Oil Price Shocks and its Implications for Stock Market in Pakistan

Muhammad Tariq Khan[*] and Muhammad Ramzan Akhtar[†]

Abstract

This paper identifies different underlying oil price shocks and investigates the consequences of these shocks on the stock market in Pakistan which is highly an oil import dependent country. With some reasonable modifications to the existing approaches this paper uses structural VAR decomposed methodology of oil prices shocks for its analysis. The investigation proceeds in two steps. In the first step oil supply, aggregate demand and oil specific demand shocks were identified as main sources of oil price shocks. In the second step impact of these shocks on the stock market index in Pakistan is analyzed. The results of impulse response functions and variance decomposition analysis confirm the significant role of oil supply shocks and aggregate demand shocks on the stock market while oil specific demand shocks exert little influence on the changes in the stock market prices. The main conclusion of the paper is that impact of oil prices shocks is not the same; it differs and depends upon the underlying source of shock. Therefore the policy making authorities and investors must take care of source of oil shock before making policy and investment decisions.

Keywords: Oil price, Structural oil-price shocks, real stock price, VAR, Developing countries.

Introduction

Pakistan is a developing country. It is facing serious macro economic problems like wide spread poverty, unemployment, slow economic growth and staggering foreign exchange etc. For the economy energy resource is the driving factor. Pakistan is highly dependent on the import of oil and other energy sources. Pakistan spent $14.77 billion on import of oil in 2014 which was about 1/3rd of its import bill.

Decrease in international oil prices in 2016 caused reduction of about 37 percent in the oil import bill of country which fell from $12.166 to $7.667 billion in FY15. Therefore, changes in the international oil prices have become an important issue for the economy. In this context,

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our basic purpose is to undertake this research work to identify oil price shocks and investigate its implications for the stock market in Pakistan. Frequently rising oil prices increase cost of production and consequently reduce the profits of corporations. It also reduces customers' demand as rise in oil prices leads to rise in inflation, resultantly less disposable amount available to customers for spending. Additionally oil price shocks create uncertainty for investment, leading to demand of higher rate of returns by investors, which becomes another independent factor inhibiting the level of investment at the stock market. This increase in production costs, reduced profits decreasing demand and increased uncertainty constrains the level of investment in financial and real assets. Further reduced profits and increased discounts rates result in decreased share prices. Therefore changes in oil prices play an important role for macroeconomic fluctuations in the short to medium term.

The existing literature has widely discussed the implications of the oil price. In his paper, Hamilton (2008) shows that in the period since World War II, every single recession in the USA except one has been preceded by a spike in oil prices. Relevant past literature shows mixed results regarding the effects of oil-prices shocks on the stock markets returns. Chen et al. (1986) claims no effect of oil price changes on movement of share prices, whereas Jones and Kaul (1996) show proof of a negative relationship. This negative effect, on the other hand, is not supported by Wei (2003). Kilian (2009) criticized previous studies, for the reason that they took oil prices shocks as exogenous shocks. There are studies however, arguing that changes in the oil prices also respond to the same factors that affect the changes in the stock prices (Kilian, 2009; Hamilton, 2003; Kilian 2009). Kilian (2009) argued that oil prices shocks must be decomposed into underlying structural sources which could reveal the endogenous characteristics of relevant oil price shock. Decomposing the oil price shocks can help eliminate, deficiency of past studies treating oil price shocks as exogenous shock. Additionally decomposition of the oil price shocks also help to analyze the respective difference of effect and importance of each differentiated shock on stock prices, investment and other macro economic variables.

While there is substantial research available for the developed countries, the existing research on the topic is quite scanty in Pakistan. Fatima and Bashir (2014) found evidence in favor of negative and asymmetric effect of oil price on these emerging stock markets. Naurin and Qayyum (2016) also show positive and asymmetric impact of oil price volatility on stock market index.

Examining the implications of oil price shocks for stock market in Pakistan is necessary for many reasons. First existing studies in

Pakistan produced mixed and inconclusive results as former study argued negative, while the later paper has favored positive effects of oil price shocks. Even recent studies based on SVAR methodology lack consensus, as some reported importance of shocks from the demand side like Kilian (2009) and Apergis & Miller (2009) while others advocate the importance of supply side shocks like Gupta & Modise (2013). Second economy of Pakistan compared with other developing countries is highly dependent on imported oil for its energy and other needs. Demand for petroleum products in Pakistan is approximately 16 million tons, 82% of which is met through imports while only 18% of it is met locally according to the Ministry of Petroleum and Natural Resources (MPNR). Third consumption of oil is increasing with much higher speed as import of oil by Pakistan nearly doubled in a span of 6 years from 113.78 thousand barrels per day in 2004 to 227.07 in 2010. This much heavy reliance on import of oil lead Pakistani economy and markets, very much sensitive to the international oil price movements. Therefore it is essential to study the implications of oil price shock on the stock markets. Final and crucial reason is the gap that need to be addressed is that past studies available in Pakistan suffer from the limitations of traditional approach of treating oil price as exogenous shock, which is criticized by Kilian (2009) discussed above. None of past studies in Pakistan has been based on this most widely accepted Kilian (2009) structural VAR approach which decomposes oil price shocks. Therefore this paper uses the Kilian (2009) structural VAR framework with few changes and therefore contributes to the existing stock of literature on the topic in an oil import dependent developing country. This paper intends to apply Kilian (2009) structural method to identify sources of oil price shocks and examine their impacts shocks on the stock market of a developing economy relying highly on oil imports like Pakistan. Therefore, research questions what can be underlying components of oil price shocks in Pakistan and to what extent underlying oil price shocks can affect stock market prices in Pakistan are the focus of this paper.

Since unit root tests show that global oil production in terms of percentages and the stock market returns of U.S. are stationary variables i.e., I (0), whereas global real economic activity and the real price of oil are non-stationary variables i.e., I (1). Therefore, Kilian and Park (2009) used inconsistent time series estimation of a structural VAR model as pointed out by Apergis and Miller (2009). This study therefore modifies the Kilian's (2009) procedure for identifying oil price shocks by using the levels of world crude oil production, world real economic activity and the real price of crude oil, so that a consistent time series can be estimated for analysis.

Plan of the study is organized as follows. Section 2 reviews the literature on oil price shocks on stock market prices from both the theoretical and empirical perspectives. Section 3 discusses data and methodology used in this study and discusses econometrics issues. Section 4 presents results and discussion regarding effects of different oil price shocks on the stock market prices. Section 5 derives conclusions and recommendations.

Literature Review

This section describes the previous research work discussing the linkages between oil price shocks and stock or asset prices. As for literature on this topic is concerned, there is no consensus regarding consequences of oil price shocks on the stock markets. El-Sharif et al. (2005) investigated and found a positive relationship between oil prices and stock returns of oil sector; nevertheless, potency of this relationship varies across the different sectors of the London Stock Exchange. (Nandha and Faff, 2008 O'Neil et al., 2008 and Park and Ratti, 2008) argued the negative impact of oil price shocks especially on output and profitability of an oil intensive firm.

Kilian (2009) criticized the past studies, for the reason that researchers treated oil-price shocks as exogenous. There are studies on the other hand, which argued that oil price changes also react to the same causes affecting the stock market prices also Hamilton, 2005; Kilian, 2009). Therefore, aggregate oil price shocks must be decomposed into the underlying structural shocks reflecting the endogenous features of such oil price shocks.

Chen, Hamori and Kinkyo (2014) made an extension to the Kilian's (2009) model by identifying an exogenous underlying shock to the oil prices, which arises from fluctuations in the financial market conditions and examined the resultant impacts of oil price changes on the macroeconomic variables. Their results confirmed the important role of financial shock in determining the oil prices and consequently on macroeconomic changes.

Wei and Guo (2017) followed the Kilian (2009) methodology to investigate the effects of oil price shocks on return and volatility of Chinese stock market. Bastianin and Manera (2017) while examining the reaction of U.S stock market volatility to the oil price shocks also used the SVAR method. They found results in favor of important role of aggregate demand shocks and oil specific demand shocks where as less important role of oil supply shocks.

Despite the high level of dependency of Pakistan on imported oil and sensitivity of its economy to oil price changes there are only few

studies which examined the association between oil price shocks and stock price index is concerned. Fatima and Bashir (2014) investigated the relationship between oil prices volatility and stock market changes in Pakistan and China. They used monthly data from 1998 to 2013 and found evidence in favor of negative and asymmetric effect of oil price on these emerging stock markets. Naurin and Qayyum (2016) show positive and asymmetric impact of oil price volatility on stock market index. In a most recent study Jebran et. al. (2017) reported adverse effects of oil price shocks in periods before the 2007 financial crisis where as positive effects in periods after such crisis.

These studies in Pakistan however have limited scopes as they used traditional approach by treating oil price shocks as exogenous shock, which is criticized by Lutz Kilian (2009) as mentioned earlier in detail. Main stream literature on the subject after that has seconded the view point of Lutz Kilian (2009), as there exist reverse casualty between oil shocks and macro economic variables like stock markets. This study therefore follows Lutz Kilian decomposed model of oil price shocks which has never been applied in Pakistani case.

In the light of foregoing literature review oil supply shocks and oil specific demand shocks are expected to have negative effect and aggregate demand oil shocks are likely to have positive effects on the stock market prices in Pakistan.

Data Analysis and Methodology

This study used the monthly data from July 1997 to June 2017. Since objective of the present paper is the investigation of the impacts of changes in oil prices on the aggregate stock prices of the market, therefore PSX index is used as a measure of stock market. Since individual stock price has undiversifiable risk associated with the individual entity and industry it belongs to so different industries have different degrees of oil dependence. Some use crude oil as a raw input while others may only use it for transportation and heating. Thus, the individual stock price may show a biased response when facing oil price fluctuations. The real stock returns are calculated by deducting the inflation rate CPI from the returns in the logs of Pakistani stock price index (KSE 100).

The present paper uses global oil production (WOP) to reflect both the OPEC and non OPEC countries political uncertainties and cartel activities. This data is available from the website of the Energy Information Administration (EIA). To represent the global real economic activity (REA) this paper follows Kilian's (2009) which used dry cargo freight rates as an indicator of world real economic activity.

Real Oil Price (ROP) is measured by using the Free-on-Board (FOB) importing price of crude oil in US by following Kolodzeij and Kaufmann (2014). Monthly data of FOB oil prices is available from US EIA. Free on board oil price measure is used since other measures like US West Texas Intermediate prices contain the effects of freight charges also. Finally real oil price is obtained after deflating the oil prices by the US inflation rate. The US CPI data is available from the IMF's International Financial Statistics.

In this paper structural VAR model is estimated to identify sources of oil price shocks and to examine their consequences for the stock market in Pakistan. The structural oil shocks include global oil supply shock, an aggregate demand shock and an oil-specific demand shock. The structural VAR model represented as following:

$$A_0 y_t = \alpha = \sum_{i=1}^{p} A_i y_{t-1} + \varepsilon_t$$

Here yt represent a (4 × 1) vector that contains world crude oil production (WOP), world real economic activity (REA) real oil prices (ROP) and real stock price (STP). A0 denotes coefficient matrix a at the same time, α symbolizes constant term vector, and εt represent a vector of structural shocks which are serially and mutually uncorrelated. After applying the reasonable restrictions to identify, reduced-form errors estimated obtained from equation given below can help recover the structural shocks:

$$e_t = A_0^{-1} \varepsilon_t$$

where et denotes the reduced-form errors

Following Kilian (2009), a VAR is estimated to identify oil shocks in first step of analysis. In second step this paper analyzed the effects of these identified shocks on the stock market index. Also following Kilian (2009) lags of 24 used each variable. This lag criterion of 24 months can well capture the delayed effect also and can help in estimating the possible long-run impacts of these variables. Additionally standard techniques used in calculating the suitable lag periods are also used by this paper. For selecting the appropriate lags there are many criterions available however the most commonly used are Schwarz' Bayesian Information Criterion (SIC/BIC/SBIC) and the Akaike Information Criterion (AIC) are used by this investigation.

Identification of structural oil price shocks is done by using the Choleski decomposition method. Insight from the literature shows that the order of variables according to the exogeneity of variables is WOP,

REA, ROP and STP. Order in this sequence implies that a shock to a variable higher in the order has contemporary impacts on the variables in the lower order but not vice versa. Past studies including the Kilian (2009) imply that a World oil production (WOP) has the least response to other variables due to higher cost of adjustment. This order becomes REA, ROP and STP in terms of exogeneity. By adopting this ordering, we assume that the oil supply shock, aggregate demand shock and oil-specific demand shock can be captured by using the structural shock to WOP, REA and ROP and STP respectively.

Therefore, the VAR in the reduced-form is hereby formed after multiplying both the sides of Eq. (1) by $A0^{-1}$, and it is represented below in a recursive structure:

$$\begin{pmatrix} u1_t \\ u2_t \\ u3_t \\ u4_t \end{pmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ a21 & 1 & 0 & 0 \\ a31 & a32 & 1 & 0 \\ a41 & a42 & a43 & 1 \end{bmatrix} \mathrm{X} \begin{pmatrix} \varepsilon_{oil\ supply\ s\square ock} \\ \varepsilon_{aggregate\ demand\ \ s\square ock} \\ \varepsilon_{oil\ specific\ demand\ s\square ock} \\ \varepsilon_{Stock\ Price\ s\square ock} \end{pmatrix}$$

To illustrate the relative importance of the structural shocks identified in as a source of oil price changes and stock prices, the impulse responses of real oil prices (ROP) and other related variables to a shock of one standard deviation are performed. Additionally variance decomposition is estimated to investigate how much different structural shocks contribute to the changes in other variables included in the VAR model.

Empirical Results

Results from the analysis are described in two steps. First part presents results regarding the identification of the sources of oil prices shocks through impulse responses and variance decomposition analysis of the SVAR model. Second part presents the finding from the structural VAR analyzing the impacts of identified shocks on the stock market index.

Identifying the Sources of Oil Price Shocks

Impulse response of oil prices to structural shocks.

In this section impulse response function was used to assess the respective role of structural oil shocks in causing changes in oil prices.

Fig. 1 below shows the impulse responses of real oil prices and other variables to a shock of one standard deviation. Two standard error bands are shown by dotted lines. Results show that changes in aggregate demand shock (REA) causes significant and stable increase in real oil prices. This significant change lasts about six months. A shock coming from oil specific demand causes an immediate, large, stable and significant positive effect on oil prices in the international oil market.

Response to structural one standard deviation shocks with two standard error confidence bands

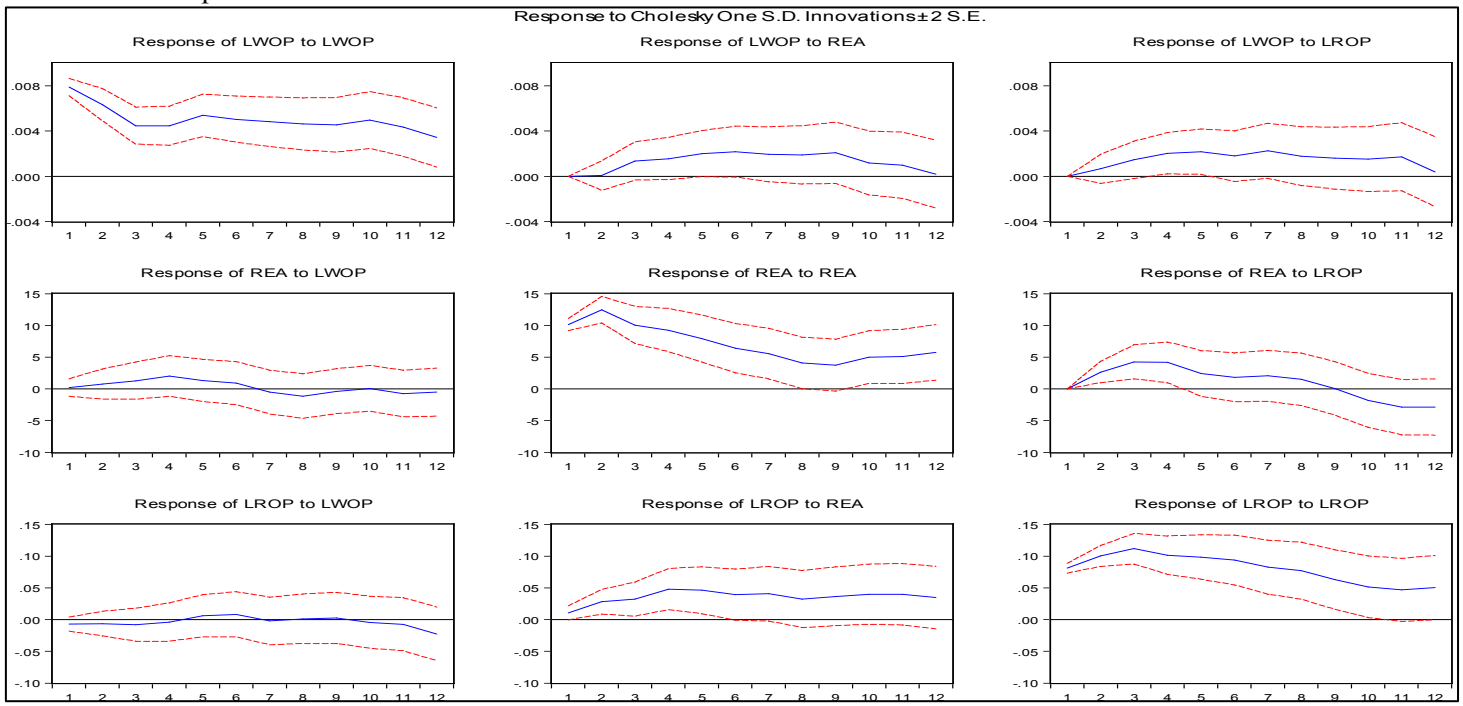

Fig. 1: Structural VAR impulse responses

Note: the LWOP denotes the log of world oil production; REA is the world real economic activity and ROP is the log value of real oil prices.

Variance decomposition of oil shocks.

In addition to impulse response functions, the relative role of different structural shocks in VAR in causing oil price changes is also explored by estimating the variance decomposition. Results of variance decomposition comprising the part played by structural variables like oil supply shocks, oil aggregate demand shocks and oil specific demand shocks in causing changes in oil prices are shown by Table 1.

Table 1 Variance Decomposition (Oil Price Shocks)

Period	Oil Supply shock		Aggregate demand shock		Oil specific demand shock	
1	0.76	(1.35)	1.715	(1.88)	97.52	(2.23)
5	0.37	(1.74)	11.49	(7.21)	88.13	(7.28)
10	0.33	(2.88)	14.90	(10.22)	84.75	(10.30)
15	2.04	(4.64)	17.59	(11.88)	80.35	(12.10)
20	4.09	(6.52)	20.22	(13.19)	75.67	(13.58)

Standard Errors: Monte Carlo (1000 repetitions)

The biggest contributing element in oil price changes is oil specific demand shocks itself. However, part played by this shock decreases gradually with passage of time, but still it is major contributor by causing 75% changes in oil price shocks after 20 months. The aggregate demand shock explains the 20% variation in oil price shocks after 20 months. On the other hand, the oil supply shock accounts for the lowest share of ROP fluctuations (4% after 20 months), which could be seen as an indication of its low explanatory power. These results are broadly similar to the findings for the impulse responses analysis presented above.

Structural Oil Price Socks and Stock Prices

Impulse response of stock market to structural oil shocks.

The impulse response functions conducted for the response of stock market prices to the structural oil price shocks are presented in Fig 2. The lines in dots show the standard errors. These standard error bands determine the statistical significance of one standard deviation shock to a variable concerned.

Response of KSE index to structural one standard deviation shocks with two standard error confidence bands

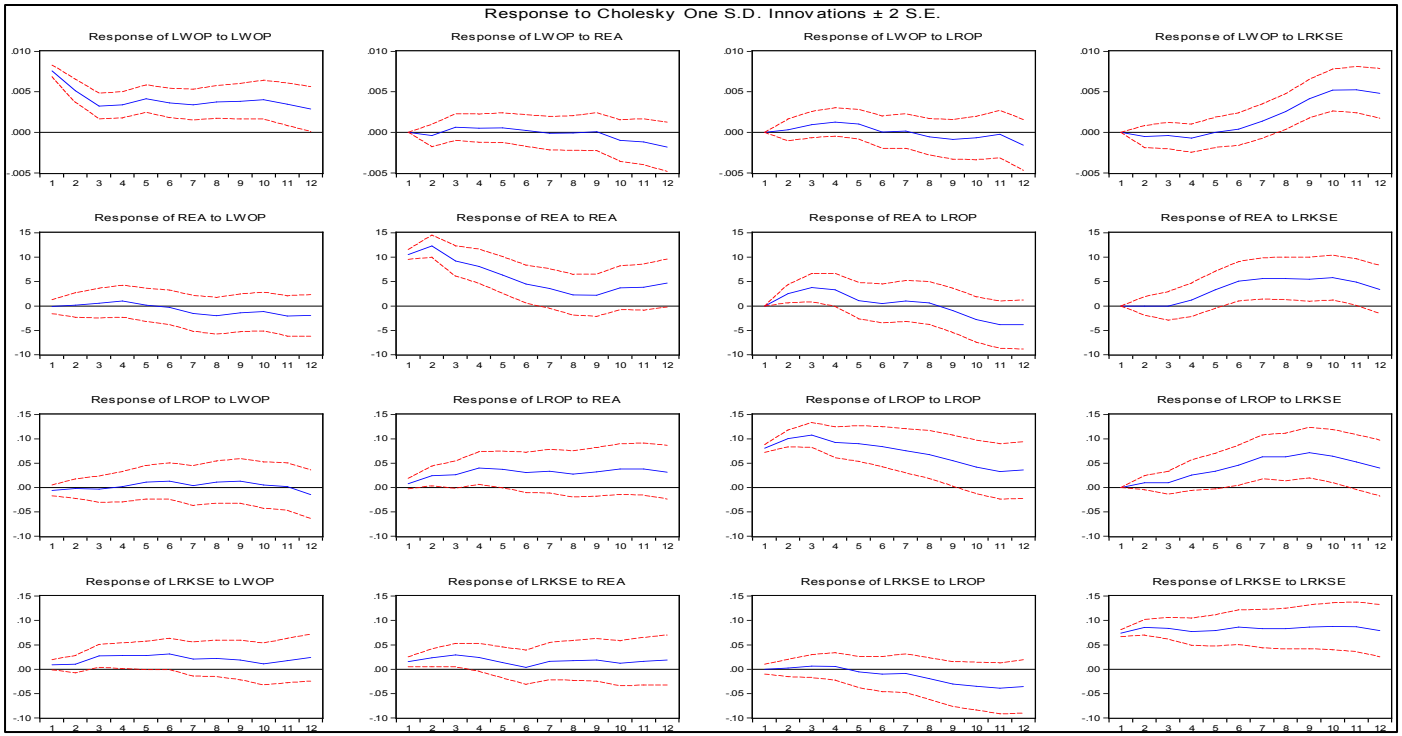

Fig. 2: Structural VAR impulse responses of stock market to oil shocks

Note: the LWOP denotes the log value of world oil production; REA is the world real economic activity; ROP is the log value of real oil prices and logged value of Karachi stock exchange index is denoted by LKSE

According to the results shown by Fig. 2 an increase in oil supply shocks is associated with the increasing stock prices in Pakistan. This increase in stock prices remained significant during the 3rd to 6th month approximately. These results are consistent with the study by Chen et al. (2014). An increase in aggregate demand shocks increases stocks prices which remains significant for first three months. After 3 months a gradually decreasing but insignificant trend of stock prices is observed. These results are nearly consistent with the findings of Kilian (2009). An increase in oil specific demand shocks have a decreasing effect on stock prices in Pakistan, however this decrease is not significant.

Variance decomposition of structural stock market shocks

Table 2 shows the variance decomposition analysis results. It uncovers the role of structural oil shocks identified in the SVAR model discussed above in relation with the asset prices like stock prices of KSE 100. Three structural oil markets shocks together account for 30% innovations in stocks prices in 24 months period. These results are close to Kang & Ratti (2013) which reported oil price shocks accounting for about 33% variation in U.S stock market. Oil supply shocks though exert little influence on changes in oil prices, but they have significant influential role in changing the stock prices in Pakistan by accounting for about 16% variation. While aggregate demand and oil specific demand shocks have minor role in stock price innovations in Pakistan.

Table 2 Variance Decomposition Test (Stock Market)

Period	Oil Supply shock		Aggregate demand shock		Oil specific demand shock		KSE	
1	1.36	(1.57)	3.92	(2.52)	0.00	(0.61)	94.71	(2.99)
6	7.52	(6.20)	5.21	(5.17)	0.47	(2.70)	86.78	(7.92)
12	5.78	(6.86)	4.15	(6.47)	5.82	(7.78)	84.24	(11.11)
18	8.80	(9.66)	4.43	(8.09)	9.29	(11.11)	77.46	(14.46)
24	15.65	(12.48)	4.39	(8.52)	9.10	(11.75)	70.84	(15.63)

Standard Errors: Monte Carlo (1000 repetitions)

Conclusions, Implications and Suggestions

Realizing the heavy reliance and sensitivity of Pakistani economy to the imported oil and sudden changes in recent international oil prices, this paper undertakes investigating the oil price shocks and its implications for the stock prices in Pakistan at the aggregate market level. For this purpose this paper for the first time uses the Kilian (2009) structural VAR decomposed oil price shocks methodology for analysis in Pakistan.

This approach distinguishes this research effort from past few papers in Pakistan. Using this approach is important since it addresses the caveat of traditional methodology of treating oil price shocks as exogenous variable. Additionally it also allows for analyzing the distinguished effects of underlying sources of oil price variation.

Analysis of this paper proceeds in two steps. In first step sources of oil price shocks were identified like aggregate oil supply shock, aggregate demand shocks and oil specific shocks. Impulse response and variance decompositions results show that oil specific demand and aggregate demand for oil shocks have important bearing on the oil price shocks while oil supply shocks have little role.

In the second step implications of these identified underlying oil price shocks for the aggregate stock market prices were analyzed by following the SVAR framework used by Kilian & Park (2009). Results of this second step show that oil supply shocks and aggregate demand shocks have significant effect on the stock prices, whereas oil specific demand shocks have little effect on the stock market prices in Pakistan. Additionally cumulative impulse response analysis reported in Fig. B in the Appendix imply more stable effect of oil supply shocks however, effects of aggregate demand for oil changes over the time. These results are also in line with the Chen et al. (2014) findings.

Results of this study imply that impact of oil price shocks on stock markets vary greatly depending upon the nature and source of the shock and each shock is responded by stock markets in a different way. Therefore, policy makers, investors and managers must take care of sources of underlying oil price shocks in making their decisions regarding this oil price risks and investments. This paper is limited to the Pakistan only, it is therefore recommended for future research, a comparative study of other oil importing developing countries of the region as well, to see the differences and similarities of effects and sensitivities of their respective markets to the oil price shocks. Additionally investigating the oil price shocks effects on various sectors can also help better understanding the differences of effects.

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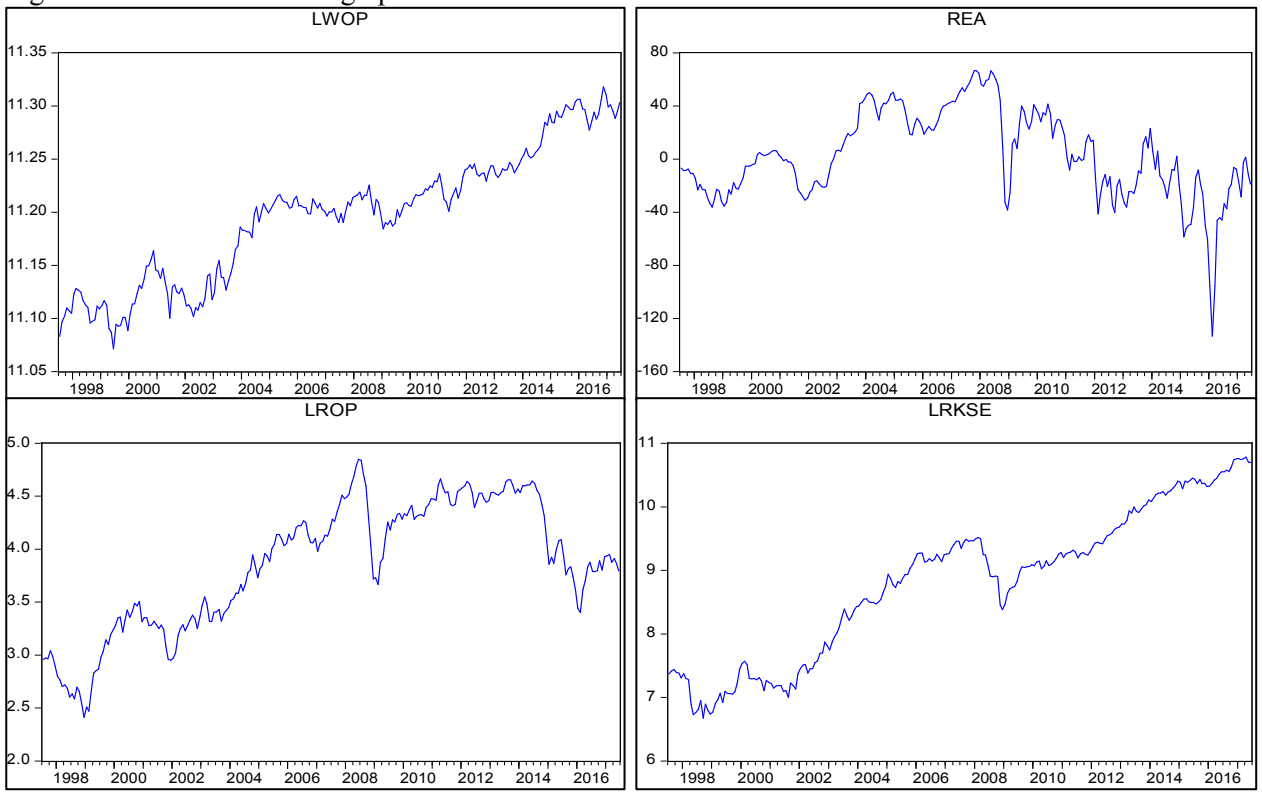
APPENDIX

Figure A Time series graphs



Cumulative response to structural one standard deviation shocks with two standard error confidence bands

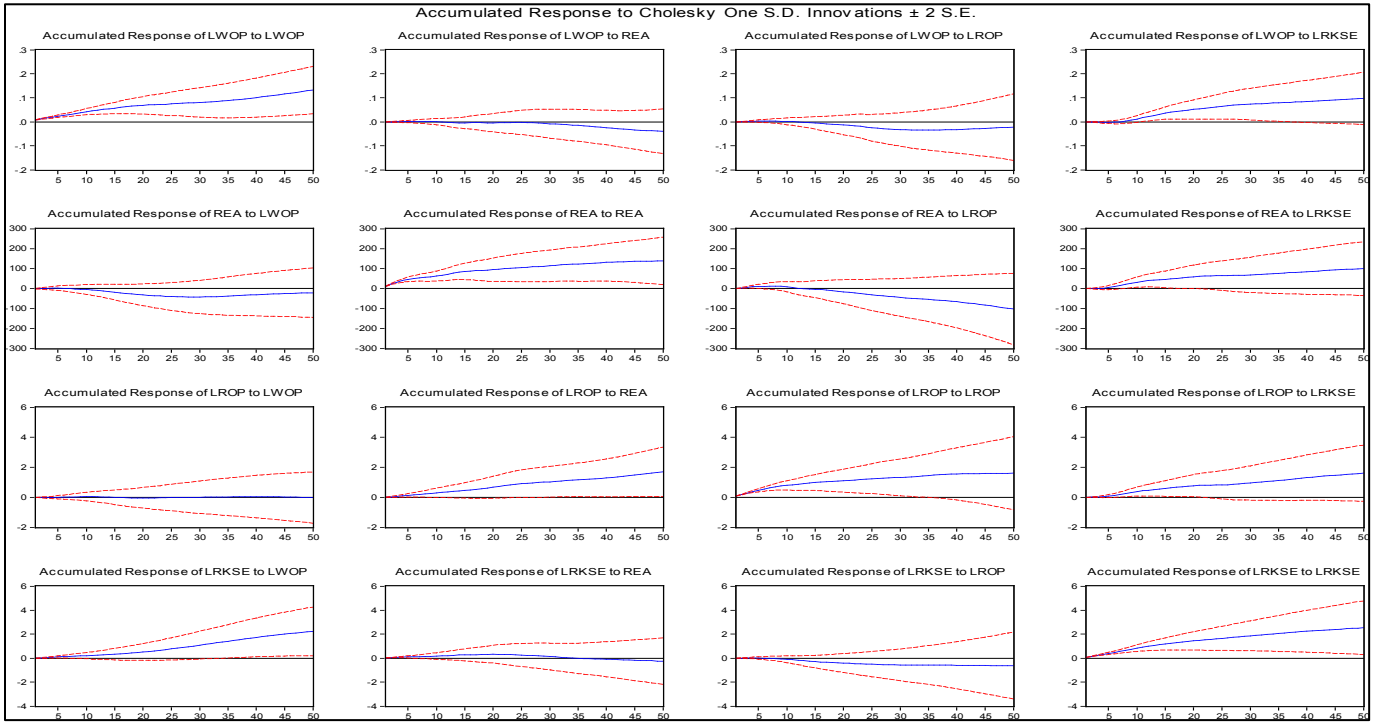


Fig. B Cumulative impulse responses of stock prices to structural oil shocks for 50 months horizon
Note: the LWOP denotes the log value of world oil production; rea is the world real economic activity; rop is the log value of real oil prices and logged value of Karachi stock exchange index is denoted by LKSE