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Article

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International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2017, 7(5), 83-92.

Oil Price Shock and its Impact on the Macroeconomic Variables of Pakistan: A Structural Vector Autoregressive Approach

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ABSTRACT

This study examines the dynamic effects of the oil price (OP) shocks on the key macroeconomic variables of Pakistan. A structural vector autoregressive model is used on yearly data from 1960 to 2014. The impulse response functions indicate that the OP shocks depress the real gross domestic product while the real exchange rate also experiences depreciation. However, the long-term interest rate and the inflation rate (INF) rise as a result of a positive OP shock. The unanticipated changes in these macroeconomic variables threaten the economic stability of Pakistan; specifically, higher inflation and interest rates hamper the economy's growth rate. Lastly, the variance decomposition analysis illustrates that the OP shocks have the most impact on the INF of Pakistan.

Keywords: Structural Vector Autoregressive, Oil Price Shocks, Macroeconomic Variable
JEL Classifications: C22, E40, E31, E50, Q43

1. INTRODUCTION

Oil price (OP) shocks have been a leading source of concern globally; however, the oil-importing countries are the most anxious owing to their high dependency on imported oil. OP fluctuations threaten macroeconomic stability of developing countries such as Pakistan through various channels. Firstly, majority of the industries use oil as a primary input therefore an increase in OP results in a decrease in industry output due to high production costs. Secondly, increased OP result in modification of the terms of trade such that income is transferred from oil-importing to oil-exporting countries. As a result, the oil-importing countries lose out on their real income. Lastly, inflation increases directly due to an increase in the OP through higher prices of petroleum products and imported goods. Consequently, if higher inflation results in an increase in the wage rate the central bank is compelled to raise the interest rates (Jamali et al., 2011).

The ability and the magnitude by which the price shocks affect an economy depend upon the economy's degree of reliance on imported oil, the share of the cost of oil in the national income and the capability of the end consumers to reduce their consumption and to move off to alternatives (Malik, 2008). For the year 2012-2013, oil accounted for 29% of the total energy consumption in Pakistan which is lower than the 32% noted in the year 2005-2006. This goes to show that over the years the share of oil has reduced in the total energy consumption however, it remains the second largest source of energy after natural gas which accounts for 44% of the total energy consumption for the year 2012-2013[1].

With a population of more than 170 million Pakistan has a high level of energy consumption which puts pressure on the country's limited energy resources therefore, Pakistan has to import a large quantity of oil and oil related products in order to satisfy the

1 For the year 2005-2006, the natural gas accounted for 39% of the energy source. Hence, a move towards increased usage of natural gas in place of oil can be observed between the years 2006-2013; however, according to the Pakistan Economic Survey 2014-2015 due to gas load management, share of oil has started to rise again.

growing domestic demand[2]. By the end of year 2007-2008, total imports were recorded twice as much as the total exports with a value of $40 billion. This acceleration in imports is attributed to the surge in international OP and Pakistan's huge dependence on oil imports. According to the U.S. Energy International Administration, crude oil imports grew an annual 11% from July 2013 to March 2014. Hence, fluctuating OP have a direct bearing on the economic outlook of Pakistan.

Consequently, this study is designed to investigate the impact of OP shocks on the macroeconomic variables of Pakistan namely real gross domestic product (RGDP), real exchange rate (RER), inflation rate (INF), and the long-term interest rate (LTINT).

The rest of the paper is organized as follows: Section 2 evaluates the existing literature on this area of research, section 3 describes the data and its properties in detail; whereas, section 4 focuses on the methodology and the identifying restrictions. Section 5 presents the empirical results and finally section 6 concludes.

2. LITERATURE REVIEW

The first oil shock in 1973/1974 triggered interest of various researchers into the OP and the macro-economy nexus. Higher OP means increased inflation, panics in the stock exchange (if the change is sudden) and generally reduced economic growth which can all combine to trigger financial and monetary instability[3] (Aliyu, 2009).

Changes in OP impact the economic activity via different transmission mechanisms that include the supply and demand channels. Crude oil is used as a basic input in a production process therefore, a rise in OP leads to an increase in production costs. Consequently, the firms reduce their output. This constitutes the supply side effect. On the demand side, OP hikes impact investment and consumption. Consumption is affected incidentally via its positive relationship with disposable income (Jiménez-Rodríguez and Sánchez, 2005). Investment, on the other hand, is affected by increased firm costs as a result of a surge in OP. The higher production costs result in lower rate of return on investment which in turn adversely impacts the investment demand. Moreover, increased changeability of the OP may affect investment by raising the uncertainty pertaining to future movements in the price levels (Rafiq et al., 2009).

Of the earlier researchers, Hamilton (1983) sought out to evaluate the relationship between the aggregate economy and the OP by formulating three hypotheses that looked at the OP shock and the output correlation. He concluded that the oil shocks played a significant role in slowing the macroeconomic activity in the United States.

Burbidge and Harrison (1984) viewed the OP shock of 1973 as one of the factors that deepened a recession that was already on its way. Following in the steps of Hamilton, Burbidge and Harrison used a seven variable vector autoregressive (VAR) model using monthly data from 1961 to 1982 for five Organizations for Economic Cooperation and Development (OECD) countries[4] to test the impact of the OP shocks on the macro economy. They concluded that the oil shocks had a substantial impact on the price level prevailing in the United States and Canada. Moreover, the industrial production in all the OECD countries under consideration was negatively affected. The greatest impact was observed for the United States (U.S) and the United Kingdom (U.K).

Further, OP fluctuations have varying impacts on oil-importing and oil-exporting countries. An increase in OP serves as a means of wealth transfer from oil-importing to oil-exporting countries; thereby, asserting that positive OP shocks are considered a relief in oil-exporting countries and a nuisance in oil-importing countries (Jiménez-Rodríguez and Sánchez, 2005). Hence, countries that are self-sufficient in oil resources can react very differently to OP shocks (Bjornland, 2000).

The failure of the 1986 OP plunge to revive the economy towards a boom as opposed to the economic downturn triggered by the 1973 OP surge resulted in numerous authors hypothesizing the presence of an asymmetric correlation between changes in the OP and the economic activity. Although a rise in OP has distinct negative effects on the output growth, a decline in OP do not always have a positive impact (Cologni and Manera, 2008). Mork (1989) certifies that the link between the OP and the macro economy breaks down if the study by Hamilton is extended to incorporate the collapse of 1986 OP. Other authors like Hooker (1996) and Burbidge.

The standard theory of exchange rate determination advocates that a surge in the OP depreciates the currency of the oil importing country as the supply of its domestic currency in the foreign exchange market increases on the other hand, a positive oil shock appreciates the currency of an oil exporting country (Basnet and Upadhyaya, 2015). Amanoa and Norden (1998) specify OP to be a leading source of shock in the RER. Similar results are obtained by Chaudhuri and Daniel (1998) who assert that the real OP have been a major source of fluctuation in the U.S. RER. Shair et al. (2015) posit that an increase in crude OP depreciates the exchange rate of Pakistan causing inflation which diminishes the purchasing power of the people. Huang and Guo (2007) using a structural VAR (SVAR) model found that an increased real OP leads to a slight appreciation of the RER[5] of China (an oil importer) which in turn is likely to worsen its terms of trade.

Cologni and Manera (2008) investigated the effect of OP on interest rates and inflation for the period 1980-2003 using

2 Imports of the petroleum products meet 82% of the country's demand for these products. Malik (2007) for a detail deliberation on the condition of Pakistan's oil sector.

3 Jiménez-Rodríguez and Sánchez (2005) assert that economic policy responses may be procured as a result of a few indirect effects. Authors like Bernanke et al. (1997) contend that a combination of both the monetary responses and the shocks themselves can be held responsible for the post oil shock economic dips. Further, McKillop (2004) posits that this could result in increased inflation and interest rates or even recession.

4 Germany, United States, Japan, Canada and United Kingdom Burbidge and Harrison (1984) that the relationship between the oil prices and the macro economy has dramatically decreased since 1973.

5 This impact is attributed to two reasons: Firstly, China is less reliant on oil imports than its partners in trade. Secondly, due to stringent government regulation the domestic oil prices of China are less synchronized with the price movements prevalent in the world market.

quarterly data in a co-integrated VAR framework for the G-7 countries. They found that OP impact the INF significantly which in turn affects the real economy by raising the interest rates. After an OP shock a tightening monetary policy is usually observed whereby the federal funds rate is increased which in turn affects the output growth (Ferderer, 1996). By using the impulse response functions for the U.S. economy, Brown et al. (1995) affirm that a positive OP shock results in a rise in the price level and the federal funds rate. However, only a transient increase in the short-term interest rates is seen as the impulse responses to the federal funds rate lose significance after the twelfth quarter. Reicher and Utlaut (2010) finds a robust positive correlation between the OP and the long-run interest rates for the U.S. economy; however, the relationship is said to have weakened post 1985.

3. DATA

This section gives an in-depth description of the data used for analysis and its sources. Further, test for stationarity and lag length selection are discussed.

3.1. Data Description and Sources

The analysis in this paper is based on annual data covering the time period 1960-2014 for the following variables: OP, RER, RGDP, LTINT, and the INF. The data on these variables has been collected from the World Economic Database, the International Monetary Fund, BP Statistical Review of World Energy 2015, World Bank, and the International Financial Statistics.

For the purpose of analysis, RGDP is expressed in billions of 2000 U.S. dollars whereas the Brent crude OP is measured in U.S. dollars per barrel.

The RER is represented by the ratio of the tradable prices to the non-tradable prices times the nominal exchange rate. The wholesale price index of U.S. is used as a proxy for the tradable prices whereas the consumer price index of Pakistan is used as a proxy for non-tradable prices. The nominal exchange rate is expressed as Rupees per U.S. dollar.

The INF, in this paper, depicts the percentage change in the average consumer prices over the years and the LTINT is the rate on government securities/bonds. All the variables except for the LTINT are taken in log form.

3.2. Unit Root Test

In order for VAR estimates to be consistent it is necessary that the time series data is stationary. Non-stationary data leads to misleading or spurious regression results. In order to check for stationarity, the augmented Dickey Fuller test is used. The null hypothesis of the test states that the variable contains a unit root, that is, the variable is non-stationary while the alternative hypothesis states that the variable is generated by a stationary process. In case of a unit root, the variables are differenced until stationarity is realized. Table 1 depicts the results from the test which shows that the INF is stationary at levels, meaning it is integrated of order zero, I(0) while all other variables are stationary at first difference, that is, they are integrated of order one, I(1).

3.3. Akaike Information Criterion (AIC)

As the VAR model is lag sensitive, it is essential to determine an appropriate lag length. Following Jamali et al. (2011) and Eltony and Al-Awadi (2001), the AIC is employed for this purpose. The lag length chosen is the one that keeps at a minimum the following:

$$AIC=-2\ln(L)+2K \tag{1}$$

Where, K represents the total number of parameters and L represents the maximum value of the likelihood function for the model. Table 2 summarizes the results of employing this technique. As the AIC criterion is minimized for order 1, a VAR model with a lag length of 1 is employed for this study.

4. METHODOLOGY

This section sheds light on the SVAR model employed to analyze the oil shock-macro economy relationship along with the identifying restrictions.

4.1. SVAR Model

SVAR uses economic theory to evaluate the contemporaneous relationships between the variables and provides a better empirical fit which serves as its advantage over other specifications of VAR models. Moreover, the SVAR model helps examine the impact of unanticipated shocks to one variable on the remaining variables in the system (Chuku et al., 2011). Further, VAR evaluation is extremely responsive to the lag order of the variables. Hence, an adequate lag length can help manifest the long term effect of some of the variables on other variables in the system. However, a longer lag length may result in the problem of collinearity and will, as a result, decrease the degrees of freedom (Tang et al., 2010).

Table 1: Augmented Dickey-Fuller test for the presence of unit root

Variable	Level		First difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend
LNOP	−1.33732	−1.77080	−5.19538*	−5.13631*
LNRGDP	−2.48980	−1.17889	−3.70788*	−4.45162*
LNINF	−3.6272*	−3.66401**	−6.95194*	−6.88156*
LNRER	−1.14764	−2.29184	−5.26927*	−5.23118*
LTINT	−2.73419	−3.43010	−6.49739*	−6.43343*

Significance at 1%, 5% and 10% level of significance is denoted by *,**,***respectively

Table 2: Optimal lag length

Lag length	AIC
0	−80.3848
1	−82.8624*
2	−61.5009
3	−2.1967
4	121.8236
5	284.5839
6	690.4348
7	1837.5918

*Optimal lag length. AIC: Akaike information criterion

4.1.1. Specification

Following Khan and Ahmed (2014), the SVAR model with the number of lags denoted by "p" can be written as follows:

$$AX_t=A_1X_{t-1}+A_1X_{t-1}\ldots A_1X_{t-1}+\varepsilon_t \quad (2)$$

Where A is a matrix of coefficients that is invertible and it captures the contemporaneous relations on the endogenous variables, X_t is a vector of endogenous variables and ε_t is a vector of structural error terms (ε_t~N(0, Ω), where Ω is a diagonally normalized variance-covariance matrix such that Ω=I). For this paper, the vector X_t is represented by the following:

$$X_t=(\Delta LnOP_t, \Delta LnRGDP_t, \Delta LnINF_t, \Delta LnRER_t, \Delta LTINT_t) \quad (3)$$

Where $\Delta LnOP_t$ is the first difference of the log of OP, $\Delta LnRGDP_t$ is the first difference of the log of RGDP, $\Delta LnINF_t$ is the log of the INF, $\Delta LnRER_t$ is the first difference of the log of RER and $\Delta LTINT_t$ is the first difference of the LTINT.

By assumption, μ_t, the model residuals are related linearly to the structural shocks such that $\mu_t=(\gamma\varepsilon_t)$ where γ is a structural coefficients matrix structural coefficients matrix demonstrating the effects of structural shocks. ε_t is assumed to be orthogonal such that the impact of each shock can be expressed independently. In light of the above assumptions, the model can be stated as:

$$AX_t=A_1X_{t-1}+A_2X_{t-2}+\ldots A_pX_{t-p}+Y\varepsilon_t \quad (4)$$

Under this specification the model cannot be directly observed and so it cannot be estimated directly to give the true values of the coefficients of A, A_i's and ε_t. Therefore, to overcome this problem the above model needs to be expressed in its reduced form which is achieved by pre-multiplying the entire equation by matrix "A"s' inverse such that the model can be expressed as follows:

$$X_t=A_1{}^*X_{t-1}+A_2{}^*X_{t-2}+\ldots A_p{}^*X_{t-p}+\mu_t \quad (5)$$

Where $A_i{}^* = A^{-1}A_i$ and μ_t is the vector of residuals. By assumption, μ_t~N (0, Ω) such that Ω=($\mu_t \cdot \mu_t$)'. Orthogonality of μ_t and X_t is also assumed, hence, the estimates of μ_t can be used to get Ω and a simple ordinary least square analysis can be done to retrieve consistent estimates of $A_i{}^*$.

Given the above model specification, it is observed that the reduced-form VAR (represented by equation 5) is ineffectual in tracing the concurrent relationship among variables that leads to cross-correlation within residuals as the right-hand side of the VAR comprises of all the lagged-terms. This contemporaneous relationship may have an impact on the impulse response functions, therefore, in order to cater to this problem the relationship between the reduced-form VAR and the structural VAR (represented by equation 4) is used, such that:

$$A\mu_t=\gamma\varepsilon_t \text{ or } \mu_t=A^{-1}\gamma\varepsilon_t \quad (6)$$

To recover the structural parameters, restrictions need to be imposed on either matrix A or γ, or both. As stated by Breitung et al. (2004), when either A or γ matrix is presumed to be an identity n(n−1)/2 additional restrictions are required, where "n" denotes the number of variables in the system. In this paper, 10 restrictions need to be imposed on the matrix "γ" to estimate the model as 5 variables are under consideration.

4.1.2. Identifying restrictions

Based on $\mu_t=(\gamma\varepsilon_t)$, the identification scheme can be written as follows:

$$\begin{bmatrix}\mu_{LNOP}\\ \mu_{LNRGDP}\\ \mu_{LNINF}\\ \mu_{LNRER}\\ \mu_{LTINT}\end{bmatrix}=\begin{bmatrix}1&0&0&0&0\\ b_{21}&1&0&0&0\\ b_{31}&b_{32}&1&0&0\\ b_{41}&b_{42}&b_{43}&1&0\\ b_{51}&b_{52}&b_{53}&b_{54}&1\end{bmatrix}\begin{bmatrix}\varepsilon_{LNOP}\\ \varepsilon_{LNRGDP}\\ \varepsilon_{LNINF}\\ \varepsilon_{LNRER}\\ \varepsilon_{LTINT}\end{bmatrix} \quad (7)$$

The OP are assumed to be exogenous such that the OP shock is not contemporaneously affected by other shocks. The supply and demand of oil in the world market helps determine the optimal OP so a singular economy might not have a significant domination (Chuku et al., 2011); therefore, the exogeneity of OP appears to be a reasonable assumption. Hence, four restrictions are imposed on the first row of the matrix "γ" such that uOP=εOP.

In line with Alom et al. (2013), the RGDP is assumed to be affected by itself and the OP only. Therefore, three restrictions are imposed on the second row of the matrix "γ" such that μ_{RGDP}=b21εOP+εRGDP.

Next, the INF is assumed to be contemporaneously affected by itself, OP shocks and output shocks. This seems to be a plausible assumption as an increase/decrease in OP or output result in an increase/decrease of the INF. Thus, two restrictions are imposed on the third row of the matrix "γ" such that uINF=b31εOP+b32εRGDP+εINF.

Further, it is assumed that the RER is impacted by itself and the shocks to OP, RGDP and inflation. The LTINT is presumed to have no contemporaneous effect on the RER. Hence, only one restriction is imposed on the fourth row of the matrix "γ" such that uRER=b41εOP+b42εRGDP+b43εINF+εRER.

Lastly, shocks to the LTINT are assumed to be affected by shocks to all other variables therefore the LTINT shocks can be modeled as uLTINT=b51εOP+b52εRGDP+b53εINF+b54εINF+εLTINT.

5. EMPIRICAL RESULTS

This section presents the analysis of the shocks to the macroeconomic variables based on the short-run restrictions imposed to identify the model.

5.1. Impulse Response Functions

The impulse response functions show the impact of a one standard deviation (SD) shock of one variable to all other variables in the system; therefore, it is considered as an essential tool in the empirical causal analysis along with the analysis of policy effectiveness. This paper uses the impulse responses in order to study the impact of shocks to OP and the macroeconomic variables under consideration.

5.1.1. Impact of the OP shock

Figure 1 shows the impulse response functions of each of the variables to a positive one SD shock to OP. Following an OP shock a decline in the RGDP is observed, it is at its lowest through years 7-14. This result coincides with the findings of Sultan and Waqas (2014) for Pakistan. The plunge in the RGDP can be attributed to the increase in the INF due to an OP shock. The INF reaches its highest value at around year 9 and the trend continues in the long-run. This increase in inflation leads to an increase in the input costs which are then translated as higher prices for the consumers. Increased input costs leads to lower output as a result the aggregate supply falls. Consequently, the real GDP growth is hampered.

The RER shows an initial depreciation subsequent to the OP shock however, after the 1st year it starts to appreciate slightly and it becomes constant after the 3rd year. These fluctuations lead to trade imbalances thereby, negatively impacting the economy of Pakistan.

After a shock to the OP, the LTINT increases sharply until year 1 after which it fluctuates slightly before becoming constant at a higher value than the initial. Under macroeconomic theory, the LTINT s move in tandem with the short-term interest rates (Abel and Bernanke, 2005). After the INF increases, the monetary policy comes in to play and as discussed by Ferderer (1996) usually a tightening monetary policy is observed in order to control inflation therefore, the central bank increase interest rates; thus, the movement observed for the LTINT makes sense after the OP shock.

From the above analysis, it becomes clear how the tightening monetary policy has helped in containing the worsening economic conditions of Pakistan due to the OP shock. The State Bank of Pakistan could have possibly responded by increasing the money supply as the increased INF reduces the purchasing power of people which in turn increases the money demand. But by doing so, the bank risks increasing INF further.

5.1.2. Impact of RGDP shock

Figure 2 presents the impulse response functions to a positive one SD. shock to the RGDP. The OP rise slightly during the 1st year after changes in the RGDP are observed; however, this increase does not last long and the effect on the OP dies out quickly and they revert back to their pre-shock value. Therefore, this illustrates that a shock to the RGDP of Pakistan does not contribute to OP changes in the long-run.

The positive shock to the RGDP results in a fall of the INF of Pakistan. Keeping in view the equation of exchange arranged in light of Friedman's assumption of constant velocity of money (inflation = money growth − RGDP growth), the results observed above are in line with economic theory. Findings of Ayyoub et al. (2011) also support the negative correlation between INF and the GDP growth for the case of Pakistan. According to Friedman (1992) inflation is only a monetary phenomenon which infers that historically continued inflation has always been as a result of growth in the money supply and not due to sustained growth in the velocity or persistent negative growth in the real income. The rise in RGDP leads to an increment in the LTINT of Pakistan. This result coincides with the findings of Gilani et al. (2010) who state that for the case of Pakistan the interest rates and the economic growth seem to share a positive relationship.

Further, the RER appreciates after a shock in the RGDP is realized. After fluctuating insignificantly up till year 4 the RER becomes constant at a lower value than the initial. Increased interest rates as a result of a positive shock to the RGDP also play a pivotal role in the exchange rate appreciation.

5.1.3. Impact of inflationary shock

The impulse responses to a one SD. positive shock to the INF are presented in Figure 3. The increase in the INF results in a rise in the OP which become constant at a higher value than the initial after year 7.

Figure 1: Impulse responses to oil price shock

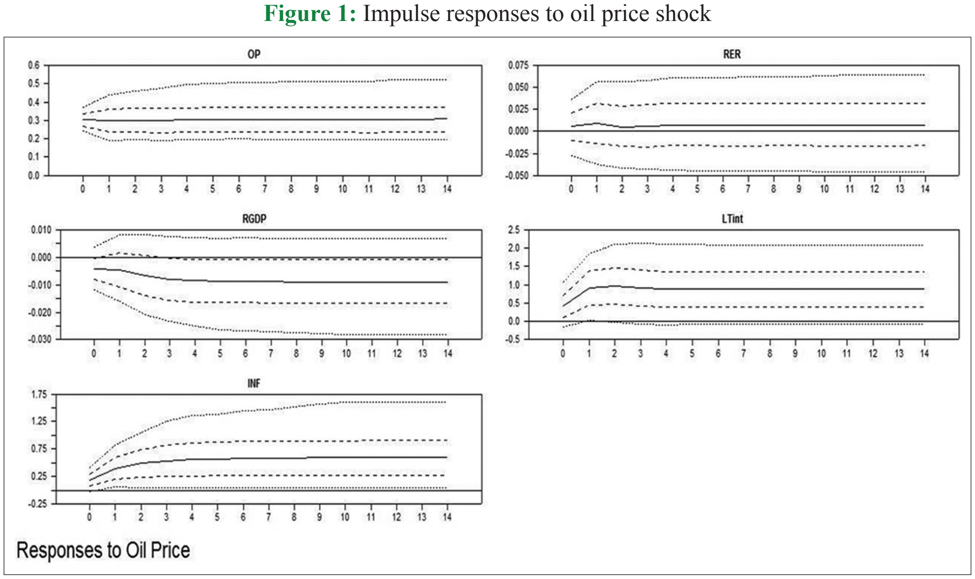


Figure 2: Impulse responses to real gross domestic product shock

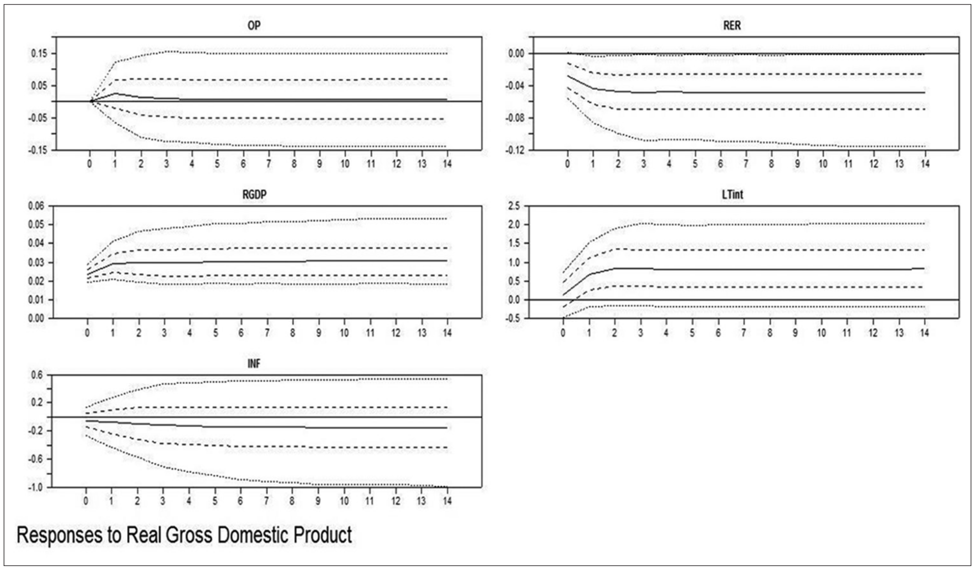
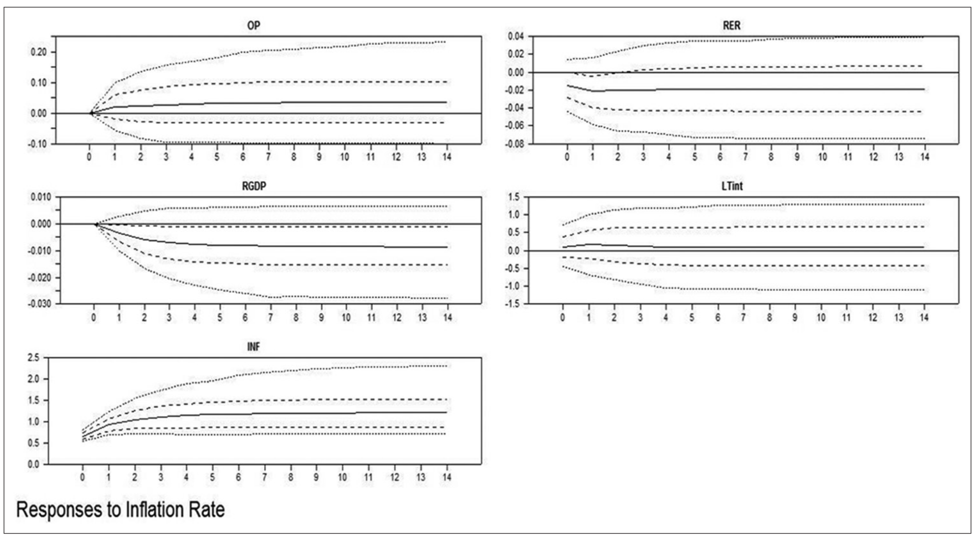


Figure 3: Impulse responses to inflationary shock



The inflationary shock results in a decline in the RGDP of Pakistan. According to economic theory as inflationary pressures increase, the aggregate supply of goods decrease as the increased input costs make it difficult for the firms to produce the same level of output as before the increase in prices[6].

With an increase in the INF a rise in the LTINT is observed. However, this increase in the LTINT appears to die out completely soon after the 3rd year as the value of the interest rate reverts back to its pre-shock value.

The RER decreases after the inflationary shock is observed and becomes constant a value lower than the initial after year 3. This means that the RER of Pakistan appreciates in response to the increase in inflation. This can be due to the increase in the interest rates which allows capital inflow in the economy despite higher inflation.

6 Principles of Macroeconomics by Greenlaw et al. (2014). p. 278.

5.1.4. Impact of RER shock

Figure 4 represents the impulse responses to a one SD positive shock to the RER. The RGDP increases till year 1 after the RER shock however, a fall in the RGDP is observed after the 1st year which becomes constant after year 5. This result corresponds to the findings of Datta (2012) who found expansionary effects of devaluation on output growth in the short run while in the long run contractionary effects were observed for Pakistan.

Shocks to the RER increase the INF of Pakistan. RER depreciation increases the price of the imported goods while the price of domestic goods for the foreigners decreases thus exports become more attractive than imports (Iqbal et al., 2014). Higher prices of imported inputs may increase the production cost of domestically produced goods resulting in an overall increase in the price level (Hyder and Shah, 2004). Iqbal et al. (2014) also finds a positive correlation between the RER and the INF for Pakistan.

Figure 4: Impulse responses to real exchange rate shock

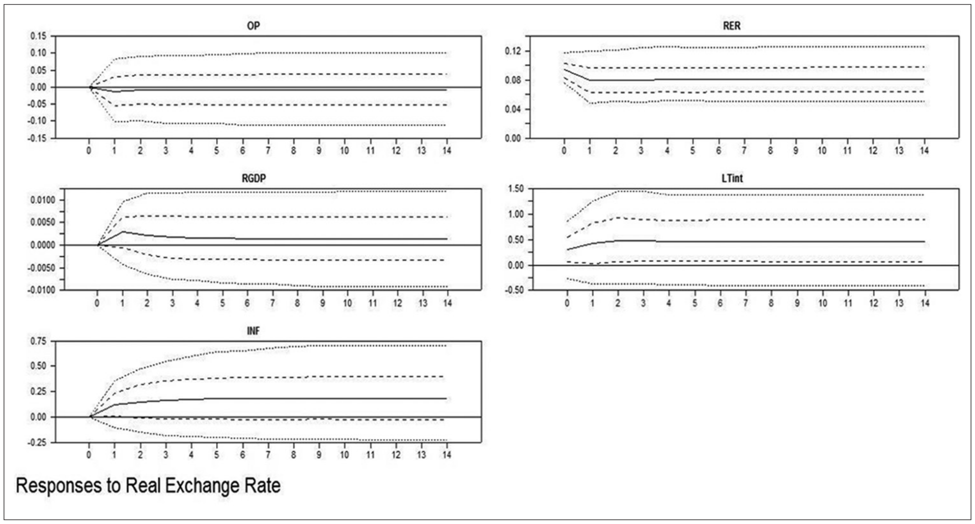
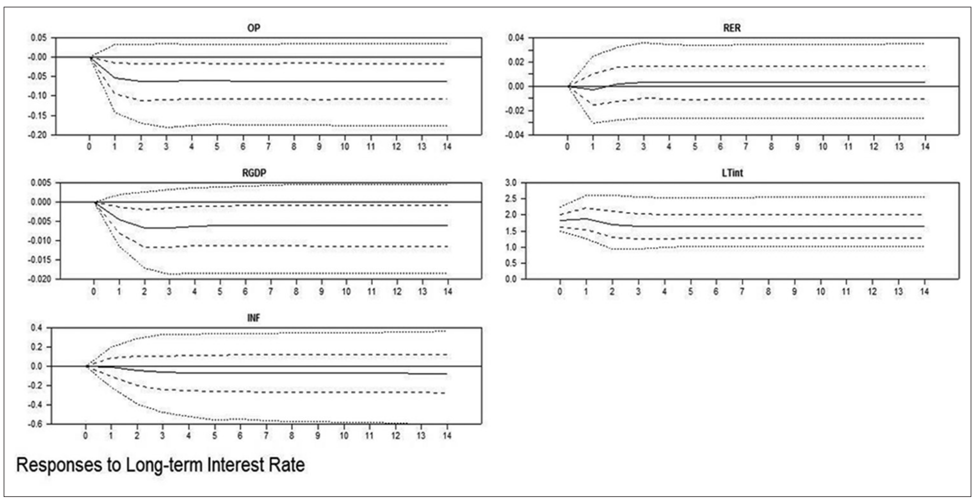


Figure 5: Impulse responses to long-term interest rate shock



Following a RER depreciation, the LTINT rises till year 3 after which it becomes constant through year 14.

5.1.5. Impact of LTINT shock

Figure 5 shows the impulse responses to a one SD positive shock to the LTINT. A rise in the LTINT leads to a fall in the INF which is observed after the 1st year. A decline in the RGDP is also observed post shock to the LTINT. An increase in the LTINT results in higher borrowing costs which represses the economic growth. As the economic theory suggests, increased borrowing costs result in a decline in investment and consumption. People have more incentive to save rather than consume resulting in an overall fall in aggregate demand which leads to a fall in prices.

RER appreciates immediately after a positive shock to the LTINT is observed. However, after year 1 the RER starts to depreciate and becomes constant after the 2nd year. This means that only a transitory RER appreciation is observed when the LTINT s rise[7].

7 The variance decomposition analysis of the remaining variables has been included in the Appendix.

6. CONCLUSION

This study makes use of the SVAR model in order to evaluate the impact of OP shocks on the macroeconomic variables of Pakistan from 1960 to 2014 namely: RGDP, INF, LTINT and the RER. Results suggest that the OP shocks negatively impact the RGDP. The INF and the LTINT s rise as a result of an increase in the OP; whereas, the RER shows an immediate depreciation following an OP shock which is only transitory.

Pakistan is highly dependent on imported oil with the domestic OP linked to the international prices thus making Pakistan's economy more vulnerable to OP shocks. The INF is highly sensitive to changes in the OP, therefore, with the recent plunge in the OP Pakistan has witnessed a decline in the INF. At an average value of 4.8% during July-April 2014-15, it is the lowest INF Pakistan has experienced since 2003. The decrease in OP provided the State Bank of Pakistan an opportunity to decrease the policy rate. This in turn provided relief to the private investment which was otherwise suffering due to internal and external factors. However, due to strengthening of the U.S. dollar the exchange rate of Pakistan depreciated which contributed to a fall in imports.

According to the variance decomposition analysis, the OP shocks have the most significant impact on the INF of Pakistan. Over the 10 year horizon, on average, 17.04% of the variation in INF is attributable to the changes in OP which is the highest impact amongst all other variables. 4.79% of the variation (on average) in the LTINT is attributed to the changes in the OP followed by 2.51% of the variation in the RGDP explained by the OP shocks. The RER appears to be the least affected by the variability in the OP as only 0.238% of the variation in the RER is explained by the price shocks.

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APPENDIX

Variance Decomposition Analysis

Table 1 presents the results for the variance decomposition of the INF. The variation in the INF is mainly explained by itself however, the amount of variability decreases from 77.18% in the 1st year to 70.09% in the last year.

Apart from the INF itself, the OP shocks appear to be the most significant source of variability in the INF of Pakistan with the magnitude of variation increasing from 10.87% in the 1st year to 17.87% in the 6th year after which it remains constant at that value till the last year. This co-movement of the OP and the INF is evident for the case of Pakistan as the recent collapse in the OP resulted in a fall of the INF to 4.8% in the year 2014-15.

However, the LTINT appears to be the weakest contributor to the variability of Pakistan's INF. Even though the amount of variability increases through the 10 years horizon but it remains low at a value of 0.293% at year 5 and onwards.

The RGDP explains 9.28% variation in the INF in the 1st year after which this value drops to 8.61% at year 5 and then remains constant at this value thereafter.

Lastly, the amount of variation explained by the RER in the INF increases from 2.66% in the 1st year to 3.13% in the last year.

Table 2 depicts the variance decomposition of the OP over a span of 10 years. As seen from the results above, the OP shocks are the most significant source of variation in the OP with the highest variability of 94.73% in the 1st year. However, this value decreases 2nd year onwards till the last year with a constant variation of 90.18% through years 6-10.

The RGDP explains only a low amount of variation in the OP in the 1st year with a figure of 0.318% but over the course of the next 9 years the amount of variation explained by the RGDP increases significantly with a value of 1.45% at year 10.

Similarly, the INF contributes only 0.928% of variation in the OP in the 1st year but this value increases to 1.51% from years 5 to 10. Therefore, it can be safely said that for Pakistan the INF is an essential source of variation in the OP.

The RER's contribution to the variation in OP is relatively lower than the other variables under consideration. In the 1st year, only 0.12% of the variation in the OP can be explained by the RER shocks which goes on to a value of 0.348% till year 10.

Lastly, the LTINT shock appears to be one of the most important source of variation in the OP. In the 1st year, the LTINT explains 3.90% of the variability in the OP which goes up to 6.51% percent through years 5-10.

Table 3 shows the variance decomposition of the RGDP. The results show that the variation in RGDP is mainly explained by its own shocks with a value of 87.34% in the 1st year. However, this value decreases over time and remains at 83.82% from years 6 through 10.

The OP shocks, and the inflationary shocks follow a very similar trend when it comes to the magnitude of variation in the RGDP explained by these shocks. The amount of variability decreases from the 1st year to the 2nd year after which a smooth increase is observed up till year 6; the magnitude of variation later becomes constant. The OP shocks explains 2.14% of the variability in the 1st year which goes on to 2.66% in the last year. Similarly, the inflationary shock explains 4.97% of the variation in the 1st year which increases to 5.51% by year 10.

Table 1: Variance decomposition of INF

Period	Standard error	DLNOP	DLNRGDP	LNINF	DLNRER	DLTINT
1	0.61738171	10.870	9.282	77.176	2.658	0.013
2	0.69623274	16.696	8.672	71.245	3.202	0.185
3	0.70926441	17.786	8.557	70.252	3.147	0.259
4	0.71127098	17.860	8.589	70.123	3.137	0.292
5	0.71164082	17.868	8.609	70.096	3.134	0.293
6	0.71171907	17.871	8.613	70.090	3.133	0.293
7	0.71173576	17.871	8.613	70.089	3.133	0.293
8	0.71173907	17.872	8.613	70.089	3.133	0.293
9	0.71173968	17.872	8.613	70.089	3.133	0.293
10	0.71173979	17.872	8.613	70.089	3.133	0.293

INF: Inflation rate

Table 2: Variance decomposition of oil prices

Period	Standard error	DLNOP	DLNRGDP	LNINF	DLNRER	DLTINT
1	0.26677544	94.730	0.318	0.928	0.120	3.904
2	0.27320893	90.434	1.364	1.506	0.324	6.372
3	0.27357484	90.231	1.407	1.510	0.347	6.506
4	0.27364135	90.188	1.452	1.509	0.348	6.503
5	0.27365191	90.182	1.454	1.510	0.348	6.506
6	0.27365426	90.181	1.454	1.511	0.348	6.506
7	0.27365466	90.181	1.454	1.511	0.348	6.506
8	0.27365470	90.181	1.454	1.511	0.348	6.506
9	0.27365471	90.181	1.454	1.511	0.348	6.506
10	0.27365471	90.181	1.454	1.511	0.348	6.506

Table 3: Variance decomposition of RGDP

Period	Standard error	DLNOP	DLNRGDP	LNINF	DLNRER	DLTINT
1	0.02170564	2.141	87.344	4.965	1.259	4.292
2	0.02309087	1.958	85.590	4.725	2.743	4.983
3	0.02335019	2.367	83.884	5.332	2.684	5.735
4	0.02340898	2.636	83.476	5.489	2.685	5.714
5	0.02341667	2.660	83.423	5.508	2.686	5.724
6	0.02341742	2.661	83.419	5.509	2.686	5.726
7	0.02341756	2.661	83.419	5.509	2.686	5.726
8	0.02341759	2.661	83.418	5.509	2.686	5.726
9	0.02341760	2.661	83.418	5.509	2.686	5.726
10	0.02341760	2.661	83.418	5.509	2.686	5.726

RGDP: Real gross domestic product

Table 4: Variance decomposition of real exchange rate

Period	Standard error	DLNOP	DLNRGDP	LNINF	DLNRER	DLTINT
1	0.09066091	0.000	3.700	0.028	96.191	0.080
2	0.09296820	0.095	5.384	1.505	92.470	0.546
3	0.09316710	0.278	5.493	1.498	92.143	0.587
4	0.09319301	0.283	5.491	1.501	92.093	0.632
5	0.09319769	0.288	5.493	1.503	92.083	0.633
6	0.09319827	0.288	5.493	1.503	92.082	0.633
7	0.09319833	0.288	5.493	1.503	92.082	0.633
8	0.09319834	0.288	5.493	1.503	92.082	0.633
9	0.09319834	0.288	5.493	1.503	92.082	0.633
10	0.09319834	0.288	5.493	1.503	92.082	0.633

Table 5: Variance decomposition of LTINT

Period	Standard error	DLNOP	DLNRGDP	LNINF	DLNRER	DLTINT
1	1.74464458	0.000	3.724	0.105	0.377	95.793
2	1.86746949	5.236	8.037	0.741	0.429	85.557
3	1.88565290	5.301	8.997	0.752	0.491	84.460
4	1.88787450	5.328	8.979	0.775	0.491	84.428
5	1.88831982	5.348	8.986	0.785	0.492	84.389
6	1.88837335	5.348	8.987	0.786	0.493	84.386
7	1.88837820	5.348	8.987	0.786	0.493	84.386
8	1.88837912	5.348	8.987	0.786	0.493	84.386
9	1.88837926	5.348	8.987	0.786	0.493	84.386
10	1.88837929	5.348	8.987	0.786	0.493	84.386

LTINT: Long-term interest rate

On the other hand, the amount of variation in the RGDP explained by the RER shock increases from 1.26% in the 1st year to 2.72% in the 2nd year after which it declines slightly and remains at 2.68%.

Therefore, from the above results it can be concluded that apart from its own shocks, the LTINT shocks play a very vital role in the variation of the RGDP for Pakistan.

Table 4 represents the variance decomposition of the RER. The result depicts that the OP shock contributes the least to the deviation in the RER. For the 1st year, the OP shock does not contribute to the deviation in the RER however, over the course of the 10 years approximately 0.288% of the variability is explained by the OP.

The variability in the RER is mainly explained by itself. The highest value is recorded for the 1st year (96.19%) after which it declines and remains approximately at 92% for the remaining time horizon.

Amongst all other variables, RGDP shocks contribute the most to the deviation in the RER. After a value of 3.70% in the 1st year, the value increases to 5.93% in the 5th year and remains constant at this value till the last year.

Finally, the amount of variation explained by the INF and the LTINT increase over the 10 years horizon. At year 10, 1.50% of the variability in the RER is being elucidated by the change in the INF and 0.633% of the variation is explained by the LTINT.

Table 5 depicts the outcome of the variance decomposition of the LTINT. For the 1st year, the OP shock does not contribute to the variation in the LTINT, however, over the remaining time horizon the OP explains approximately 5.30% of the variability in the LTINT.

The RGDP explains the most amount of variation in the LTINT of Pakistan apart from the interest rate itself[8]. For the 1st year, 3.72% of the variability in the RER can be elucidated by the RGDP. This magnitude increases to 8.98% by the last year.

The INF and the RER follow a similar increasing trend with regards to their contribution to the variability in the LTINT of Pakistan. By the end of year 10, the INF explains 0.786% of the variability in the LTINT whereas, the RER explains 0.493% of the variability.

8. 0.377% of the deviation in the LTINT is explained by itself after which the value rises to 0.493% in year 6 and remains at it up until year 10.