Oil Price Return Volatility on the Stock Market Return of Major Oil Exporting Countries

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INTRODUCTION

The global economy is highly dependent on the production and accessibility to the crude oil. Much of today’s geopolitical tension centers on the ability to secure an uninterrupted supply of crude oil. The provision of heat, light, transport and raw material of production depends on oil and there has not been a single energy source that is able to replace crude oil. Four factors of US markets, international financial markets, economic crises and commodity markets are known as the most effective global variables in security and financial markets of nations. The theory of market efficiency and future cash flows have been regarded as cornerstone to link the shocks effect of oil price as the largest commodity market through financial markets in different aspects.

By the consequences of quadrupling the oil price in 1973, a large and growing body of literature has investigated the linkage of oil price shocks and macroeconomic performance of nations. In one of pioneering study, Rasche and Tallon [51] keep an eye on impact of the first oil price shocks to the good prices, industrial production and employment. Their findings demonstrated dramatic surge in unemployment and pronounced fall in industrial production of United State for 1973-1975. Darby points out that the negative impact of oil price shock on real income of US and Japan and magnified that Japan economy is in higher level of sensitivity to unexpected surge in oil price. “Hamilton [22]” highlighted the nexus post world war II recession of United State for 1975. “Burbidge and Harrison [7]” carried out a comparison reaction among developed countries in order to investigate macroeconomic performance reaction to the oil price shock. Asymmetric impact of oil price shocks through economic activity was undertaken by "Mork [44]", he showed existence of negative relationship between hike in oil price and GNP growth in US. "Lee et al. [37]" concurred the findings of "Mork [44]" on asymmetric impact of oil price on unemployment and GNP growth. Over time interaction of macroeconomic performance and oil price shock is investigated by "Cologni & Manera [12]", "Chang and Wong [8]" and "Blanchard and Gali [5]" that they performed a minor effect of oil price shocks in last years among Singapore and G7 countries.

In the most pioneering studies on the association between financial market and oil price, "Bittiligmayer [3]" identifies that stock market is affected by the oil price shocks because considerable surge in oil price increase the war risk in Middle East. "Kilian and Park [35]" documented evidence that consequence of growing uncertainty of demand shock in the oil market cause a larger depressive impact on US stock market than supply oil price shocks. In his case study of US stock market, "Chen [10]" utilized Markov-switching model to

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investigate impact of higher oil price on probability of switching between bull and bear state of stock market and he highlighted that oil price shock pushes the stock market significantly from bull into bear territory. "Lee and Chiu [38]" investigate asymmetric impact of future and spot price of oil in S&P500 return through daily analysis of 16 years. They claim that asymmetric effect of oil price impresses S&P500 negatively under high volatility condition of oil market.

A large and growing body of literature has investigated impact of oil price shocks on stock market return. In the studies on the oil exporting countries, "Gierde & Sættem [18] reported the positive impact of oil price changes on the stock return of Norway and Saudi Arabia. "Papapetrou [49]" reported negative impact of shocks to the oil price on stock market of Greek. "Maghyereh’s comparative study [39]" of 22 emerging equity markets showed insignificant response of market return to the shock on oil price. "Hammoudeh & Choi [25]" found positive response to the increasing oil price among majority of GCC member’s stock markets while it has depressive impact on US stock market return. "Nandha and Hammoudeh [46]" investigated oil-sensitivity of 15 Asian pacific stock markets under both domestic and US dollar price of oil they performed south Korea and Philippines are the only markets that are affected by the oil price shocks while oil price is measure by domestic currency of their countries.

There is a large volume of published studies describing the role of oil price variation on stock market volatility. "Guidi et al [20]" documented evidence on asymmetric impact of oil price shocks on manufacturing and service sectors level they also keep an eye on role of OPEC decision days on market volatility. "Hammoudeh and Choi [24]" emphasized the role played by spot oil price in volatility of GCC stock market and found that Saudi and Omani stock market show longer volatility reaction in response to the shock in spot oil price. "Malik & Hammoudeh [41]" examined the volatility transmission from oil market to the stock markets oil exporting countries they have found oil price variation have spillover effect on stock market volatility. Investigation of "Hammoudeh and Li [27]" on linkage of oil price and unexpected changes of volatility show that oil price shocks are accounted as significant factor on sudden shift of volatility in GCC stock markets return. "Vo [53]" demonstrated that future oil price and stock price of S&P500 are inter-related meanwhile their time varying correlation increased during higher volatile markets. In their major study on GCC countries "Arouri et al [1]" pointed out that stock market return volatility are considerably affected by the shocks and volatility on the oil price and they are more sensitive under crises condition.

The first serious discussion of nonlinear association of oil price variation and stock market was merged by "Ciner [11]". He documented evidence on nonlinear linkage and asymmetric impact of oil price shocks on USA stock market return. The later studies of "Basher and Sadorsky [2]", "Maghyereh and Al-Kandari [39]" and "Odusami [48]" are corroboratively supportive of nonlinear linkage of oil price shocks effect on stock market return. "Huang et al, [29]" declare that effect of oil price shock under threshold level have less explanatory power on stock market return performance of Japan, Canada and USA. Miller and Ratti show that long run effect of oil price shocks are more robust than short run impacts. Odusami found evidence on variation of oil price and jump in US stock market return.

Considerable numbers of investigations are mostly focused on oil price shocks and industrial level reaction of equity markets. "Faff & Brailsford [17]" and found significant and negative effect of oil price shocks on stock return of packaging and transport industries in Australia stock market. "Sadorsky [52]" and "El-Sharif et al [16]" and "Boyer and Filion [6]" documented evidences that oil and Gas companies are benefited from surge in oil price. "Hammoudeh [22]" findings indicated that oil price volatility because echoing response on volatility of oil companies stock. "Nandha and Faff [45]" indicated that using exchange rate in both short and long rung have no distinctive influence on oil price variation on stock return."Jiménez-Rodríguez [31]" claimed that stock of companies which are related to the personal consumption are less affected by the oil price shocks. "Gogineni [19]" argues that even industries which are not related to the oil in their business cycle or production are affected by the variation in oil market.

**Fig. 1**: Oil production of countries and ratio from oil market.
So far, the issue of oil price and stock market performance, have been controversial and disputed subject of aforementioned studies. By the best of our knowledge, most of studies have consistently focused on developed countries stock markets and there is a lack of investigation on stock market reaction of oil exporting countries. As it mentioned before, some of researches carried on GCC countries stock market that it could not be interpreted and justified for reaction of oil exporting countries because this countries are highly sensitive to geopolitical tension and crises in Middle East and specially Persian Gulf region. For these purpose we are chosen 6 major net oil producer which produce more than 50% of oil market demand for the 2007. Furthermore, the time period of 2005 to 2010 can be considered because of historical oil price of 142 US $ per barrel and the later dramatic fall in oil price. In this study we examine the spillover impact of oil price return volatility on the stock market return volatility of 6 major oil exporting countries of Saudi Arabia, Russia, Iran, Nigeria, Norway and United Arab Emirates. We also compare the findings of oil price volatility effect on stock market return volatility under both domestic and US dollar value of oil in weakly data.

**Data and variables identification:**

To examine the volatility transmission from oil price return to the stock market return, weakly data for the time span of 17/ 1/ 2005 to 15/ 6/ 2010 is employed in our study which contains 284 observations. One month forward rate of crude oil of Brent is used for oil price per barrel it was chosen because of noisy price of spot oil price.

**Oil price return:**

In our study, It was decided that changes of oil price [22] is the best method to adopt for oil price return in our investigation. Hamilton [22] introduced oil price changes (COP) as logarithms difference of two according periods. In our estimations we compare finding of oil price volatility transmission under both domestic and US dollar value of oil per barrel. For simplicity in our expression by the rest of article COP is indicator of oil price return in US dollar value of oil and CODP is indicator of oil price return in domestic value. The CODP data was prepared according to the procedure of equation 1;

\[ \text{CODP}_t = \ln(Op_t \times Er_t) - \ln(OP_{t-1} \times Er_{t-1}) = \ln ODP_t - \ln ODP_{t-1} \]

Where

- \( \text{Er}_t \) = exchange rate of one US dollar in domestic currency of countries at time t
- \( OP_t \) = Us dollar value of oil price per barrel at time t
- \( \text{CODP}_t \) = crude oil price return in domestic price of oil at time t

in which CODP is calculated by the logarithm difference of oil domestic price in two following periods.

**Stock market return:**

Stock markets of oil exporting countries work in different days of week, in case of IRAN, SAUDI ARBIA, and U.A.E stock markets work for period of Saturday to Wednesday While, RUSSIA, NORWAY and NIGERIA markets work for period of Monday to Friday. On the other words, just 3 days of Monday, Tuesday and Wednesday are in common among them. Different working day among case study maybe lead to unreliable comparison findings among oil exporting countries. For this purpose, market index of Tuesdays is adopted as benchmark of stock market index in week; this approach was previously applied by "Hammoudeh and Choi [25]" study. Tuesdays as benchmark of week index are much advantaged in comparison to the Wednesdays and Mondays since, Mondays and Wednesdays are affected by the shocks impact of beginning and closing working day in sample countries. As it is shown, stock market return is calculated by the logarithmic difference of all share index for two consecutive Tuesdays.

\[ \text{STR}_t = \ln STI_t - \ln STI_{t-1} \]

Where:

- \( \text{STR}_t \); stock market return at time t
- \( STI_t \); all share index at time t
- \( STI_{t-1} \); all shares index at time t-1

**Model identification:**

Bivariate BEKK GARCH (1, 1) approach is chosen to examine the spillover impact of oil price return (shocks and volatility) on the stock market return volatility. Various studies have used bivariate BEKK GARCH (1,1) to examine dynamic interactions of shocks and conditional variances of time series [41]. The efficient and
stable GARCH estimation of BEKK model is advantaged it in comparison models like to vectorized conditional heteroskedasticity (VECH), diagonal VECH and Constant Conditional Correlations (CCC) models.

The mean equations of both oil price and the stock market return are given by;

\[ R_{i,t} = \mu_i + \rho_i R_{i,t-1} + \varepsilon_{i,t} \quad \text{where} \quad \varepsilon_{i,t} \sim N(0, H_t) \]

Where \( R_{i,t} \) is return at time \( t \), \( \mu_i \) is the long run drift of equation and \( \varepsilon_{i,t} \) show the error term. Bivariate BEKK model of GARCH (1, 1) can be given by;

\[ H_t = C'C + G'H_{t-1}G + A'e_{t-1}e'_{t-1} \]

Where \( H_t \) a matrix of conditional variance at time \( t \) and it is captures the GARCH effect in the model. \( C \) in bivariate model is lower diagonal \( 2 \times 2 \) matrix. \( G \) in the model captures relationship between lag and leads conditional variances (coefficient of GARCH effect) of two series which is shown by \( 2 \times 2 \) matrices. The role of \( A \) as a \( 2 \times 2 \) matrix is that to transmit magnitude impact of shocks and unpredictable events (ARCH effect) of latter period in former period conditional variances.

\[ A = \begin{bmatrix} a_{ss} & a_{so} \\ a_{os} & a_{oo} \end{bmatrix} \quad G = \begin{bmatrix} g_{ss} & g_{so} \\ g_{os} & g_{oo} \end{bmatrix} \quad C = \begin{bmatrix} c_{ss} & c_{so} \\ c_{os} & c_{oo} \end{bmatrix} \]

\( S \) and \( O \) as subscripts of matrices elements are indicators of stock market and oil price respectively. In our study conditional variance of stock market return by considering the lags effect of shocks and volatility of stock market return and oil price return can be shown as;

\[ H_{ss} = c_{ss} + (a_{ss} \varepsilon_{ss,t-1} + a_{os} \varepsilon_{os,t-1})^2 + (g_{ss} h_{ss,t-1} + g_{os} h_{os,t-1})^2 \]

\( a_{ss} \) and \( g_{ss} \) are accordingly coefficients of lag-lead relationship of shocks and volatility on the stock market return volatility. \( a_{os} \) Captures the impact of shocks in oil market on volatility of stock market return and \( g_{os} \) shows spillover of oil price return volatility on the stock market return volatility. The main aim of this model is to examine sensitivity of stock market return to volatility and shocks of oil price return. The maximum likelihood estimation is used under assumption of conditional normality in order to estimate matrices element of BEKK GARCH (1, 1) model by RATS in our study.

RESULT AND DISCUSSION

The results of BEKK GARCH model in Table 1 indicate that conditional volatility of Iranian stock market return is majorly explained by the shocks and variance of its lag. However, magnitude of GARCH impact coefficient under both criterions (DC and UC) implies that IRAN stock market return changes more due to variance of lagged stock market return than shocks to the market return\( |g_{ss}| > |a_{ss}| \). Significant of \( a_{os} \) indicates that shocks to the national and US oil price return have detrimental effect on the volatility of the stock market return. The insignificant of \( a_{os} \) shows inadequate evidence for oil price return volatility response to the stock market return shocks. This finding is generally consistent in both US and domestic oil price identifications. Interestingly, the spillover impact of oil price volatility to the stock market return \( g_{os} \) is only significantly supported for domestic oil (DC) price return. On the other word, the oil price return volatility under US dollar identification is failed to detect volatility spillover impact of oil price return on the stock market return. The results indicate that volatility of national oil price return is significantly affected by the stock market return volatility of last period \( g_{os} \). Figure 2 show the time varying correlation of stock market variance and oil price variance, it highlights that time varying variance correlation Iranian stock market return and national oil price return volatility explain more widely than US oil price return association.

As it is shown in Table 1, volatility of NIGERIAN stock market return is mostly sensitive to the lagged impact of its own shocks and variance. However, the lagged value of it variance brings out greater volatilities than shocks to the stock market return. It is found significant evidence on transmission of volatility from oil price return to the NIGERIA stock market return. This finding is consistent with both oil price specifications. Moreover, it is found that conditional variance of stock market return is significantly fluctuated by a shock to the oil price return in US dollar while, there is no significant support for the relationship between lagged shocks to the national oil price and stock market return volatility. Surprisingly, it is also shown that volatility of oil price return is found to be sensitive to the lagged impact of shocks and volatility of NIGERIAN stock market. Figure 3 presents the time varying correlation of variance in stock market return and the oil price return variance.
and their correlation is ranged from 0 to 70%. However, there is no evidence of considerable difference in range of time varying correlations in domestic and US currency of oil price and stock market return.

(A) Time-varying variance correlation of market return and oil price return in Iran Domestic currency

(B) Time-varying variance correlation of Tehran market return and oil price return in US dollar

Fig. 2: Time varying variance correlation of stock market return and oil price return –IRAN.

(A) Time-varying variance correlation of market return and oil price return in Nigerian currency

(B) Time-varying variance correlation of NIGERIA stock market return and oil price return in US dollar

Fig. 3: Time varying variance correlation of stock market return and oil price return- Nigeria.

Table 1 reveals that large deviation of stock market return can be explained by the lagged impact of shocks and volatility by itself. By concerning the cross- market effect analysis, the domestic oil price shocks is not accounted for volatility of stock market return at the 10% level of significant but the effect of US dollar oil price shock is significant. The findings of both oil price identifications show that α₁ is statistically significant at the 5% level; it can be emerged from this findings that variation of oil price return has spillover impact on volatility of stock market return. It is worth noting that there is lag-lead relationship from shocks to Norwegian market to
volatility of national oil price. Further analysis showed that US oil price varies as a consequence of lagged variance of Norway stock market return. Figure 4 consistently demonstrates that conditional variation of Norway stock market return and oil price return are positively correlated for the entire period of analysis and it reached the peak of 82% for US dollar value of oil price return.

![Time-varying variance correlation of market return and oil price return in NORWAY currency](image)

(B) Time-varying variance correlation of Oslo stock market return and oil price return in US dollar

![Time-varying variance correlation of stock market return and oil price return Norway](image)

Fig. 4: Time varying variance correlation of stock market return and oil price return Norway.

The results of GARCH effect (Table 1) of BEKK analysis demonstrate that volatility of oil price return has significant spillover impact to the variation of stock market return. This finding is in line in both domestic and US price of oil per barrel. Furthermore, the variation of stock market return is significantly associated with the shocks to the oil price return. However, the Russian stock market return is more fluctuated for the lagged impact oil price shocks \( \alpha_{m} \) than volatility of oil price return \( \gamma_{m} \), \(|0.34|>|0.19| \) in domestic and \(|0.64|>|0.36| \) in US currency. These observations suggest that Russian stock market performance is highly dependent for the oil price shocks and volatility. Oil price return volatility is found to be affected significantly by variation of stock market return. Figure 5 depicts the time varying correlation of variances of Russian stock market return and oil price return. It is observed that their variances are positively correlated for the whole period and sensitive to each other.

As shown in Table 1, the conditional volatility of SAUDI ARABIA stock market return majorly can be explained by the lagged impact of its counterpart and lagged effect of variance in stock market return. The finding of indirect impact of oil features implies that there is no significant evidence on volatility spillover of oil price return to stock market return at 10% level. Another important finding is that \( \alpha_{m} \) responses significantly for both national and US dollar value of oil per barrel at 5% level. This finding implies that fluctuation of stock market return is affected by the lagged shock to the oil price. The results obtained from the multivariate GARCH analysis of Saudi market and oil price illustrates that oil price volatility performance is not significantly responsive to the shocks and volatility of Saudi stock market return. Time varying correlation of volatility of stock market return and oil price return (Figure 6) shows ultimately 80% correlation among the data for the period of January 2005 to June 2010.

As shown in Table 1, the stock market stability of UAE as measured by conditional variance of stock market return is mostly fluctuated by its own lagged shocks and volatility. However, the impact of its lagged volatility is larger than shocks to the stock market. By considering the cross-variable analysis of volatility, shocks to the oil price returns have insignificant impact on performance of stock market return. It is also found that variation of domestic oil price return has spillover impact on volatility of stock market return at 10% level of significant. However, this finding is supported for the US dollar oil price identification. It is worth noting that deviation of oil price return cannot be explained by the shock and volatility of UAE stock market return and it is consistently supported for both US and national oil price specifications. As depicted in figure 7, the time varying correlation of volatility of stock market return and oil price return implies that their variances are
correlated from -0.55% to 0.5% during January of 2005 to June of 2010. However, their variances are correlated for wider range in US dollar identification of oil price.

Fig. 5: Time varying variance correlation of stock market return and oil price return – Russia.

Fig. 6: Time varying variance correlation of stock market return and oil price return – Saudi Arabia.
A) Time-varying variance correlation of market return and oil price return in U.A.E currency

B) Time-varying variance correlation of U.A.E stock market return and oil price return in US dollar

**Fig. 7:** Time varying variance correlation of stock market return and oil price return - U.A.E.

**Conclusion:**

Numbers of studies have been carried out to examine the magnitude impact of oil price on the stock market behavior. In this study, the main objective was designed to investigate existence of volatility spillover from oil price return to the stock market return of 6 major oil exporting countries and for this purpose oil price return is identified under both oil price return in domestic and US dollar value.

The findings in lag-lead relationship model of volatility have shown that five out of six countries (IRAN, NORWAY, NIGERIA and RUSSIA, SAUDI ARABIA) volatility of stock market return are affected by the oil price shocks. However, a shock to the oil price is not a significant factor on variance of U.A.E stock market which can be explained because of UAE stock market structure. It should be notified that NIGERIA and NORWAY stock market volatility are sensitive to those lagged oil price shocks which are specified in non-domestic oil price per barrel. In an overall finding, it can be said that in countries that have larger portion of the world oil reserve and oil production (SAUDI ARABIA, RUSSIA and IRAN) the volatility transmission from the oil price return to the stock market return is traceable under both oil price identifications. While by decrease of volume of oil export in case of other countries the volatility transmission decreased.

In a general conclusion it is found that stock market return of 5 out of 6 major oil exporting countries (IRAN, NIGERIA, NORWAY, RUSSIA and United Arab Emirates) are affected by the fluctuation of oil price return. While, the instability of oil price return is not significant for variation of Saudi stock market return. It is also concluded that IRAN and UAE stock market are sensitive to the volatility of oil price return when the oil price for per barrel is presented in domestic currency. As a conclusion it can be said that volatility transmission from oil price return to the stock market return is supported in the cases of IRAN, NIGERIA, NORWAY, RUSSIA and SAUDI ARABIA in the first lag model. It is suggested that for volatility reaction among market prevail of national price of oil help to find relationship between oil and market volatility.

**REFERENCES**


