methodology that serves as a first indicator of both oil prices, and oil company's stock return levels. Second, it provides a guide on understanding the oil industry and its different reactions to crude oil volatility. Finally, this paper demonstrates the timely movements and the significance of these fluctuations on oil stock returns.

There are three major findings in this paper. First, it proves the validity of the trend signals discussed for predicting swings in oil prices, and that the relations between these indicators and the benchmark selected (WTI) monitor a particular tactic depending on the type of analysis being made. Second, it demonstrates the action-reaction movements that exist between crude oil prices and integrated, upstream, and downstream companies and the approach to take in analyzing each type of company independently. Third, it finds the most statistically significant variables to be considered as effective indicators for oil stocks performance, in this case, downstream companies resulted to be the most statistically significant variables to predict abnormal returns in comparison to crude oil price volatility and market indicators.

Lastly, it is noteworthy that the methodology proposed in this paper is an examination of financial historical data, and many direct and indirect factors which also play an important role on determining oil prices and volatility have been left out of this study, and it's a matter of further research. Given that many factors are in play, it is difficult to predict how oil prices will fluctuate during a given period of time, but the methodology recommended in this paper serves as a good strategy to approach oil markets.

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