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Response of Pakistan's Economy on Oil Price Fluctuations

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Abstract

This paper attempts to quantify the impact of oil price changes on key macroeconomic aggregates for the economy of Pakistan using linear and nonlinear specifications with major emphasis on regulatory reforms initiated in the oil sector during the last decade. The empirical investigation confirms that the nexus between oil price and macro-economy has significantly changed after 2002-03 and that there is ample evidence of structural breaks. The study makes use of multivariate VAR using monthly data over the period 1995:1 to 2014:11 and finds significant relationship between changes in international oil prices and output during the post-deregulation period (2003-2014). However, the relationship turned out to be asymmetric in nature. Compared to this, the study did not find any significant relationship between oil price changes and major macroeconomic aggregates during the pre-deregulation period (1995-2002).

Keywords: Oil price shocks, macro-economy, regulatory reforms

1. Introduction

A cursory look at the world crude oil price for the last two decades show how wildly it has fluctuated between US$ 14 per barrel and US$ 124 per barrel. The surprise acceleration was observed in 2002 and since then the

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upward trend continued for the next five years till the price touched US$ 70 per barrel mark. The second episode of sharp price increase started in the first quarter of 2007 and lasted for one and a half year when the crude oil price reached its highest-ever level of US$ 124 per barrel. Even though there has been a steady but remarkable decline after that, yet the fluctuation in price has been a persistence phenomenon[1]. These sharp swings in prices have divergent consequences for the net oil importing economies like Pakistan. The fluctuations in crude oil prices adversely affect aggregate demand and supply via different micro and macro channels. At the micro level, because of its pass-through effect on final consumable petroleum products, the increase in price discourages investment as higher cost of production reduces net profit of firms. Similarly, the purchasing power of households also contracts, which further reduces household demand for goods. On macro level, the impact of rising oil prices is complicated and multidimensional. It aggravates the balance of payments and fiscal deficit positions and cause high unemployment along with high inflation (stagflation) that finally translates into slower economic growth. Furthermore, these fluctuations introduce uncertainty in the system that also dampens economic activity of an economy.

Due to high energy intensities and market imperfections, the developing economies in general and Pakistan's economy in particular has been susceptible to oil price shocks. The increase in oil prices has put extra pressure on limited foreign exchange reserves and leaves limited amount for the purchase of capital goods. Intuitively, in the presence of increasing dependence of Pakistan's economy on imported oil and more market oriented oil pricing mechanism, the impact of oil price fluctuations on macro-economy has attained huge significance. The present study intends to examine the nature of relationship between oil price movements and macroeconomic aggregates of Pakistan using linear and nonlinear oil price specification employing multivariate VAR approach based on monthly data over the period 1995M1 to 2014M11. The present study, for the first time in Pakistan, empirically investigates the impact of oil sector regulatory reforms

[1]See Appendix 1 for graphical exposition of world oil price fluctuations.

on how oil price changes have influenced the economy. Specifically, the dynamic impact of oil price shocks on macroeconomic aggregates is evaluated through impulse response functions and forecast variance decomposition through explicit treatment of the reform process.

Rest of the paper is organized as such, after a brief review of the oil sector in Pakistan, there is review of relevant literature which focuses on transmission channels and various nonlinear oil price specifications. The empirical methodology is followed by discussion and analyses of results. The final section of the paper offer concluding remarks.

1.1 Oil Sector in Pakistan

Pakistan being the sixth most populous country in the world is growing moderately and its demand for energy products is growing quite rapidly. During the last two and half decades the structure of economy, especially the oil sector has changed significantly. The regulatory reforms initiated in early 2000s attracted a lot of foreign direct investment in down-stream and mid-stream oil and gas sector. Large scale exploration and extraction activities in the oil and gas sector reduced Pakistan's dependence on imported oil to some extent. The share of oil in final energy consumption considerably declined after the deregulation from 48 percent in 1995 to 29 percent in 2012-13. Unfortunately, the oil self-sufficiency index has depicted short-term development that improved by 5 percent in 2003-04. After optimal utilization of domestic natural gas reserves, Pakistan's dependence has risen again and today it stands at the same level as that of 1990s. On the other hand, crude oil extraction from domestic reserves has been almost stagnant since 1990s with minimum fluctuations. As a result, the share of crude oil and other petroleum products in total import bill have increased sharply during the last twenty years, from about 15 percent in 1995, to 23 percent and 33 percent in 2005 and 2012, respectively.

Similar to the developing world, the policy planners in Pakistan also formulated and executed plans to deal with oil price shocks and the resulting

energy crises. To start with, pro-market regulatory reforms were initiated in 2001 whereby the role of government was restricted to policy issues only and all other responsibilities to manage the oil sector were transferred to an independent regulatory authority, the Oil Company Advisory Committee (OCAC). It was authorized to fix and announce petroleum product prices in the country in April, 2001. Moreover, Oil Marketing Companies (OMCs) and other bulk consumers were granted licenses to import crude and furnace oils from the Gulf market according to their requirements. Prior to deregulation the state owned oil marketing company, the Pakistan State Oil (PSO) was the sole importer of crude and other petroleum products. In 2006, Oil and Gas Regulatory Authority (OGRA) was authorized to review, fix and announce petroleum product prices along with the power of granting licenses to the new entrants. This reform process has continued since then and in 2011 onwards prices of various petroleum products were deregulated and the OMCs were allowed to fix and announce the major petroleum products' prices including MS, HSD, HOBC, LDO, JP1, JP4 and JP8 independently. However, OGRA has been mandated to review and announce SKO ex-depot price along with inland freight equalization margin for all products to ensure price uniformity across the country. Before the oil sector regulatory reforms important issues regarding petroleum products consumer pricing and imports of crude oil were under the strict government regulations and were exercised on purely political considerations.

2. Literature Review

The oil price shocks of 1970s triggered considerable number of studies focusing on the relationship between oil price changes and macroeconomic performance for developed countries. Hamilton (1983), a pioneering attempt in this field found a robust negative correlation between oil prices and the US economic activity. Later on, other researchers made significant contributions to understand major transmission channels and varying nature of oil price-macroeconomy relationship. These included Burbidge and Harrison (1984), Bruno and Sachs (1985), Gisser and Goodwin (1986), Loungani (1986), Mork (1989), Mork and Oslen (1994), Lee, Ni, and Ratti (1995), Hooker

(1996), and Ferderer (1997) among others. Keeping in view Hamilton's findings it was generally presumed that oil price decrease should have positive impact on the global economic activity. But this was not the case as no sign of economic revival was experienced after the oil market collapse in mid-1980s that could have been attributed to easing of pressure on economy emanating from the oil sector. This necessitated the re-examination of oil macroeconomy-relationship, therefore, Mork (1989) extended the Hamilton's work by dividing the oil price variation into oil price increase and oil price decrease. He found an asymmetric impact of oil price changes on output growth for the US economy by demonstrating that only oil price increase impairs output but the decrease casts no impact on economic activity.

A great deal of volatility in oil prices with an average upward trend was observed after mid 1980s and early 1990s, creating uncertainties in connection with future oil pricing; this prompted many researchers to understand the impact of these frequent fluctuations on the economy. In this regard Lee, Ni, and Ratti (1995), Hooker (1996) and Ferderer (1997) demonstrated that when the data sample was extended up to mid-1990s, the oil price changes (in level) failed to Granger cause output and other macro variables for the US economy. They also observed that oil price volatility was more important than oil price itself and added that the impact of oil price shock on real GNP and employment mainly depended on the environment in which these shocks hit the economy. They showed that an oil price shock of the same magnitude could cause greater decline in real GNP in a stable environment. On the contrary, Hamilton (1996, 2003), presented the concept of net oil price increase (NOPI) that considers an oil price increase as the one that establishes new highs as compared to the most recent (last year) price experienced. Later, a large number of studies have employed Hamilton's (NOPI) specification and examined the asymmetric relationship between world oil price changes and macroeconomic activities for different economies including Zhang (2008); Rodriguez and Sanchez (2005); Kumar (2009); Gounder and Bartleet (2007); Aliyu (2011) & Du et al., (2010).

Another important strand of literature is the theoretical contribution

exploring the transmission channels of oil price shocks that affect economic performance of oil importing countries. The existing literature reports several channels might be helpful in understanding the negative relationship between oil price hike and economic activity including the supply side effect (Rasche and Tatom, 1981; Hamilton, 1983; Brown and Yucel, 1999), demand side effect (Bernanke, 1983; Pindyck, 1991; Edelstein and Kilian, 2007, 2009; Hamilton, 1988, 2009), wealth transfer effect (Dohner, 1981; Backus and Crucini, 2000), real balance effect (Pierce and Enzler, 1974), subsequent contractionary monetary policy to counter the inflationary consequences (Bohi, 1991; Bernanke Gertler and Watson, 1997; Leduc and Sill, 2004; Carlstrom and Fuerst, 2006) and finally the resource reallocation effect or adjustment cost effect (Lilien, 1982; Loungani, 1986; Hamilton, 1988; Davis and Haltiwanger, 2001). Moreover, given the very small share of oil as a factor of production various other studies attempted to explain the greater loss in GDP after an oil price shock. These studies considered variable mark-up (Rotemberg and Woodford, 1996), capital-oil complementarity (Atkinson and Kehoe, 1999) and capital utilization hypothesis (Finn, 2000) as possible explanations that accounted for deeper and broader recessions due to oil price shocks.

The supply side effect focuses on increasing marginal cost of production and reduced capacity utilization due to which the growth of output and productivity slows down that further depresses real wages and increase unemployment ending up with stagflation (Lescaroux and Mignon, 2008). The demand side effects stem from various factors including discretionary income effect, uncertainty effect, operating cost effect and increased precautionary savings. Discretionary income effect implies that consumers are left with less money after paying high energy bills. The uncertainty effect works through delayed or postponed purchase of irreversible consumer durables and investment projects due to uncertain energy prices and expected low demand for the firm's products in the future. The operating cost effect means decline in demand for those consumer durables which are complementary in use, like oil in vehicles. Finally, it is generally presumed that recessions are caused by oil price shocks, as a result households try to

save more today to be safeguarded against coming recessions which further decrease current aggregate demand.

Wealth transfer effect implies shifting of purchasing power from oil importing nations to oil exporting nations, thus it deteriorates the terms of trade for oil importing economies causing balance of payments deficit. Where the deficit in balance of payments could have negative impact on aggregate demand of the net oil importing economies as net exports form a major component of aggregate demand in an open economy. Finally, the real balance effect consider the increased transaction demand for real cash balances, due to high energy prices, might push nominal interest rate with constant money supply. That could discourage interest elastic demand (investment and consumer durables) hindering economic growth.

To cope with oil price shocks a large number of studies have debated the role of macroeconomic policies, specifically the appropriate monetary policy stance. The policy makers generally perceive oil price shocks as the major source of inflation and respond with monetary tightening to control the probable inflation. The increased interest rate no doubt is an effective measure to control expected inflation but on the other hand it leads to decelerated economic growth. Finally, inter-sectoral and intra-sectoral reallocation of resources among energy intensive and energy efficient sectors significantly contribute to high unemployment and slows down economic growth after an oil price increase and decrease. According to the sectoral adjustment effect, substantial adjustment cost is involved in absorbing displaced resources from adversely affected sectors into energy efficient sectors which further reinforce the distortionary impact of oil price shock. Whereby, a transitory decrease in oil price stimulating output growth is somehow counterbalanced by adjustment cost.

The high economic growth experienced during the last decade has been accompanied with soaring oil prices which prompted mass attention to scrutinize this new phenomenon generally termed as the great moderation by Blanchard and Simon (2001) in modern literature. That important strand of

literature focuses on the changing relationship between oil price movements and aggregate macroeconomic activities. A large number of studies reported lower pass-through from oil prices to inflation and other aggregate macroeconomic variables for the US and other countries (Barsky and Kilian 2002, 2004; Hooker, 2002; Herrera and Pesavento, 2009; Edelstein and Kilian 2007; Gregorio et al., 2007; Blanchard and Gali, 2007 and Blanchard and Riggi, 2013 among others). Based on rolling VAR approach, these studies put forward various explanations which account for the changing oil price macroeconomy relationship including reaction of the central banks, composition of the economy, varying energy intensity, flexible labour markets and deregulation of the energy sector. However, Kilian (2009), through an identified VAR model showed that the impact of an oil price shock on macroeconomic activity mainly depend on the underlying cause that affect changes in oil price. He distinguished oil price shocks as driven by oil supply shock, global aggregate economic activity shock and oil market specific demand shock. He established that the impact of an increase in oil price caused by various sources have dissimilar consequences for the US economy.

In case of Pakistan only few studies have quantified the impact of oil price shocks on the macroeconomic aggregates. One of the most important study is Khan and Ahmed (2011) who studied the impact of exogenous oil price shocks on major macroeconomic indicators through structural VAR framework over the period 1990M1-2011M7. They found negative impact of oil price shocks on aggregate demand along with high inflation. However, they didn't consider the impact of oil sector reforms that could possibly lead to unstable parameter estimates. Moreover, they assumed linear relationship between oil price and output level where most of the studies reported nonlinear and asymmetric relationship among the two variables. Other important studies include Malik (2007, 2008), the 2007 study briefly surveyed the oil sector deregulation process in Pakistan with no empirics while the later (2008) is an empirical contribution. Malik (2008) using quarterly data over the period 1979Q1-2007Q2 showed that oil price surge has an adverse impact on economic growth. Another relevant study is Javaid

and Munir (2011) which employed the structural VAR technique to assess the role of various structural shocks contributing to economic fluctuations in Pakistan. They found oil price shock as one of the major source of inflation and interest rate movements in Pakistan.

This study extends the oil price macroeconomy literature by examining the asymmetric relationship between oil price shocks and macroeconomic activities for Pakistan using linear and nonlinear specifications. Structural stability issues are carefully addressed as various regulatory reforms were initiated during the last decade on petroleum products pricing that have significantly changed oil market operations in the country. To the best of our knowledge, the role of regulatory reforms initiated in oil and gas sector have never been studied empirically for Pakistan.

3. Methodology and Data

Since the publication of an influential article of Sims (1980), the vector autoregressive (VAR) models are widely employed to examine the dynamic response of the macroeconomic variables to exogenous shocks.[2] The standard VAR model can be stated as:

$$y_t = \omega + \sum_{i=0}^{p} \varphi_i \, y_{t-i} + \sum_{i=0}^{p} \sigma_i z_{t-i} + \varepsilon_t$$

Where $\boldsymbol{y_t = (op_t, gdp_t, \pi_t, q_t, i_t)'}$ is a $n \times 1$ vector of endogenous variables and $\boldsymbol{z_t = (\pi_t^{us}, i_t^{us})'}$ is a vector of exogenous variables, while y_{t-i} and z_{t-i} are the corresponding lagged terms of order i. $\boldsymbol{\varphi_i}$ and $\boldsymbol{\sigma_i}$ are the coefficient matrices of vectors y_{t-i} and z_{t-i}. $\boldsymbol{\omega}$ is a $(n \times 1)$ matrix of constant terms and $\boldsymbol{\varepsilon_t}$ is a white noise error term.

The present study uses multivariate vector auto-regression model and the

[2] See Brown and Yucel (2002), Du et al. (2010), Aliyu (2011), and Cashin et al. (2014).

data for estimation are gathered from different national and international sources. To start with, since a longer time series is required to estimate VAR models, and Pakistan Bureau of Statistics (PBS) publishes the GDP data annually, the present study uses industrial production index as proxy for GDP (in log form) that is available on monthly basis from 1995 onward. Overall Inflation rate π_t, for the economy is proxied by the log difference of consumer price index of the same month in two consecutive years, and West Texas Intermediate (WTI) spot crude oil price in US dollars is chosen as the proxy for world crude oil price. The real price of oil op_t in domestic currency is calculated by multiplying the dollar price of oil with average US dollar exchange rate (Pak. Rupee-US Dollar) and divided by the domestic CPI in the corresponding month. q_t represents real effective exchange rate (CPI adjusted). Call money rate is used as proxy for short term interest rate i_t. Monthly interest rate is calculated with formula, 1/12*(1+money market rate/100). Finally, to capture the impact of global business cycle movements two foreign variables are also included. π_t^{us} is the US consumer price inflation rate and i_t^{us} stands for the US Federal funds rate as proxy for world inflation rate and world short run interest rate. Monthly data for the above mentioned variables including, ($gdp_t, \pi_t, q_t, i_t, \pi_t^{us}, i_t^{us}$) are retrieved from the International Financial Statistics (IFS) database and the WTI spot crude oil price is obtained from US Energy Information Administration (EIA) website. It is to be noted that all the variables except interest rate are used in logarithmic form.

4. Empirical Results

The estimated results of the multivariate vector auto-regression including the structural stability test, the Granger causality tests, impulse response functions, and forecast variance decomposition, are presented in this section. Since, the study mainly focuses on the interrelationship between oil price fluctuations and output, this area gets pointed attention in the paper. The impact on other important macroeconomic aggregates such as inflation rate, real effective exchange rate and short term interest rate is also discussed to

investigate the effectiveness of wealth transfer effect and monetary policy reaction function.

4.1 Unit Root Test

Acknowledging that the determination of statistical adequacy of the data in time-series analysis is a pre-requisite, therefore the order of integration and stationarity of the variables is examined through unit root test. For this purpose the standard ADF test (Dickey Fuller, 1979) and PP test (Phillips and Perron, 1988) have been used. The null hypothesis for both the tests assume that variables are non-stationary (having unit root). If the null hypothesis is accepted, we take the standard route of first differencing of the series and rechecking for unit root by employing the same tests. The estimated results (t-statistic) for both tests in level and at first difference are reported along with corresponding p-values in Table 1. Both tests suggest that all variables are non-stationary at level except interest rate which is stationary even at level according to the PP test. However, the null hypothesis of having unit root at first difference is rejected for all variables by both tests. The stationarity of the variables at first difference implies that all variables are integrated of order one, AR(1).

Table 1
Unit Root test

	ADF				PP			
	Level		1st Difference		Level		1st Difference	
Variable	t-Stat	Prob.	t-Stat	Prob.	t-Stat	Prob.	t-Stat	Prob.
GDP	-1.23	0.66	-9.04	0.00	-1.29	0.63	-30.10	0.00
Inflation rate	-1.27	0.64	-8.29	0.00	-2.47	0.12	-13.89	0.00
OP	-1.99	0.29	-11.78	0.00	-1.74	0.41	-11.78	0.00
REER	-1.89	0.34	-12.54	0.00	-1.85	0.35	-12.37	0.00
Interest rate	-1.66	0.45	-5.92	0.00	-5.69	0.00	-33.05	0.00

4.2 Parameters Stability Test

Invariably the developing economies keep on introducing structural

reforms at the behest of IFIs to improve upon their systems and procedures. This process renders stability of parameters questionable. Theory provides ample guidance to check for the structural break at a specific date through the standard Chow breakpoint test, if the break date is known exactly. However, if structural reforms are introduced at different points of time and the break date is not known in advance, we need to resort to the multiple breakpoint test as advocated by Bai (1997) and Bai and Perron (1998).

The review of Pakistan's economy for the last two decades suggests that several structural reforms in diversified areas were introduced as part of conditionality of the IMF programs[3]. The oil sector was no exception in this matter where oil market mechanism especially domestic petroleum products pricing and import of crude and other products changed considerably. As indicated, prior to these regulatory reforms the oil sector was under tight government control. But after the pro-market regulatory reforms initiated in the oil sector, domestic petroleum products' prices were initially adjusted on monthly basis by an independent body. However, most of the petroleum product prices were completely deregulated in 2011-12. Consequently, domestic petroleum product prices came closer to international oil markets and were frequently (monthly and fortnightly) adjusted in-line with the

Table 2
Multiple Breakpoint Test

				Break Dates	
Variable	Break Test	F-stat	Scaled F-stat	Sequential	Repartition
OP	0 vs. 1 *	5.38	80.74	2002M11	1999M10
	1 vs. 2 *	3.23	48.49	1999M10	2002M10
NOPI	0 vs. 1 *	5.34	80.14	2002M11	1999M08
	1 vs. 2 *	2.63	39.44	1999M08	2002M10
NOPD	0 vs. 1 *	5.55	83.26	2002M11	1999M09
	1 vs. 2 *	2.62	39.37	1999M09	2002M10

Note: 1. Critical Values ranging between 27.03 and 29.24 are based on Bai and Perron (1998) and Bai-Perron (2003).
2. * Significant at 0.05 level.

[3] For details see Hyder (2014), and Gira and Nina (2007).

international oil price fluctuations. Intuitively, the correlation between international oil prices and domestic petroleum products prices and hence, the nature of oil-macroeconomy relationship should be different in pre-deregulation and post-deregulation periods. The Bai (1997) and Bai and Perron (1998) multiple breakpoint test permits us to identify multiple breakpoints simultaneously. The test results confirm structural break in 2002M11 irrespective of the fact how the oil price variable's specified, i.e., linearly or nonlinearly. Accordingly, the entire sample is divided into two sub-samples, 1995M1-2002M12 and 2003M1-2014M11.

4.3 Granger Causality Test

The first step in this empirical analysis is to investigate the causal relationship between the variables of interest. The Granger causality test is the most suitable tool in this regard hence, we resort to this test too.[4] Even though our primary objective is to investigate the causal relationship between oil price and GDP but we have carried out the test between oil price and inflation rate, real effective exchange rate and interest rate. Based on the estimated results, we conducted the granger causality test for the whole sample and for the sub-samples individually. The results are summarized in Table 3.

Result for the whole sample (1995-2014) reported in the first two columns indicates that world oil price affect general price level at 10 percent significance level and real effective exchange rate at 5 percent level of significance. But it does not affect the aggregate demand and short run interest rate. For the sub-sample 1995-2002, the world oil price again doesn't cause GDP and inflation rate however oil price does not affect real effective exchange rate at 5 percent significance level and interest rate at 1 percent level of significance. It shows that oil price shock works through inflation effect and wealth transfer effect prior to deregulation of the oil sector as suggested by Backus and Crucini, (2000) and Bernanke Gertler and Watson (1997). Results for the sub-sample (1995-2002) are closely related to the

[4] The relevant tests are VAR Granger Causality/Block Exogeneity Wald Tests.

overall results as in both cases oil price does not Granger cause GDP significantly. The results for sub-sample 2003-2014, indicate that oil price significantly affected GDP (1 percent level) and inflation rate (at 10 percent level) during the post-deregulation period.

Table 3
Granger Causality Test

	1995-2014		1995-2002		2003-2014	
Null Hypothesis:	χ^2, stat	Prob.	χ^2, sta	Prob.	χ^2, sta	Prob.
OP does not Granger Cause GDP	1.98	0.96	7.13	0.42	9.87	**0.01**
OP does not Granger Cause Inflation rate	13.75	**0.06**	11.72	0.11	5.28	**0.07**
OP does not Granger Cause REER	15.63	**0.03**	15.96	**0.03**	1.36	0.51
OP does not Granger Cause Interest rate	10.83	0.15	14.19	**0.00**	2.83	0.24

The results presented in Table 3 are mostly in-line with a-prior expectations and evidence from the existing literature. During the pre-deregulation period domestic petroleum products' prices were largely hedged and revised only on political considerations. This could be the reason that there is no causal relationship between world oil price and domestic economic activity. Moreover, during the last decade (2001-2010) huge foreign direct investment was attracted in the oil and gas sector of Pakistan due to wide ranging concessions and market-access measures which, in turn, generated economic activity in midstream and downstream oil and gas sectors. There was a switch, though not significant, from imported oil to domestically extracted gas. As a result, Pakistan's dependence on imported oil decreased. The percentage share of oil has significantly decreased from 47 percent in 1999-00 to 29 percent in 2011-12 (Pakistan Economic Survey, 2013).

4.4 Impulse Response Functions

To investigate the dynamic response of oil price shocks on endogenous variables including GDP, inflation rate, real effective exchange rate and short

run interest rate, the study is embarked upon deriving the impulse response functions. Taking lead from the previous result of Granger causality test, the focus of analysis is sub-sample 2003M1-2014M11 only as there was not enough evidence for the earlier sub-sample (see Table 3). Figure 1 shows the responses of oil price shock on endogenous variables of the system. It can be seen that GDP reacts to the shock immediately, attain its peak in the second month after the oil price shock hit the economy, and then stays above its long-run equilibrium level for a long period of time. However, this influence reduces infinitesimally after eighteen months. Inflation rate starts to rise in the second month, touches the highest point in the eighth month, and stays at this level for twelve months. Inflation rate declines after a year and it takes thirty months to converge to its initial level. Real effective exchange rate depreciates instantaneously after the oil price shock and reaches its lowest level in four months. It takes fourteen months to revert to its steady state

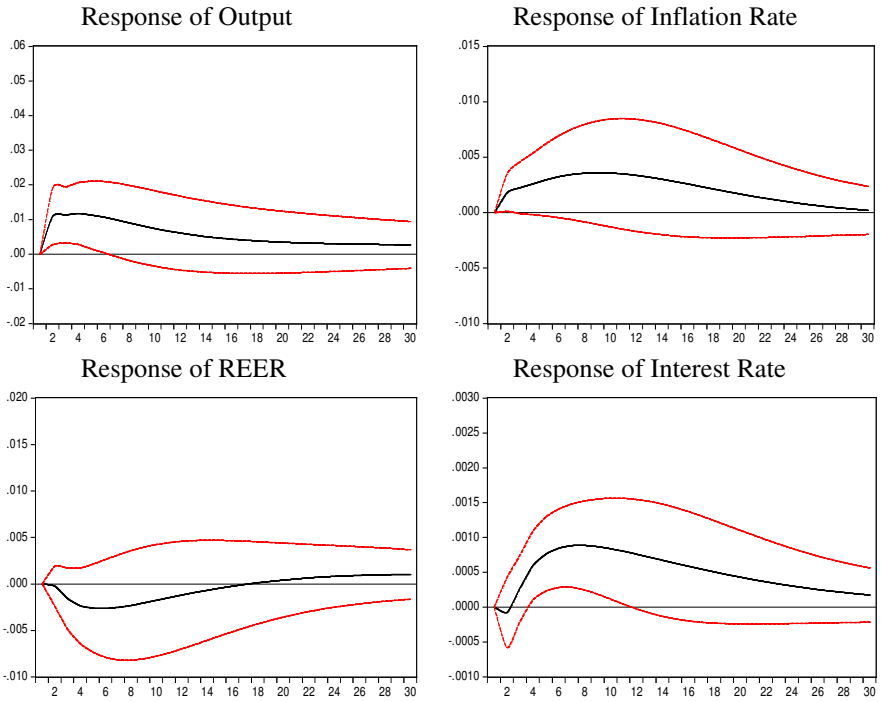

Fig. 1 Impulse response functions of GDP, Inflation rate, Exchange rate and Interest rate to real World oil price over the period 2003M1-2014M11.

level and starts to appreciate ever after. Interest rate also increases after the oil price shock to curb inflationary consequences.

The estimated results show that output increases with an increase in real price of oil. Although this result appears to be inconsistent theoretically, it is in conformity with the recent literature. Studies by Blanchard and Gali, (2007), Kilian (2009), Kilian and Lewis (2011), Campolmi (2008), Cashin et al., (2014), Herrera and Pessavento (2009), and Du et al., (2010) have shown that there has been increased resilience of the world economy to oil price shocks for most of the developed and emerging economies. These studies stress the role of oil price endogeniety in increased resilience of the world economy to the recent oil price shocks. According to Kilian (2009) the recent oil price surge is mainly demand driven caused by increased economic activity in newly emerging economies especially, China, India, Turkey and Brazil. According to Campolmi (2008), increase in economic activity raises the demand for oil putting upward pressure on oil price. On the other hand, it also increases the demand for domestically produced goods from rest of the world. Thus there is a net positive impact on output level.

4.5 Variance Decomposition

An evaluation of the relative importance of stochastic innovation in influencing endogenous variables at different horizons can be had by examining the forecast error variance decomposition. The decomposition analysis for 2003-2014 is reported in Tables (4 to 7). Table 4 shows that the major part of variation in output is explained by output itself. However, oil price shock, along with exchange rate shock, are also important sources of fluctuation in output. Oil price shock individually explains 16 percent of variation in output for a one-year period, which declines to about 10 percent after 30 months. While the contribution of real effective exchange rate increases to 31 percent during 30 periods. The contribution of interest rate and inflation rate in output variation is almost negligible, less than 1 percent throughout the duration of the analysis.

Table 4
Variance Decomposition of Output

Period	S.E.	World Oil Price Shock	Aggregate Demand Shock	Cost Push Shock	Exchange Rate Shock	Interest Rate Shock
1	0.04	1.64	98.36	0.00	0.00	0.00
2	0.05	7.14	91.57	0.12	1.17	0.01
6	0.07	16.20	75.87	0.26	7.29	0.37
12	0.08	15.01	66.45	0.35	17.69	0.50
18	0.09	12.73	61.25	0.30	24.84	0.88
24	0.10	11.37	57.89	0.27	29.19	1.28
30	0.10	10.61	55.92	0.28	31.67	1.53

Table 5
Variance Decomposition of Inflation rate

Period	S.E.	World Oil Price Shock	Aggregate Demand Shock	Cost Push Shock	Exchange Rate Shock	Interest Rate Shock
1	0.01	1.95	2.35	95.70	0.00	0.00
2	0.01	6.64	1.73	91.27	0.12	0.23
6	0.02	19.87	3.62	69.37	5.21	1.93
12	0.03	27.24	6.69	48.28	12.54	5.26
18	0.04	28.82	7.59	40.94	15.66	6.99
24	0.04	28.93	7.70	38.66	17.00	7.70
30	0.04	28.81	7.65	38.12	17.52	7.90

Table 6
Variance Decomposition of REER

Period	S.E.	World Oil Price Shock	Aggregate Demand Shock	Cost Push Shock	Exchange Rate Shock	Interest Rate Shock
1	0.01	6.35	0.17	2.18	91.30	0.00
2	0.02	7.07	0.81	1.93	89.06	1.13
6	0.03	13.90	2.31	6.43	74.02	3.34
12	0.04	14.87	1.73	6.83	69.53	7.04
18	0.04	13.62	1.98	6.07	69.99	8.34
24	0.04	12.72	2.90	5.67	70.18	8.53
30	0.05	12.31	4.03	5.53	69.73	8.40

In case of inflation rate major part of the volatility is explained by the shock to inflation rate itself (Table 5). Oil price shock followed by exchange rate shock is the other major source of variation in inflation rate. The contribution of oil price shock and exchange rate shock are about 29 percent and 17.5 percent respectively at 30 months horizon. Oil price shock takes second place in contributing to variability in real effective exchange rate, causing 15 percent variation in twelve months (Table 6). For interest rate, the contribution of oil price shock is almost negligible in the first two months, but it steadily jumps to 18 percent in the sixth month and keep on increasing up to 24 percent in 30 periods (Table 7).

Table 7
Variance Decomposition of Interest rate

Period	S.E.	World Oil Price Shock	Aggregate Demand Shock	Cost Push Shock	Exchange Rate Shock	Interest Rate Shock
1	0.00	0.49	0.87	0.15	1.53	96.95
2	0.00	0.50	1.15	0.34	1.30	96.72
6	0.00	18.29	3.35	12.29	1.18	64.90
12	0.01	31.23	15.15	19.15	0.69	33.78
18	0.01	32.74	21.61	18.39	0.57	26.69
24	0.01	32.70	24.37	17.56	0.78	24.59
30	0.01	32.31	25.52	17.09	1.31	23.77

5. Nonlinear Oil Price Specification

The analysis so far has assumed a linear relationship between oil price and macroeconomic variables. However, since a large number of studies have reported asymmetric relationship between the two groups of variables, we now use Hamilton (1996) non-linear transformation to explore oil price-output nexus further.[5] Hamilton (1996) propose the use of net oil price increase ($NOPI_t$) which considers the net change in oil price over the period of last year, i.e., a comparison of current period oil price with the maximum

[5] It is believed that the Hamilton specification is more intuitive than others like Mork (1989) and Lee, Ni and Ratti (1995).

price that prevailed during the preceding year (12 months or four quarters). If the current price is less than the previously recorded level of past one year, then the series is defined as zero. On the contrary, if it is more than the maximum price that prevailed during the previous year, the percentage change over the last maximum price is calculated. Net oil price decrease ($NOPD_t$) can be defined in the same way. In this study we consider ($NOPI_t$) and ($NOPD_t$) to assess the symmetric/ asymmetric impact of oil price shock on macroeconomic variables. Net oil price increase ($NOPI_t$) and net oil price decrease ($NOPD_t$) can be defined as.

$$NOPI_t = max\{0, O_t - max\{O_{t-1}, O_{t-2}, \ldots, O_{t-12}\}\}$$
$$NOPD_t = min\{0, O_t - min\{O_{t-1}, O_{t-2}, \ldots, O_{t-12}\}\}$$

To proceed further first we test the stationarity of the ($NOPI_t$) and ($NOPD_t$) series and both are found to be stationary at level. Next we estimate the same VAR model with the transformed series for both the periods (1995M1-2002M12 and 2003M1-2014M11). The results for Granger causality test for the transformed oil price series and all other variables are reported in Table 8. The results demonstrate that for the sub-sample 1995M1-2002M12, the positive and negative shocks to world oil price do not

Table 8:
Granger Causality test (VAR Granger Causality/Block Exogeneity Wald Tests)

	2003-2014		1995-2002	
Null Hypothesis:	χ^2. *stat.*	Prob.	χ^2. *stat.*	Prob.
NOPI does not Granger Cause GDP	0.88	0.64	2.16	0.14
NOPD does not Granger Cause GDP	5.42	**0.07**	1.30	0.25
NOPI does not Granger Cause Inflation rate	1.62	0.45	0.10	0.75
NOPD does not Granger Cause Inflation rate	10.47	**0.01**	0.25	0.62
NOPI does not Granger Cause REER	3.32	0.19	0.15	0.70
NOPD does not Granger Cause REER	3.00	0.22	0.05	0.83
NOPI does not Granger Cause Interest rate	10.48	**0.01**	0.04	0.85
NOPD does not Granger Cause Interest rate	6.78	**0.03**	2.49	0.11

affect any variable significantly. For the sub-sample 2003M1-2014M11, a shock to net oil price increase fails to affect GDP, inflation rate and exchange rate. However, it significantly causes interest rate at 1 percent level. On the other hand, negative oil price shock leaves a significant impact on GDP at 10 percent significance level, inflation rate at 1 percent level and interest rate at 5 percent level. Intuitively, a decrease in real price of oil should have positive impact on the economic activity in oil importing resource constrained economies.

The impulse response functions for GDP, inflation rate, exchange rate and interest rate to net oil price variation are plotted in Figures 2 and 3. Figure 2, reports the dynamic response of domestic macroeconomic variables to net oil price increase. As discussed, net oil price increase has no

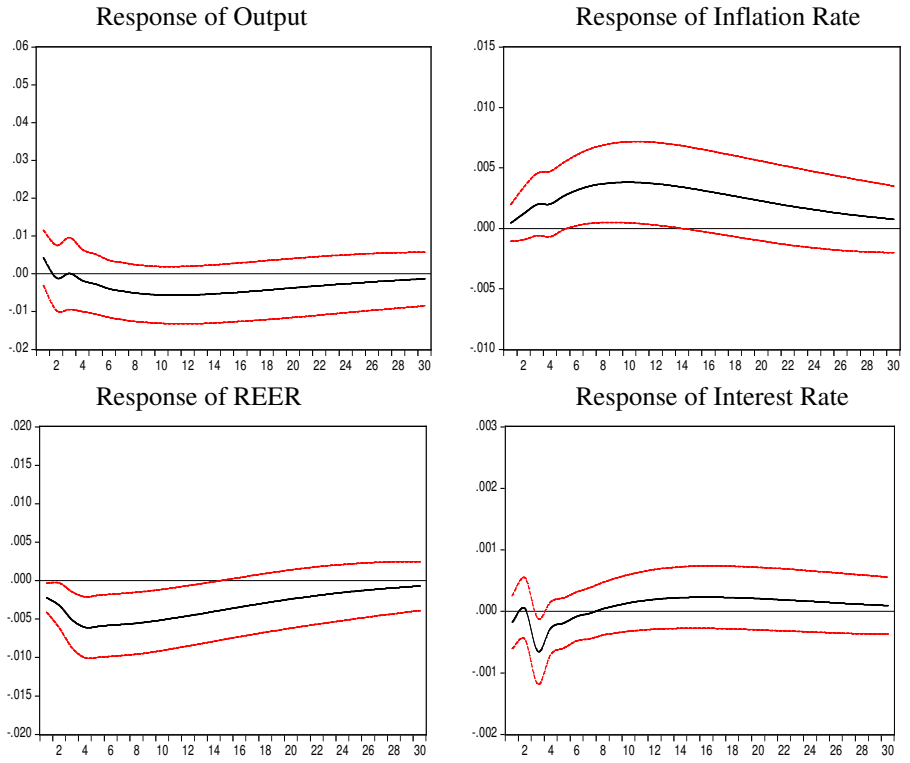

Fig. 2 Impulse response functions of GDP, inflation rate, exchange rate and interest rate to NOPI over the period 2003M1-2014M11.

significant impact on Pakistan's GDP, inflation rate and exchange rate but it significantly affects interest rate. Interest rate initially decreases but it starts to increase after four months and stays above the initial level for about eighteen months. It starts to decline and completely dies out in thirty months. GDP declines and inflation rises after a positive shock to oil price even though insignificantly.

From figure 3, we can see that net oil price decrease have significant positive impact on GDP for the economy of Pakistan. Intuitively a decrease in oil price has positive impact on the output for a net oil importing economy.

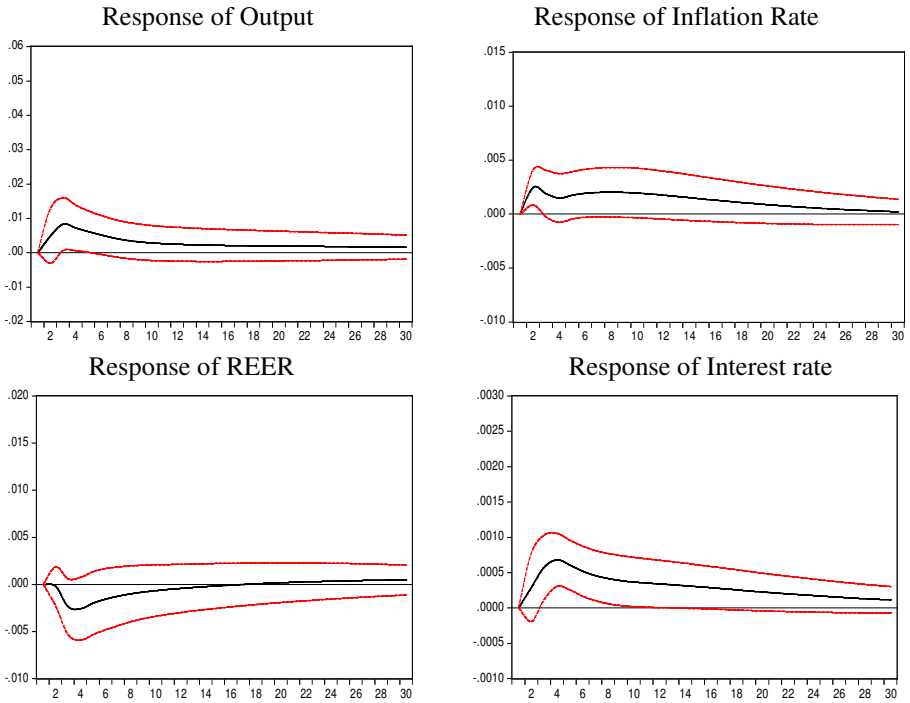

Fig. 3 Impulse response functions of GDP, inflation rate, exchange rate and interest rate to NOPD over the period 2003M1-2014M11.

GDP increases instantaneously in response to a negative shock to real world oil price and reaches the highest in the third month. GDP starts to decline in the fourth month and becomes negligible after twelve months. Inflationary

consequences are accompanied by negative shock to real oil price which can be attributed to increased demand for domestically produced goods by the domestic households and from rest of the world. Real effective exchange rate depreciates after an oil price decrease although the impact of oil price decrease on exchange rate is statistically insignificant. The insignificant impact may be due to government intervention in foreign exchange market. In Pakistan, exchange rate is mostly pegged by the government to protect the export sector that is why oil price fluctuations seem to have insignificant impact on exchange rate in the short-run. Lastly, interest rate rises even after an oil price decrease. However, as we have noticed that general price level increases even after an oil price decrease. Inflationary pressures after an oil price decrease can be due to increased demand for energy and other products (see response of output in Figure 3). The Monetary Authority i.e., the State Bank of Pakistan, resorts to monetary contraction to curb inflationary pressures.

6. Conclusion

The primary aim of present study was to investigate the relationship between oil price and key macroeconomic aggregates using linear and nonlinear oil price specifications. Keeping in view the introduction of diversified economic reforms in the oil sector structural stability of the relationship has been addressed through the multiple breakpoint tests. The oil price shocks are generated through multivariate VAR approach to examine the dynamic response of domestic macroeconomic aggregates including aggregate demand, inflation rate, exchange rate and nominal interest rate using monthly data over the period 1995M1-2014M11. The relative importance of various shocks contributing to macroeconomic fluctuations is quantified through the variance decomposition analysis.

One of the major achievements of this study is that we have been able to uncover some of the previously unnoticed facts about the interaction between oil price and macroeconomic aggregates. The striking finding is that the nexus between oil price and macro-economy has significantly altered after

the deregulation of oil and gas sector in Pakistan. Secondly, there has been an asymmetric impact of oil price movements on output level over the period 2003-2014. Whereas an oil price decrease significantly stimulated output in the short-run over the period 2003-2014, the net oil price increase caused a decline in output along with evidence of high inflation. The simulation exercise further showed that although the policy stance of the State Bank of Pakistan was accommodative in nature in case of smaller oil price fluctuations, but it opted for countercyclical policy for perceived net oil price changes as the major source of macroeconomic instability. The holistic picture of these empirical results demonstrated that net oil price increase and decrease did not Granger cause any variable in the short-run over the period 1995M1 to 2002M12.

The study has found that the abolition of unnecessary regulations and pro-market initiatives have considerably improved the economic resilience of the economy to cope with exogenous shocks. Oil market deregulation program has paved the way for further easing out of the regulatory regime. This, nonetheless, has to be coupled with a close watch on optimal sequencing of the reform process. A rational policy measure to promote value added exports, diversification of energy mix and improved efficiency in energy consumption and production is strongly recommended to ensure sustainable economic growth.

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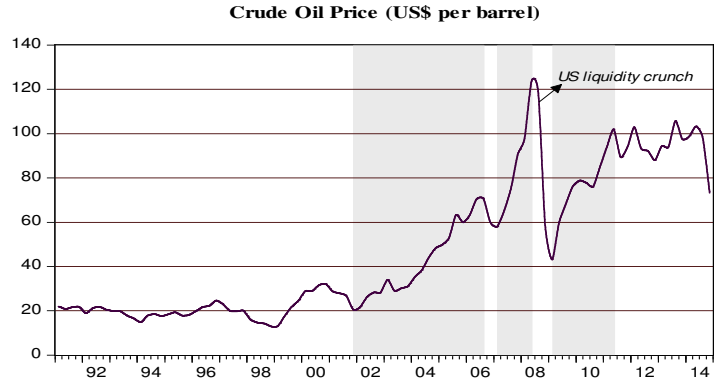
Appendix 1: World Crude Oil Price (US $/barrel)



Source: US. Energy Information Administration (Quarterly Average)

Note: The shaded area depicts positive oil price shocks, horizontal distance shows the duration of oil price shock.