

# The Influence of Major Energy Prices on China's Industries

Jin Boon Wong<sup>1,2\*</sup> and Qin Zhang<sup>1</sup>

<sup>1</sup> Macquarie University, Sydney, NSW 2109, Australia

<sup>2</sup> Capital Markets CRC, Sydney, NSW 2000, Australia

## Abstract

As one of the largest importers and consumers of energy in the world, it is important to understand how fluctuations in major fuel contracts can impact various industries in China. This issue is particularly important as China becomes increasingly globalized and the energy market has undertaken some key reforms. This study first examines how the returns and price volatility of major international benchmarks in energy like Brent crude oil, WTI crude oil, Henry Hub natural gas, and Newcastle thermal coal future contracts affects various specific industries in China. Using the entire firm-level data of 3750 stock listings available across both Shanghai and Shenzhen stock exchanges and segregating the companies under the Global Industry Classification Standard (GICS) into 138 detailed sub-industries, this research provide empirical evidence that crude oil, particularly Brent future prices have the most influence on China's companies. This analysis is further extended to examine how China's key oil pricing reform on 27<sup>th</sup> March 2013, which seeks to align Chinese refined oil price to international benchmarks, affects various sub-industries pre-and-post event. Results suggest that stock returns of sub-industries closely related to oil production are now significantly impacted by Brent and WTI's future returns. More importantly, Chinese listed stocks which appears to be relatively insulated previously are now more exposed to global crude oil price volatility after the latest reform.

*Keywords: Energy, Commodities, Firm returns, Crude Oil, Gas, Coal, Refined oil pricing reform, Brent, WTI, China.*

---

\* Corresponding author. Jin Boon Wong. Tel: +61 (2) 9850 6862. Email: jeffrey.wong@mq.edu.au Macquarie University, Sydney, NSW 2109, Australia.

## **1. Introduction**

The importance of crude oil as a vital source of energy for world economies can be traced back to Edwin L. Drake's first commercial oil well in Titusville, Pennsylvania. While progress has been made in the pursuit of alternative energy sources, crude oil is likely to continue as a strategic asset that holds the balance of power in global development for arguably the next few decades. This has driven considerable interest by industry and academia to better understand the relationship between crude oil prices and stock market returns.

Since earlier works by Huang et al. (1996) and Jones and Kaul (1996), considerable research using different methods and alternative data sources have generally agreed that international oil prices have a significant and negative impact on stock market returns (see for example in US stock markets, Kilian and Park, 2009; and Kang et al., 2015; in US and major European stock markets, Jammazi et al., 2017; in US and major Asian stock markets, Ding et al., 2016; in Indian stock markets, Ghosh and Kanjilal, 2016; in China and Vietnam stock markets, Nguyen and Bhatti, 2012; and in emerging stock markets, Basher et al., 2012). These findings indicate that crude oil movements may have important implications for international stock markets in terms of portfolio risk management and asset allocations.

The theory underlying this effect suggests that higher oil prices increase the cost of production for companies requiring oil as an input (directly or indirectly). This is likely to reduce their expected returns, assuming that higher costs cannot be fully transferred to clients and thereby negatively affect the stock market performance of affected firms (Miller and Ratti, 2009). Irwing et. al. (2009) also suggest that crude oil as the world's largest commodity futures market is the dominant driver in prices of other commodities. Higher crude oil prices seem to lead higher prices of other commodities and increase inflation rates, which can lead to central banks raising interest rates, negatively affecting the discount rate for corporate cash flow and be consequently priced into the stock market.

Since overtaking Japan as the second largest consumer of oil in the world in 2003, China's enormous appetite for energy which can be directly linked to the rapid economic growth over the past three decades, has significant impact on the world energy and financial markets. With the growing implications of China's energy demand as the world's second largest economy, there has been considerable research interest in the relationship between international oil prices

and the impact on China's stock performance. For example, Cong et al. (2008) analyse the relationship between oil price shocks and Chinese stock market and show negative impacts on oil stocks and some positive effects on manufacturing, mining, petrochemical industries but insignificant effects on most other indices. Zhang and Chen (2011) investigate the impact of international oil price shocks on China's stock market and document a positive but minor relationship between the pair. Li et al. (2012) at the sector level found a positive relationship between oil and Chinese stock market and emphasize the negative short run and positive long run effect on stocks by focusing on the Granger causality relationship. Chen and Lv (2015) observe the driven force of economic cycles creates a positive extremal dependence between China's stock market and global crude oil market. They also document that China's price regulation of oil has led to a distorted transition mechanism from oil prices to the stock market.

Using the Fama-French 3 factors model, Broadstock et al. (2016) documents that 89.2% and 95.7% of Chinese firms in their sample are susceptible to oil and gasoline shocks, respectively, with positive and negative reactions observed even for firms within the same industry. Ding et al. (2016) examines the relationships between WTI, Dubai crude oil returns and S&P 500, Nikkei, Hang Seng, Shanghai, and KOSPI indices and observe an asymmetric Granger causal relationship between WTI and Dubai crude oil returns and Shanghai index returns. Ding et al. (2017) found that international crude oil price fluctuations significantly Granger cause negative Chinese stock market investor sentiment in the short-and-long run. Luo and Qin (2017) investigate the impact of oil price and volatility shocks on China's stock market and five sector returns. The authors provide evidence to suggest that oil price shocks positively affect Chinese stock returns and that CBOE crude oil volatility index shocks have significant and negative effects on the Chinese stock market. Peng et al (2018) examines the extreme risk spillover of global crude oil to stock returns for Chinese stocks and observe the effects of positive risk spillovers are more pronounced than negative risk spillovers, is dependent on firm's industry features and that China's refined oil pricing reform of 27<sup>th</sup> March 2013 has amplified the negative spillovers from oil prices to firms.

The literature to-date has provided considerable insights into the relationship between crude oil and China's stock market. However, most of these studies have focused on the aggregate market and its industry perspective with limited papers that apply firm level data. Broadstock et al (2016) and Peng et al. (2018) advocates the use of firm level data for analysis of industry level results as it allows new and detailed insights to be observed. However, both studies have

focused only on firms listed in the Shanghai stock exchange and no research thus-far have covered the entire listings of both Shanghai and Shenzhen stock exchanges in China. The inclusion of companies listed in the Shenzhen stock exchange is likely to provide a more complete analysis of any energy research on Chinese stock markets since it is the world's 8th largest stock exchange, linked internationally via the Shenzhen-Hong Kong stock connect on 5th December 2016 and has A-shares that are part of the Morgan Stanley Capital International (MSCI) Emerging Markets Index from 31st May 2018.

A review of existing literature also shows that studies that have examine industry returns have utilized sector indices from Shenzhen stock exchange (Li et al. 2012) and Shanghai stock exchange (Luo and Qin, 2017), industry sector index from Shenwan Research database (Chen and Lv, 2015), RESSET Financial Database (Broadstock et al, 2012, Zhu, et al. 2016; You et al., 2017) and China Securities Regulatory Commission standard industry classification (Peng et al, 2018). With the inclusion of Chinese listed stocks in MSCI Emerging Markets Index, China's stock markets are increasingly integrated with the rest of the world. Therefore, to provide a more meaningful analysis, it is useful to adopt an internationally recognized and widely accepted classification system. The Global Industry Classifications Standard (GICS) system is ideal as Bhojraj et al (2003) documents evidence that show GICS is significantly better when compared to Morgan Stanley Capital International (MSCI), Standard Industrial Classification (SIC) codes and North American Industry Classification System (NAICS) codes in capital markets research. In particular, GICS's consistency from year to year which is most pronounced among large firms is superior at explaining stock return co-movements, cross-sectional variations in valuation multiples, forecasted and realized growth rates, research and development expenditures, and various key financial ratios. The ability to segregate firms into detailed sub-industries is also likely to provide more comprehensive insights.

Further, while there is substantial interest in understanding the relationship between oil and China's stock returns (since it is the world's largest net oil importer and second largest oil consumer), there is a paucity of research incorporating other major energy future contracts in the analysis of Chinese stock returns. It is noteworthy that China is also the world's top importer of natural gas and second largest buyer of liquified natural gas. In addition, it is the largest producer and consumer of coal in the world and is the second largest buyer of coal in the world. Despite similar import and consumption patterns to oil, there has been limited research linking China's stock returns to natural gas or thermal coal prices. Batten et al (2017)

for example, highlights the importance of considering oil, gas and coal prices as an energy portfolio when considering a hedging tool for portfolio management in Asia. The authors suggest that when energy portfolio risk is decomposed into its individual components, coal and gas offer may better hedging possibilities for the Asian region compared to oil as there is strong dependence for coal as an energy fuel.

Hence, this paper contributes to the energy-stock price nexus in China by utilizing the firm-level data of the entire 3750 listed companies available in both Shanghai and Shenzhen stock exchanges, segregated into the most detailed 138 sub-industries as classified by GICS and incorporating both Brent and West Texas Intermediate (WTI), Henry Hub natural gas and Newcastle thermal coal future contracts into the analysis. This provides arguably one of the most comprehensive dataset to-date which adds further insights into how changes in returns and price volatility of major energy fuel sources that are imported and heavily consumed by China affects various specific industries. These findings are particularly useful for regulators and policy makers wishing to understand which precise sectors are more susceptible to fluctuations in a specific energy benchmark and is also valuable to investors wishing to understand their portfolio risk exposures in China's industries.

In addition to the enormous energy requirements, China's oil market is unique. Prior to 1998, the Chinese central government strictly controlled the price of refined oil and set it to be lower than international markets. Since then, rapid economic expansion which is accompanied by the stress of substantial growth in oil consumption that has outstripped domestic supply (Broadstock et al 2016) have instigated China's central authority to revised price controls 5 times (since 1998) to manage the costs of oil imports. With each continuously propelling process of oil pricing mechanism reform, China's oil prices reflect more information regarding the price changes in international oil prices, and its economy has been increasingly influenced by the international oil price fluctuations.

The key event is the market-orientated pricing for refined oil on 27<sup>th</sup> March 2013, which reduces the price adjustment cycle from 22 working days to 10 working days and removing the 4% world oil-price-fluctuation trigger point. This more closely aligns China's domestic oil prices with global levels and makes it more responsive to international oil price fluctuations and has been identified in the literature as a key milestone in the history of China's energy market-orientated reform which needs to be considered in analysis of energy-stock price nexus

in China (see Chen and Lv, 2015, Bouri et al, 2017; and Peng et al 2018). In particular, Bouri et al. (2017) highlighted the importance of considering the key refined oil pricing mechanism reform of 27<sup>th</sup> March 2013 when researching the co-movement between international oil prices and China's stock markets, as they demonstrate that the causality-in-mean between global oil markets and sector indices strengthened after this event, whereas the causality-in-variance is almost non-existence afterwards.

This study seeks to extend the literature by using firm-level data for firms listed across both Shanghai and Shenzhen stock exchanges, segregated into GICS sub-industries to provide a comprehensive analysis into how the key reform of China's refined oil pricing mechanism on 27<sup>th</sup> March 2013 impacts specific industries in China. Both WTI and Brent crude oil futures are included to provide comparison and robustness. It is worth highlighting that since different companies possess varied attributes, all equity industries are unlikely to be affected equally by oil prices changes or volatility spikes. It is probable that industries which are strongly related to oil, such as the energy and industrial sectors, are more affected by price changes in global crude oil benchmarks compared to others not related to oil, such as the service and technology sectors. By focusing on cross-industries heterogeneity, this research seeks to assist portfolio managers better diversify their portfolios across the sub-industries in Chinese market to maximize return and minimize risk. Further, it provides empirical support for regulators and policy makers to better understand the impact of their actions on financial markets and help formulate appropriate choices at the sub-industry levels.

The remainder of this paper is organized as follows. The next section provides a description of the data that is used in this study. The third section explains the research methodology and descriptive statistics on the sample data employed. The fourth section presents the empirical results, the fifth section provides a discussion of the findings and the conclusions are provided in the final section.

## **2. Data**

The Shanghai and Shenzhen listed companies list is extracted from Bloomberg as of 31<sup>st</sup> December 2018 and consists of the entire 3750 available stocks that is domiciled in China. The GICS sub-industry grouping for the sample segregates these firms into 138 classifications and is presented in Table 1. Data utilized in this research includes transaction records, company information and official interest rates that are secured from three sources, Thomson Reuters

Tick History (TRTH) via Datascope and Bloomberg. The first part of the data set includes all end-of-day transaction records which contain daily closing prices and quotes, daily high and low prices, and daily trading activity (volume and shares traded) that is obtained from TRTH. This data is supplemented by Bloomberg which provides the Global Industry Classification Standard (GICS), market capitalization, book-value-per-share, book value, earnings per share and outstanding shares. To ensure data integrity, Bloomberg end-of-day historical records that are similar to TRTH is also extracted and cross-checked. The Chinese government bond rates data is extracted from (<http://yield.chinabond.com.cn/cbweb-pbc-web/pbc/>).

### **INSERT TABLE 1 HERE**

### **3. Methodology**

To investigate the relationship between China sub-industries returns and energy price changes, this study adopts the Fama and French three-factor approach to control for risks associated with firm size and valuations (Elyas et al. 2011; Broadstock et al, 2012; and You et al., 2017). Daily data from 1 March 2006 to 31 December 2018 are utilized as the start date coincides with the first available data period for the Chinese government bond rates which is required for the Fama–French three factors analysis. The returns on the nearest to expiry West Texas Intermediate (WTI) crude oil futures traded on the New York Mercantile Exchange (NYMEX), Brent crude oil futures (Brent) traded on Intercontinental Exchange (ICE), Henry Hub natural gas futures (NG) traded on Chicago Mercantile Exchange (CME) and Newcastle thermal coal futures (Coal) traded on ICE are utilized. Since prior studies are mixed on the use of WTI (Wang et al. 2015 and You et al. 2017) and Brent (Bouri, 2015; and Chen and Lv, 2015; and Peng et al 2018), this study adopts analysis on both WTI and Brent to provide richer insights into which oil futures has more influence on various sub-industries in China. The futures data are used in this study for two reasons. First, as pointed out by Sadorsky (2001), spot prices are more heavily affected by temporary random noise than the futures prices are. Second, if a firm engages in hedging, the effectiveness of such hedging activities is judged by the variability of the futures prices. The returns are calculated as,

$$(P_t - P_{t-1}) / P_{t-1} \quad (1)$$

where  $P$  is the price of WTI, Brent, NG and Coal.

Price volatility is the logarithmic difference between the daily high and low prices and is represented by,

$$\text{Log}(\text{DailyHigh}_t / \text{DailyLow}_t) \quad (2)$$

For the Fama and French three-factor approach to control for risks associated with firm size and valuations, the excess return for each sub-industry is calculated as,

$$ER_{i,t} = R_{i,t} - R_{f,t} \quad (3)$$

where  $R_{i,t}$  is the continuously compounded daily return for industry  $i$  at time  $t$  and  $R_{f,t}$  is the 3-months Chinese Government bond rate (risk-free rate).

The Fama and French three-factors include the excess market return (RM) defined as the return on the CSI300 index<sup>1</sup> minus the 3-months Chinese Government bond rate, the average return on portfolios of small cap stocks minus portfolios of large cap stocks, (SMB), and the average return on portfolios of high book-to-market stocks minus portfolios of low book-to-market stocks, (HML). To calculate both SMB and HML for stocks listed on both Shanghai and Shenzhen Stock Exchanges, this study adopts the methodology as outlined in Fama and French (1993) and utilize 6 value-weight portfolios formed on size (market capitalization,  $MC$ ) and book-to-market value ( $BM$ ). To construct the 6 portfolios, on the 1 January of each year, the intersections of 2 portfolios formed on  $MC$  and 3 portfolios formed on the ratio of book-to-market value to market capitalization ( $BM/MC$ ). The size breakpoint for year  $t$  is the median market equity of listed stocks across both Shanghai and Shenzhen Stock Exchanges on the 1 January of year  $t$ .  $BM/MC$  for 1 January of year  $t$  is the book-to-market value for the last calendar year end in  $t-1$  divided by  $MC$  for December of  $t-1$ . The  $BM/MC$  breakpoints are the 30<sup>th</sup> and 70<sup>th</sup> percentiles across stocks listed in both Shanghai and Shenzhen Stock Exchanges.

RM is the return on CSI300 index minus the 3-months Chinese Government bond rate,

$$RM_t = \text{CSI300}R_t - R_{f,t} \quad (4)$$

---

<sup>1</sup> CSI300 index is selected as this study utilize stock listings from both Shanghai and Shenzhen stock exchanges.



where  $CSI300R_t$  is the continuously compounded daily return for CSI300 index at time  $t$  and  $R_{f,t}$  is the 3-months Chinese Government bond rate (risk-free rate).

SMB (Small Minus Big) is the average return on the three small portfolios minus the average return on the three big portfolios,

$$SMB = 1/3 (Small Value + Small Neutral + Small Growth) - 1/3 (Big Value + Big Neutral + Big Growth) \quad (5)$$

HML (High Minus Low) is the average return on the two value portfolios minus the average return on the two growth portfolios,

$$HML = 1/2 (Small Value + Big Value) - 1/2 (Small Growth + Big Growth) \quad (6)$$

where small value is below the market capitalization median and in the 70<sup>th</sup> percentile, small neutral is below the market capitalization median and between the 30<sup>th</sup> and 70<sup>th</sup> percentile, small growth is below the market capitalization median and in the 30<sup>th</sup> percentile, big value is above the market capitalization median and in the 70<sup>th</sup> percentile, big neutral is above the market capitalization median and between the 30<sup>th</sup> and 70<sup>th</sup> percentile, and big growth is above the market capitalization median and in the 30<sup>th</sup> percentile.

The primary interest of this study is to determine whether energy futures returns, and its volatility provide incremental information, beyond the generally accepted return generating factors such as the Fama–French factors, in describing industry stock returns. To achieve this, the research characterizes the industry excess stock return ( $ER_{i,t}$ ) as a function of the three Fama–French factors and examine the daily returns and volatility of WTI, Brent, NG and Coal. To account for the difference in trading days and opening hours, the 1-day lagged statistics are utilized to align the close of the trading hours for NYMEX, CME and ICE with the start of the new trading day in China.<sup>2</sup>

$$ER_t = \alpha_0 + \alpha_1 RM_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 WTIR_{t-1} + \alpha_5 WTIV_{t-1} + \varepsilon \quad (7)$$

---

<sup>2</sup> This is consistent with the hypothesis of a delayed reaction by investors (see Driesprong et al., 2008; and Elyasiani et al 2008).

$$ER_t = \alpha_0 + \alpha_1 RM_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 BrentR_{t-1} + \alpha_5 BrentV_{t-1} + \varepsilon \quad (8)$$

$$ER_t = \alpha_0 + \alpha_1 RM_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 NGR_{t-1} + \alpha_5 NGV_{t-1} + \varepsilon \quad (9)$$

$$ER_t = \alpha_0 + \alpha_1 RM_t + \alpha_2 SMB_t + \alpha_3 HML_t + \alpha_4 CoalR_{t-1} + \alpha_5 CoalV_{t-1} + \varepsilon \quad (10)$$

where  $WTIR_t$  is the 1-day lagged daily return on the nearest to expiry WTI crude oil futures,  $BrentR_t$  is the 1-day lagged daily return on the nearest to expiry Brent crude oil futures,  $NGR_t$  is the 1-day lagged daily return on the nearest to expiry Henry Hub natural gas futures,  $CoalR_t$  is the 1-day lagged daily return on the nearest to expiry Newcastle coal futures,  $WTIV_t$  is the 1-day lagged daily volatility of returns for nearest to expiry WTI crude oil futures,  $BrentV_t$  is the 1-day lagged daily volatility of returns for nearest to expiry Brent crude oil futures,  $NGV_t$  is the 1-day lagged daily volatility of returns for nearest to expiry Henry Hub natural gas futures, and  $CoalV_t$  is the 1-day lagged daily volatility of returns for nearest to expiry Newcastle coal futures.

### 3.1 Key event analysis: China's refined oil pricing mechanism reform

To further extend the understanding of energy futures returns and price volatility on Chinese sub-industries, this study adopts the key refined oil pricing mechanism reform on 27<sup>th</sup> March 2013 as a major event (see Chen and Lv, 2015; Bouri et al, 2017; and Peng et al, 2018). The full sample is segregated into (i) a pre-event sample which consists of the period from 1<sup>st</sup> March 2006 to 26<sup>th</sup> March 2013, and (ii) a post-event sample that includes 27<sup>th</sup> March 2013 to 31<sup>st</sup> December 2018.

## 4. Results

Table 2 presents regression results for GICS sub-industries that have statistically significant relationships with the 1-day lagged WTI future returns and price volatility.<sup>3</sup> Table 2a indicates that overall across the entire sample period from 1 March 2006 to 31 December 2018, there are 21 GICS sub-industries (10 positives and 11 negatives) that are affected by changes in WTI crude oil future prices and have regression coefficients above 0. The results suggest that Gold

---

<sup>3</sup> Due to the high volume of regression results from the entire 138 GICS sub-industries, only statistically significant results above 5% and 95% level are presented for all tables. The full results are available upon request from the authors.

(15104030), Diversified Metals & Mining (15104020), Coal & Consumable Fuels (10102050), Oil & Gas Equipment & Services (10101020), Specialty Stores (25504040), Integrated Oil & Gas (10102010), Aluminum (15104010), Financial Exchanges & Data (40203040), Fertilizers & Agricultural Chemicals (15101030) and Steel (15104050) are most likely to benefit from increases in WTI future prices. On the other hand, Airlines (20302010), Alternative Carriers (50101010), Consumer Electronics (25201010), Brewers (30201010), Distillers & Vintners (30201020), Motorcycle Manufacturers (25102020), Technology Hardware, Storage & Peripherals (45202030), Marine (20303010), Airport Services (20305010), Pharmaceuticals (35202010) and Automobile Manufacturers (25102010) have significant negative coefficients indicating that these companies are likely to experience adverse wealth effects increases in WTI future prices.

Table 2b illustrates that Chinese listed firms listed in 3 GICS sub-industries are negatively affected by 1-day lagged WTI futures price volatility. Companies in Home Furnishings (25201020), Airport Services (20305010) and Railroads (20304010) exhibit statistically significant negative regression coefficients that above 0, suggesting increase WTI price volatility reduces their stock returns.

### **INSERT TABLE 2 HERE**

The 1-day lagged Brent returns and volatility regression results are displayed on Table 3. Table 3a illustrates that 16 GICS sub-industries (11 positives and 5 negatives) are significantly impacted by changes in WTI crude oil future prices and have regression coefficients above 0. Chinese listed companies in Gold (15104030), Diversified Metals & Mining (15104020), Coal & Consumable Fuels (10102050), Oil & Gas Equipment & Services (10101020), Integrated Oil & Gas (10102010), Aluminum (15104010), Oil & Gas Exploration & Production (10102020), Specialty Stores (25504040), Wireless Telecommunication Services (50102010), Fertilizers & Agricultural Chemicals (15101030) and Steel (15104050) show a significant positive correlation with Brent returns indicating that these sub-industries are likely to benefit the most from increases in Brent prices. Conversely, Airlines (20302010), Alternative Carriers (50101010), Airport Services (20305010), Consumer Electronics (25201010) and Technology Hardware, Storage & Peripherals (45202030) are negatively affected by increases in Brent prices.

It is observed in Table 3b that 13 GICS sub-industries are affected by changes in the price volatility of Brent futures. The stock returns of most Chinese listed companies react negatively to increase in the price volatility of Brent oil futures. Firms that are affected include Home Furnishings (25201020), Tires & Rubber (25101020), Cable & Satellite (50201030), Automotive Retail (25504050), Railroads (20304010), Industrial Conglomerates (20105010), Hotels, Resorts & Cruise Lines (25301020), Marine Ports & Services (20305030), Airport Services (20305010), Personal Products (30302010), Paper Products (15105020) and Construction Machinery & Heavy Trucks (20106010). The only exception is Regional Banks (40101015) which shows a positive and significant coefficient.

### **INSERT TABLE 3 HERE**

Table 4 display regression results for GICS sub-industries that have statistically significant relationships with the 1-day lagged Henry Hub natural gas returns and volatility. Table 4a documents that 6 GICS sub-industries (5 positives and 1 negative) are impacted by changes in NG prices. Stock returns of firms in Oil & Gas Exploration & Production (10102020), Gold (15104030), Health Care Supplies (35101020), Oil & Gas Equipment & Services (10101020) and Diversified Metals & Mining (15104020) demonstrate positive relationships between the 1-day lagged Henry Hub natural gas returns. Table 4b suggests that over the study's sample period, increased price volatility in NG futures appear to have a positive impact on Airlines (20302010).

The 1-day lagged Newcastle thermal coal returns and volatility regression results are presented on Table 5. Table 5a indicates that stocks return from 8 GICS sub-industries (5 positives and 3 negatives) have significantly influenced by changes in thermal coal prices from Australia. Stocks return from Household Products (30301010), Precious Metals & Minerals (15104040), Aluminum (15104010), Oil & Gas Equipment & Services (10101020) and Diversified Metals & Mining (15104020) have significant positive correlations with Coal returns. Conversely, stocks return in Internet & Direct Marketing Retail (25502020), Oil & Gas Exploration & Production (10102020) and Household Appliances (25201040) have negative relationships with Coal returns. Table 5b further shows that price volatility in Newcastle coal affects the stocks returns of 2 GICS sub-industries negatively, Multi-line Insurance (40301030) and Automobile Manufacturers (25102010).

## **INSERT TABLE 4 HERE**

Based on these empirical results, there are evidence to suggest that international oil prices (i.e. WTI and Brent) have more influence on listed companies in China compared to Henry Hub natural gas and Newcastle thermal coal.

### **4.1 Further analysis: China's refined oil pricing mechanism reform**

To provide a more comprehensive analysis on the relationship between crude oil futures and Chinese stock returns, this study adopts the key refined oil pricing mechanism reform on 27<sup>th</sup> March 2013 as a major event and segregates the full sample into (i) a pre-event sample which consists of the period from 1<sup>st</sup> March 2006 to 26<sup>th</sup> March 2013, and (ii) post-event sample that includes 27<sup>th</sup> March 2013 to 31<sup>st</sup> December 2018. Table 6 and 7 display results for the pre-and-post sample, respectively.

Results from Table 6a demonstrate that during the pre-event period, there are 22 GICS sub-industries (4 positives and 18 negatives) that are affected by changes in WTI crude oil future prices and have regression coefficients above 0. The results suggest that Gold (15104030), Coal & Consumable Fuels (10102050), Diversified Metals & Mining (15104020) and Aluminum (15104010) are most likely to benefit from increases in WTI future prices. On the other hand, Airlines (20302010), Motorcycle Manufacturers (25102020), Consumer Electronics (25201010), Hotels, Resorts & Cruise Lines (25301020), Leisure Facilities (25301030), Education Services (25302010), Automobile Manufacturers (25102010), Household Appliances (25201040), Department Stores (25503010), Airport Services (20305010), Marine (20303010), General Merchandise Stores (25503020), Electrical Components & Equipment (20104010), Construction Machinery & Heavy Trucks (20106010), Textiles (25203030), Distributors (25501010), Highways & Railtracks (20305020) and Construction & Engineering (20103010) have significant negative coefficients indicating that these companies are likely to experience adverse wealth effects increases in WTI future prices.

Table 6b demonstrates that Chinese listed firms listed in 3 GICS sub-industries (2 positive and 1 negative) are affected by 1-day lagged WTI futures price volatility. Companies in Marine (20303010) observe a negative relationship, whereas Home Electronic Manufacturing Services (45203020) and Regional Banks (40101015) exhibit statistically significant positive regression coefficients that above 0.

## **INSERT TABLE 6 HERE**

Table 7a documents that in the post-event period, 26 GICS sub-industries (25 positives and 1 negatives) are significantly impacted by changes in WTI crude oil future prices and have regression coefficients above 0. Chinese listed companies in Oil & Gas Exploration & Production (10102020), Oil & Gas Equipment & Services (10101020), Integrated Oil & Gas (10102010), Oil & Gas Storage & Transportation (10102040), Multi-Utilities (55103010), Drug Retail (30101010), Diversified Metals & Mining (15104020), Other Diversified Financial Services (40201020), Gold (15104030), Fertilizers & Agricultural Chemicals (15101030), Commodity Chemicals (15101010), Air Freight & Logistics (20301010), Aerospace & Defense (20101010), Automotive Retail (25504050), Gas Utilities (55102010), Aluminum (15104010), Trading Companies & Distributors (20107010), Textiles (25203030), Industrial Machinery (20106020), Coal & Consumable Fuels (10102050), Water Utilities (55104010), Steel (15104050), Department Stores (25503010), Electric Utilities (55101010) and Construction Machinery & Heavy Trucks (20106010) show a significant positive correlation with WTI returns indicating that these sub-industries are likely to benefit the most from increases in WTI prices. Only Airlines (20302010) exhibit a significant and negative relationship to increases in Brent prices ex post event.

After China's major refined oil pricing mechanism reform on 27<sup>th</sup> March 2013, it is observed in Table 7b that 11 GICS sub-industries (0 positive, 11 negatives) are affected by changes in the price volatility of WTI futures. All of them display significant negative relationships with higher price volatility from WTI and include firms in Copper (15104025), Health Care Services (35102015), Tires & Rubber (25101020), Aerospace & Defense (20101010), Industrial Machinery (20106020), Aluminum (15104010), Hotels, Resorts & Cruise Lines (25301020), Construction Machinery & Heavy Trucks (20106010), Construction Materials (15102010), Auto Parts & Equipment (25101010) and Pharmaceuticals (35202010). This may indicate that with the key reforms that shortens the volatility spill-over, more Chinese industries are exposed to international oil prices volatility.

## **INSERT TABLE 7 HERE**

Results for the 1-day lagged Brent returns during the pre-event period are provided on Table 8a and show that 34 GICS sub-industries (6 positives and 28 negatives) are significantly impacted by changes in Brent crude oil future prices and have regression coefficients above 0. Chinese listed companies in and Gold (15104030), Coal & Consumable Fuels (10102050), Diversified Metals & Mining (15104020), Specialty Stores (25504040) Aluminum (15104010), Precious Metals & Minerals (15104040) show a significant positive correlation with Brent returns indicating that these sub-industries are likely to benefit the most from increases in Brent prices. Conversely, Airlines (20302010), Health Care Equipment (35101010), Drug Retail (30101010), Airport Services (20305010), Health Care Distributors (35102010), Motorcycle Manufacturers (25102020), Brewers (30201010), Home Furnishings (25201020), Distillers & Vintners (30201020), Pharmaceuticals (35202010), Technology Hardware, Storage & Peripherals (45202030), Health Care Supplies (35101020), Hotels, Resorts & Cruise Lines (25301020), Automobile Manufacturers (25102010), General Merchandise Stores (25503020), Consumer Electronics (25201010), Personal Products (30302010), Department Stores (25503010), Real Estate Development (60102030), Packaged Foods & Meats (30202030), Electronic Components (45203015), Construction Machinery & Heavy Trucks (20106010), Apparel, Accessories & Luxury Goods (25203010), Diversified Real Estate Activities (60102010), Distributors (25501010), Independent Power Producers & Energy Traders (55105010), Construction & Engineering (20103010) and Electrical Components & Equipment (20104010) are negatively affected by increases in Brent prices.

Table 8b demonstrates that Chinese listed firms listed in 3 GICS sub-industries (2 positive and 1 negative) are affected by 1-day lagged Brent futures price volatility. Companies in Electronic Manufacturing Services (45203020) and Regional Banks (40101015) observe a positive relationship, whereas Railroads (20304010) exhibit statistically significant negative regression coefficients that above 0.

### **INSERT TABLE 8 HERE**

Results from Table 9a illustrate that for the post-event sample, there are 37 GICS sub-industries (36 positives and 1 negatives) that are affected by changes in Brent crude oil future prices and have regression coefficients above 0. The results suggest that Oil & Gas Exploration & Production (10102020), Oil & Gas Equipment & Services (10101020), Integrated Oil & Gas (10102010), Oil & Gas Storage & Transportation (10102040), Drug Retail (30101010), Multi-

Utilities (55103010), Diversified Metals & Mining (15104020), Gold (15104030), Health Care Equipment (35101010), Commercial Printing (20201010), Coal & Consumable Fuels (10102050), Gas Utilities (55102010), Fertilizers & Agricultural Chemicals (15101030), Aerospace & Defense (20101010), Aluminum (15104010), Trading Companies & Distributors (20107010), Commodity Chemicals (15101010), Agricultural Products (30202010), Automotive Retail (25504050), Steel (15104050), Textiles (25203030), Hotels, Resorts & Cruise Lines (25301020), Industrial Machinery (20106020), Electric Utilities (55101010), Distributors (25501010), Industrial Conglomerates (20105010), Electronic Components (45203015), Real Estate Operating Companies (60102020), Health Care Distributors (35102010), Water Utilities (55104010), Paper Products (15105020), Construction Machinery & Heavy Trucks (20106010), Renewable Electricity (55105020), Electrical Components & Equipment (20104010), Auto Parts & Equipment (25101010) and Real Estate Development (60102030) exhibits positive above 0 regression coefficients suggesting their stock returns are most likely to benefit from increases in Brent future prices. Only stock returns of Airlines (20302010) display a negative relationship indicating an adverse reaction to higher Brent prices.

Table 9b provide evidence to show that 44 GICS sub-industries (0 positive, 44 negatives) are affected by changes in the price volatility of Brent futures. Consistent with the findings from WTI futures, all of them demonstrate significant negative relationships with higher price volatility from Brent and include firms in Tires & Rubber (25101020), Aerospace & Defense (20101010), Oil & Gas Storage & Transportation (10102040), Copper (15104025), Health Care Facilities (35102020), Motorcycle Manufacturers (25102020), Systems Software (45103020), Home Furnishings (25201020), Other Diversified Financial Services (40201020), Industrial Conglomerates (20105010), Aluminum (15104010), Technology Distributors (45203030), Hotels, Resorts & Cruise Lines (25301020), Industrial Machinery (20106020), Agricultural Products (30202010), Diversified Chemicals (15101020), Marine Ports & Services (20305030), Auto Parts & Equipment (25101010), Construction Machinery & Heavy Trucks (20106010), Specialty Stores (25504040), Construction Materials (15102010), IT Consulting & Other Services (45102010), Consumer Electronics (25201010), Semiconductors (45301020), Trading Companies & Distributors (20107010), Oil & Gas Equipment & Services (10101020), Electric Utilities (55101010), Communications Equipment (45201020), Automotive Retail (25504050), Packaged Foods & Meats (30202030), Diversified Real Estate Activities (60102010), Personal Products (30302010), Health Care Distributors (35102010), Paper Products (15105020), Fertilizers & Agricultural Chemicals (15101030), Distributors



(25501010), Apparel, Accessories & Luxury Goods (25203010), Gas Utilities (55102010), Electrical Components & Equipment (20104010), Commodity Chemicals (15101010), Pharmaceuticals (35202010), Heavy Electrical Equipment (20104020), Renewable Electricity (55105020) and Automobile Manufacturers (25102010).

## **INSERT TABLE 9 HERE**

### **5. Discussion of results**

The first part of this study examines how returns and price volatility of 4 major energy future contracts impacts various listed companies in China as grouped by the GICS sub-industry classifications. Using a 3 factor Fama and French model, results suggest that over the period from 1<sup>st</sup> March 2006 to 31<sup>st</sup> December 2018, crude oil futures (i.e. WTI and Brent) are the most influential compared with Henry Hub natural gas and Newcastle thermal coal.

This research further extends the analysis by segregating the sample period into pre-and-post the most recent China oil pricing reform of 27<sup>th</sup> March 2013. The revision of the pricing mechanism is regarded as a major step in market-oriented pricing for refined oil, since this new automatic pricing mechanism shortens the current price adjustment cycle from 22 working days to 10 working days and removes the 4% threshold in world oil-price-fluctuation. One of the key observations from this study is that prior to this event, listed companies in China appears relatively insulated from the price volatility in international oil pricing benchmarks (i.e. WTI and Brent). After the oil pricing reform, it is observed that the stock returns of Chinese sub-industries that are exposed to world oil-price-fluctuation has increased substantially. For example, during the pre-event sample, only 3 GICS sub-industries (2 positive and 1 negative) are affected by both 1-day lagged WTI and Brent futures price volatility. In the post-event sample, WTI's price volatility affects 11 GICS sub-industries (0 positive, 11 negatives) and more importantly, price volatility for Brent oil futures impacts 44 GICS sub-industries (0 positive, 44 negatives). It is noteworthy that after this key oil reform, stock returns of all affected GICS sub-industries have significant and negative relationships with heightened crude oil price volatility.

Findings from this research also indicate that overall, during the pre-event sample 22 GICS subindustries (4 positives and 18 negatives) and 34 GICS subindustries (6 positives and 28 negatives) are affected by changes in returns of WTI and Brent futures, respectively. In the

post-event sample, 26 GICS subindustries (25 positives and 1 negatives) and 37 GICS subindustries (36 positives and 1 negatives). While the absolute number of GIC sub-industries that are impacted by variations in WTI and Brent futures returns have only increased slightly, the stock returns of most GICS sub-industries appear to be more positively affected by increases in global crude oil prices (except Airlines). Industries that appear to benefit the most are linked to oil productions and include Chinese listed companies in the Oil & Gas Exploration & Production (10102020), Oil & Gas Equipment & Services (10101020), Integrated Oil & Gas (10102010) and Oil & Gas Storage & Transportation (10102040). The analysis of regression coefficients indicate major increases in the positive coefficients of these stocks *ex post* key reform event and suggest that a 1% rise in WTI (Brent) oil prices is likely to increase stock returns of Oil & Gas Exploration & Production (10102020) by 0.149% (0.175%), Oil & Gas Equipment & Services (10101020) by 0.13% (0.157%), Integrated Oil & Gas (10102010) by 0.123% (0.138%) and Oil & Gas Storage & Transportation (10102040) by 0.103% (0.116%).

Overall, it may be worth highlighting that the global benchmark Brent crude oil future prices appear to have more influence on Chinese listed stocks compared to the North American focused WTI future prices, particularly after the key China oil pricing reform on 27<sup>th</sup> March 2013.

## **6. Conclusion**

In conclusion, this paper provides empirical evidence that crude oil futures have the most influence on Chinese stocks compared with natural gas and coal. Further analysis shows that after the key China oil pricing reform on 27<sup>th</sup> March 2013, Chinese stocks appears to be more exposed to global crude oil fluctuations and sub-industries related to oil production have benefited from the international alignment of Chinese oil price to international markets. Results are consistent across both WTI and Brent crude oil futures.

## References

- Basher, S.A., Haug, A.A., Sadorsky, P., 2012. Oil prices, exchange rates and emerging stock markets. *Energy Economics*. 34 (1), 227–240.
- Batten, J. A., Kinateder, H., Szilagyi, P. G., & Wagner, N. F. 2017. Can stock market investors hedge energy risk? Evidence from Asia. *Energy Economics*, 66. 559-570.
- Bouri, E., Chen, Q., Lien, D., Lv, X., 2017. Causality between oil prices and the stock market in China: the relevance of the reformed oil product pricing mechanism. *International Review of Economics and Finance*. 48, 34–48.
- Broadstock, D.C., Cao, H., Zhang, D., 2012. Oil shocks and their impact on energy related stocks in China. *Energy Economics*. 34 (6), 1888–1895.
- Broadstock, D.C., Fan, Y., Ji, Q., Zhang, D., 2016. Shocks and stocks: a bottom-up assessment of the relationship between oil prices, gasoline prices and the returns of Chinese firms. *Energy Journal*. 37, 55–86.
- Chen, Q., Lv, X., 2015. The extreme-value dependence between the crude oil price and Chinese stock markets. *International Review of Economics and Finance*. 39, 121–132.
- Cong, R.G., Wei, Y.M., Jiao, J.L., Fan, Y., 2008. Relationships between oil price shocks and stock market: an empirical analysis from China. *Energy Policy*. 36 (9), 3544–3553.
- Ding, H., Kim, H.G., Park, S.Y., 2016. Crude oil and stock markets: causal relationships in tails? *Energy Economics*. 59, 58–69.
- Ding, Z., Liu, Z., Zhang, Y., Long, R., 2017. The contagion effect of international crude oil price fluctuations on Chinese stock market investor sentiment. *Applied Energy*. 187, 27–36.
- Driesprong, G., Jacobsen, B., Maat, B., 2008. Striking oil: Another puzzle? *Journal of Financial Economics*. 89, 307–327.
- Elyasiani, E., Mansur, I., & Odusami, B. 2011. Oil price shocks and industry stock returns. *Energy Economic*. 33(5), 966-974.
- Ghosh, S., Kanjilal, K., 2016. Co-movement of international crude oil price and Indian stock market: evidences from nonlinear cointegration tests. *Energy Economics*. 53, 111–117.
- Huang, R.D., Masulis, R.W., Stoll, H.R., 1996. Energy shocks and financial markets. *Journal of Futures Market*. 16, 1–27.
- Jammazi, R., Ferrer, R., Jareño, F., Shahzad, S.J.H., 2017. Time-varying causality between crude oil and stock markets: what can we learn from a multiscale perspective? *International Review of Economics and Finance*. 49, 453–483.
- Jones, C.M., Kaul, G., 1996. Oil and the stock markets. *Journal of Finance*. 51 (2), 463–491.
- Kang, W., Ratti, R.A., Yoon, K.H., 2015. The impact of oil price shocks on the stock market return and volatility relationship. *Journal of International Financial Markets, Institutions and Money*. 34, 41–54.
- Kilian, L., & Park, C. 2009. The impact of oil price shocks on the US stock market. *International Economic Review*, 50(4), 1267-1287.
- Li, S.F., Zhu, H.M., Yu, K., 2012. Oil prices and stock market in China: a sector analysis using panel cointegration with multiple breaks. *Energy Economics*. 34 (6), 1951–1958.
- Luo, X., Qin, S., 2017. Oil price uncertainty and Chinese stock returns: new evidence from the oil volatility index. *Finance Research Letters*. 20, 29–34.

- Miller, J. I., & Ratti, R. A. (2009). Crude oil and stock markets: Stability, instability, and bubbles. *Energy Economics*, 31(4), 559-568.
- Nguyen, C.C., Bhatti, M.I., 2012. Copula model dependency between oil prices and stock markets: evidence from China and Vietnam. *Journal of International Financial Markets, Institutions and Money*. 22 (4), 758–773.
- Peng, C., Zhu, H., Guo, Y. and Chen, X., 2018. Risk spillover of international crude oil to China's firms: Evidence from granger causality across quantile. *Energy Economics*. 72, pp.188-199.
- Sadorsky, P., 2001. Risk factors in stock returns of Canadian oil and gas companies. *Energy Economics*. 23, 17–28.
- Wang, X., Zhang, C., 2014. The impacts of global oil price shocks on China' s fundamental industries. *Energy Policy* 6. 394–402.
- You, W., Guo, Y., Zhu, H., & Tang, Y. 2017. Oil price shocks, economic policy uncertainty and industry stock returns in China: Asymmetric effects with quantile regression. *Energy Economics*, 68, 1-18.
- Zhang, C., Chen, X., 2011. The impact of global oil price shocks on China's stock returns: evidence from the ARJI (-ht)-EGARCH model. *Energy* 36 (11), 6627–6633.

Table 1: GICS distribution of stocks listed in Shanghai Stock Exchange and Shenzhen Stock Exchange

Table 1 provides the distribution of stocks listed in Shanghai Stock Exchange and Shenzhen Stock Exchange based on the GICS sub-industry classification system.

GICS Sub Industry	GICS Sub Industry Name	Firms	GICS Sub Industry	GICS Sub Industry Name	Firms	GICS Sub Industry	GICS Sub Industry Name	Firms
10101010	Oil & Gas Drilling	1	20305030	Marine Ports & Services	19	35202010	Pharmaceuticals	175
10101020	Oil & Gas Equipment & Services	25	25101010	Auto Parts & Equipment	120	35203010	Life Sciences Tools & Services	8
10102010	Integrated Oil & Gas	3	25101020	Tires & Rubber	12	40101010	Diversified Banks	10
10102020	Oil & Gas Exploration & Production	3	25102010	Automobile Manufacturers	17	40101015	Regional Banks	13
10102030	Oil & Gas Refining & Marketing	5	25102020	Motorcycle Manufacturers	6	40201020	Other Diversified Financial Services	2
10102040	Oil & Gas Storage & Transportation	8	25201010	Consumer Electronics	19	40201040	Specialized Finance	2
10102050	Coal & Consumable Fuels	27	25201020	Home Furnishings	20	40202010	Consumer Finance	3
15101010	Commodity Chemicals	179	25201030	Homebuilding	2	40203010	Asset Management & Custody Banks	3
15101020	Diversified Chemicals	5	25201040	Household Appliances	35	40203020	Investment Banking & Brokerage	36
15101030	Fertilizers & Agricultural Chemicals	52	25201050	Housewares & Specialties	11	40203040	Financial Exchanges & Data	3
15101040	Industrial Gases	1	25202010	Leisure Products	24	40301020	Life & Health Insurance	2
15101050	Specialty Chemicals	91	25203010	Apparel, Accessories & Luxury Goods	48	40301030	Multi-line Insurance	2
15102010	Construction Materials	37	25203020	Footwear	6	45102010	IT Consulting & Other Services	53
15103010	Metal & Glass Containers	11	25203030	Textiles	48	45102020	Data Processing & Outsourced Services	3
15103020	Paper Packaging	19	25301020	Hotels, Resorts & Cruise Lines	26	45102030	Internet Services & Infrastructure	7
15104010	Aluminum	26	25301030	Leisure Facilities	5	45103010	Application Software	54
15104020	Diversified Metals & Mining	51	25301040	Restaurants	4	45103020	Systems Software	21
15104025	Copper	6	25302010	Education Services	3	45201020	Communications Equipment	93
15104030	Gold	8	25302020	Specialized Consumer Services	7	45202030	Technology Hardware, Storage & Peripherals	25
15104040	Precious Metals & Minerals	3	25501010	Distributors	15	45203010	Electronic Equipment & Instruments	102
15104050	Steel	71	25502020	Internet & Direct Marketing Retail	6	45203015	Electronic Components	107
15105010	Forest Products	12	25503010	Department Stores	37	45203020	Electronic Manufacturing Services	8
15105020	Paper Products	24	25503020	General Merchandise Stores	9	45203030	Technology Distributors	8
20101010	Aerospace & Defense	27	25504010	Apparel Retail	3	45301010	Semiconductor Equipment	9
20102010	Building Products	39	25504020	Computer & Electronics Retail	3	45301020	Semiconductors	55
20103010	Construction & Engineering	86	25504040	Specialty Stores	5	50101010	Alternative Carriers	3
20104010	Electrical Components & Equipment	167	25504050	Automotive Retail	7	50101020	Integrated Telecommunication Services	5
20104020	Heavy Electrical Equipment	45	25504060	Homefurnishing Retail	1	50102010	Wireless Telecommunication Services	2
20105010	Industrial Conglomerates	7	30101010	Drug Retail	4	50201010	Advertising	14
20106010	Construction Machinery & Heavy Trucks	60	30101020	Food Distributors	1	50201020	Broadcasting	2
20106015	Agricultural & Farm Machinery	3	30101030	Food Retail	9	50201030	Cable & Satellite	9
20106020	Industrial Machinery	250	30101040	Hypermarkets & Super Centers	5	50201040	Publishing	25
20107010	Trading Companies & Distributors	40	30201010	Brewers	7	50202010	Movies & Entertainment	30
20201010	Commercial Printing	7	30201020	Distillers & Vintners	29	50202020	Interactive Home Entertainment	21
20201050	Environmental & Facilities Services	44	30201030	Soft Drinks	1	50203010	Interactive Media & Services	3
20201060	Office Services & Supplies	9	30202010	Agricultural Products	34	55101010	Electric Utilities	16
20201070	Diversified Support Services	5	30202030	Packaged Foods & Meats	93	55102010	Gas Utilities	10
20202010	Human Resource & Employment Services	1	30301010	Household Products	7	55103010	Multi-Utilities	3
20202020	Research & Consulting Services	25	30302010	Personal Products	11	55104010	Water Utilities	19
20301010	Air Freight & Logistics	25	35101010	Health Care Equipment	25	55105010	Independent Power Producers & Energy Traders	32
20302010	Airlines	6	35101020	Health Care Supplies	14	55105020	Renewable Electricity	15
20303010	Marine	7	35102010	Health Care Distributors	18	60102010	Diversified Real Estate Activities	35
20304010	Railroads	5	35102015	Health Care Services	4	60102020	Real Estate Operating Companies	12
20304020	Trucking	13	35102020	Health Care Facilities	3	60102030	Real Estate Development	94
20305010	Airport Services	6	35103010	Health Care Technology	5	60102040	Real Estate Services	1
20305020	Highways & Railtracks	16	35201010	Biotechnology	37	-	No classification	209

Table 2a: GICS Sub-Industries affected by changes in WTI Oil Futures 1-Day Lagged Returns

Table 2a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of WTI Oil Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0*	0.06**	-0.001*	0.665**	-0.019	0.888**	0.528
		0.989	0.000	0.966	0.000	0.638	0.000	
10102010	Integrated Oil & Gas	0.000	0.045**	0.015	0.813**	0.11*	1.002**	0.460
		0.665	0.007	0.431	0.000	0.031	0.000	
10102050	Coal & Consumable Fuels	0.000	0.069**	0.006	0.643**	0.103**	1.151**	0.683
		0.805	0.000	0.681	0.000	0.004	0.000	
15101030	Fertilizers & Agricultural Chemicals	0.000	0.025*	-0.001	0.944**	0.036	0.976**	0.707
		0.545	0.010	0.930	0.000	0.244	0.000	
15103020	Paper Packaging	0.000	0*	0.009	0.807**	-0.213**	0.254**	0.194
		0.438	0.983	0.585	0.000	0.000	0.000	
15104010	Aluminum	0.000	0.045**	-0.010	0.643**	0.016	1.144**	0.634
		0.621	0.000	0.506	0.000	0.694	0.000	
15104020	Diversified Metals & Mining	0.000	0.071**	0.008	0.524**	-0.085*	1.066**	0.645
		0.945	0.000	0.587	0.000	0.020	0.000	
15104030	Gold	0.000	0.086**	0.032	0.601**	0.031	0.824**	0.399
		0.561	0.000	0.085	0.000	0.518	0.000	
15104050	Steel	0.000	0.018*	-0.004	0.867**	0.097**	1.018**	0.764
		0.341	0.034	0.679	0.000	0.000	0.000	
20302010	Airlines	0.000	-0.121**	0.004	0.157*	-0.031	1.102**	0.482
		0.820	0.000	0.852	0.039	0.531	0.000	
20303010	Marine	0.001	-0.027*	-0.027	0.882**	0.038	1.065**	0.587
		0.095	0.046	0.097	0.000	0.366	0.000	
20305010	Airport Services	0.001**	-0.025*	-0.029*	0.266**	0.011	0.858**	0.595
		0.007	0.012	0.014	0.000	0.720	0.000	
25101020	Tires & Rubber	0.001	0**	-0.027	0.952**	0.091	0.835**	0.427
		0.195	0.999	0.143	0.000	0.058	0.000	
25102010	Automobile Manufacturers	0.000	-0.022*	-0.002	0.617**	0.052	0.975**	0.699
		0.345	0.021	0.845	0.000	0.076	0.000	
25102020	Motorcycle Manufacturers	0.001	-0.034*	-0.022	1.469**	0.076	0.941**	0.477
		0.060	0.049	0.276	0.000	0.151	0.000	
25201010	Consumer Electronics	0.001	-0.047**	-0.013	0.975**	-0.053	0.866**	0.553
		0.167	0.000	0.389	0.000	0.183	0.000	
25504040	Specialty Stores	-0.001	0.055**	0.022	0.561**	0.014	0.888**	0.353
		0.367	0.002	0.312	0.000	0.803	0.000	
30201010	Brewers	0.001	-0.037**	-0.009	0.352**	-0.074	0.904**	0.537
		0.258	0.002	0.527	0.000	0.052	0.000	
30201020	Distillers & Vintners	0.001	-0.035**	-0.004	0.434**	-0.099**	0.948**	0.617
		0.262	0.002	0.751	0.000	0.004	0.000	
35202010	Pharmaceuticals	0.001	-0.022*	-0.010	0.535**	-0.082**	0.868**	0.671
		0.100	0.015	0.373	0.000	0.004	0.000	
40203040	Financial Exchanges & Data	-0.001	0.042*	0.017	0.909**	-0.261**	0.373**	0.193
		0.150	0.021	0.444	0.000	0.000	0.000	
45202030	Technology Hardware, Storage & Peripherals	0.000	-0.032*	-0.007	0.934**	-0.062	0.971**	0.598
		0.494	0.012	0.620	0.000	0.114	0.000	
45203020	Electronic Manufacturing Services	-0.001	0.001*	0.040	0.604**	-0.036	0.494**	0.135
		0.307	0.968	0.106	0.000	0.578	0.000	
50101010	Alternative Carriers	0.000	-0.056*	0.020	0.348**	-0.122	1.013**	0.303
		0.826	0.011	0.444	0.001	0.078	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 2b: GICS Sub-Industries affected by changes in WTI Oil Futures 1-Day Lagged Volatility

Table 2b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of WTI Oil Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0*	0.06**	-0.001*	0.665**	-0.019	0.888**	0.528
		0.989	0.000	0.966	0.000	0.638	0.000	
15102010	Construction Materials	0.000	-0.006	-0.001*	0.952**	0.069*	1.026**	0.711
		0.346	0.552	0.955	0.000	0.029	0.000	
20102010	Building Products	0.000	-0.006	0.001*	1.183**	0.095*	0.861**	0.575
		0.402	0.611	0.964	0.000	0.013	0.000	
20103010	Construction & Engineering	0.000	-0.009	0*	0.92**	0.046	1**	0.781
		0.376	0.264	0.984	0.000	0.071	0.000	
20201010	Commercial Printing	0.000	-0.004	0**	1.206**	0.043	0.903**	0.294
		0.832	0.871	0.995	0.000	0.555	0.000	
20304010	Railroads	0.001*	-0.011	-0.027*	0.497**	0.037	0.925**	0.653
		0.037	0.253	0.022	0.000	0.227	0.000	
20305010	Airport Services	0.001**	-0.025*	-0.029*	0.266**	0.011	0.858**	0.595
		0.007	0.012	0.014	0.000	0.720	0.000	
25201020	Home Furnishings	0.001	-0.016	-0.038*	0.533**	0.046	0.972**	0.434
		0.094	0.337	0.047	0.000	0.360	0.000	
25203010	Apparel, Accessories & Luxury Goods	0.000	-0.007	-0.001*	0.975**	0.105**	0.889**	0.661
		0.296	0.511	0.954	0.000	0.001	0.000	
30101010	Drug Retail	0.000	0.004	-0.001*	1.053**	0.006	0.993**	0.412
		0.601	0.822	0.967	0.000	0.921	0.000	
40101010	Diversified Banks	0*	-0.006	0*	-0.339**	0.112**	0.957**	0.620
		0.975	0.541	0.975	0.000	0.000	0.000	
40201040	Specialized Finance	0.000	0.003	0*	0.06*	-0.029	0.043**	0.019
		0.621	0.564	0.968	0.030	0.107	0.000	
50202010	Movies & Entertainment	0.001	0.013	-0.001*	0.957**	-0.032	0.765**	0.488
		0.191	0.307	0.962	0.000	0.435	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 3a: GICS Sub-Industries affected by changes in Brent Oil Futures 1-Day Lagged Returns

Table 3a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of Brent Oil Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1BrentR	Lag1BrentV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0.000	0.079**	-0.016	0.668**	-0.018	0.886**	0.529
		0.432	0.000	0.345	0.000	0.648	0.000	
10102010	Integrated Oil & Gas	0.000	0.066**	-0.001*	0.816**	0.111*	0.999**	0.461
		0.798	0.000	0.975	0.000	0.030	0.000	
10102020	Oil & Gas Exploration & Production	0.001	0.046*	-0.014	0.825**	0.124*	0.913**	0.360
		0.489	0.028	0.584	0.000	0.033	0.000	
10102050	Coal & Consumable Fuels	0.000	0.085**	0.004	0.646**	0.103**	1.149**	0.684
		0.898	0.000	0.788	0.000	0.004	0.000	
15101030	Fertilizers & Agricultural Chemicals	0.001	0.03**	-0.010	0.945**	0.036	0.975**	0.707
		0.250	0.005	0.461	0.000	0.243	0.000	
15104010	Aluminum	0.001	0.056**	-0.024	0.646**	0.016	1.143**	0.634
		0.265	0.000	0.167	0.000	0.687	0.000	
15104020	Diversified Metals & Mining	0.000	0.096**	-0.001*	0.527**	-0.084*	1.064**	0.647
		0.664	0.000	0.953	0.000	0.020	0.000	
15104030	Gold	0.000	0.108**	0.019	0.604**	0.031	0.821**	0.400
		0.947	0.000	0.352	0.000	0.521	0.000	
15104050	Steel	0.001	0.027**	-0.015	0.869**	0.097**	1.017**	0.764
		0.092	0.005	0.201	0.000	0.000	0.000	
15105020	Paper Products	0.001*	0*	-0.028*	0.921**	0.058	0.91**	0.686
		0.024	0.989	0.034	0.000	0.053	0.000	
20302010	Airlines	0.000	-0.123**	0.013	0.155*	-0.029	1.104**	0.480
		0.894	0.000	0.557	0.043	0.560	0.000	
20305010	Airport Services	0.001**	-0.039**	-0.032*	0.266**	0.011	0.859**	0.596
		0.009	0.001	0.020	0.000	0.720	0.000	
25101010	Auto Parts & Equipment	0.001*	0*	-0.019	0.873**	0.015	0.991**	0.742
		0.012	0.966	0.126	0.000	0.596	0.000	
25101020	Tires & Rubber	0.001*	-0.001*	-0.051*	0.954**	0.092	0.834**	0.427
		0.032	0.963	0.015	0.000	0.056	0.000	
25201010	Consumer Electronics	0.001	-0.035*	-0.017	0.976**	-0.050	0.866**	0.552
		0.140	0.015	0.322	0.000	0.204	0.000	
25501010	Distributors	0.001*	0**	-0.023	1.055**	0.054	1.023**	0.736
		0.012	0.992	0.080	0.000	0.075	0.000	
25504040	Specialty Stores	0.000	0.044*	-0.003	0.561**	0.012	0.887**	0.352
		0.934	0.026	0.887	0.000	0.833	0.000	
30301010	Household Products	0.000	0*	-0.001*	1.015**	-0.003*	1**	0.404
		0.921	0.988	0.959	0.000	0.956	0.000	
45202030	Technology Hardware, Storage & Peripherals	0.001	-0.029*	-0.019	0.935**	-0.061	0.97**	0.597
		0.232	0.036	0.272	0.000	0.121	0.000	
45203010	Electronic Equipment & Instruments	0.000	0**	0.007	1.01**	0.082	0.929**	0.527
		0.835	0.994	0.702	0.000	0.058	0.000	
45301020	Semiconductors	0.001	0.001*	-0.016	0.747**	-0.121**	1.026**	0.650
		0.193	0.967	0.293	0.000	0.001	0.000	
50101010	Alternative Carriers	0.000	-0.053*	0.007	0.348**	-0.121	1.014**	0.303
		0.824	0.031	0.819	0.001	0.081	0.000	
50102010	Wireless Telecommunication Services	0.000	0.035*	0.008	0.060	-0.097*	0.925**	0.458
		0.737	0.026	0.663	0.370	0.027	0.000	
60102020	Real Estate Operating Companies	0.001	0*	-0.005	1.005**	0.051	0.933**	0.607
		0.196	0.980	0.754	0.000	0.172	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.



Table 3b: GICS Sub-Industries affected by changes in Brent Oil Futures 1-Day Lagged Volatility

Table 3b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of Brent Oil Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1BrentR	Lag1BrentV	SMB	HML	RM	Adjusted R2
10102010	Integrated Oil & Gas	0.000	0.066**	-0.001*	0.816**	0.111*	0.999**	0.461
		0.798	0.000	0.975	0.000	0.030	0.000	
15104020	Diversified Metals & Mining	0.000	0.096**	-0.001*	0.527**	-0.084*	1.064**	0.647
		0.664	0.000	0.953	0.000	0.020	0.000	
15105020	Paper Products	0.001*	0*	-0.028*	0.921**	0.058	0.91**	0.686
		0.024	0.989	0.034	0.000	0.053	0.000	
20105010	Industrial Conglomerates	0.001**	0.009	-0.036*	1.053**	-0.018	0.969**	0.625
		0.007	0.522	0.027	0.000	0.631	0.000	
20106010	Construction Machinery & Heavy Trucks	0.001*	-0.003	-0.026*	0.634**	-0.017	1.017**	0.762
		0.011	0.717	0.025	0.000	0.528	0.000	
20301010	Air Freight & Logistics	0.000	0.006	0*	1.121**	0.064	0.969**	0.624
		0.465	0.653	0.981	0.000	0.089	0.000	
20304010	Railroads	0.001**	-0.006	-0.038**	0.499**	0.038	0.924**	0.653
		0.010	0.570	0.004	0.000	0.210	0.000	
20305010	Airport Services	0.001**	-0.039**	-0.032*	0.266**	0.011	0.859**	0.596
		0.009	0.001	0.020	0.000	0.720	0.000	
20305030	Marine Ports & Services	0.001*	0.006	-0.034*	0.733**	0.039	0.918**	0.665
		0.021	0.604	0.012	0.000	0.208	0.000	
25101020	Tires & Rubber	0.001*	-0.001*	-0.051*	0.954**	0.092	0.834**	0.427
		0.032	0.963	0.015	0.000	0.056	0.000	
25201020	Home Furnishings	0.002*	-0.026	-0.06**	0.535**	0.047	0.972**	0.435
		0.020	0.151	0.006	0.000	0.355	0.000	
25301020	Hotels, Resorts & Cruise Lines	0.001**	-0.009	-0.036*	0.818**	-0.006	0.938**	0.587
		0.007	0.519	0.031	0.000	0.878	0.000	
25504050	Automotive Retail	0.001*	0.004	-0.041*	0.758**	-0.022	0.927**	0.544
		0.024	0.794	0.020	0.000	0.590	0.000	
30301010	Household Products	0.000	0*	-0.001*	1.015**	-0.003*	1**	0.404
		0.921	0.988	0.959	0.000	0.956	0.000	
30302010	Personal Products	0.001*	-0.013	-0.031*	0.7**	-0.014	0.92**	0.607
		0.040	0.287	0.044	0.000	0.685	0.000	
40101015	Regional Banks	-0.001*	-0.005	0.042*	0.014	0.068	0.831**	0.395
		0.027	0.736	0.028	0.836	0.120	0.000	
50201030	Cable & Satellite	0.001*	-0.006	-0.043*	0.717**	-0.057	1.005**	0.525
		0.037	0.713	0.027	0.000	0.206	0.000	
50202020	Interactive Home Entertainment	0.000	0.022	0.001*	0.908**	0.21**	0.887**	0.346
		0.862	0.282	0.974	0.000	0.000	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 4a: GICS Sub-Industries affected by changes in Henry Hub Natural Gas Futures 1-Day Lagged Returns

Table 4a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of Henry Hub Natural Gas Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1NGR	Lag1NGV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0.000	0.02*	-0.001	0.659**	-0.026	0.892**	0.525
		0.935	0.042	0.923	0.000	0.523	0.000	
10102020	Oil & Gas Exploration & Production	0.000	0.035*	0.003	0.818**	0.119*	0.918**	0.360
		0.927	0.013	0.901	0.000	0.040	0.000	
15104020	Diversified Metals & Mining	-0.001	0.018*	0.020	0.517**	-0.093*	1.07**	0.642
		0.312	0.038	0.124	0.000	0.011	0.000	
15104030	Gold	-0.001	0.029*	0.029	0.593**	0.021	0.828**	0.394
		0.470	0.011	0.091	0.000	0.669	0.000	
15105020	Paper Products	0.000	0*	0.005	0.919**	0.058	0.91**	0.686
		0.950	0.951	0.611	0.000	0.055	0.000	
30101040	Hypermarkets & Super Centers	-0.001	0**	0.009	0.601**	-0.099	0.911**	0.392
		0.348	0.991	0.650	0.000	0.064	0.000	
30201020	Distillers & Vintners	0.000	-0.019*	0.005	0.438**	-0.095**	0.946**	0.616
		0.705	0.021	0.691	0.000	0.005	0.000	
35101020	Health Care Supplies	-0.001	0.025*	0.029	0.279**	-0.090	0.886**	0.399
		0.337	0.034	0.089	0.000	0.065	0.000	
35202010	Pharmaceuticals	0.000	0*	-0.002	0.537**	-0.08**	0.867**	0.671
		0.332	0.986	0.816	0.000	0.005	0.000	
40101010	Diversified Banks	0.000	0**	0.005	-0.338**	0.112**	0.956**	0.620
		0.689	0.992	0.614	0.000	0.000	0.000	
40201040	Specialized Finance	0.000	0*	0.002	0.06*	-0.030	0.043**	0.019
		0.468	0.978	0.762	0.031	0.102	0.000	
45301020	Semiconductors	0.000	0*	0.013	0.746**	-0.121**	1.026**	0.650
		0.604	0.967	0.324	0.000	0.001	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 4b: GICS Sub-Industries affected by changes in Henry Hub Natural Gas Futures 1-Day Lagged Volatility

Table 4b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of Henry Hub Natural Gas Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1NGR	Lag1NGV	SMB	HML	RM	Adjusted R2
20301010	Air Freight & Logistics	0.000	0.006	-0.001*	1.12**	0.064	0.969**	0.624
		0.482	0.499	0.968	0.000	0.091	0.000	
20302010	Airlines	-0.001	-0.014	0.041*	0.169*	-0.018	1.093**	0.473
		0.083	0.247	0.022	0.028	0.713	0.000	
40203010	Asset Management & Custody Banks	0.000	0.008	0*	0.459**	-0.066	0.969**	0.280
		0.742	0.650	0.988	0.000	0.353	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 5a: GICS Sub-Industries affected by changes in Newcastle Thermal Coal Futures 1-Day Lagged Returns

Table 5a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of Newcastle Thermal Coal Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1CoalR	Lag1CoalV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0*	0.057*	-0.079	0.663**	-0.002*	0.891**	0.514
		0.961	0.035	0.477	0.000	0.956	0.000	
10102020	Oil & Gas Exploration & Production	0.000	-0.095*	-0.117	0.618**	0.009	0.813**	0.297
		0.574	0.016	0.464	0.000	0.882	0.000	
15104010	Aluminum	0.000	0.06*	-0.031	0.731**	0.042	1.098**	0.604
		0.840	0.027	0.780	0.000	0.297	0.000	
15104020	Diversified Metals & Mining	0.000	0.056*	-0.109	0.593**	-0.042	1.085**	0.612
		0.173	0.033	0.309	0.000	0.273	0.000	
15104040	Precious Metals & Minerals	0.001	0.084*	-0.189	0.763**	-0.011	1.038**	0.458
		0.217	0.017	0.191	0.000	0.838	0.000	
20101010	Aerospace & Defense	0.001	0.002*	-0.056	0.634**	-0.172**	0.934**	0.474
		0.173	0.953	0.666	0.000	0.000	0.000	
20103010	Construction & Engineering	0.000	-0.001*	-0.064	0.818**	0.008	0.963**	0.753
		0.243	0.964	0.379	0.000	0.767	0.000	
20106010	Construction Machinery & Heavy Trucks	0.000	-0.001*	-0.122	0.667**	-0.010	0.965**	0.722
		0.326	0.956	0.110	0.000	0.721	0.000	
25201040	Household Appliances	0.000	-0.07**	-0.127	0.522**	-0.035	0.972**	0.592
		0.575	0.004	0.200	0.000	0.328	0.000	
25502020	Internet & Direct Marketing Retail	0.000	-0.099*	0.160	0.969**	-0.142*	0.912**	0.308
		0.409	0.040	0.417	0.000	0.046	0.000	
30301010	Household Products	0.000	0.086*	0.043	0.94**	-0.046	0.907**	0.363
		0.913	0.035	0.796	0.000	0.444	0.000	
35101020	Health Care Supplies	0.000	-0.002*	-0.079	0.249**	-0.143**	0.774**	0.324
		0.233	0.962	0.561	0.002	0.004	0.000	
40203040	Financial Exchanges & Data	-0.001	-0.003*	0.165	0.965**	-0.133*	0.631**	0.239
		0.138	0.953	0.368	0.000	0.045	0.000	
55103010	Multi-Utilities	0.000	0**	-0.070	0.957**	-0.005	0.856**	0.378
		0.927	0.992	0.648	0.000	0.931	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 5b: GICS Sub-Industries affected by changes in Newcastle Thermal Coal Futures 1-Day Lagged Volatility

Table 5b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of Newcastle Thermal Coal Futures over the period from 1 March 2006 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1CoalR	Lag1CoalV	SMB	HML	RM	Adjusted R2
20201050	Environmental & Facilities Services	0.000	0.018	0.004*	0.832**	0.007	0.911**	0.520
		0.659	0.537	0.973	0.000	0.875	0.000	
20304010	Railroads	0.000	0.024	0.001**	0.511**	0.022	0.883**	0.634
		0.720	0.238	0.992	0.000	0.462	0.000	
25102010	Automobile Manufacturers	0.000	-0.037	-0.187*	0.566**	0.038	0.941**	0.650
		0.067	0.075	0.027	0.000	0.210	0.000	
25301020	Hotels, Resorts & Cruise Lines	0.000	-0.026	0.003*	0.766**	-0.024	0.856**	0.570
		0.114	0.287	0.977	0.000	0.506	0.000	
35201010	Biotechnology	0.001	-0.018	0.004*	0.531**	-0.14**	0.791**	0.394
		0.083	0.566	0.977	0.000	0.003	0.000	
40301030	Multi-line Insurance	0.001	0.040	-0.43*	0.129	0.001*	1.035**	0.308
		0.307	0.349	0.014	0.207	0.987	0.000	
55105020	Renewable Electricity	0.000	0.013	-0.002*	0.601**	0.031	0.757**	0.554
		0.312	0.528	0.979	0.000	0.326	0.000	
60102020	Real Estate Operating Companies	0.001*	-0.011	0.001**	0.842**	-0.005	0.872**	0.569
		0.032	0.674	0.996	0.000	0.898	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 6a: GICS Sub-Industries affected by changes in WTI Oil Futures 1-Day Lagged Returns (Pre-Event)

Table 6a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of WTI Oil Futures over the pre-event period from 1 March 2006 to 26 March 2013.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
10102010	Integrated Oil & Gas	-0.001	0**	0.034	1.392**	0.025	1.112**	0.548
		0.593	0.999	0.151	0.000	0.822	0.000	
10102050	Coal & Consumable Fuels	0.000	0.088**	0.014	0.73**	0.078	1.185**	0.725
		0.794	0.000	0.410	0.000	0.320	0.000	
15104010	Aluminum	-0.001	0.047**	0.015	0.448**	-0.301**	1.254**	0.685
		0.461	0.004	0.446	0.000	0.001	0.000	
15104020	Diversified Metals & Mining	0.000	0.076**	0.020	0.136	-0.475**	1.126**	0.694
		0.589	0.000	0.234	0.131	0.000	0.000	
15104030	Gold	0.000	0.105**	0.034	0.613**	-0.343**	0.919**	0.487
		0.659	0.000	0.117	0.000	0.001	0.000	
15105010	Forest Products	0.000	-0.001*	0.006	1.466**	-0.266**	0.951**	0.582
		0.888	0.963	0.749	0.000	0.003	0.000	
20103010	Construction & Engineering	0**	-0.023*	0.010	1.159**	-0.077	1.056**	0.822
		0.992	0.019	0.401	0.000	0.150	0.000	
20104010	Electrical Components & Equipment	0.000	-0.029**	0.013	0.493**	-0.53**	1.037**	0.762
		0.688	0.009	0.324	0.000	0.000	0.000	
20106010	Construction Machinery & Heavy Trucks	0.000	-0.027**	0.004	0.522**	-0.203**	1.087**	0.805
		0.645	0.010	0.731	0.000	0.000	0.000	
20302010	Airlines	0.001	-0.084**	-0.018	0.260	-0.136	1.144**	0.500
		0.330	0.000	0.488	0.061	0.259	0.000	
20303010	Marine	0.001	-0.033*	-0.042*	1.055**	0.020	1.121**	0.664
		0.061	0.039	0.025	0.000	0.817	0.000	
20305010	Airport Services	0.001	-0.038**	-0.025	-0.035	-0.096	0.839**	0.633
		0.165	0.002	0.083	0.652	0.153	0.000	
20305020	Highways & Railtracks	0.000	-0.023*	-0.011	0.906**	0.208**	0.904**	0.717
		0.869	0.047	0.422	0.000	0.001	0.000	
25102010	Automobile Manufacturers	0.000	-0.042**	0.016	0.77**	-0.102	1.044**	0.734
		0.659	0.001	0.278	0.000	0.129	0.000	
25102020	Motorcycle Manufacturers	0.001	-0.06**	-0.002	2.031**	-0.163	1.061**	0.547
		0.409	0.004	0.921	0.000	0.146	0.000	
25201010	Consumer Electronics	0.000	-0.051**	0.008	1.045**	-0.339**	0.896**	0.586
		0.814	0.001	0.671	0.000	0.000	0.000	
25201040	Household Appliances	0.001	-0.039**	-0.009	1.12**	-0.154	0.977**	0.640
		0.302	0.008	0.601	0.000	0.056	0.000	
25203030	Textiles	0.000	-0.025*	0.009	1.683**	-0.141*	1.073**	0.746
		0.811	0.050	0.534	0.000	0.046	0.000	
25301020	Hotels, Resorts & Cruise Lines	0.000	-0.047**	-0.002	0.905**	-0.385**	1.025**	0.619
		0.509	0.003	0.921	0.000	0.000	0.000	
25301030	Leisure Facilities	0.000	-0.044*	0.013	1.559**	-0.216	0.959**	0.485
		0.941	0.033	0.579	0.000	0.054	0.000	
25302010	Education Services	-0.001	-0.044*	0.010	1.277**	-0.479**	1.059**	0.557
		0.535	0.022	0.644	0.000	0.000	0.000	
25501010	Distributors	0*	-0.025*	0.011	1.376**	-0.084	1.104**	0.808
		0.975	0.022	0.368	0.000	0.159	0.000	
25503010	Department Stores	0.001	-0.039**	-0.002	0.933**	-0.231**	0.928**	0.693
		0.292	0.001	0.902	0.000	0.001	0.000	
25503020	General Merchandise Stores	0.001	-0.03*	-0.021	0.522**	-0.374**	0.91**	0.663
		0.109	0.017	0.161	0.000	0.000	0.000	
25504020	Computer & Electronics Retail	-0.001	-0.048*	0.008	1.194**	-0.597**	1.002**	0.431
		0.637	0.037	0.780	0.000	0.000	0.000	
25504040	Specialty Stores	-0.002	0.071**	0.056	0.364*	-0.152	0.883**	0.314

		0.078	0.005	0.058	0.023	0.272	0.000	
25504050	Automotive Retail	0.001	-0.038*	-0.025	0.682**	-0.41**	0.978**	0.550
		0.225	0.029	0.216	0.000	0.000	0.000	
30201010	Brewers	0.000	-0.059**	-0.006	-0.180	-0.758**	0.969**	0.549
		0.614	0.000	0.746	0.085	0.000	0.000	
30201020	Distillers & Vintners	0.001	-0.053**	-0.010	0.236*	-0.732**	1.02**	0.637
		0.191	0.000	0.579	0.011	0.000	0.000	
30202010	Agricultural Products	0.001	0*	-0.002	1.22**	-0.347**	1.024**	0.621
		0.482	0.982	0.926	0.000	0.000	0.000	
30202030	Packaged Foods & Meats	0.000	-0.028*	0.008	1.091**	-0.427**	1.035**	0.764
		0.808	0.016	0.566	0.000	0.000	0.000	
30302010	Personal Products	0.001	-0.03*	-0.013	0.444**	-0.332**	0.975**	0.640
		0.289	0.033	0.445	0.000	0.000	0.000	
35101010	Health Care Equipment	0.000	-0.056**	0.034	0.200	-0.805**	1.036**	0.457
		0.655	0.009	0.173	0.140	0.000	0.000	
35101020	Health Care Supplies	-0.001	-0.038*	0.023	0.287*	-0.547**	0.995**	0.496
		0.404	0.047	0.303	0.018	0.000	0.000	
35102010	Health Care Distributors	0*	-0.047**	0.012	0.211*	-0.656**	0.916**	0.520
		0.952	0.005	0.536	0.046	0.000	0.000	
35202010	Pharmaceuticals	0.000	-0.044**	0.003	0.392**	-0.667**	0.934**	0.697
		0.540	0.000	0.829	0.000	0.000	0.000	
40201040	Specialized Finance	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	
45103020	Systems Software	-0.001	-0.043*	0.020	-0.433**	-1.257**	1.008**	0.476
		0.249	0.030	0.377	0.001	0.000	0.000	
45202030	Technology Hardware, Storage & Peripherals	0.000	-0.046**	0.007	1.019**	-0.532**	1.068**	0.668
		0.506	0.002	0.703	0.000	0.000	0.000	
45203015	Electronic Components	0.000	-0.029*	0.016	1.008**	-0.512**	1.088**	0.745
		0.459	0.020	0.285	0.000	0.000	0.000	
50101010	Alternative Carriers	0*	-0.067*	0.021	0.593**	-0.424**	1.115**	0.343
		0.959	0.025	0.551	0.002	0.009	0.000	
50201020	Broadcasting	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	
50202010	Movies & Entertainment	0.001	-0.001*	0.004	1.134**	-0.47**	0.864**	0.595
		0.391	0.951	0.826	0.000	0.000	0.000	
55105010	Independent Power Producers & Energy Traders	0.000	-0.022*	0.018	0.951**	0.219**	0.952**	0.759
		0.328	0.040	0.156	0.000	0.000	0.000	
60102010	Diversified Real Estate Activities	0.000	-0.022*	0.022	1.264**	-0.015	1.009**	0.807
		0.440	0.029	0.065	0.000	0.778	0.000	
60102030	Real Estate Development	0.000	-0.028**	0.007	1.303**	0.275**	1.068**	0.824
		0.945	0.006	0.552	0.000	0.000	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 6b: GICS Sub-Industries affected by changes in WTI Oil Futures 1-Day Lagged Volatility (Pre-Event)

Table 6b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of WTI Oil Futures over the pre-event period from 1 March 2006 to 26 March 2013.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
20303010	Marine	0.001	-0.033*	-0.042*	1.055**	0.020	1.121**	0.664
		0.061	0.039	0.025	0.000	0.817	0.000	
25101020	Tires & Rubber	0.000	-0.018	-0.001*	1.053**	-0.214*	0.937**	0.531
		0.727	0.295	0.950	0.000	0.026	0.000	
30301010	Household Products	0.000	-0.036	0.001*	1.183**	-0.337*	1.118**	0.457
		0.703	0.134	0.975	0.000	0.011	0.000	
35201010	Biotechnology	0.001	-0.021	0.001*	-0.024	-1**	0.896**	0.496
		0.186	0.222	0.970	0.824	0.000	0.000	
40101015	Regional Banks	-0.002**	-0.007	0.047*	0.054	0.286**	0.737**	0.450
		0.006	0.672	0.012	0.597	0.001	0.000	
40201040	Specialized Finance	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	
45203020	Electronic Manufacturing Services	-0.002	-0.008	0.081**	0.635**	-0.227	0.527**	0.143
		0.053	0.745	0.008	0.000	0.110	0.000	
50201020	Broadcasting	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	
50202020	Interactive Home Entertainment	0.000	0.020	0.001*	1.829**	0.048	1.105**	0.556
		0.831	0.329	0.953	0.000	0.668	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 7a: GICS Sub-Industries affected by changes in WTI Oil Futures 1-Day Lagged Returns (Post-Event)

Table 7a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of WTI Oil Futures over the post-event period from 27 March 2013 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0.001	0.13**	-0.028	0.781**	0.012	0.791**	0.483
		0.333	0.000	0.293	0.000	0.810	0.000	
10102010	Integrated Oil & Gas	0.000	0.123**	-0.021	0.667**	-0.022	0.758**	0.356
		0.927	0.000	0.525	0.000	0.705	0.000	
10102020	Oil & Gas Exploration & Production	0.001	0.149**	-0.046	0.676**	-0.094	0.511**	0.223
		0.290	0.000	0.222	0.000	0.171	0.000	
10102040	Oil & Gas Storage & Transportation	0.003*	0.103**	-0.071	0.875**	0.066	0.682**	0.279
		0.016	0.001	0.061	0.000	0.342	0.000	
10102050	Coal & Consumable Fuels	0.000	0.038*	-0.012	0.653**	0.071	1.066**	0.618
		0.915	0.042	0.589	0.000	0.093	0.000	
15101010	Commodity Chemicals	0.001	0.048**	-0.028	0.942**	0.036	0.806**	0.711
		0.051	0.001	0.101	0.000	0.254	0.000	
15101030	Fertilizers & Agricultural Chemicals	0.001	0.053**	-0.027	0.961**	0.032	0.841**	0.667
		0.135	0.001	0.169	0.000	0.372	0.000	
15104010	Aluminum	0.001	0.044*	-0.052*	0.915**	0.049	0.889**	0.568
		0.081	0.027	0.034	0.000	0.272	0.000	
15104020	Diversified Metals & Mining	0.001	0.061**	-0.016	0.81**	0.025	0.95**	0.590
		0.535	0.002	0.505	0.000	0.570	0.000	
15104030	Gold	0.000	0.057*	0.025	0.73**	0.053	0.635**	0.297
		0.671	0.027	0.427	0.000	0.367	0.000	
15104050	Steel	0.001	0.033*	-0.017	0.854**	0.027	0.861**	0.675
		0.208	0.030	0.363	0.000	0.441	0.000	
20101010	Aerospace & Defense	0.002*	0.048*	-0.069*	0.904**	-0.039	0.864**	0.476
		0.017	0.048	0.022	0.000	0.474	0.000	
20106010	Construction Machinery & Heavy Trucks	0.001*	0.028*	-0.048**	0.795**	0.001*	0.855**	0.710
		0.011	0.046	0.005	0.000	0.973	0.000	
20106020	Industrial Machinery	0.002**	0.04*	-0.055**	0.978**	0.021	0.843**	0.674
		0.007	0.013	0.005	0.000	0.554	0.000	
20107010	Trading Companies & Distributors	0.001	0.041**	-0.031	0.953**	0.041	0.864**	0.723
		0.053	0.004	0.076	0.000	0.197	0.000	
20301010	Air Freight & Logistics	0.000	0.048*	0.005	1.081**	0.060	0.851**	0.547
		0.625	0.026	0.862	0.000	0.211	0.000	
20302010	Airlines	-0.001	-0.18**	0.040	0.168	-0.054	1.012**	0.452
		0.242	0.000	0.159	0.050	0.289	0.000	
25203030	Textiles	0.001	0.041*	-0.018	1.162**	0.041	0.702**	0.603
		0.187	0.020	0.420	0.000	0.300	0.000	
25503010	Department Stores	0.001	0.033*	-0.020	0.939**	0.007	0.795**	0.669
		0.214	0.031	0.294	0.000	0.833	0.000	
25504050	Automotive Retail	0.001	0.047*	-0.030	0.843**	0.050	0.867**	0.546
		0.234	0.019	0.225	0.000	0.266	0.000	
30101010	Drug Retail	0.001	0.091**	-0.004	1.037**	0.058	0.917**	0.402
		0.564	0.002	0.904	0.000	0.388	0.000	
40201020	Other Diversified Financial Services	0.001	0.06*	-0.027	0.588**	-0.003*	1.113**	0.455
		0.558	0.028	0.430	0.000	0.966	0.000	
55101010	Electric Utilities	0.001	0.031*	-0.037	0.958**	0.059	0.818**	0.672
		0.074	0.042	0.050	0.000	0.087	0.000	
55102010	Gas Utilities	0.001	0.044*	-0.017	0.771**	0.108**	0.85**	0.553
		0.335	0.017	0.451	0.000	0.010	0.000	
55103010	Multi-Utilities	0.001	0.093**	-0.045	1.029**	-0.009	0.772**	0.360
		0.492	0.002	0.223	0.000	0.889	0.000	
55104010	Water Utilities	0.000	0.037*	-0.007	0.755**	0.010	0.858**	0.637
		0.647	0.022	0.732	0.000	0.783	0.000	

Table 7b: GICS Sub-Industries affected by changes in WTI Oil Futures 1-Day Lagged Volatility (Post-Event)

Table 7b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of WTI Oil Futures over the post-event period from 27 March 2013 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
15102010	Construction Materials	0.002*	0.002	-0.042*	0.903**	0.028	0.882**	0.667
		0.026	0.909	0.033	0.000	0.446	0.000	
15104010	Aluminum	0.001	0.044*	-0.052*	0.915**	0.049	0.889**	0.568
		0.081	0.027	0.034	0.000	0.272	0.000	
15104025	Copper	0.002	0.048	-0.094*	1.07**	0.061	0.732**	0.341
		0.075	0.112	0.010	0.000	0.361	0.000	
20101010	Aerospace & Defense	0.002*	0.048*	-0.069*	0.904**	-0.039	0.864**	0.476
		0.017	0.048	0.022	0.000	0.474	0.000	
20106010	Construction Machinery & Heavy Trucks	0.001*	0.028*	-0.048**	0.795**	0.001*	0.855**	0.710
		0.011	0.046	0.005	0.000	0.973	0.000	
20106020	Industrial Machinery	0.002**	0.04*	-0.055**	0.978**	0.021	0.843**	0.674
		0.007	0.013	0.005	0.000	0.554	0.000	
25101010	Auto Parts & Equipment	0.002**	0.026	-0.042*	0.881**	0.010	0.86**	0.695
		0.007	0.081	0.022	0.000	0.770	0.000	
25101020	Tires & Rubber	0.002	0.032	-0.074*	1.042**	0.084	0.623**	0.325
		0.105	0.239	0.028	0.000	0.174	0.000	
25301020	Hotels, Resorts & Cruise Lines	0.002*	0.031	-0.05*	0.878**	0.016	0.787**	0.559
		0.014	0.101	0.030	0.000	0.698	0.000	
35102015	Health Care Services	0.004**	0.048	-0.082*	0.298*	-0.101	0.446**	0.117
		0.004	0.133	0.037	0.013	0.157	0.000	
35202010	Pharmaceuticals	0.001*	0.015	-0.034*	0.674**	0.036	0.797**	0.665
		0.043	0.292	0.046	0.000	0.247	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.



Table 8a: GICS Sub-Industries affected by changes in Brent Oil Futures 1-Day Lagged Returns (Pre-Event)

Table 8a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of Brent Oil Futures over the pre-event period from 1 March 2006 to 26 March 2013.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTR	Lag1WTIV	SMB	HML	RM	Adjusted R2
10102050	Coal & Consumable Fuels	0.000	0.101**	0.019	0.726**	0.078	1.183**	0.725
		0.688	0.000	0.345	0.000	0.321	0.000	
15104010	Aluminum	0.000	0.058**	0.012	0.446**	-0.301**	1.252**	0.686
		0.596	0.002	0.613	0.000	0.001	0.000	
15104020	Diversified Metals & Mining	0.000	0.098**	0.025	0.133	-0.475**	1.124**	0.696
		0.507	0.000	0.201	0.140	0.000	0.000	
15104030	Gold	0**	0.122**	0.025	0.608**	-0.344**	0.916**	0.486
		0.997	0.000	0.332	0.000	0.001	0.000	
15104040	Precious Metals & Minerals	0.000	0.054*	-0.010	0.672**	-0.58**	1.177**	0.548
		0.801	0.023	0.731	0.000	0.000	0.000	
20103010	Construction & Engineering	0*	-0.026*	0.012	1.159**	-0.077	1.057**	0.822
		0.959	0.022	0.400	0.000	0.150	0.000	
20104010	Electrical Components & Equipment	0.000	-0.025*	0.018	0.494**	-0.53**	1.037**	0.761
		0.562	0.049	0.249	0.000	0.000	0.000	
20106010	Construction Machinery & Heavy Trucks	0.000	-0.03*	0*	0.523**	-0.203**	1.087**	0.805
		0.456	0.011	0.977	0.000	0.000	0.000	
20302010	Airlines	0.001	-0.081**	-0.023	0.267	-0.134	1.145**	0.499
		0.311	0.001	0.454	0.055	0.265	0.000	
20305010	Airport Services	0.001	-0.058**	-0.023	-0.034	-0.096	0.841**	0.634
		0.263	0.000	0.170	0.663	0.149	0.000	
20305030	Marine Ports & Services	0.000	0*	-0.011	0.834**	0.078	0.96**	0.731
		0.691	0.988	0.510	0.000	0.219	0.000	
25102010	Automobile Manufacturers	0.000	-0.042**	0.016	0.772**	-0.102	1.044**	0.734
		0.724	0.003	0.348	0.000	0.131	0.000	
25102020	Motorcycle Manufacturers	0.001	-0.056*	-0.017	2.037**	-0.162	1.062**	0.546
		0.221	0.017	0.548	0.000	0.149	0.000	
25201010	Consumer Electronics	0.000	-0.041*	0.016	1.048**	-0.337**	0.896**	0.584
		0.601	0.017	0.460	0.000	0.000	0.000	
25201020	Home Furnishings	0.001	-0.055*	-0.049	0.217	-0.503**	1.071**	0.489
		0.181	0.021	0.095	0.099	0.000	0.000	
25203010	Apparel, Accessories & Luxury Goods	0.000	-0.03*	0.002	1.324**	-0.292**	0.997**	0.742
		0.601	0.027	0.897	0.000	0.000	0.000	
25301020	Hotels, Resorts & Cruise Lines	0.001	-0.045*	-0.012	0.909**	-0.385**	1.026**	0.619
		0.306	0.014	0.581	0.000	0.000	0.000	
25501010	Distributors	0.001	-0.028*	-0.007	1.378**	-0.084	1.104**	0.808
		0.271	0.023	0.638	0.000	0.158	0.000	
25503010	Department Stores	0.001	-0.033*	-0.009	0.937**	-0.231**	0.929**	0.692
		0.180	0.017	0.610	0.000	0.001	0.000	
25503020	General Merchandise Stores	0.001	-0.041**	-0.023	0.524**	-0.374**	0.911**	0.663
		0.123	0.004	0.186	0.000	0.000	0.000	
25504040	Specialty Stores	-0.001	0.072*	0.042	0.357*	-0.154	0.881**	0.313
		0.239	0.013	0.233	0.026	0.267	0.000	
30101010	Drug Retail	0.000	-0.068*	0.003	1.21**	-0.476**	1.065**	0.431
		0.937	0.015	0.925	0.000	0.000	0.000	
30201010	Brewers	0.000	-0.055**	0.012	-0.178	-0.757**	0.971**	0.548
		0.816	0.003	0.599	0.089	0.000	0.000	
30201020	Distillers & Vintners	0.001	-0.052**	-0.019	0.241**	-0.731**	1.021**	0.636
		0.111	0.002	0.355	0.009	0.000	0.000	
30202010	Agricultural Products	0.000	0.001*	0.011	1.219**	-0.347**	1.024**	0.621
		0.864	0.966	0.619	0.000	0.000	0.000	
30202030	Packaged Foods & Meats	0.000	-0.03*	0.005	1.092**	-0.427**	1.036**	0.764

		0.656	0.022	0.769	0.000	0.000	0.000	
30302010	Personal Products	0.001	-0.034*	-0.018	0.446**	-0.332**	0.976**	0.640
		0.227	0.037	0.347	0.000	0.000	0.000	
35101010	Health Care Equipment	0.000	-0.077**	0.015	0.200	-0.807**	1.037**	0.457
		0.800	0.002	0.616	0.140	0.000	0.000	
35101020	Health Care Supplies	-0.001	-0.047*	0.025	0.286*	-0.547**	0.996**	0.496
		0.437	0.032	0.343	0.018	0.000	0.000	
35102010	Health Care Distributors	0.000	-0.057**	0.006	0.212*	-0.656**	0.917**	0.520
		0.726	0.003	0.805	0.045	0.000	0.000	
35202010	Pharmaceuticals	0.000	-0.048**	0**	0.394**	-0.667**	0.935**	0.697
		0.445	0.000	0.999	0.000	0.000	0.000	
40201040	Specialized Finance	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	
45202030	Technology Hardware, Storage & Peripherals	0.000	-0.047**	0.004	1.021**	-0.531**	1.068**	0.667
		0.628	0.006	0.857	0.000	0.000	0.000	
45203015	Electronic Components	0.000	-0.03*	0.009	1.009**	-0.512**	1.088**	0.745
		0.756	0.035	0.589	0.000	0.000	0.000	
50201020	Broadcasting	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	
55105010	Independent Power Producers & Energy Traders	0.000	-0.026*	0.010	0.951**	0.219**	0.952**	0.759
		0.706	0.034	0.491	0.000	0.000	0.000	
60102010	Diversified Real Estate Activities	0.000	-0.028*	0.014	1.264**	-0.016	1.009**	0.807
		0.926	0.014	0.322	0.000	0.771	0.000	
60102030	Real Estate Development	0.000	-0.031**	0.012	1.303**	0.275**	1.069**	0.824
		0.831	0.008	0.374	0.000	0.000	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 8b: GICS Sub-Industries affected by changes in Brent Oil Futures 1-Day Lagged Volatility (Pre-Event)

Table 8b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of Brent Oil Futures over the pre-event period from 1 March 2006 to 26 March 2013.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
20102010	Building Products	0.000	-0.008	0**	1.49**	-0.285**	0.968**	0.655
		0.577	0.631	1.000	0.000	0.000	0.000	
20106010	Construction Machinery & Heavy Trucks	0.000	-0.03*	0*	0.523**	-0.203**	1.087**	0.805
		0.456	0.011	0.977	0.000	0.000	0.000	
20107010	Trading Companies & Distributors	0.000	-0.011	0.001*	1.261**	-0.097	1.11**	0.844
		0.435	0.302	0.953	0.000	0.065	0.000	
20304010	Railroads	0.001	-0.027	-0.039*	0.398**	0.090	0.913**	0.671
		0.086	0.059	0.024	0.000	0.188	0.000	
20304020	Trucking	0.000	-0.029	-0.001*	1.16**	-0.005*	1.062**	0.616
		0.845	0.133	0.965	0.000	0.955	0.000	
25203030	Textiles	0.000	-0.027	-0.001*	1.684**	-0.141*	1.073**	0.746
		0.744	0.066	0.951	0.000	0.046	0.000	
30101030	Food Retail	-0.001	0.008	0.001*	0.139	-0.385**	0.158**	0.079
		0.233	0.555	0.951	0.061	0.000	0.000	
35202010	Pharmaceuticals	0.000	-0.048**	0**	0.394**	-0.667**	0.935**	0.697
		0.445	0.000	0.999	0.000	0.000	0.000	
40101015	Regional Banks	-0.002**	-0.017	0.056*	0.048	0.284**	0.738**	0.450
		0.007	0.358	0.013	0.634	0.001	0.000	
40201040	Specialized Finance	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	
40203010	Asset Management & Custody Banks	0.001	0.009	0.001*	0.52**	-0.046	0.952**	0.331
		0.543	0.764	0.984	0.002	0.747	0.000	
40203020	Investment Banking & Brokerage	0.001	-0.026	0.001*	0.57**	0.036	1.178**	0.709
		0.402	0.120	0.951	0.000	0.658	0.000	
45203020	Electronic Manufacturing Services	-0.002	-0.010	0.09*	0.628**	-0.228	0.527**	0.143
		0.066	0.724	0.013	0.000	0.108	0.000	
50201020	Broadcasting	0**	0**	0**	0**	0**	0**	0.000
		0.000	0.000	0.000	0.000	0.000	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 9a: GICS Sub-Industries affected by changes in Brent Oil Futures 1-Day Lagged Returns (Post-Event)

Table 9a provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Returns of Brent Oil Futures over the post-event period from 27 March 2013 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0.002	0.157**	-0.056*	0.791**	0.013	0.788**	0.488
		0.074	0.000	0.047	0.000	0.782	0.000	
10102010	Integrated Oil & Gas	0.001	0.138**	-0.046	0.675**	-0.022	0.756**	0.358
		0.494	0.000	0.185	0.000	0.713	0.000	
10102020	Oil & Gas Exploration & Production	0.001	0.175**	-0.050	0.686**	-0.093	0.508**	0.226
		0.274	0.000	0.209	0.000	0.177	0.000	
10102040	Oil & Gas Storage & Transportation	0.004**	0.116**	-0.1*	0.883**	0.067	0.68**	0.281
		0.003	0.000	0.012	0.000	0.331	0.000	
10102050	Coal & Consumable Fuels	0.000	0.063**	-0.019	0.658**	0.073	1.063**	0.620
		0.751	0.002	0.432	0.000	0.084	0.000	
15101010	Commodity Chemicals	0.002**	0.053**	-0.047**	0.946**	0.036	0.805**	0.712
		0.005	0.000	0.009	0.000	0.247	0.000	
15101030	Fertilizers & Agricultural Chemicals	0.002*	0.059**	-0.049*	0.966**	0.033	0.84**	0.668
		0.019	0.001	0.018	0.000	0.364	0.000	
15103010	Metal & Glass Containers	0.002	0.002*	-0.051	1.09**	0.026	0.793**	0.395
		0.119	0.957	0.167	0.000	0.683	0.000	
15104010	Aluminum	0.002*	0.055**	-0.075**	0.92**	0.051	0.887**	0.570
		0.017	0.009	0.004	0.000	0.258	0.000	
15104020	Diversified Metals & Mining	0.001	0.093**	-0.039	0.816**	0.028	0.947**	0.593
		0.164	0.000	0.121	0.000	0.529	0.000	
15104030	Gold	0.000	0.09**	0.008	0.735**	0.055	0.633**	0.299
		0.944	0.001	0.810	0.000	0.347	0.000	
15104050	Steel	0.001*	0.046**	-0.036	0.858**	0.028	0.859**	0.676
		0.043	0.005	0.073	0.000	0.421	0.000	
15105020	Paper Products	0.002*	0.037*	-0.05*	0.921**	-0.003	0.713**	0.611
		0.021	0.032	0.019	0.000	0.925	0.000	
20101010	Aerospace & Defense	0.003**	0.053*	-0.101**	0.909**	-0.038	0.861**	0.478
		0.002	0.025	0.001	0.000	0.490	0.000	
20104010	Electrical Components & Equipment	0.001*	0.032*	-0.048*	0.855**	-0.008	0.824**	0.686
		0.017	0.041	0.013	0.000	0.815	0.000	
20105010	Industrial Conglomerates	0.002**	0.041*	-0.075**	0.995**	-0.009	0.874**	0.625
		0.005	0.038	0.002	0.000	0.828	0.000	
20106010	Construction Machinery & Heavy Trucks	0.002**	0.035*	-0.065**	0.798**	0.002	0.853**	0.711
		0.001	0.018	0.000	0.000	0.945	0.000	
20106020	Industrial Machinery	0.002**	0.042*	-0.072**	0.981**	0.022	0.841**	0.675
		0.001	0.014	0.001	0.000	0.541	0.000	
20107010	Trading Companies & Distributors	0.002**	0.053**	-0.059**	0.958**	0.042	0.862**	0.725
		0.002	0.000	0.001	0.000	0.181	0.000	
20201010	Commercial Printing	0.001	0.078*	-0.039	1.174**	0.067	0.796**	0.303
		0.423	0.038	0.401	0.000	0.397	0.000	
20302010	Airlines	-0.002	-0.183**	0.063	0.159	-0.054	1.014**	0.451
		0.072	0.000	0.133	0.065	0.295	0.000	
25101010	Auto Parts & Equipment	0.002**	0.032*	-0.066**	0.884**	0.011	0.858**	0.697
		0.000	0.044	0.001	0.000	0.747	0.000	
25203030	Textiles	0.002*	0.046*	-0.039	1.165**	0.042	0.701**	0.604
		0.037	0.014	0.091	0.000	0.294	0.000	
25301020	Hotels, Resorts & Cruise Lines	0.002**	0.044*	-0.074**	0.882**	0.018	0.785**	0.561
		0.001	0.028	0.003	0.000	0.669	0.000	
25501010	Distributors	0.002*	0.042*	-0.049*	1.002**	-0.011	0.853**	0.659
		0.011	0.020	0.027	0.000	0.781	0.000	
25504050	Automotive Retail	0.002	0.049*	-0.054*	0.847**	0.050	0.866**	0.546

		0.054	0.020	0.038	0.000	0.262	0.000	
30101010	Drug Retail	0.001	0.104**	-0.033	1.042**	0.059	0.915**	0.403
		0.226	0.001	0.401	0.000	0.382	0.000	
30202010	Agricultural Products	0.002*	0.05*	-0.071**	0.883**	-0.010	0.753**	0.526
		0.011	0.018	0.006	0.000	0.823	0.000	
35101010	Health Care Equipment	0.002	0.08*	-0.074	0.841**	0.100	0.8**	0.277
		0.195	0.023	0.083	0.000	0.176	0.000	
35102010	Health Care Distributors	0.002**	0.04*	-0.051*	0.865**	0.073	0.798**	0.596
		0.007	0.029	0.021	0.000	0.057	0.000	
45103020	Systems Software	0.003**	-0.002*	-0.085*	0.744**	-0.189**	0.857**	0.432
		0.002	0.952	0.015	0.000	0.002	0.000	
45203015	Electronic Components	0.002*	0.041*	-0.044	0.989**	0.005	0.809**	0.597
		0.041	0.037	0.069	0.000	0.896	0.000	
55101010	Electric Utilities	0.002*	0.042*	-0.055**	0.961**	0.060	0.816**	0.674
		0.013	0.010	0.005	0.000	0.080	0.000	
55102010	Gas Utilities	0.002*	0.06**	-0.048*	0.776**	0.109**	0.848**	0.555
		0.041	0.002	0.045	0.000	0.008	0.000	
55103010	Multi-Utilities	0.001	0.097**	-0.061	1.035**	-0.009	0.77**	0.361
		0.330	0.003	0.118	0.000	0.892	0.000	
55104010	Water Utilities	0.001	0.038*	-0.032	0.758**	0.010	0.857**	0.637
		0.142	0.025	0.130	0.000	0.782	0.000	
55105020	Renewable Electricity	0.002*	0.032*	-0.042*	0.632**	0.039	0.723**	0.578
		0.011	0.050	0.032	0.000	0.258	0.000	
60102020	Real Estate Operating Companies	0.001	0.04*	-0.020	0.865**	-0.013	0.826**	0.566
		0.138	0.048	0.418	0.000	0.762	0.000	
60102030	Real Estate Development	0.001*	0.03*	-0.035	0.8**	0.032	0.933**	0.736
		0.028	0.038	0.054	0.000	0.298	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.

Table 9b: GICS Sub-Industries affected by changes in Brent Oil Futures 1-Day Lagged Volatility (Post-Event)

Table 9b provides regression results for GICS sub-industries that are impacted by changes in the 1-Day Lagged Volatility of Brent Oil Futures over the post-event period from 27 March 2013 to 31 December 2018.

GICS Sub-Industry	GICS Sub-Industry Description	Intercept	Lag1WTIR	Lag1WTIV	SMB	HML	RM	Adjusted R2
10101020	Oil & Gas Equipment & Services	0.002	0.157**	-0.056*	0.791**	0.013	0.788**	0.488
		0.074	0.000	0.047	0.000	0.782	0.000	
10102040	Oil & Gas Storage & Transportation	0.004**	0.116**	-0.1*	0.883**	0.067	0.68**	0.281
		0.003	0.000	0.012	0.000	0.331	0.000	
15101010	Commodity Chemicals	0.002**	0.053**	-0.047**	0.946**	0.036	0.805**	0.712
		0.005	0.000	0.009	0.000	0.247	0.000	
15101020	Diversified Chemicals	0.002*	0.044	-0.069*	1.137**	0.084	0.796**	0.467
		0.046	0.092	0.031	0.000	0.129	0.000	
15101030	Fertilizers & Agricultural Chemicals	0.002*	0.059**	-0.049*	0.966**	0.033	0.84**	0.668
		0.019	0.001	0.018	0.000	0.364	0.000	
15102010	Construction Materials	0.002**	0.003	-0.063**	0.905**	0.028	0.881**	0.668
		0.003	0.845	0.003	0.000	0.432	0.000	
15104010	Aluminum	0.002*	0.055**	-0.075**	0.92**	0.051	0.887**	0.570
		0.017	0.009	0.004	0.000	0.258	0.000	
15104025	Copper	0.002	0.053	-0.1*	1.075**	0.063	0.73**	0.342
		0.076	0.093	0.010	0.000	0.351	0.000	
15105020	Paper Products	0.002*	0.037*	-0.05*	0.921**	-0.003	0.713**	0.611
		0.021	0.032	0.019	0.000	0.925	0.000	
20101010	Aerospace & Defense	0.003**	0.058*	-0.101**	0.909**	-0.038	0.861**	0.478
		0.002	0.025	0.001	0.000	0.490	0.000	
20104010	Electrical Components & Equipment	0.001*	0.032*	-0.048*	0.855**	-0.008	0.824**	0.686
		0.017	0.041	0.013	0.000	0.815	0.000	
20104020	Heavy Electrical Equipment	0.001*	0.020	-0.045*	0.888**	0.040	0.899**	0.701
		0.045	0.215	0.023	0.000	0.235	0.000	
20105010	Industrial Conglomerates	0.002**	0.041*	-0.075**	0.995**	-0.009	0.874**	0.625
		0.005	0.038	0.002	0.000	0.828	0.000	
20106010	Construction Machinery & Heavy Trucks	0.002**	0.035*	-0.065**	0.798**	0.002	0.853**	0.711
		0.001	0.018	0.000	0.000	0.945	0.000	
20106020	Industrial Machinery	0.002**	0.042*	-0.072**	0.981**	0.022	0.841**	0.675
		0.001	0.014	0.001	0.000	0.541	0.000	
20107010	Trading Companies & Distributors	0.002**	0.053**	-0.059**	0.958**	0.042	0.862**	0.725
		0.002	0.000	0.001	0.000	0.181	0.000	
20305030	Marine Ports & Services	0.002**	0.016	-0.066**	0.753**	-0.010	0.801**	0.583
		0.005	0.398	0.004	0.000	0.790	0.000	
25101010	Auto Parts & Equipment	0.002**	0.032*	-0.066**	0.884**	0.011	0.858**	0.697
		0.000	0.044	0.001	0.000	0.747	0.000	
25101020	Tires & Rubber	0.003*	0.039	-0.11**	1.047**	0.085	0.621**	0.327
		0.019	0.180	0.002	0.000	0.166	0.000	
25102010	Automobile Manufacturers	0.001*	0.014	-0.041*	0.636**	0.025	0.828**	0.653
		0.015	0.362	0.028	0.000	0.442	0.000	
25102020	Motorcycle Manufacturers	0.003**	0.032	-0.09*	1.343**	-0.023	0.7**	0.422
		0.010	0.286	0.015	0.000	0.723	0.000	
25201010	Consumer Electronics	0.002**	-0.022	-0.063*	0.962**	-0.011	0.851**	0.522
		0.010	0.344	0.028	0.000	0.820	0.000	
25201020	Home Furnishings	0.002*	0.016	-0.078*	0.833**	0.163**	0.789**	0.370
		0.038	0.558	0.018	0.000	0.004	0.000	
25203010	Apparel, Accessories & Luxury Goods	0.002*	0.021	-0.049*	0.932**	0.08*	0.702**	0.581
		0.012	0.227	0.024	0.000	0.031	0.000	
25301020	Hotels, Resorts & Cruise Lines	0.002**	0.044*	-0.074**	0.882**	0.018	0.785**	0.561
		0.001	0.028	0.003	0.000	0.669	0.000	
25501010	Distributors	0.002*	0.042*	-0.049*	1.002**	-0.011	0.853**	0.659

		0.011	0.020	0.027	0.000	0.781	0.000	
25504040	Specialty Stores	0.002	0.007	-0.065*	0.649**	0.083	0.925**	0.426
		0.059	0.784	0.041	0.000	0.132	0.000	
25504050	Automotive Retail	0.002	0.049*	-0.054*	0.847**	0.050	0.866**	0.546
		0.054	0.020	0.038	0.000	0.262	0.000	
30202010	Agricultural Products	0.002*	0.05*	-0.071**	0.883**	-0.010	0.753**	0.526
		0.011	0.018	0.006	0.000	0.823	0.000	
30202030	Packaged Foods & Meats	0.002**	0.011	-0.053**	0.831**	0.028	0.792**	0.690
		0.003	0.462	0.004	0.000	0.361	0.000	
30302010	Personal Products	0.001	0.015	-0.051*	0.909**	0.065	0.812**	0.573
		0.064	0.436	0.033	0.000	0.119	0.000	
35102010	Health Care Distributors	0.002**	0.04*	-0.051*	0.865**	0.073	0.798**	0.596
		0.007	0.029	0.021	0.000	0.057	0.000	
35102020	Health Care Facilities	0.003*	0.027	-0.092*	0.869**	-0.157*	0.543**	0.270
		0.030	0.417	0.023	0.000	0.025	0.000	
35202010	Pharmaceuticals	0.001*	0.022	-0.046**	0.677**	0.037	0.795**	0.665
		0.011	0.130	0.010	0.000	0.233	0.000	
40201020	Other Diversified Financial Services	0.002	0.050	-0.076*	0.591**	-0.003*	1.112**	0.455
		0.084	0.083	0.033	0.000	0.957	0.000	
45102010	IT Consulting & Other Services	0.002*	0.028	-0.063*	1.076**	-0.026	0.781**	0.504
		0.012	0.247	0.036	0.000	0.611	0.000	
45103020	Systems Software	0.003**	-0.002*	-0.085*	0.744**	-0.189**	0.857**	0.432
		0.002	0.952	0.015	0.000	0.002	0.000	
45201020	Communications Equipment	0.002*	0.026	-0.054*	1.024**	-0.023	0.84**	0.560
		0.013	0.241	0.050	0.000	0.626	0.000	
45203030	Technology Distributors	0.002*	0.024	-0.075*	1.098**	0.007	0.762**	0.440
		0.045	0.385	0.024	0.000	0.905	0.000	
45301020	Semiconductors	0.002**	0.025	-0.062*	0.882**	-0.035	0.87**	0.597
		0.007	0.219	0.012	0.000	0.410	0.000	
55101010	Electric Utilities	0.002*	0.042*	-0.055**	0.961**	0.060	0.816**	0.674
		0.013	0.010	0.005	0.000	0.080	0.000	
55102010	Gas Utilities	0.002*	0.06**	-0.048*	0.776**	0.109**	0.848**	0.555
		0.041	0.002	0.045	0.000	0.008	0.000	
55105020	Renewable Electricity	0.002*	0.032*	-0.042*	0.632**	0.039	0.723**	0.578
		0.011	0.050	0.032	0.000	0.258	0.000	
60102010	Diversified Real Estate Activities	0.002**	0.028	-0.052**	0.834**	0.006	0.858**	0.710
		0.005	0.059	0.005	0.000	0.844	0.000	

\*Denotes significance at the 5% level and \*\* denotes significance at the 1% level.