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INDUSTRIAL SECTOR AND GLOBAL OIL PRICE FLUCTUATIONS: A Case Study of Pakistan

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Abstract

This study empirically investigates the dynamic relationship between global oil price fluctuations and industrial sector of Pakistan for the time period 1974-2015 by employing an Autoregressive Distributed Lag Model. The findings suggest that industrial sector is prone to the global oil price fluctuations where observed and forecasted oil price volatility along with the net oil price increase relative to preceding three years has negatively significant effect on industrial value added share in GDP. Moreover, the oil price shock driven by the global demand has positive while the oil market-specific shock geared by precautionary increase in oil demand has negative effect on industrial value added, in the long run. Overall, uncertain oil price fluctuations and endogenously determined nature of oil price increase has dominant effect on the industrial sector in Pakistan than the annual oil price changes. The findings suggests domestic price stability along with move towards export diversification to form a strong industrial base rendering international oil price fluctuations impartial, on the one hand and for reaping the potential benefits of devaluation of domestic currency, on the other. However, improved energy efficiency and low oil dependency in the long run will be required to stimulate the industrial sector's contribution in GDP.

Keywords: Industrialization; Energy, Macro Economy; Pakistan.
JEL Classification: O14; O53; Q43.

I. Introduction

The oil price fluctuations and macroeconomic performance have remained highly debated subject in the energy sector of world economies since the oil price shocks in the 1970s. The empirical research conducted on the issue mostly focuses on GDP, inflation, employment, interest rate, stock prices and the government expenditures for its potential link with the oil price changes. The unexpected changes in oil prices have emerged as the main driver of real economic activity. Regarding industrialization, the repercussion of oil price fluctuations for aggregate industrial production has remained

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the major centre of attention. Bohi (1989) and Lee and Ni (2002) are the pioneers in industry-level production studies of oil price changes. However, Bohi (1989) provided the evidence of no correlation between industrial-level output and energy intensity while Lee and Ni (2002) came up with the negative effect of oil price shocks on U.S. oil-intensive industries. Initially, the focus of studies was mainly the United States including Darby (1982), Hamilton (1983, 1996, 2003), Mork (1989) and Hooker (1996), to mention few. Some other studies focused on the other world economies including Burbidge and Harrison (1984) for five OECD (Organization for Economic Cooperation and Development) countries, Mork, et al. (1994) for oil-importing and oil-exporting countries, Rodriguez (2008) for the industrialized world and Kilian (2005) for G-7 countries and provided significant evidence for aggregate economic activities and oil price changes relationship.

Initially, the oil prices shock was treated as positive exogenous shock to the oil-exporting countries while negative for oil-importing countries. Later it was realized that the dynamics of oil price depends on the endogenously determined nature of oil price shocks and the way oil price is being determined in the literature varies from supply and demand's perspectives [Kilian (2009)]. In particular, rapidly growing emerging economies and their rising oil demand along with the integration of global supply chains, determines the oil price changes and its transmission channels, variedly.

According to Fukunaga, et al. (2010), oil price increases due to unexpected oil supply disruption and increase in oil-specific demand tends to reduce the industrial production. While oil price increases due to rising global demand activity can raise industrial production, the underlying reason for comparatively smaller effects of oil price surges in the 2000s than 1970s. Hence, it is generally believed that the earlier phases of oil price shocks starting from the 1970s were driven by the oil supply disruption. Later episodes in the 1990s onward are mostly dependent on the rising demand from emerging economies.

Keeping in view the slow industrialization and high oil-dependence of Pakistan, this study is an attempt to investigate the oil price implications for the industrial sector in Pakistan, measured through industrial value-added in GDP for the time period 1974-2015. The literature on oil price fluctuations and macroeconomy of Pakistan not only lacks in the choice of measures for oil price fluctuations, but its focus has also been revolving around the overall economic growth effects. This study has used a number of measures for oil price fluctuations, including both exogenous and endogenously determined oil price changes to gauge the extent to which various measures of oil price fluctuations differ in affecting industrialization. Firstly, asymmetries in oil prices entailing both positive and negative oil price shocks are used as net oil price changes. Secondly, the relative oil price increase in a given year with respect to last three years and; thirdly, the annual oil price fluctuations are measured in terms of volatility through General Autoregressive Conditional Heteroscedasticity (GARCH) that reflects both the unanticipated component and time-varying conditional variance component. Besides, fluctuations are also measured as a time-varying moving standard deviation that renders the realized volatility in oil prices. Such volatilities are expected to exert a significant impact on the industrial value-added through industrial sector's growth.[2]

On further count, although Pakistan being a small open economy cannot (find) exercise pressure on the global oil prices, but the globally determined nature of oil price can affect industrial sector variedly. Hence, we have also used structural shocks based on Kilian's (2009) which applied Structural Vector Autoregression (SVAR) model to identify the underlying reason of oil price shock driving the industrial sectors' performance. Both the exogenously given and endogenously determined oil price fluctuations along with its volatility are used to gauge the effect of oil price fluctuations, controlling for the real exchange rate and domestic consumer prices.

The major findings of this study provide a negative effect on the industrial value-added share in GDP of; a) oil price volatilities; b) net oil price increase with respect to preceding three years oil price change; and c) the oil price increase driven by an increase in precautionary demand due to unpredictable future oil availability and oil supply disruption. The structural oil price shock due to the increase in global demand for industrial commodities tends to stimulate the industrial value-added in GDP. Moreover, the short-run response of industrial sector remained sluggish as compared to the long-run.

The rest of the paper is organized as follows. Section II provides an overview of industrialization in Pakistan. Section III provides the review of literature. Methodology section IV deliberates measures of oil price fluctuations, empirical model, data description and estimation technique. Section V reports and interprets the results from the empirical model. Section VI concludes the paper with some policy implications.

II. Industrialization in Pakistan

Industrialization in Pakistan faced many upheavals, and the industrial sector's share in GDP has been declining over time. According to Pakistan, Government of (2016-17), the latest figures of the industrial sector's growth stands at 5.02 per cent. The industry is the second major commodity-producing sector of the economy that has multidimensional direct and indirect linkages with the rest of the economy. The major source of tax revenue, the industrial sector has remained vital in the budgeting and financing policies of the government, but the composition of the economy has gradually shifted over time, placing services sector at first with a contribution of 59.59 per cent in GDP compared with 20.88 per cent of Industrial sector and 19.53 per cent of the agricultural sector. Such structural transformation, unfortunately, is not being governed by the development phases, but it is due to declining productivity and share of the industrial sector in GDP, the term referred as premature deindustrialization in literature.

[2] The industrial value added in GDP is used for being the closest measure of industrialization.

Historically, the industrial sector performed very well in establishing new industrial units and building a strong industrial base in Pakistan under an extreme level of protection and interventions under import-substituting policies in the 1950s and pro-industrial policies in 1960s. The growth rate was quite impressive at 23.6 per cent between 1949 and 1954 for large-scale manufacturing, and a substantial base was established in the 1960s, with 9.3 per cent growth rate of the large-scale manufacturing sector. Nevertheless, the industrial performance couldn't be sustained later and was rather disappointing in the 1970s and early 1980s. Besides the separation of East and West Pakistan (1971), nationalization of industries and financial institutions in 1972 also slowed down the pace of the industrial sector's growth. The nationalization of industrial units resulted in the complete reversal of private and public investment as the anti-industrialization policies and subsequent uncertain business environment depressed the confidence of the private sector. Moreover, the removal of export subsidies for industrialists in the wake of the devaluation of domestic currency by 131 per cent and banishing the export bonus scheme added miseries to the industrial sector [Zaidi (2014)].

In particular, liberalization experience with export-oriented policies initially provided a stimulus to the industrial sector, but deficient financial sector reforms proved a hindrance in the way of rapid industrialization. With the inconsistent macroeconomic policies and political instability playing negative role domestically, the world recession due to oil price hike acted as an exogenous global factor in slowing down the pace of the industrial sector's growth. The oil price hike not only depressed Pakistan's export demand but also revert the benefits from earlier devaluation and rising export growth. According to Zaidi (2014) after the oil price hike, the import bill grew significantly with creating high imported inflation and wiped out the positive balance of trade in one go. Specifically, oil imports increased from the U.S. 60 million dollar in 1972-73 to 225 million dollar in 1973-74.

Although import substitution industrial strategy accounted for more than 8 per cent of manufacturing growth till the eighties, 1990s observed the growth rate slipping to around 3 per cent only. According to Kemal and Khan (1997), the deregulation and liberalization in the 1980s led towards an increase in the growth rate of manufacturing sector production to 8.1 percent due to improved productivity. Later in the 1990s, the industrial sector's structural changes drove the declining production and rising inflation. Although private investment in the industrial sector expanded at the rate of 15.6 per cent during 1977-1986, growth in labour productivity and employment opportunities deteriorated in this period due to rising capital-intensity.

In the late eighties, deregulation and liberalization came forth as major structural changes and the export-led industrialization appeared as a major trade policy goal. However, the industrial sector growth rate fell from an impressive 8.21 per cent to only 4.8 per cent in 1990s and further declined to 1.5 per cent in 1990-2000. The dismal performance was followed by a sharp increase of 15.5 per cent only once in 2004-2005. Otherwise, the trend in the industrial sector in the 1990s and later only reconfirmed the deteriorating condition of the industrial sector in Pakistan [Zaidi (2014)]. Pakistan depends heavily on the imported oil due to lack of indigenous resources, and its imports have increased four times from 6per cent of merchandise imports to 22 per cent over the period 1970-2015. Furthermore, low refining capacity leaves Pakistan heavily dependent on the imported petroleum products that support 90 per cent of domestic fuel consumption and need of furnace oil for power generation. Although, the share of oil in final energy consumption reduced due to high oil prices during 1995-2012 but the incapacity of the economy to opt some alternate energy resources kept the oil dependence high.

III. Review of Literature: Oil Price Fluctuations and Industrial Sector

The theoretical and empirical literature on oil prices has identified a number of channels through which it can influence the macroeconomic activities. The preliminary literature mostly focused on the U.S. as Hamilton (1983) provided that oil price changes have a significant impact in almost every recession of the U.S. after the 2nd World War. Later, the subject has gone vastly debated; however, with no consensus on the causal relationship between oil price and several macroeconomic variables.

1. Evidence from the World Economies

Lee and Ni (2002), Reyes and Quiros (2005), Rodriguez (2008), Lippi and Nobili (2008), Kumar (2009) and Tang, Wu and Zhang (2010) found a negative association between industrial production and the oil price increase. Literature suggests minimizing the dependence on oil for sustainable industrial growth. For industry-level data, Lee and Ni (2002) applied the Vector Autoregressive (VAR) model to empirically investigate the likely effects of oil price changes for the U.S. during 1959-1997. They found that oil price shocks act as supply shocks and have declining effects on the production in oil intensive industries like petroleum refineries due to high operating costs and uncertainty. Following Lee and Ni (2002), the study by Fukunaga, et al. (2010) imposed block recursive restrictions to make the identified shocks to global oil market similar, using monthly data from 1973-2008 for U.S. and Japan. They found out the movements in U.S. production in the 2000s mainly determined by the global demand shocks in spite of that the share of U.S. in world production had declined during this time period. The effect is different for Japan, where the effect of oil supply shock on Japan's industrial production is statistically insignificant. In evidence from Asian countries, Cunado and Gracia (2003) employed the Structural Vector Autoregressive model to examine the role of structural oil shocks on the macro economy of large Asian economies; Japan, South Korea, India and Indonesia found the response of economic activities to prices country-specific. In evidence, Rodriguez (2008) assessed the dynamic effects of oil price shocks on manufacturing industries output for four European Monetary Union

(EMU) countries; France, Germany, Italy and Spain, and U.K and U.S. They applied an identified Vector Auto regression model for each economy and found the pattern of output response towards oil shock quite diverse. For France and Spain, they found the impact of becoming positive after two years of oil price shocks while permanently negative for Germany and Italy and broadly similar for the U.K and U.S.

For Turkey, Torul and Alper (2010) found that oil price increase does not significantly affect the aggregate production of the manufacturing sector but few sub-sectors negatively during 1991-2007. Bredin, et al. (2010) applied Structural VAR (SVAR) model for G-7 countries over the time period 1974-2007 and found that oil price uncertainty has a negative impact on industrial production in Canada, France, U.K and U.S. Similarly, Lippi and Nobili (2008) found the asymmetric effect of oil price change for the US over 1973-2007. They suggested that industrial production tend to decrease after negative oil-supply shock while increase after oil-demand shock. Comparatively, Eksi, et al. (2011) found significant short-term causality running from crude oil price to the industrial production in selected OECD countries except for France.

Another study by Al-Risheq (2016) focused on the relationship between oil prices and other key variables on industrial production by utilizing data from 52 developing countries for the period 1970 to 2012. Applying the fixed-effects model with instrumental variables, the study found a negatively significant impact on industrial production and re al exchange rate. They stressed to improve the oil reserve system to reduce oil shocks vulnerability of developing countries.

2. Evidence from Pakistan

As pointed out earlier, there is a dearth of studies on the oil price fluctuations and industrial sector relationship specifically for Pakistan, and few studies are there addressing overall economic growth.

According to Jawad (2013), oil price volatility along with public sector investment has an insignificant effect on GDP for the years 1973-2011 while the trade balance and private investment appeared as positively contributing factors towards GDP. The study suggested measures to maintain balance in demand and supply to mitigate the effect of oil price volatility.

Similarly, the macroeconomic impact of global food and oil prices on the economy of Pakistan is analyzed through Structural Vector Autoregressive (SVAR) model for the monthly data from 1990-2011 by Khan and Ahmed (2011).The oil price shocks and its transmission channel are observed for output, inflation, money supply, rate of interest and effective exchange rate. The results suggested that industrial production tends to decrease while inflation and interest rate increases in the wake of oil price shocks. The generalized impulse response functions identified that the real effective exchange rate is most sensitive towards price shocks. On the same count, Khan and Ahmed (2014) quantified the impact of oil price changes on macroeconomic variables focusing on regulatory reforms for monthly time series from 1995-2014. The study provided the asymmetric and significant impact of oil price changes on the economy in the post-regulation period (2003-2014), by employing the Vector Autoregressive model.

Nazir and Qayyum (2014) regarded oil prices as a major factor affecting the GDP of Pakistan using time dummies for oil price shocks for the time period 1972-2011. The application of Johansen Co-integration and Granger causality test provided the long-run dynamic relationship among all variables but no short-run impact on GDP.

Regarding the oil and domestic inflation, Malik (2010) thoroughly investigated the role of oil price behind rising domestic inflation given the high oil dependency of Pakistan for quarterly time series from 1979-1980 to 2013-2014. This study used asymmetric oil price response introduced by Hamilton (1996). The net oil price increase relative to the past four quarter's price is used to capture the impact of oil price change. Using an augmented Phillips curve framework, the empirical results based on Co-integration provided the significant relationship between inflation and oil prices, particularly when oil prices are observed to be increasing continuously over the four quarters.

IV. Methodology

This section deals with the empirical model, data description and estimation technique used for measuring the effect of oil price fluctuations on the industrial sector of Pakistan over the time period 1974-2015.

1. Measuring Oil Price Fluctuations

The international oil price fluctuations can be quantified by a number of techniques identified in the literature [Hamilton (1983), Mork (1989), Lee, et al. (1995) and Kilian, et al. (2009)]. This study used all available measures of volatility, elaborated below.

a) Realized Oil Price Volatility

Firstly, three years rolling standard deviation is used to measure the volatility from annually-averaged data of monthly WTI oil price series, specified below.

$$vop1_t = \sqrt{1/y \sum_{i=t-y+1}^{t} (op_i - \overline{op}_i)} \quad (1)$$

b) Forecasted Oil Price Volatility

As international oil prices confront uncertain changes and its behaviour unleashes the role of consumers/producers' expectations and adjustments regarding future oil prices. Another measure this study used is GARCH (1, 1) AR (1) series for volatility, specified as below:

$$op_t = c + \varepsilon_t \tag{2}$$

$$\sigma_t^2 = \omega + \alpha\,\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \tag{3}$$

Where, σ_t^2 is the conditional variance and indicates one time period next forecast variance based on the past information; ω is constant; ε_{t-1}^2 lag of squared residuals from the mean equation is the ARCH term that measures clustering effect (positive shocks being followed by the positive shock and negative shock being followed by the negative); σ_{t-1}^2 is a GARCH term which measures the last period forecasted variance, while the sum of ARCH and GARCH terms shows the extent to which volatility shock remained persistent overtime.

c) Asymmetric Oil Price Changes

The asymmetries in oil prices are captured by the non-linear transformations. We have employed asymmetric and net specification of log oil prices following the approach by Mork (1989) and Hamilton (1996), respectively. The asymmetric specification is given as:

$$dlop = lop_t - lop_{t-1} \tag{4}$$

The measure indicates positive oil price change if dlop > 0 and vice versa. The monthly oil price changes are converted into annual averages, and the normalized series for the oil price increase and decrease are used as separate measures. Whereas, the net specification measure is given as:

$$nopi_t^{+,net,3\,yr} = \max\,[0,\; nop_t - nop_t^{max}] \tag{5}$$

where, nopi stands for a net oil price increase. The value takes one if the increase in current year real oil price is higher relative to the recent past (preceding three years); 0 otherwise. According to Hamilton (1996), response to the oil price increase is significant only if the increase is larger relative to the recent past.

d) Structural Innovations as Oil Price Shocks

Kilian (2009) introduced a Structural Vector Autoregressive (SVAR) model in order to disentangle the supply and demand specific shocks in real oil prices to delineate the way oil price change affects the macro economy.[3] We have used SVAR based on monthly data to measure the percentage change in global oil production (Δprod),

[3] See Kilian (2009) for detail of measures.

index for real economic activity (rea) and log of the real price of oil (rpo).[4] The series are ordered per their degree of endogeneity given as:

$$z_t = (\Delta prod_t,\ rea_t, rpo_t)' \tag{6}$$

The autoregressive transformation of the model is given as:

$$A_0 Z_t = \alpha + \sum_{i=1}^{24} A_i Z_{t-i} + \varepsilon_t \tag{7}$$

Where, ε_t represents the vector of serially and mutually uncorrelated structural innovations. The reduced-form VAR innovations per Kilian's (2009) identification scheme can be expressed as:

$$\begin{bmatrix} \varepsilon_t^{\Delta prod} \\ \varepsilon_t^{rea} \\ \varepsilon_t^{rop} \end{bmatrix} = \begin{bmatrix} \alpha_{11} & 0 & 0 \\ \alpha_{21} & \alpha_{22} & 0 \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{shock1} \\ \varepsilon_t^{shock2} \\ \varepsilon_t^{shock3} \end{bmatrix} \tag{8}$$

where ε_t^{shock1} measures the unpredictable oil price changes due to oil supply shocks. Shock1 refers to the vertical short-run global crude oil supply shock that is assumed to be least endogenous in the model and does not vary with changes in aggregate demand for oil within the same month (referred as oil supply shocks). Similarly, ε_t^{shock2} shows the innovations to the global real economic activity that is not driven by the crude oil supply shock and reflects shocks to the global demand for industrial production (referred to as aggregate demand shocks). The innovation to the real oil price, ε_t^{shock3} , shows the changes in oil-specific demand not due to aggregate industrial products' demand. Rather it reflects the fluctuations in precautionary demand for oil that is driven by uncertain future oil supply and is treated as least exogenous. Data on monthly global oil production and real oil price as the cost of the refiner acquisition cost of crude oil are collected from the U.S. Energy Information Administration website. The annual shocks are computed by taking the annual average of monthly innovations, retrieved from the above-given model. All three shocks are normalized so that particular shock implies an increase in the oil price due to supply, demand and the oil-market-specific demand shock. The structural shocks are used with a combination of other volatility measures in the model, taken as annual averages.[5, 6]

[4] The data on global oil production are derived from US Energy Information Agency (www.eia.gov). The data for real economic activity is taken from Killian's (2009) series which is based on dry cargo single voyage ocean freight rates and refiner average imported crude oil acquisition cost from FRED data source. The monthly series are taken from 1974.1-2015.12.

[5] The volatility measures are not correlated with each other; the Spearman's correlation ranges from 0.01 to 0.20 and hence, does not lose the predictive power of either coefficient.

[6] The historical evolution of oil price volatility based on these structural shocks is presented in Appendix.

The oil price volatility is measured from monthly WTI spot crude oil price data (op), dollars per barrel, sourced from the Federal Reserve Bank of St. Louis (FRED). The nominal oil price data are deflated by US PPI data from International Financial Statistics (IFS) to make it real and compatible across both the endogenous and exogenous measures of oil price fluctuations (data on US GDP deflator was not available at the monthly frequency). The log transformation is applied.

2. Empirical Model and Estimation Technique

This study used Autoregressive Distributed Lag Model (ARDL) in order to gauge the long-run impact of various measures of oil price fluctuations on the industrial sector's share in GDP, due to non-integration of the same order of the selected variables. The ARDL model is the best Bound-testing approach to Co-integration. Unlike traditional Co-integration techniques, all variables need not be integrated of order (1) rather it can be applied to the combination of I (0) or I (1) [Pesaran and Shin (1999)]. Moreover, this technique is the most significant approach for determining the long-run co-integrating relationships among variables in the small samples. In contrast, the Johansen Co-integration technique requires a large sample for robust results as pointed out by Ghatak and Siddiki (2001) and Pahlavani, et al. (2006). Moreover, this approach does not demand symmetry in the lag length of the variables. The dynamic nature of the model provides a long-run response along with the short-run adjustment of dependent variables with respect to lag-differenced explanatory variables.

Bound testing approach is based on the F-statistics for Co-integration, and the null hypothesis is given as no long-run relationship [$H_0 = \gamma_1 = \gamma_{2i} = \gamma_{3i} = \gamma_4 = 0$] against the alternate hypothesis [$H_1 \neq \gamma_1 \neq \gamma_{2i} \neq \gamma_{3i} \neq \gamma_4 \neq 0$] which implies the long-run relationship among variables. As the critical values of Pesaran, et al. (2001) are suitable for the large sample size, Narayan (2005) has computed the critical values for a sample between 30 to 80 observations. This study used the Narayan (2005) critical values for lower and upper bound at 5 per cent level of significance under the assumption of restricted intercept and no trend, given the relatively small sample size (38-40 observations). If the computed F-statistics is higher than the upper bound critical value, then the null hypothesis of no Co-integration will be rejected. For F-statistics lying between lower and upper bound, the result will be inconclusive while for the computed values below than the lower bound critical values lead to the non-rejection of the null hypothesis.

The ARDL model can be expressed as:

$$\Delta IND_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta NDI_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta X_{jt-i} + \sum_{i=0}^{p} \xi_i \Delta shock_{t-i} + \sum_{i=0}^{p} \phi_i \Delta vop_{t-i} + \delta_1 IND_{t-1} + \delta_{2i} X_{jt-1} + \delta_{3i}\, shock_{t-1} + \delta_4\, vop_{t-1} + e_t \qquad (9)$$

In the given model, $shock_{t-i}$ refers to the lag of three structural shocks based on Kilian (2009) while vop_{t-i} refers to the lag of other four measures of oil price fluctuations including 3-years moving standard deviation of log crude oil global prices (vop1) and GARCH (1,1) AR(1) conditional variance series (vop2), net annual oil price increase and decrease (vop3 and 4) and relative oil price increase with reference to preceding three years (vop5), as discussed in Section IV (1).

The dependent variable IND_t refers to the index of industrial value-added as a percentage of GDP, data collected from the World Development Indicators, World Bank. The variables, X_{jt-1} depict the lagged controlled variables; log real exchange rate and log consumer price index for which data are collected from International Financial Statistics (IFS). The exchange rate is made real by dividing the nominal exchange rate by ratio of Pakistan and US CPI. All the variables other than indexes are expressed in log and measured in US dollars.

If we find evidence of long-run co-integrating relationship among variables, then the error correction parameterization will be specified to get the speed of adjustment to the long-run equilibrium after a short-run disruption. The error correction specification of the ARDL model is given below:

$$\Delta IND_t = \alpha + \sum_{i=1}^{p} \beta_i \Delta IND_{t-i} + \sum_{i=0}^{p} \gamma_i \Delta X_{jt-i} + \sum_{i=0}^{p} \xi_i \Delta shock_{t-i} + \sum_{i=0}^{p} \phi_i \Delta vop_{t-i} + \lambda EC_{t-1} + u_t \quad (10)$$

where λ refers to the speed of adjustment of residual obtained from the regression model. This pertinent to mention that the error-correction results are reported in all specifications as the null hypothesis of no Co-integration is rejected in almost all equations with the exception of Equation 2 and 4 in the results of Table 3.

The model is required to fulfill two conditions for the goodness of fit, a) error terms in the equation must be serially uncorrelated that will be tested through Breusch-Godfrey Correlation LM test and b) the model should be dynamically stable, and the negatively significant error correction term satisfies this condition. Similarly, the Wald test of omitted variable bias, F-test for overall significance and Durbin-Watson test are applied as other diagnostic measures.

The estimation is carried out in Eviews 9.

V. Empirical Results

1. Unit Root Test Results

The first step is to check the stationarity properties of the series, which is examined by using a modified augmented Dickey-Fuller test, allowing for structural breaks in the series with an innovative outlier. The test results reported in Table 1 show the variables are a combination of I (0) and I (1) and no variable is integrated at order 2. This allows us to proceed with the ARDL technique for Co-integration. The dependent variable, industrial value-added (IND), real exchange rate (Lrxr) and forecasted volatility (Vop2) are integrated of order one while the other variables are integrated of order 0.

TABLE 1

Unit Root Test Results with Structural Breaks

Variables	ADF t-stat				Decision
	Level	Breakpoint	1st Difference	Breakpoint	
IND	-5.304*	2005	-9.397*	2006	I(1)
Lcpi	-6.218*	2007	-5.923*	2007	I(0)
Lrxr	-1.931	2005	-7.136*	2001	I(1)
Shock1	-6.791*	1988	-12.025*	2006	I(0)
Shock2	-6.829*	2011	-8.729*	2012	I(0)
Shock3	-8.618*	1998	-8.090*	2009	I(0)
Vop1	-5.421*	1989	-6.063*	2014	I(0)
Vop2	-4.273	1990	-6.529*	2012	I(1)

Source: Author's Estimation.

Notes: The critical values for ADF-τ tests with intercept break are -5.347, -4.859 and -4.607, at 1 per cent, 5 per cent and 10 per cent, respectively.

2. *Long-run Estimates of ARDL for Industrial Sector Value Added*

Tables 2 and 3 reports the results for the bound-testing approach to ARDL for industrial value added (percentage of GDP) with oil price volatility measures (vop1 and vop2) and asymmetric oil price changes (vop3, vop4 and vop5).Panel A reports the long-run and short-run estimates, while Panel B provides diagnostic test results for all equations. Overall, diagnostic tests verify the goodness of fit of the empirical models. As a first step, F-statistic is computed by selecting the optimal length from Akaike Information Criteria as the computation of F-statistics is very sensitive to the choice of lag length. The selected optimal lag length is three. The calculated F-statistics results along with the critical values from Narayan (2005) are reported in Panel B. The computed F-statistics are higher than the upper bound critical values at 5 per cent level of significance in all equations of Table 2 and Table 3 (with the exception of Equation 2 and 4) and provide the evidence of long-run co-integrating relationship among the variables in specified models by rejecting the null hypothesis of no Co-integration.

The significance of introducing structural shocks is verified by the Wald-test's χ^2 statistic that rejects the null hypothesis: structural shocks are insignificant, in Equation (3) and (6) in Table 2, also supported by the likelihood ratio findings for Equation (2) and (5) for omitted structural shocks (it does not reject the null hypothesis of joint significance of excluded variables in the equations).Similar evidence is reported in Table 3 in Equation (1) and (3). These findings justify the inclusion of structural shocks in the equations for industrial value-added. Additionally, the Wald-test applied with the null hypothesis of the symmetric response of industrial value-added towards oil price volatility, and structural shocks are also rejected. Besides, the LM test for serial correlation identifies no serial correlation in the residuals and verifies the stability of the models.

Turning to the empirical results reported in Panel A of Table 2, the demand-specific shock, shock 2, has positive while the oil-market specific shock, shock 3, has a negative coefficient when the realized volatility is controlled. Whereas, supply shock (shock1) appeared as negatively significant when the model is controlled for the forecasted volatility. These results show that the industrial value-added in GDP tends to decline with the increase in oil prices as a result of oil supply disruption and due to increase in precautionary demand as measured by shock1 and shock3 while the demand-specific shock, shock2, that acts through the increase in the world oil demand can lead to increase in the industrial sector's share in GDP. These findings are consistent with Kilian (2009).

However, the results for the demand-specific shock to oil price turns negative when we introduced break at the year 2006.[7] This result implies that the demand-specific shock is determined by the increase in aggregate demand from emerging economies generated more competition in the world market in later years and country like Pakistan having far less negotiating power for its imported-oil share faced negative outcomes of oil price increase in the form of lower value-added of the industrial sector in GDP. A sharp fall is observed in imported-oil of Pakistan (about 24 per cent) in 2006 and in the subsequent years when the share declined by 14 per cent, 11 per cent and 8 per cent in years 2009, 2010 and 2011, respectively. Similarly, the energy intensity of Pakistan remained around 5 per cent from 1990-2008 and declined to 4 per cent of 2011 PPP adjusted GDP later, according to the World Development Indicators. The shortage of oil upset the investment plans and hence the industrial sector's share in GDP in the long-run.

Regarding volatility measures, both the observed (vop1) and forecasted volatility (vop2) in oil prices cast a negative effect on industrial value-added and the coefficients are close in magnitude to the base-line equation. Nonetheless, the effect becomes more aggressive for forecasted volatility when we controlled the structural break. As the conditional variance relies both on the past behaviour of oil price uncertainty and the lag of forecasted variance hence it yields relatively more dominant effect on the industrial value-added than the observed volatility. Besides, as the production sector is more inclined towards the oil market's demand and supply predictions, investment/production plans mostly hinge on the expected movements in the oil prices.

Linking the results with conventional channels of oil price effect, it can be stated that the reallocation effect has moderated the industrial sector's share in GDP that is surpassed

[7] In order to capture the break in industrial value added at year 2006, we have introduced a dummy for allowing break at 2006 to capture the differential impact (if any) of oil price fluctuations on industrial value added for pre and post-industrial sector performance. The assigned value is 1 for post and 0 for pre-break. This is pertinent to mention that 2006 is the year around which industrial sector's share dropped sharply.

TABLE 2

ARDL Estimates for Industrial Value Added (1974-2015) (Oil Price Volatility)

Variables	Eq. 1	Eq. 2	Eq. 3	Eq. 4	Eq. 5	Eq. 6	Eq. 7
Panel A							
Long-run Estimates							
Lcpi	-2.117*	-2.091*	-0.829*	-0.115	-1.963*	-2.229*	0.562
	(0.407)	(0.369)	(0.308)	(0.336)	(0.182)	(0.264)	(0.630)
Lrxr	4.946*	5.128*	1.022	0.337	3.901*	3.716*	-0.873
	(1.018)	(1.186)	(0.914)	(0.883)	(0.595)	(0.827)	(1.384)
Shock1	-0.507	--	-0.238	-0.422	--	-2.565***	0.104
	(0.818)		(0.807)	(0.747)		(1.411)	(0.923)
Shock2	1.642	--	5.354*	3.259*	--	1.138	-0.742*
	(1.523)		(1.274)	(0.916)		(0.942)	(0.243)
Shock3	-0.59	--	-1.519***	-2.012*	--	-0.389	-2.121*
	(0.679)		(0.843)	(0.546)		(0.525)	(0.778)
Vop1	--	-19.03***	-54.773*	-30.55**	--	--	--
		(10.541)	(10.152)	(12.535)			
Vop2	--	--	--	--	-40.872*	-53.379*	-34.20**
					(13.296)	(11.343)	(13.940)
break*vop1	--	--	--	-25.956*	--	--	--
				(7.190)			
break*vop2	--	--	--	--	--	--	-81.74*
							(12.192)
Short-run Estimates							
Δindvad(-1)	0.343***	0.22	0.5214*	0.171	0.296	--	--
	(0.195)	(0.223)	(0.165)	(0.119)	(0.225)		
Δindvad(-2)	--	--	0.428*	0.429*	--	--	--
			(0.172)	(0.122)			
Δlcpi	-1.623*	8.409	3.759	19.45*	6.96***	5.154	14.505*
	(0.541)	(6.866)	(8.142)	(6.250)	(5.926)	(5.089)	(4.570)
Δlcpi(-1)	--	-12.143*	-40.032*	-28.74*	-15.49**	-4.86	6.715
		(4.403)	(10.719)	(4.520)	(6.600)	(6.789)	(11.318)
Δlcpi(-2)	--	--	9.671***	--	--	--	-20.486*
			(6.066)				(8.047)
Δlrxr	3.793*	-2.203	1.308	0.394	3.487**	3.092*	0.261
	(1.277)	(2.817)	(1.118)	(1.047)	(1.460)	(1.237)	(2.975)
Δlrxr(-1)	--	-5.490***	--	--	--	--	1.954
		(3.099)					(3.101)
Δlrxr(-2)	--	--	--	--	--	--	-5.77
							(4.027)
Δshock1	-0.389	--	-0.3054	-0.494	--	--	0.707
	(0.632)		(1.050)	(0.932)			(0.800)
Δshock1(-1)	--	--	--		--	--	-0.639
							(0.413)
Δshock2	-0.293	--	0.458	-0.324	--	--	-0.799*
	(0.842)		(0.545)	(0.425)			(0.271)
Δshock2(-1)	--	--	-2.625*	-1.786*	--	--	--
			(0.978)	(0.641)			

(Continue.....)

TABLE 2 *(Contined)*

ARDL Estimates for Industrial Value Added (1974-2015) (Oil Price Volatility)

Variables	Eq. 1		Eq. 2		Eq. 3		Eq. 4		Eq. 5		Eq. 6		Eq. 7	
Δshock3	-0.453		--		-0.23		-0.325		--		-0.403		-0.531	
	(0.341)				(0.747)		(0.316)				(0.448)		(0.383)	
Δshock3(-1)	--		--		--		--		--		--		0.743	
													(0.639)	
Δvop1	--		-3.886		-25.988*		-6.767		--		--		--	
			(8.372)		(9.818)		(9.464)							
Δvop1(-1)	--		14.444**		27.095*		21.26*		--		--		--	
			(5.996)		(11.163)		(6.538)							
Δvop1(-2)	--		--		17.592		13.63***		--		--		--	
					(10.771)		(7.903)							
ΔVop2	--		--		--		--		-8.026		--		-16.52**	
									(6.212)				(6.584)	
ΔVop2(-1)	--		--		--		--		4.728		--		0.252	
									(6.571)				(6.183)	
ΔVop2(-2)	--		--		--		--		16.86***		--		23.66*	
									(8.630)				(4.240)	
Δ(break*vop1)	--		--		--		-30.42**		--		--		--	
							(11.541)							
Δ(break*vop2)	--		--		--		--		--		--		-88.09*	
													(21.314)	
ECT	-0.767*		-0.833*		-1.281*		-1.171*		-0.894*		-0.623*		-1.077*	
	(0.250)		(0.258)		(0.275)		(0.208)		(0.274)		(0.203)		(0.139)	
Panel B: Diagnostic Tests														
Bound Test F-stat	4.16*		5.05*		4.11*		5.26*		4.99*		4.59*		9.22*	
Critical F-	LB	UB	LB	UB	LB	UB	LB	UB	LB	UB	LB	UB	LB	UB
Values	2.93	4.02	3.1	4.08	2.62	3.86	2.52	3.83	3.1	4.08	2.62	3.86	2.52	3.83
Wald Test	10.71*		--		39.70*		--		--		14.89*		--	
χ2-stat (a)	(0.013)				(0.000)						(0.002)			
χ2-stat (b)	--		--		31.29*		--		--		10.52*		--	
					(0.000)						(0.015)			
F-test	7.549*		5.851*		6.052*		8.359*		6.797*		9.123*		10.385*	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Omitted Shocks test	--		2.797		--		--		2.086		--		--	
L-R ratio			(0.424)						(0.554)					
LM test	0.179		0.678		1.713		0.616		0.617		0.6		0.496	
F-stat	(0.837)		(0.516)		(0.210)		(0.552)		(0.547)		(0.555)		(0.619)	
D-W test	1.95		1.98		2.43		2.3		2.08		1.78		1.98	
N	39		39		39		38		38		40		38	

Source: Author's Estimation.

Notes: 1) Standard errors are reported in parentheses. 2) The values reported in the parentheses of diagnostic test results are p-values. 3) * indicates the significance at the conventional level of significances. 4) * in Bound F-stat denote statistical significance at 5% level of significance while the asymptotic critical value bounds are obtained from Narayan (2005) where LB stands for Lower Bound and UB for Upper Bound.

by the services sector in the long-run in Pakistan, on the one hand. And the high cost of production through productivity effect has resulted in depressing industrial sector's value-added and its contribution in GDP due to oil price fluctuations, on the other. Additionally, rising oil price uncertainties upset the industrial sector due to fall in aggregate demand and increasing cost of production both and eventually such oil market uncertainties make them more cautious towards bidding up new projects. According to Bernanke (1983), all else equal increased uncertainty about the oil price change led firms to postpone their investment decisions and investment expenditures tend to decline to the extent to which unexpected oil price change leads towards future oil price uncertainty.

Equation (4) and (7) provides the relative effect of oil price volatility in the pre and post-break time period.[8] The coefficient of interaction term from equation (4) provides the effect of oil price volatility after the break [-30.55-25.96 = -56.51] and before break [-30.55]. This demonstrates the effect of oil price volatility has increased in the year after the break (justification for low industrial sector's value-added in subsequent years). Comparatively, the coefficient from equation (7) yields [-34.2-81.74 = -115.94], when we controlled other variables in the model. This is worth mentioning that the petroleum sector in Pakistan became more receptive to the international oil price changes in the wake of the power sector's post-regulations.[9]

Turning to the short-run estimates in Table 2, the industrial sector's value-added sustained and followed its path every last two years. The rise in consumer prices leads to an instantaneous increase in the industrial value-added as the high consumer prices increase the producers' receipts. Afterwards, the effect dampens and switches to negative with the passing of more lags till the long-run. However, in reaction to the short-run exchange rate movements' industrial sector behaves in the same fashion as in the long-run. Regarding structural shocks, the demand-specific oil price shock depresses the industrial value-added with a lag of one year when controlled with 3-years standard deviation measure of volatility.

The other controlled variables behave almost consistently throughout the regressions with the negatively significant coefficient for consumer price index (cpi) and positively significant for the real exchange rate. The findings are as per expectations and in line with the conventional theories. The general price increase leads towards declining purchasing power that depresses the aggregate demand and negatively affects the industrial sector's share in GDP in the long run. The findings are in line with Chaudhry, Ayyoub and Imran (2013) and Ayyoub (2015). Regarding the real exchange rate index, the positively significant effect of exchange rate on the industrial sector's value-added is beneficial in terms of growth in exports for being cheaper and this can also partially offset the negative effect of domestic inflation on the industrial sector as the real exchange rate indicator has larger estimated elasticities than those for the cpi. The devaluation of the

[8] The small sample size don't allow us to segregate annual data (low degree of freedom), we have introduced break at year 2006 and interact with oil price volatility to get differentiated impact across the break (if any).

[9] The impact of asymmetric changes in oil price reported in Table 3 can explain it further.

local currency has so far remained a significant policy tool of Pakistan to improve its trade balance and to stimulate the industrial sector. However, the ever-rising consumer prices have depressed the industrial sector's contribution to GDP as the devaluation also invites domestic inflation to grow. As suggested by Habib, Mileva and Stracca (2016), devaluation as a policy lever is beneficial only in the early stages of economic development and becomes irrelevant in the long term. When a country becomes financially developed it makes the exchange rate unimportant for growth [Aghion, et al. (2009)].

Now we turn to the discussion of Table 3 which is based on the Mork's measures of the oil price increase and decrease (vop3 and vop4) and Hamilton's approach of net oil price increase using real oil price data. The consumer price index has negative and the real exchange rate has a positive effect on the industrial value-added with the same justification as discussed above. The instantaneous oil price change has an insignificant effect on the industrial value-added, without controlling structural shocks. The structural oil price shocks in Equation 2 and 4 postulated overall significance for the industrial sector but individually these shocks do not possess reasonable predictive power of the industrial value-added behaviour (justification for no long-run co-integrating relationship in these equations).

The results have sound reasoning on the ground of domestic petroleum/petroleum products' adjustments taken up by the government in the wake of international oil price changes. As a repercussion to the global oil price increase, the government is mostly inclined to increase the subsidies while tax levies are mostly increased after the oil price decrease. Both policy actions tend to mitigate the expected effect of the oil price change and keep the net effect insignificant. Exploiting global oil price changes to increase taxes by the government as a policy tool is not always recommended. Rather the government needs to focus on removing the bottlenecks in the industrial sector growth.

Moving to the net oil price increase (vop5), it has a negatively significant effect on the industrial sector as reported in Equation 5. This provides the responsiveness of the stakeholders towards the oil price increase when it's higher than the last three years oil prices. This also delivers an imperative insight into the decision-making behaviour of consumers and producers both and relates it to the empirical findings for oil price volatility.

Generally, the response of industrial sector towards oil price changes is expected to be more responsive in the short-run, tending to moderate over the long-run with the availability of more energy alternates. However, the case is not so for Pakistan, according to the empirical findings of this study, as the need for imported oil has ever been on the rise and so is the case with the oil dependence, oil share and oil vulnerability of the economy.[10] Due to lack of available energy sources and substitutes, Pakistan has long been depending on imported-oil for its industrial sector and the prevalence of oil-market uncertainties keep on intimidating its stakeholders that overall depresses the industrial sector' growth.

[10] The author has computed (published) oil price vulnerability and its decomposition with the help of Log Mean Divisia approach that can be provided on demand.

TABLE 3

Asymmetric Oil Price Response of Industrial Value Added (1974-2015)

Variables	Eq. 1	Eq. 2	Eq. 3	Eq. 4	Eq. 5
			Panel A		
			Long-run Estimates		
Lcpi	-2.135*	-2.558*	-2.124*	-2.374*	-3.11*
	(0.414)	(0.545)	(0.338)	(0.477)	(0.823)
Lrxr	4.956*	6.517*	4.966*	6.339*	8.728*
	(1.461)	(1.250)	(1.460)	(1.172)	(2.495)
Shock1	--	1.210*	--	1.1877	5.659*
		(0.852)		(1.054)	(2.482)
Shock2	--	-0.911	--	-1.225	5.062*
		(2.030)		(2.164)	(1.468)
Shock3	--	-0.714	--	-0.571	4.304
		(0.812)		(0.959)	(30.793)
Vop3	4.266	2.61	--	--	--
	(3.283)	(1.947)			
Vop4	--	--	-1.553	-1.224	--
			(1.589)	(1.224)	
Vop5	--	--	--	--	-19.237**
					(10.090)
			Short-run Estimates		
Δindvad(-1)	0.456*	0.319	--	0.352***	--
	(0.205)	(0.238)		(0.205)	
Δlcpi	-10.41***	-2.37*	--	-2.222*	-1.416*
	(6.504)	(0.901)		(0.703)	(0.488)
Δlcpi(-1)	--	--	-7.313	--	--
			(5.844)		
Δlrxr	3.849*	1.335	3.094*	2.721	3.969*
	(1.432)	(3.123)	(1.041)	(4.441)	(1.328)
Δlrxr(-1)	--	-2.993	--	0.113	--
		(3.025)		(3.169)	
Δlrxr(-2)	--	-3.618	--	-4.973	--
		(4.398)		(4.439)	
Δshock1	-0.022	1.222	--	1.111	1.675**
	(1.091)	(0.731)		(0.962)	(0.826)
Δshock2	-0.628	-0.801	--	--	0.053
	(0.571)	(0.699)			(0.464)
Δshock2(-1)	--	0.666	--	--	--
		(0.847)			

(Continue.....)

TABLE 3 *(Continued.....)*

Asymmetric Oil Price Response of Industrial Value Added (1974-2015)

Variables	Eq. 1	Eq. 2	Eq. 3	Eq. 4	Eq. 5
Δshock3	-0.403	-0.662	--	--	-0.356
	(0.495)	(0.661)			(0.728)
Δshock3(-1)	--	--	--	--	-1.547*
					(0.562)
Δshock3(-2)	--	--	--	--	-1.324**
					(0.691)
Δvop3	2.661	2.421***	--	--	--
	(1.876)	(1.469)			
Δvop4	--	--	-0.967	-1.146	--
			(0.809)	(1.037)	
Δvop5	--	--	--	--	3.627**
					(1.668)
Δvop5(-1)	--	--	--	--	6.722**
					(3.017)
ECT	-1.036*	-0.927*	-0.623*	-0.936*	-0.455*
	(0.305)	(0.294)	(0.180)	(0.229)	(0.133)
Panel B: Diagnostic Tests					
Bound Test F-stat	5.26*	2.95	4.70*	3.11	4.90*
Critical F-Values	LB UB	LB UB	LB UB	LB UB	LB UB
	3.1 4.08	2.62 3.86	3.1 4.08	2.62 3.86	2.62 3.86
Wald Test	14.89*	12.69*	--	21.72*	14.71*
χ^2-stat (a)					
	(0.002)	(0.005)		(0.000)	(0.002)
χ^2-stat (b)	10.524*	15.806*	--	18.55*	9.78*
	(0.015)	(0.001)		(0.000)	(0.020)
F-test	6.583*	5.167*	8.271*	4.75*	9.45*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Omitted Shocks test	4.09	--	2.721	--	--
L-R ratio	(0.252)		(0.437)		
LM test	0.753	0.0082	1.744	0.311	0.133
F-stat	(0.483)	(0.992)	(0.192)	(0.736)	(0.876)
D-W test	2.12	1.9	1.82	1.95	1.86
N	40	40	40	39	39

Source: Author's Estimation.

Notes: 1) Standard errors are reported in parentheses. 2) The values reported in the parentheses of diagnostic test results are p-values. 3) * indicates the significance at the conventional level of significances. 4) * in Bound F-stat denote statistical significance at 5% level of significance while the asymptotic critical value bounds are obtained from Narayan (2005).

VI. Conclusions and Policy Implications

The study carried out to investigate the empirical relationship between the industrial sector'svalue-added in GDP and international oil price fluctuations. Autoregressive Distributed Lag Model (ARDL) provides the short and long-run estimates for the time period 1974-2015 for Pakistan. The diagnostic measures satisfy the long-run stable relationship between the oil price fluctuations, real exchange rate and consumer price index with the industrial value added in GDP. The findings suggested the negative effect of observed and forecasted oil price volatilities on the industrial value-added, measured by three years moving standard deviation and Generalized Autoregressive Conditional Heteroskedastic (GARCH) variance series. Similarly, the impact of net specification of oil price increase appeared as negatively significant while the net yearly oil price change (both increase and decrease) did not show a significant impact on industrial value-added. Regarding the structural decomposition of real oil price change, this presented positively significant effect on the industrial value-added of demand-specific shock. This highlights that the boom in global demand is attached with the boosting domestic industrial sector. Whereas, the oil price specific shock accounting for the increase in precautionary oil demand due to future oil supply shortfalls leads to depressing the industrial sector. The uncertainty in business environment triggered by the unexpected oil price fluctuations holds importance in determining the industrialization phase in Pakistan and the industrial sector has been losing its significant contribution in GDP due to rising relative oil price and its uncertainty.

Other than international oil price fluctuations, inflation directly affects the industrial value-added negatively. The exchange rate depreciation can enhance the industrial value added by increasing the demand of our exports and can be sustained by increasing our export competitiveness and reducing oil dependence. Based on the empirical findings, future oil price changes are very crucial for investment and production activities in the industrial sector. With the rising global demand for industrial commodities and its positive bearing for our industrial sector, this can be perceived that export diversification and improvement in energy efficiency can be the solution to streamline industrial sector's contribution in GDP. The domestic price stability can be achieved through supply-side measures and by monitoring the coordination of domestic petroleum price policy with the international oil price changes. In the long-run, reducing imported-oil dependence and petroleum products through improvement in technology and efficiency along with increasing investment in the domestic exploration sector can be proved vibrating in boosting the industrial sector.

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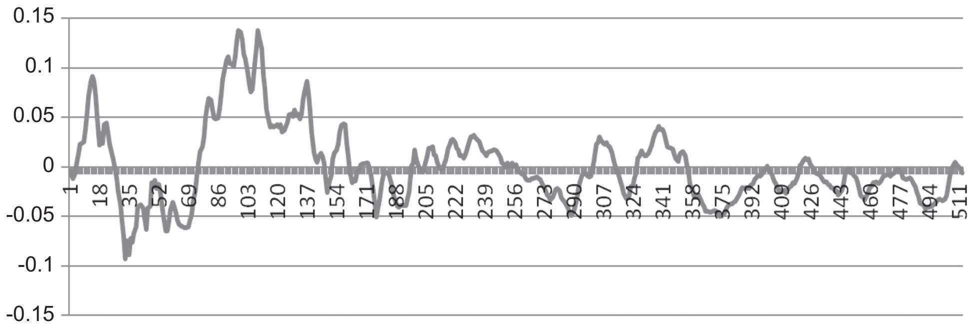
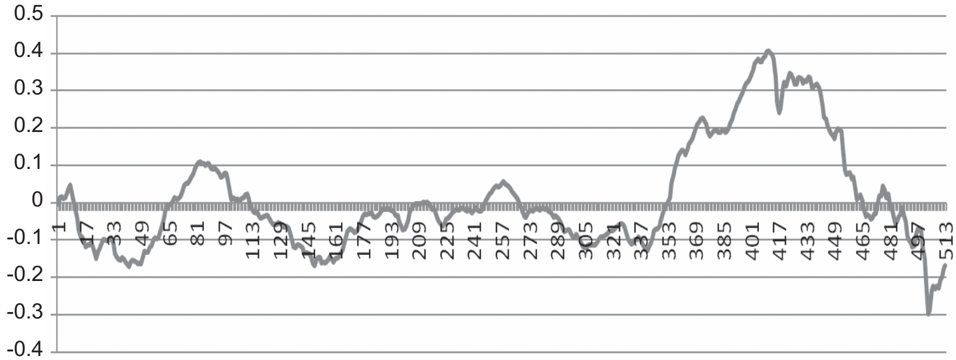
APPENDIX

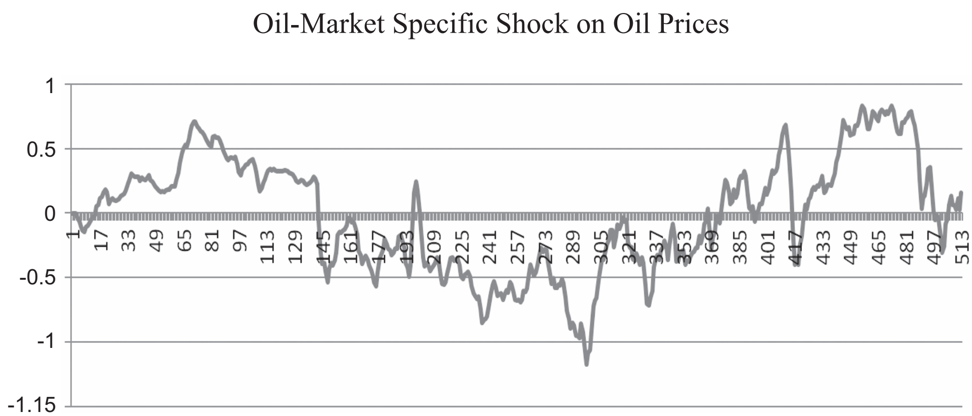
Historical Decomposition of Supply Shock, Demand Shock and Oil-Specific demand Shock on Real Oil Prices 1974.1-2016.12

Supply Shock on Oil Prices



Demand Shock on Oil Prices




Oil-Market Specific Shock on Oil Prices
1
0.5
0
-0.5
-1
-1.15
1
17
33
49
65
81
97
113
129
145
161
177
193
209
225
241
257
273
289
305
321
337
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401
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513