Oil price shocks and stock returns of oil and gas corporations*

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Abstract

In this paper we examine the impact of oil price shocks on stock returns of four oil and gas corporations listed on NYSE over the period January 1974 to December 2015. We consider different linear and nonlinear oil price specifications and take into account the structural break date of the year 1986. The novelty evidence supports a significant positive impact of oil price shocks on stock returns in the short-run. We also find that the relationship has become statistically significant during the post-1986 period.

JEL classification: C32; G10; Q43

Keywords: oil prices, linear and nonlinear specifications, vector autoregressive model, stock returns, oil and gas corporations

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1. Introduction

The seminal contributions by Jones and Kaul (1996) and Sadorsky (1999) entitled “Oil and the stock markets” and “Oil price shocks and stock market activity” respectively are two prominent studies that find a negative interaction between oil prices and stock returns. Jones and Kaul (1996) obtained that the reaction of stock prices to oil shocks can be completely accounted for by the impact of these shocks on real cash flows alone. Sadorsky (1999) detected that oil prices and oil price volatility both play important roles in affecting stock returns.

In this paper we investigate the role of real oil price shocks on real stock returns of four oil and gas corporations listed on NYSE. Our empirical analysis is carried out using a vector autoregressive (VAR) model (Park and Ratti, 2008; Cunado and Perez de Gracia, 2014; Diaz et al., 2016). In particular our paper relates to a few studies that investigate the impact of oil prices on stock returns of oil and gas companies (Sadorsky, 2001; Lanza et al., 2005; Giovannini et al., 2006; Chang et al., 2009; Sanusi and Ahmad, 2016). The study by Sadorsky (2001) proposes a multifactor market model to investigate the relationship between various risk factors and Canadian oil and gas stock returns. His results suggest that oil and gas stock returns are sensitive to several risk factors. Lanza et al. (2005) focus on the long-run determinants of the stock prices of six oil and gas companies using multivariate cointegration and vector error correction models. Their empirical results confirm the statistical significance of the major financial variables in explaining the long-run dynamics of oil companies’ stock values. Using the same dataset, Giovannini et al. (2006) investigate the stock prices’ returns and their financial risk factors for six oil companies. Using daily data of ten oil and gas companies, Chang et al. (2009) study the volatility spillovers between oil prices and stock returns of oil and gas corporations. They obtain that the conditional correlations between oil price changes and oil company stock returns are very low. In a recent study, Sanusi and Ahmad (2016) analyze the determinants of the U.K. oil and gas stock returns using multi-factor asset pricing model. Their results suggest that oil price shock has an effect on the oil and gas companies' stock returns.

Our approach extends the literature in several ways. First, previous related literature cover shorter sample period. In this study, we use a long span sample period from January 1974 to December 2015. The starting date of our sample period is determined by the availability of the stock price of four oil and gas companies. Second, we include both the Refiner Acquisition Cost (RAC) of imported crude oil and the West Texas Intermediate (WTI) crude oil spot price. Third, in this paper instead of using oil price changes as a proxy variable for oil shocks, we also employ two nonlinear oil specifications. Finally, some related studies have documented a structural break in the relationship between oil prices and macroeconomic variables (Mork, 1989) and oil prices with stock returns (Diaz et al., 2016) in the year 1986. For instance, Diaz et al. (2016) conclude that G7 stock markets have reacted negatively to higher oil price volatility after 1986, which is not as significant in the pre-1986 period. Hamilton (1996) shows that this was due to a change in oil price behavior, which during the recent period includes larger decreases and an increased volatility. Following previous empirical studies, our paper considers three different sample periods: full sample, pre-1986 and post-1986.

The structure of the paper is as follows. Section 2 describes the dataset and oil price specifications. Section 3 covers the empirical analysis. Finally, section 4 concludes.

2. Dataset and oil price specifications

2.1. Dataset

The dataset has monthly frequency and runs from January 1974 to December 2015. Following Jones and Sadorsky (1999) and Kaul and Jones (1996), we include real oil prices, real economic activity and real stock prices. All the variables are expressed in natural logarithms.

a-. Real oil prices ($o_{RAC,}$ o_{WTI}). We use the RAC of imported crude oil from U.S. Energy Information Administration and the WTI spot oil price from International Financial Statistics (International Monetary Fund). Both oil prices have been deflated using U.S. CPI.

b-. Real economic activity. We employ the U.S. industrial production index seasonally adjusted from International Financial Statistics (International Monetary Fund) as a measure of output (Sadorsky, 1999, Cunado and Perez de Gracia, 2014).

c-. Real stock returns. We use the closing stock prices of BP (BP), Chevron Corporation (Chevron), Exxon Mobil (Exxon) and Royal Dutch Shell (Shell). We select oil and gas companies listed on NYSE with the longest available stock price data. All data are obtained from Datastream. Real stock return is defined as the logarithm of the first difference of the deflated series. We deflate stock prices using U.S. CPI.

2.2. Oil price specifications

Following the studies by Park and Ratti (2008), Cunado and Perez de Gracia (2014) and Pönkä (2016), we propose different nonlinear oil specifications such as oil price increase (Mork, 1989) and net oil price increase (Hamilton, 1996, 2003).

a-. Oil price change. Initially we include a linear transformation of the oil price change defined as

$$x_{j,t} = o_{j,t} - o_{j,t-1}, \quad (1)$$

where $o_{j,t}$ is the logarithm of the real oil price at period t for oil $j = RAC, WTI$. This specification captures a linear relationship between the change in the oil price and the stock return of oil and gas corporations.

b.- Oil price increase (Mork, 1989). The nonlinear transformation can be defined as:

$$x_{j,t}^{1} = max\{0, o_{j,t} - o_{j,t-1}\}. \quad (2)$$

It assumes that only an oil price increase, and not a decrease, will determine the effect on stock value for oil and gas corporations.

c-. Net oil price increase over the previous 12(and 36)-month maximum (Hamilton, 1996, 2003). These nonlinear oil price specification are defined as

$$x_{j,t}^{12} = max\left\{0, o_{j,t} - max\{o_{j,t-1}, \dots, o_{j,t-12}\}\right\}, \quad (3)$$

$$x_{j,t}^{36} = max\left\{0, o_{j,t} - max\{o_{j,t-1}, \dots, o_{j,t-36}\}\right\}. \quad (4)$$

It seems more appropriate to compare the current price of oil with where it has been over the previous periods instead of considering uniquely the previous period. Equations (3 and 4) ignore the negative oil price changes as well as positive oil price changes that can be considered ordinary.

3. Empirical analysis

Prior to estimating the VAR model the first step is to test the unit root null hypothesis for the original variables and its first difference. In particular, we employ the augmented Dickey-Fuller (ADF, Dickey and Fuller, 1981) and the Phillips and Perron (PP, Phillips and Perron, 1988) unit root tests. The lag length of ADF unit root tests is determined by the Schwarz information criterion. The results show that each variable is stationary in first difference at the 1% level of significance. We also perform unit root tests in the pre-1986 and post-1986 sub-periods. The results for the pre-1986 and post-1986 sub-periods also corroborate that our selected variables are integrated of order one.[1] Once we have checked that all variables contain a unit root, we test for cointegration using the Johansen and Juselius test (Johansen and Juselius, 1990) for the full sample. We reject the null hypothesis of no cointegration (at a 5% significance level) only for BP using both RAC and WTI prices. Furthermore, the results suggest no existence of two or more cointegrating vectors for any of the oil and gas companies. We find no evidence of cointegration when we consider Royal Dutch Shell, Exxon Mobil and Chevron. In addition, we run cointegration tests in the pre-1986 and post-1986 sub-periods. The results for the pre-1986 and post-1986 sub-periods also suggest the absence of cointegration in most of the cases. In a next step, we also run Granger causality test. When we use the full sample, the results show unidirectional causality from oil prices changes (equation 1) and oil price increases (equation 2) to stock returns (BP, Chevron, Exxon and Shell). Similar results are found when we consider the post-1986 sub-period.[2]

*** **Insert Table 1 about here** ***

Finally, for each oil and gas company we estimate an unrestricted VAR model. A VAR model of order p that includes k variables can be expressed as:

$$y_t = A_0 + \sum_{i-1}^{p} A_i y_{t-i} + \varepsilon_t, \qquad (5)$$

where p is the number of lags, $y_t = [y_{1t} \dots y_{kt}]'$ is a column vector of all the variables in the model (real oil price transformation, real first difference of IPI and real stock returns of oil and gas corporations); A_0 is a column vector of constant terms; A_i is a

[1] We do not report here the results for both the unit root and cointegration tests for the full sample, pre-1986 and post-1986 sub-periods but are available upon request from the authors.
[2] Granger causality tests for the pre-1986 and post-1986 sub-periods are available upon request.

$k \times k$ matrix of unknown coefficients; and ε_t is a column vector of errors with the following properties:

$E(\varepsilon_t) = 0 \qquad \forall t,$

$E(\varepsilon_s \varepsilon_t') = \Omega \qquad if\ s = t,$

$E(\varepsilon_s \varepsilon_t') = 0 \qquad if\ s \neq t,$

where Ω is the variance-covariance matrix with non-zero off-diagonal elements. Following Cunado and Perez de Gracia (2014), real stock returns, are placed last in the ordering. The lag length is selected according to the Akaike information criterion. We estimate an unrestricted VAR model for each of oil and gas corporation using (i) both linear and nonlinear oil price specifications defined in equations (1 to 4) and (ii) both RAC and WTI.

Figures 1 to 2 display the generalized impulse response functions of real stock returns of oil and gas companies to the following variables: RAC and WTI oil price changes (Figure 1) and RAC and WTI oil price increases (Figure 2). The dashed lines represent the 95% confidence intervals for the response of stock returns of each company to alternative oil price shock specifications.

*** **Insert Figure 1 about here** ***

Initially we display the impulse response functions using the oil price changes of RAC. For three oil companies the oil price change has a positive and statistically significant impact on real stock returns in the same month and within one month when we consider the full sample period. This novelty result associated with oil corporations contrasts with previous views in the literature that found a negative impact of oil prices on stock returns (Sadorsky, 1999; Cunado and Perez de Gracia, 2014). In all cases, the impulse responses revert to zero usually within 6 to 8 months. In all four companies, oil price shocks have a larger positive effect on stock returns during the post-1986 period. Stock returns of BP experience the greatest response to oil price changes in both the full period and in the post-1986 sub-periods. When we use WTI, the response of the four oil and gas companies to oil price shocks are consistent with previous results of RAC imported oil prices. The results obtained for WTI are robust through all three different subsamples. Furthermore, the greatest stock return response to a shock in WTI is found for BP. In summary, we detect a significant positive impact of the linear specification of oil price on stock returns within two months after the shock.

Next, we include oil price increases in a VAR model for both RAC and WTI (Figure 2). We observe that the response of stock returns of the oil and gas companies to oil price increases is significant and positive within 2 months after the shock in all corporations. In all cases, the impulse responses revert to zero usually within 8 months. The results are robust to the inclusion of both RAC imported crude oil and WTI and different subsamples. When we analyze the different subsamples, the results still suggest a larger positive significant impact in the post-1986 subsample.

Finally, we estimate a VAR for each oil company using net oil price increases with 12(and 36)-months. As we showed in Section 2, net oil price increase incorporates the highest oil price in the preceding 12(and 36)-months. When we introduce net oil price increase, we do not find a significant impact of oil prices on stock returns.[3] These results are robust for alternative sub-periods, RAC and WTI and net oil price increase over the previous 12(and 36)-months. Implementing a VAR estimation that includes a nonlinear specification such as net oil price increase

[3] The results are not reported here but are available upon request from the authors.

with 12(and 36)-months generate no significant results since the impact of oil prices on stock returns is mainly located within 1-2 months after the shock.

***** Insert Figure 2 about here *****

5. Conclusions

To our knowledge this is the first empirical study that analyze the impact of oil prices on stock returns of oil and gas corporations (i) covering four decades of oil price fluctuations, (ii) using both RAC and WTI, (iii) considering four alternative linear and nonlinear oil price specifications and (iv) taking into account the structural break date of year 1986 already find in related studies. The main results are the following. First, we provided evidence that the linear specification oil price changes have a positive significant impact on real stock returns of oil and gas corporations in the short-run. Second, we also provided evidence that a nonlinear specification such as oil price increases has a positive impact on stock returns in the short-run. Previous results are robust to the inclusion of alternative oil prices namely RAC crude oil and WTI and amongst all four companies. Third, our results indicate that oil price shocks have become more significant for stock value of oil and gas companies during the post-1986 period. Finally, we found no evidence that net oil price increases help to explain real stock returns using both oil price measures and different subsamples.

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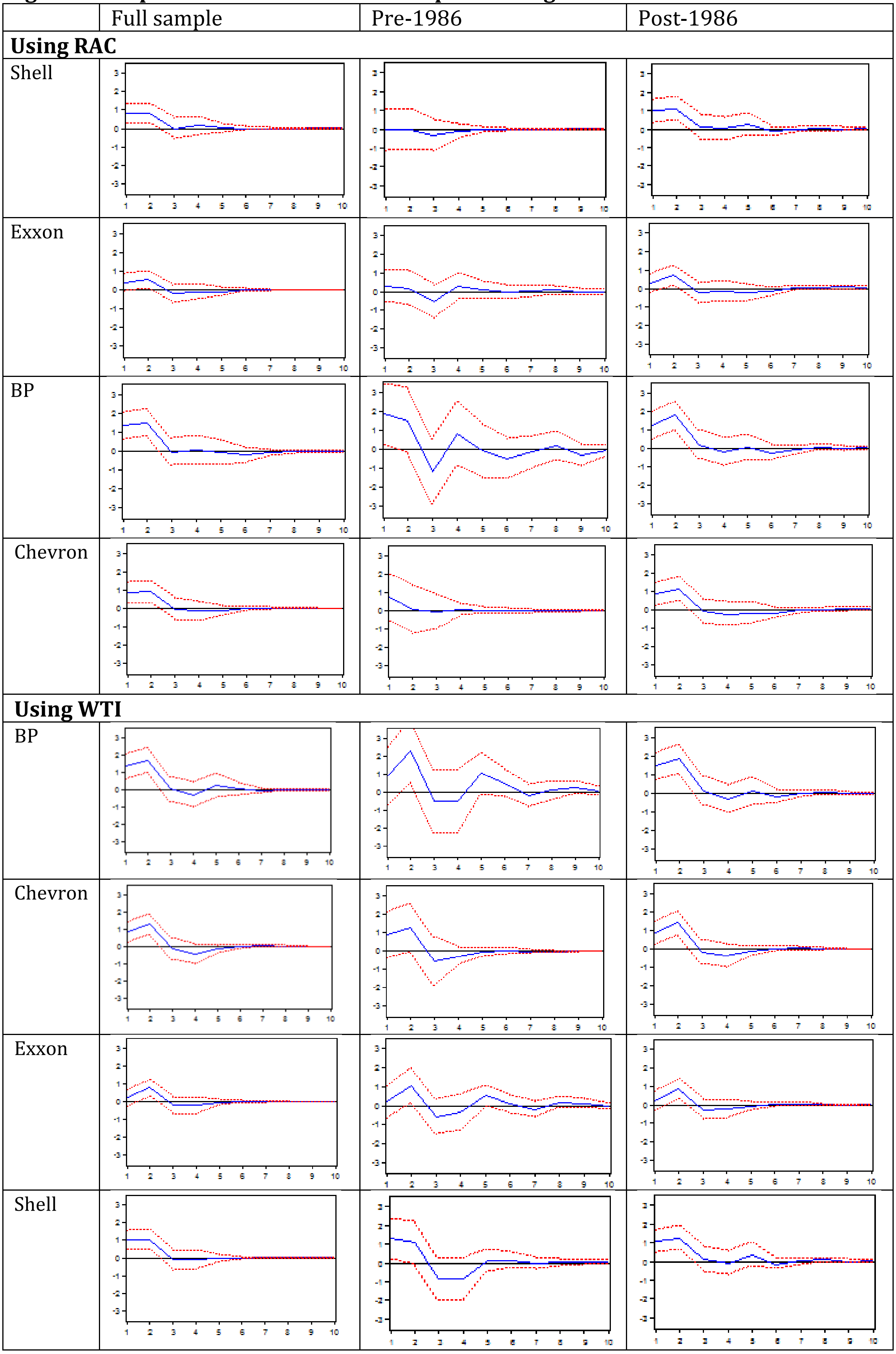
Table 1. Granger causality test (full sample)

	Oil price increase		Oil price increase		NOPI 12 months		NOPI 36 months	
	RAC	WTI	RAC	WTI	RAC	WTI	RAC	WTI
BP → o	2.325	1.327	3.398	1.206	3.468	1.822	1.587	0.752
o → BP	8.812*	10.831*	8.695*	8.569*	1.286	0.253	0.011	0.009
Chevron → o	0.684	0.332	1.856	1.275	2.500	1.311	0.046	0.031
o → Chevron	6.764*	12.373*	5.094*	8.152*	0.143	1.175	0.010	0.101
Exxon → o	0.634	0.414	2.610	0.649	5.399	0.818	0.924	0.358
o → Exxon	4.364*	6.881*	5.371*	6.261*	0.341	0.297	0.477	0.151
Shell → o	2.680	1.955	2.583	0.735	2.151	0.935	0.046	0.030
o → Shell	5.798*	9.162*	7.479*	8.471*	0.656	0.260	0.010	0.101

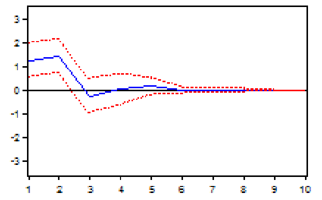
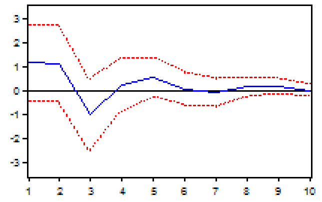
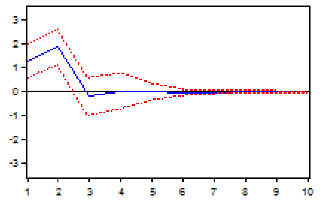
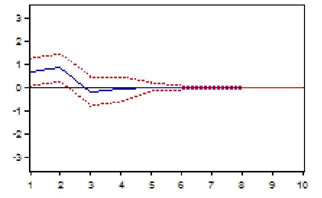
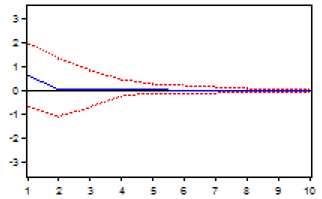
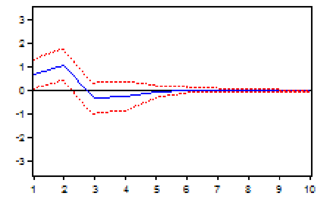
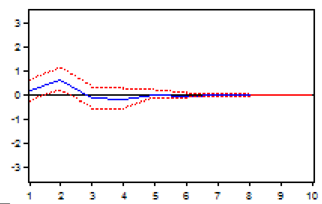
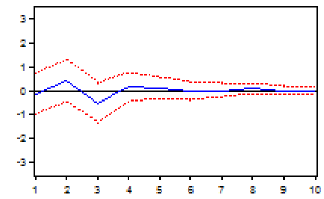
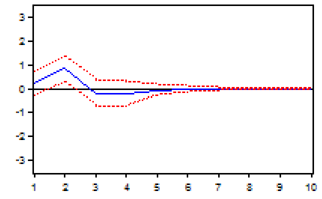
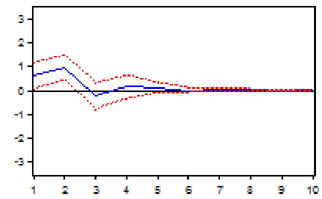
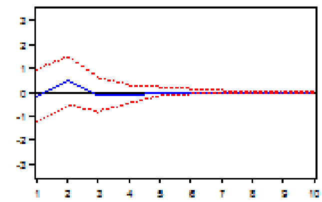
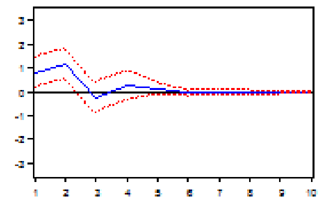
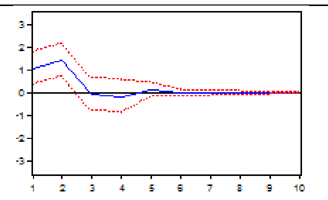
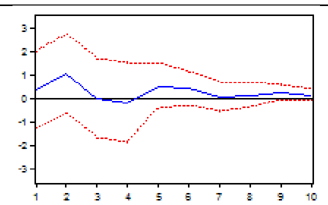
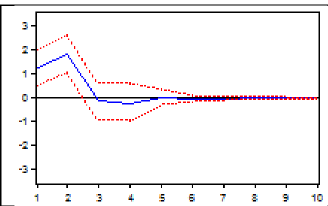
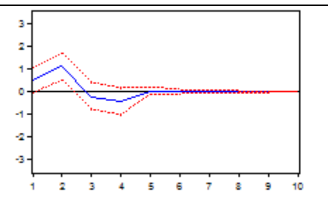
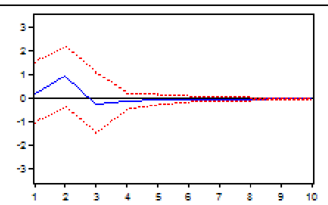
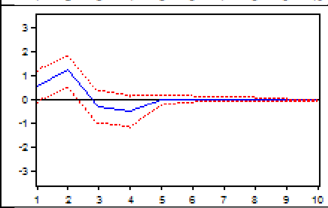
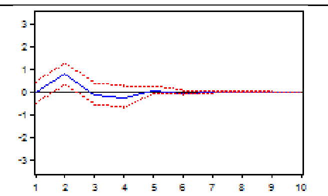
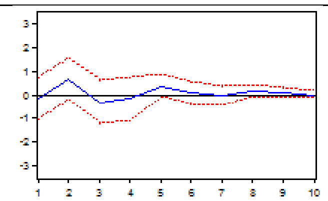
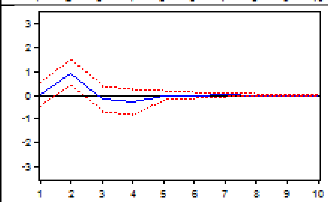
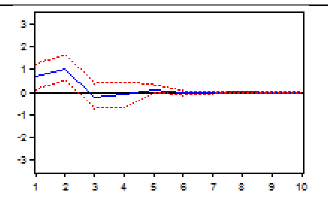
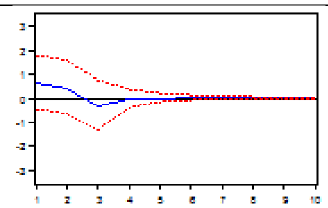
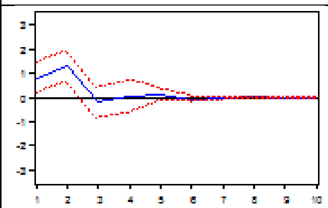
Notes. * Denotes p-value statistical significance at 5% and 1% level. The lag length was determined using the Schwarz information criterion.

Figure 1. Response of stock returns to oil price changes



Notes. The dashed lines represent the 95% confidence intervals for the response of stock returns to oil changes using RAC and WTI.

Figure 2. Response of stock returns to oil price increases

	Full sample	Pre-1986	Post-1986
Using RAC			
BP			
Chevron			
Exxon			
Shell			
Using WTI			
BP			
Chevron			
Exxon			
Shell			

Notes. The dashed lines represent the 95% confidence intervals for the response of stock returns to oil price increases using RAC and WTI.