Decomposing the links between oil price shocks and macroeconomic indicators: Evidence from SAARC region

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Decomposing the links between oil price shocks and macroeconomic indicators: Evidence from SAARC region

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Abstract

This study examines the impact of oil price shocks on key macroeconomic variables (i.e., real GDP, interest rate, inflation and exchange rate) for five SAARC countries (i.e., India, Pakistan, Bangladesh, Sri Lanka and Bhutan). For this purpose, we adopt contemporary macroeconomic policy modeling tool called impulse response function (IRF) and forecast error variance decomposition method (FEVDM) in the structural vector autorepression (SVAR) setting using time series data over the extended period from 1982 to 2014. In addition, Johansen and Juselius (1990) cointegration method is applied for long-run relationship. The results of cointegration test confirms the long-run equilibrium relationship between all the underlying variables. However, the empirical findings of IRF explained significant variation among all underlying macroeconomic variables in response to exogenous oil price shocks at different time horizons. It means the macroeconomic factors are sensitive to even small oil price shocks and possess various socio-economic implications in the region. The results of FEVDM evidence that each country in a study group responds differently to oil price shocks, it corresponds their independent policies, macroeconomic

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fundamentals, sector constructions and heterogeneity across the countries. The findings help governments to reform public policies in the region by controlling macroeconomic fluctuations due to oil price shocks.

Keywords: Oil price shocks; Interest rate; GDP; SAARC; SVAR model

1. Introduction

The oil crisis was the major cause of 1970's recession which mainly affected the western economies. Since then, there is a plethora of literature studying the effect of oil price shocks on macroeconomic variables. Yet, the debate on this front is ongoing due to contrasting empirical findings and overall macroeconomic implications of oil price shocks both in developed and developing countries (Morana, 2017). For example; many researchers have examined the causal links between oil price shocks and key macroeconomic indicators, and found that effect significantly varies across the countries (Iwayemi and Fowowe, 2011). Nonetheless, majority of the studies conclude that the oil price shocks are detrimental to economic growth (see: Van-de-ven and Fouquet, 2017; Rafiq and Bloch, 2016). For instance; Hamilton (1983) and Mork (1989) conclude that the oil price shocks originate economic downturn. Furthermore, their results explain that the oil price shocks affect real economic output from both the supply side and as well as the demand side. The supply side effect comes from the production side when market supply diminishes due to rising resource (oil) prices and shifts the market equilibrium downward. Whereas, the demand side impact is associated with the spending and consumption pattern of the families. The increasing oil prices reduce the purchasing power of households because the demand for oil is inelastic. Consequently, the soaring oil prices result in lowering demand for other consumer products and services. Moreover, high oil prices have direct impact on other consumer goods and services which cause uncertainty in the future. This notion generally compel both firms and households to reduce their consumptions and investments activities (Sill, 2007). Increase in oil prices negatively affects short-run economic performance as it distracts spending on large ticket intake and capital goods (Bernanke, 1983).

Nevertheless, the soaring oil prices not only impede economic growth but, also cause the general increase in the price level in the economy. Since the crude oil is extensively used as a common input for the production and as well as the distribution of goods, the increasing oil prices directly affect cost of the production and indirectly affect the delivery cost of goods and services. Besides, the oil price volatility directly influence the exchange rate volatility; however, the direction of change depends upon whether the country is net exporter or an importer (Amano and Van Norden, 1998; Hamilton, 1996; Issa et al., 2008; Richard and Michael, 1980). Purchasing Power Parity (PPP) theory suggests that if demand for currency of the country increases, this will cause currency of that country to appreciate. Similarly, inflated oil prices increase the value of currency of an oil-exporting realm because the demand for its currency increases in foreign market. Contrarily, higher oil prices cause to decrease value of currency of an oil-importing country as its currency's supply increases in the international market. Moreover, some studies found that the actions by monetary authority are likely to elucidate the effect of changing oil price on an economy (Clarida, Gali, & Gertler, 1997; Tatom, 1988; Shahbaz et al., 2017). As oil price shocks affect real economy and overall price level, central banks generally face policy challenges in stabilizing the price level and output, simultaneously. For example: if the central banks try to maintain the growth rate, the common practice they follow is to decrease the interest rates to neutralize the incurring losses in the real GDP; however, it may lead to increasing inflationary stress. Alternatively, the government may also adopt a bendable inflation targeting approach in response to exogenous supply side shock by raising the interest rate to avoid the adverse impact on the output (Bernanke et al., 1997).

However, most of the prior studies that examined the impact of oil prices on economic undertakings have been conducted in developed countries such as US and European countries. Whereas, Asian countries are given less attention despite of their growing =importance in oil consumption. Eichengreen (2008) argued that since the advent of globalization, Asia's share in global GDP has significantly increased. In 1950, GDP share of Asia to World GDP was around 20% and it is expected to be more than 40% by 2030. It is also projected that the share of Asia in global economy is anticipated to be greater than that of US, European Union or G-7 by 2030 (IMF, 2012). Such an astounding current and future economic growth prospects in Asia are pursued by increasing oil demand in Asian economies. In this connection, according to one of the world's leading oil and gas companies mentioned in its report that the oil demand in OECD[2] countries has declined by 5.3% over the last half decade, whereas in non-OECD countries oil demand has enlarged by 20.3%, especially spurred by China and other Asian countries ("BP Statistical Review of World Energy ", 2012).

Recently, Asian Development Bank reports that, "South Asia remains the fastest growing of all subregions, with growth reaching 7% in 2017 and 7.2% in 2018". Similarly the SAARC[3], the union of eight South Asian nations (India, Pakistan, Bangladesh, Sri Lanka, Bhutan, Maldives, Nepal and Afghanistan), is the largest regional organization in term of population with 1.7 billion residents, 3rd largest economy in terms of gross private product (GPP) and 7th largest economy in terms GDP (Nominal), in the World. It is the World's fastest growing economic region (Michael, 2013). In recent past, the GDP growth of SAARC nations such as India, Bangladesh, Pakistan and Sri Lanka has been increasing remarkably from 6% to 9% annually (SAARC, 2010). The ever-increasing economic growth in SAARC region has massively increased demand for oil and other energy sources. All SAARC countries mainly depend on imported oil and petroleum product

[2] Organization for Economic Co-operation and Development
[3] South Asian Association for Regional Cooperation

(SAARC, 2010). India alone stands 3rd largest oil consumer in the world. Whereas, Pakistan ranks 33rd, Bangladesh 73rd and Sri Lanka 80th (GEYB, 2017)

To our knowledge, no comprehensive study has been conducted for SAARC countries despite having significant share in the world economy. Few individual country specific studies are found mixed with other socio-economic indicators. For example; the study by Khan and Ahmed (2011) examined the short-run effect of oil and food prices in Pakistan, and found an affirmative association between oil price shocks and inflation. Ghosh (2011) investigates the relationship between oil prices and exchange rate for India, their findings conclude that the inflated oil prices tend to depreciate Indian currency against US dollar, and shocks in oil price found to have permanent impact on exchange rate volatility. More recently, Timilsina (2015) suggested that an increase in oil prices tend to have adverse impact on the GDP of developed countries. Another empirical study was conducted in 45 countries (out of which 28 were developed and 17 were developing including India and Sri Lanka) find out that the both nominal and real oil price volatilities have also adverse effect on the economic development of 11 out 17 developing countries and 12 out of 28 developed countries (Narayanet al., 2014). Keeping in view the impressive economic growth and importance of region in world, this study is designed to analyze the impact of oil price shocks on the gross domestic output, inflation, exchange rate and interest rate in selected five SAARC countries (i.e., India, Pakistan, Bangladesh, Sri Lanka and Bhutan). The selection of five countries out of eight SARRC member countries is based on the availability of data. The aim of this paper is to study how these emerging South Asian economies respond to oil prices shocks over different time horizons in order to provide some important policy implications for researchers and policy makers.

Further, the section wise breakup of the study is as follows: Section-2 describes the review of relevant literature. Section-3 contains the methodological framework and data. Section-4 shows the empirical results and their discussion. Lastly, section-5 provides conclusion and policy implications.

2. Review of relevant literature

The prominent studies on oil price shocks and economic growth nexus include Abeysinghe (2001), Cunado and De-Gracia (2005), Leduc and Sill (2004), and Bohi (1989). The study of Abeysinghe (2001) covers twelve countries including ten Asian economies (i.e., Malaysia, Japan, Philippines, China, Thailand, Taiwan, Hong Kong, Singapore, South Korea, and Indonesia) and concluded that Malaysia and Indonesia are vulnerable to oil price hike even they are the net oil exporting countries. Furthermore, the study suggests that the long-run impact of the oil prices in their trading partner countries is not positive. Cunado and De-Gracia (2005) analyze the relationship between oil price and the macroeconomic indicators of sixth Asian countries (i.e., Japan, Thailand, Malaysia, South Korea, Philippines, and Singapore) and found significant effect of oil price hikes on their macroeconomic indicators in the long-run. However, they further explained that in short-run, the effect varies mostly depending on whether the country is net oil importer or net oil exporter. Another study by Leduc and Sill (2004) provide a model of equilibrium to understand the economic behavior to the shocks of oil prices under many structures of the monetary policies. They observed that many policies related to easy inflation widen the range of negative outcome towards the positive oil shocks. In contrast, the monetary policies having proper estimation on the overall price level has no impact on oil price shocks.

Nonetheless, the role of monetary policy and macroeconomic indicators in relation to oil prices volatility has also been widely discussed. For example: the study of Bohi (1989) ranks among the seminal studies that investigate the relationship between oil price volatility and economic recessions. The study confirms that the inappropriate monetary policy to deal the oil price hike leads the country to suffer economic recession. The possible explanation of this outcome could be, the inappropriate monetary policy during the oil price shocks may transfer asymmetric information in an aggregate economy that further leads the market to recession. While, Tatom (1988) suggests that the economy receives symmetric impact during oil price shocks if appropriate monetary policy tools are placed. Moreover, the study also discusses some early findings where monetary policy had an asymmetric output to the shocks of the oil price if the monetary policy is not taken in to account.

However, there are many studies that have studied the impact of oil price fluctuations on the macro-economic behavior i.e., Pierceet al. (1974), Rasche and Tatom (1977), Mork and Hall (1980), and Darby (1982). These studies conclude that there is a negative correlation between oil price hikes and macroeconomic indicators. Subsequently, Gisser and Goodwin (1986) define the relationship between GDP and the rising crude oil price in St. Louis-type equations[4] along with four variables of economic activity at macro level and found similar findings. Using vector auto regression analysis (VAR), Burbidge and Harrison (1984) endorse the findings of Darby (1982) and further explained that in various cases the first and second oil price shocks are more detrimental to economy than the subsequent shocks. More recently, Cologni and Manera (2008) conducted the causality analysis using cross-country analysis and found bidirectional causality between oil price shocks and overall economic activity for the majority of countries. The severe

[4] The St. Louis equations explain the effect of fiscal policy on the macroeconomic behavior.

economic slowdown due to oil price shocks in 1986 convinced researchers to account asymmetric relationship between oil price fluctuation and various macroeconomic indicators.

Kim (2005) investigate the asymmetric and symmetric effects between macroeconomic variables and increasing oil price shock. Their findings confirmed that the price has an asymmetric impact on the macroeconomic variables. Lee et al., (1995) establish that the unpredictable increase of oil prices is more detrimental to macroeconomic indicators than the frequent but predictable price changes. The bulk oil price change creates uncertainty in market, leading the investors and consumers to lose confidence in their future investment and consumption expectations (Edelstein and Kilian, 2009; Raza et al., 2016). The empirical evidence of confirming strong negative relationship between oil price shock and business tendency to expand are consistently found in literature since 1973 (for detailed review of literature see Huntington (2005)).

Nonetheless, most of the mentioned studies are concentrated on the developed and developing countries other than the member states of SAARC. Viewing the fact that increasing economic growth has rising demand for oil because oil is used as a primary source of energy in SAARC region. Thus, it stands very essential to study the impact of oil price fluctuation on the macroeconomic indicators of SAARC nations.

3. Methodological Framework and Data

Based on the theoretical foundation developed in the introductory section and the review of the pertinent literature, this study incorporates Structural Vector Autoregressive (SVAR) model, a contemporary macroeconomic modeling technique to analyse the oil price shocks on the real GDP, exchange rate, interest rate and inflation in the five SAARC nations (i.e. Sri Lanka, Bangladesh, Pakistan, India and Bhutan), for details see: Bernanke et al., 1997; Cunado and de-Gracia, 2015;

Kilian and Park, 2009; Parket al., 2011; Peersman, 2005; Peersman and Van Robays, 2009. However, the following empirical test are incorporated to reach the objectives of the paper.

3.1 Unit root test

Since this study incorporates time series technique, the standard practice of checking the data for stationarity is followed by using Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips and Perron (PP) (Phillips and Perron, 1988) unit root test. The following eq. (1) and eq.(2) are the test equations of the unit root test model.

$$\Delta y_t = \alpha + \beta t + \phi yt + \delta_1 \Delta y_{t-1} + ... + \delta_{p-1} \Delta y_{t-p+1} + \mu_t ......(1)$$

$$\Delta y_t = (\rho - 1) y_t + \mu_t ......(2)$$

3.2 Multivariate Cointegration Analysis

After checking stationarity property of each time series, we check the long-run association among the variables. In this regard, multivariate cointegration method based on vector autoregression (VAR) and proposed by Johansen (1991) is used assuming linear deterministic trend in the series and intercept in the equation. This method captures only lagged. The initial form of Johannsen's methodology takes following form in VAR model:

$$y_t = \mu + A_1 y_{t-1} + ... + A_p y_{t-p} + \varepsilon_t ....(3)$$

where y_t represents $n \times 1$ vector of variables integrated at first order $I(1)$ and ε_t is $n \times 1$ vector of innovations. This VAR can also be written in following form;

$$\Delta y_t = \mu + \prod y_{t-1} + \sum_{i=1}^{p=1} \Gamma_i \Delta y_{t-1} + \varepsilon_t ....(4)$$

$$\prod = \sum_{i=1}^{p=1} A_i - I \text{ and } \Gamma_i = -\sum_{i=i+1}^{p=1} A_i ....(5)$$

However, Johansen approach suggests two different likelihood ratio (LR) tests i.e. trace (λ_{trace}) and maximum eigenvalue (λ_{max}) statistics. Both tests are computed as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1-\hat{\lambda}_i)......(6)$$

$$\lambda_{trace}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1})......(7)$$

Where T represents the size of sample; $\hat{\lambda}_i$ and $\hat{\lambda}_{r+1}$ show the measured values of characteristic roots acquired from the $\prod$ matrix. The null hypothesis of r cointegrating vectors in contrast to the alternate hypothesis of n cointegrating vectors is tested through the trace test, whereas the null hypothesis of$r$ cointegrating vectors in contrast to the alternate hypothesis of$r+1$ cointegrating vectors is tested using maximum eigenvalue test.

3.3 Structural Vector Autoregressive (SVAR) model

3.3.1 SVAR model is following:

$$A_0 Y_t = A_1 Y_{t-1} + ... + A_p Y_{t-p} + \varepsilon_t \quad ....(11)$$

Where, Y_t shows an (n x 1) vector of relevant factors as follows: $Y_t = [\Delta \ln op_t, \Delta \ln rgdp_t, \Delta \ln ex_t, \Delta \ln \text{int}_t, \Delta \ln \text{inf}_t]$, A_i represents 5 x 5 matrix of coefficients, such as $i = 0,1...P$ and ε_t is the vector of structural shocks represented by $\left[\varepsilon_t^{\ln op}, \varepsilon_t^{\ln rgdp}, \varepsilon_t^{\ln ex}, \varepsilon_t^{\ln \text{int}}, \varepsilon_t^{\ln \text{inf}}\right]$. These vectors are assumed to be independent and identically distributed (i.i.d.), ε_t is an n-vector of serially uncorrelated, $\left(E(\varepsilon_t)=0\right)$ and $\sum_\varepsilon = E[\varepsilon_t \varepsilon_t'] = I$. The reduced form of the SVAR can be represented as below:

$$A_0 Y_t = A_1 Y_{t-1} + \ldots + A_p Y_{t-p} + \varepsilon_t \ldots\ldots\ldots(12)$$

$$Y_t = A_0^{-1} A_1 Y_{t-1} + \ldots + A_0^{-1} A_p Y_{t-p} + A_0^{-1} \varepsilon_t \ldots\ldots\ldots..(13)$$

$$Y_t = B(L) Y_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(14)$$

$$B(L) Y_t = A_0^{-1} A_1(L), \text{ and } A_0 \mu_t = \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots(15)$$

Where, μ_t is the reduced form of VAR and understood as an independent and identically distributed. $A_1(L)$ is polynomial matrix in the lag operator (Enders, 2004; Park et al., 2011).

3.3.2. Identification and Contemporaneous restrictions

The identification restrictions are imposed on the origin of different economic theories and intuitions. However, this study has applied short-run restrictions on contemporaneous relationships as the SVAR model performs well in this condition (Christiano et al., 2007). Principally, current feedback results amongst variables in the model are controlled by the short-run restrictions (Basnet and Upadhyaya, 2015).

3.1.3. Imposing restrictions on variables included in SVAR model:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & 0 & 0 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 & 0 \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & 1 \end{bmatrix} \begin{bmatrix} \mu \ln op \\ \mu \ln rgdp \\ \mu \ln ex \\ \mu \ln \inf \\ \mu \ln \operatorname{int} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon \ln op \\ \varepsilon \ln rgdp \\ \varepsilon \ln ex \\ \varepsilon \ln \inf \\ \varepsilon \ln \operatorname{int} \end{bmatrix} \ldots\ldots\ldots..(16)$$

The imposing of identification restrictions are based on subsequent economic reasons i.e. as all five SAARC countries are oil importing, not price makers in oil market and international oil price cannot be influenced by domestic output, exchange rate, interest rate and overall price level of any of our sample countries but by the worldwide oil market conditions. Therefore, oil price is considered as exogenous variable. So, the reduced error term of global oil price may be equal to its structural error term, showed as follows:

$$\mu \ln op = \varepsilon \ln op \text{ ....(17)}$$

On the contrary, variation in global oil price may have concurrent impact on other variables that are in model because increase (decrease) in oil price lead to lift up (bring down) the cost of production because oil is considered for example an essential input of manufacturing and distribution of goods and services as well. Secondly, it is considered that domestic output may not be contemporaneously affected by changes of other domestic variables as shown in second row of identification matrix. Finally, we assume that domestic price level may not be affected by all study variables except exchange rate, and restrictions are not imposed on exchange rate because it reacts to fluctuations in other study factors.

The followings are reduced forms of error terms of the variables include real GDP, the exchange rate, interest rate, and the price level:

$$\mu_{\ln rgdp} = -\alpha_{21}\mu_{\ln op} + \varepsilon_{\ln rgdp} \text{ ....(18)}$$

$$\mu_{\ln ex} = -\alpha_{31}\mu_{\ln op} - \alpha_{32}\mu_{\ln rgdp} + \varepsilon_{\ln ex} \text{ ...... (19)}$$

$$\mu_{\ln int} = -\alpha_{51}\mu_{\ln op} - \alpha_{52}\mu_{\ln rgdp} - \alpha_{53}\mu_{\ln ex} + \varepsilon_{\ln int} \text{ ....(.20)}$$

$$\mu_{\ln inf} = -\alpha_{61}\mu_{\ln op} - \alpha_{62}\mu_{\ln rgdp} - \alpha_{63}\mu_{\ln ex} - \alpha_{65}\mu_{\ln int} + \varepsilon_{\ln inf} \ldots(21)$$

Moreover, equations 8-11 help to conclude the impact oil price shocks on the domestic variables for five nations of SAARC region.

3.3 Data

This study uses time series data with annual frequency covering the period of 1982 to 2014, for the panel of five SAARC countries (Sri Lanka, Bangladesh, Pakistan, Bhutan and India). The data for the variables is collected from the world bank's world development indicators (WDI-2017). The GDP is measured in real GDP per capita (US$ 2010 constant). Exchange rate is measured in real exchange rate of respective local currency in terms of US$. Interest rate and inflation. From various sources, data have been collected for this study. Firstly, for oil price, WTI (West Texas Intermediate) index is used as a proxy for world oil prices, and it is extracted from US Energy Information Agency (EIA) website in US dollars. Secondly, all countries' data of real GDP, exchange rate, interest rate and inflation except interest rate of Pakistan are obtained from World Development Indicators (WDI). Lastly, interest rate data of Pakistan is gathered from annual reports of State Bank of Pakistan. Then, all variables are changed into natural logarithms.

4. Empirical Results and Discussion

This research uses Augmented Dickey Fuller (ADF) and Phillips–Perron unit root test to scrutinize time series properties of study variables because usually time series data have unit root, which may yield spurious results. To avoid this problem, stationarity of the variables must be confirmed. In this regard, results of both ADF and Phillips–Perron unit root tests are presented in (Table 1).

Table 1: Unit Root tests

ADF	PP

Countries	Variables	Level	1st Difference	Level	1st Difference
India	$lnrgdp_t$	2.032	-4.584***	3.785	-4.594***
	$lnex_t$	-2.386	-3.901***	-2.071	-3.980***
	$lninf_t$	-0.583	-3.458**	-0.961	-3.466**
	$lnint_t$	-1.136	-5.815***	-0.751	-9.329***
Pakistan	$lnrgdp_t$	-1.259	-3.409**	-2.211	-3.396**
	$lnex_t$	-2.873*	-4.186**	-1.569	-4.148***
	$lninf_t$	0.457	-2.850*	0.800	-2.894*
	$lnint_t$	-2.264	-4.910***	-2.423	-4.947***
Bangladesh	$lnrgdp_t$	-1.939	-4.513***	-1.936	-4.510***
	$lnex_t$	-2.418	-3.975***	-4.486***	-4.902***
	$lninf_t$	-1.321	-3.850***	-1.127	-3.754***
	$lnint_t$	-2.788*	-4.712***	-1.745	-3.133**
Sri Lanka	$lnrgdp_t$	2.716	-3.915***	2.716	-3.983***
	$lnex_t$	-2.464	-4.798***	-2.582	-4.835***
	$lninf_t$	-1.516	-4.553***	-1.573	-4.512***
	$lnint_t$	-1.574	-6.194***	-1.276	-4.619***
Bhutan	$lnrgdp_t$	-0.264	-3.312**	-0.319	-3.425**
	$lnex_t$	-2.387	-3.900***	-2.071	-3.979***
	$lninf_t$	-0.647	-2.632*	-1.538	-2.738*
	$lnint_t$	-3.477**	-5.650***	-1.625	-1.865***
	$lnop_t$	-5.075	-5.075***	-0.291	-0.291***

Note: (a)***, **, * denote significance at the 1%, 5%, 10% level, respectively.
(b) Akaike Information Criterion (AIC) was used for lag length selection.

Results of both tests specify that all the variables are not stationary at level except (real exchange rate in case of Pakistan and Bangladesh which is significant at 10% and 1% level, respectively; and interest rate in case of Bangladesh and Bhutan which is significant at 10% and 5% level, respectively). However, after taking the first difference, all the variables found to be stationary (see. Table-1). It means all the variables are integrated at the order of *I* (1). After determining the order of integration for each underlying series, it recommended that the variables are tested for long-run equilibrium relationship before the long-run estimates are calculated. Thus, the J-J cointegration test is conducted to determine the long-run association among the variables. Akaike information criterion (AIC) was used for selecting lag lengths of unrestricted co-integration. According to AIC, the appropriate lag lengths of the variables such real GDP, inflation, interest rate and real exchange rate are 2, 3, 3 and 2 respectively. The results are reported in Table-2.

Table-2 Johnson Co-integration Test

H_0	**H_1**	**Test statistics**	**5% Critical values**	**Probability**
$lnrgdp_t$ (Lag 2)				
λ_{trace}		λ_{trace}		
$r=0$	$r>0$	127.492	69.818	0.000
$r\leq 1$	$r\geq 1$	70.291	47.856	0.000
$r\leq 2$	$r\geq 2$	29.383	29.797	0.055
$r\leq 3$	$r\geq 3$	10.469	15.494	0.246
$r\leq 4$	$r\geq 4$	0.001	3.841	0.966
$\lambda_{\max} value$		$\lambda_{\max} value$		
$r=0$	$r>0$	57.200	33.876	0.000
$r\leq 1$	$r\geq 1$	40.908	27.584	0.000
$r\leq 2$	$r\geq 2$	18.913	21.131	0.099
$r\leq 3$	$r\geq 3$	10.468	14.264	0.183
$r\leq 4$	$r\geq 4$	0.001	3.841	0.966
$lninf_t$ (Lag 3)				
λ_{trace}		λ_{trace}		
$r=0$	$r>0$	228.924	69.818	0.000
$r\leq 1$	$r\geq 1$	140.095	47.856	0.000
$r\leq 2$	$r\geq 2$	75.012	29.797	0.000
$r\leq 3$	$r\geq 3$	29.306	15.494	0.000
$r\leq 4$	$r\geq 4$	1.362	3.841	0.243
$\lambda_{\max} value$		$\lambda_{\max} value$		
$r=0$	$r>0$	88.829	33.876	0.000
$r\leq 1$	$r\geq 1$	65.083	27.584	0.000
$r\leq 2$	$r\geq 2$	45.705	21.131	0.000
$r\leq 3$	$r\geq 3$	27.944	14.264	0.000

$r \leq 4$	$r \geq 4$	1.362	3.841	0.243
$lnint_t$ (Lag 3)				
λ_{trace}		λ_{trace}		
$r = 0$	$r > 0$	150.700	69.818	0.000
$r \leq 1$	$r \geq 1$	86.420	47.856	0.000
$r \leq 2$	$r \geq 2$	43.878	29.797	0.000
$r \leq 3$	$r \geq 3$	19.451	15.494	0.012
$r \leq 4$	$r \geq 4$	0.113	3.841	0.736
$\lambda_{\max} value$		$\lambda_{\max} value$		
$r = 0$	$r > 0$	64.280	33.876	0.000
$r \leq 1$	$r \geq 1$	42.542	27.584	0.000
$r \leq 2$	$r \geq 2$	24.426	21.131	0.016
$r \leq 3$	$r \geq 3$	19.337	14.264	0.007
$r \leq 4$	$r \geq 4$	0.113	3.841	0.736
$lnex_t$ (Lag 2)				
λ_{trace}		λ_{trace}		
$r = 0$	$r > 0$	109.286	69.818	0.000
$r \leq 1$	$r \geq 1$	72.422	47.856	0.000
$r \leq 2$	$r \geq 2$	38.267	29.797	0.004
$r \leq 3$	$r \geq 3$	14.891	15.494	0.061
$r \leq 4$	$r \geq 4$	2.420	3.841	0.119
$\lambda_{\max} value$		$\lambda_{\max} value$		
$r = 0$	$r > 0$	36.864	33.876	0.021
$r \leq 1$	$r \geq 1$	34.155	27.584	0.006
$r \leq 2$	$r \geq 2$	23.375	21.131	0.023
$r \leq 3$	$r \geq 3$	12.470	14.264	0.094
$r \leq 4$	$r \geq 4$	2.420	3.841	0.119

In Table-2, the null hypothesis ($r = 0$) of no cointegration against the alternative (r > 0) is tested based on the trace statistics (λ_{trace}) and maximum eigenvalue ($\lambda_{\max} value$) statistics. If the numerical value of statistics are greater than the critical value (at 5% significant level) in the second last column, the null hypothesis is rejected and cointegration relationship is established. Therefore, the cointegration results conclude that in each set of Table-2, most of the variables are cointegrated. It means the real GDP, real interest rate, inflation and exports have long-run equilibrium relationship in case of five SAARC countries (Bangladesh, Bhutan, India, Pakistan and Sri Lanka). However, it does not mean that the countries do not differ from each other in terms of policy context because SAARC regional cooperation has yet to exploit its potential. Infact, the short-run difference among these countries may be corrected by the overall resemblance in the socio-economic context of the region (Darrat and Al-Shamsi, 2005). Moreover, this phenomenon deliberates that the SAARC economies progress together in long run.

The impulse response analysis is conducted to investigate oil price shocks' impact on real GDP, inflation, interest rate and real exchange rate. The model shows the time varying volatility in the model. In VAR system, Monte Carlo simulation method is used for the calculation of standard error and Cholesky ordering with degree of freedom adjusted is selected to evaluate the results. The results of impulse response function are plotted in Figure-1 to Figure-5. Figure-1 shows the response of real GDP, interest rate, inflation and real exchange rate to shock of oil price. The real output shows slightly positive response to oil price innovation over first to second time horizon after the impact, and then it promptly starts declining and hits its bottom level at third time horizon after which impact remains stagnant up to fourth time lag (Fig. 1a). The impacts of oil shock are statistically significant. This suggests that elevated oil prices raise cost of production that leads to a decrease in output and eventually a fall in aggregate supply in an economy. However, after fourth time horizon economy undergo expansionary impact until sixth phase after which it begins decreasing and stays negative up to eight-time horizon. This very short positive impact diminishes after ninth, which shows the way to the again contractionary phase in long run. This supports the findings of Jiménez-Rodríguez et al. (2005). They found that oil price shock has negative aggregate effect on oil-importing countries like India. (Fig. 1b) the reaction of interest to oil price shock is statistically significant and volatile over defined time horizon. Initially, oil shock affects positively after first to second time horizon, and then it starts declining rapidly and hits bottom level at third time horizon after which it goes up and reaches its maximum level during the phase four. After fourth time horizon, the interest rate volatility begins to decrease up to sixth time frame. This implies that from monetary perspective Indian Central Bank might have increased interest rate to encounter adverse effect of oil price on real output. After sixth time horizon interest rate again goes up, and then gets down after eighth period. Following contractionary period after ninth period interest rate begins to rise.

In the beginning, the oil price impact on inflation is found negative during the first three-time horizons, and then it shoots up following dampening on output (Fig. 1c). After fourth phase, inflation starts decreasing and smacks its bottom level at sixth time horizon, which shows negative demand shock induced by oil price on Indian economy. This result concurs with the Khan and Ahmed (2011), they found pervasiveness of negative demand shocks of oil price in emerging economies like Malaysia. At first Indian currency appreciates but after second time horizon it starts depreciating (Fig. 1d). The response of real exchange rate is volatile and significant over the period. However, Indian currency experiences depreciation in long run. The impulse responses of all variables (real GDP, interest rate, inflation and real exchange rate) are statistically significant, indicating that oil price shocks have negative impact on Indian economy.

Figure-1 India

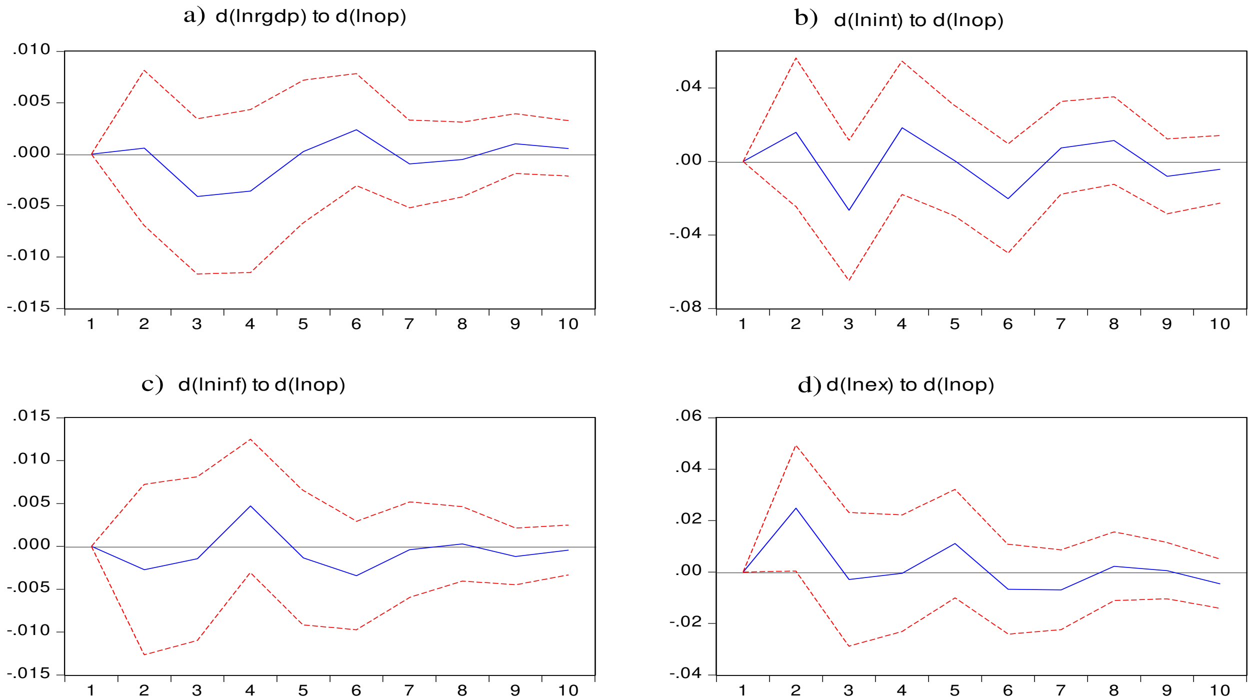
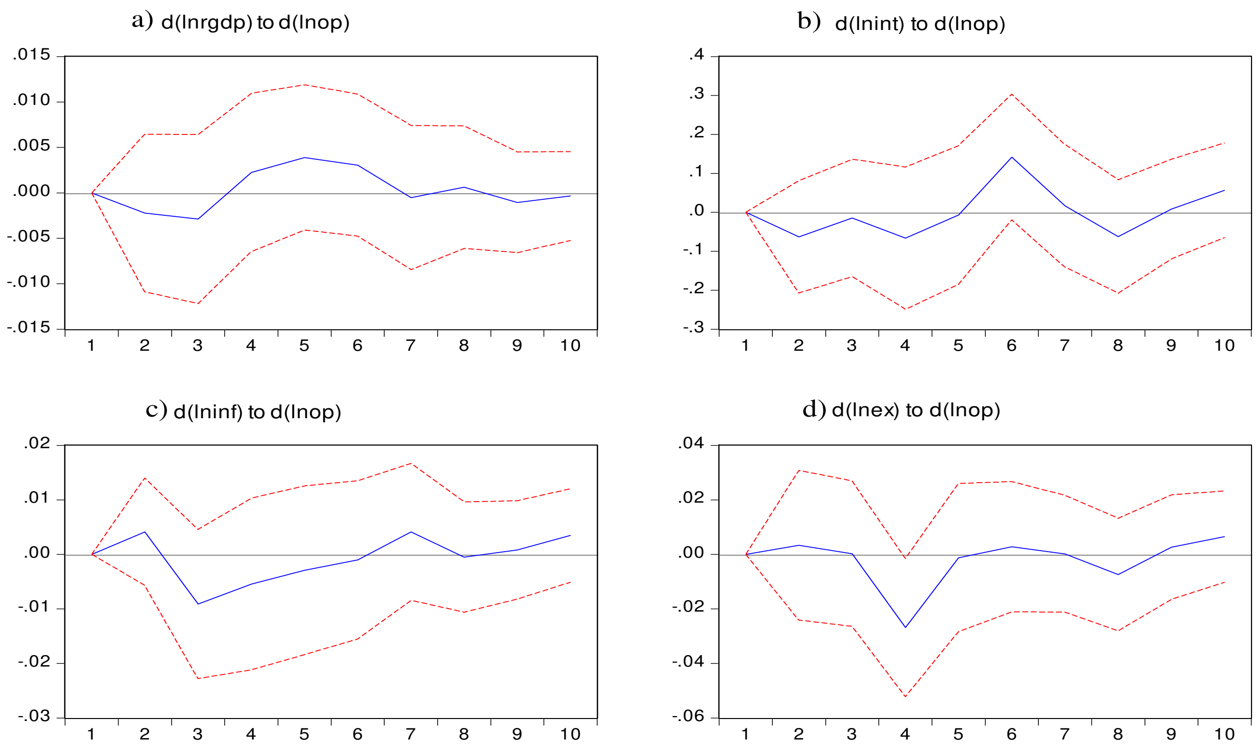


Figure-2 illustrates impulse responses of variables (real GDP, interest rate, inflation and real exchange rate) in Pakistani context. As expected, shock of oil price has negative impact on real output and it continuously goes down and hits the bottom level during third time horizon (Fig. 2a). Afterwards, it starts rising and reaches its maximum level during fifth time horizon after which it begins to fall up to seventh time horizon. Moreover, after eighth time horizon Pakistani economy experiences contractionary impact in long run. This implies that rising oil prices cause to decrease availability of input, which leads to lower output in oil-importing countries like Pakistan (Lescaroux & Mignon, 2008). The reaction of interest rate to oil price is observed negative for the first five-time horizons, and then it begins rising and attains its peak at sixth time horizon (see. Fig. 2b). However, after sixth time horizon interest rate starts declining and knocks its bottom at eighth time horizon after which it moves upward. This implies that shock of oil price has adverse impact on interest rate in short run but positive in long run. It is observed that inflation goes up after oil price shock up to second time horizon, and then it starts decreasing and hits bottom level at third time horizon (Fig. 2c). After third time horizon price level begins to rise and reaches its maximum level at seventh time horizon after which it falls for very short period. It again starts rising after ninth time horizon and onward. This suggests that shocks of oil price have inflationary impact on economy of Pakistan and this finding is similar to findings of Khan and Ahmed (2011) in case of Pakistan.

Figure-2 Pakistan



The real exchange rate reveals some positive response to oil price shock up to third time horizon, and then it sharply falls and reaches its minimum level at fourth time horizon (Fig. 2d). The response of real exchange is observed volatile over period of consideration. This implies that oil shock has short term negative impact on real exchange rate of Pakistan.

Figure-3 Bangladesh

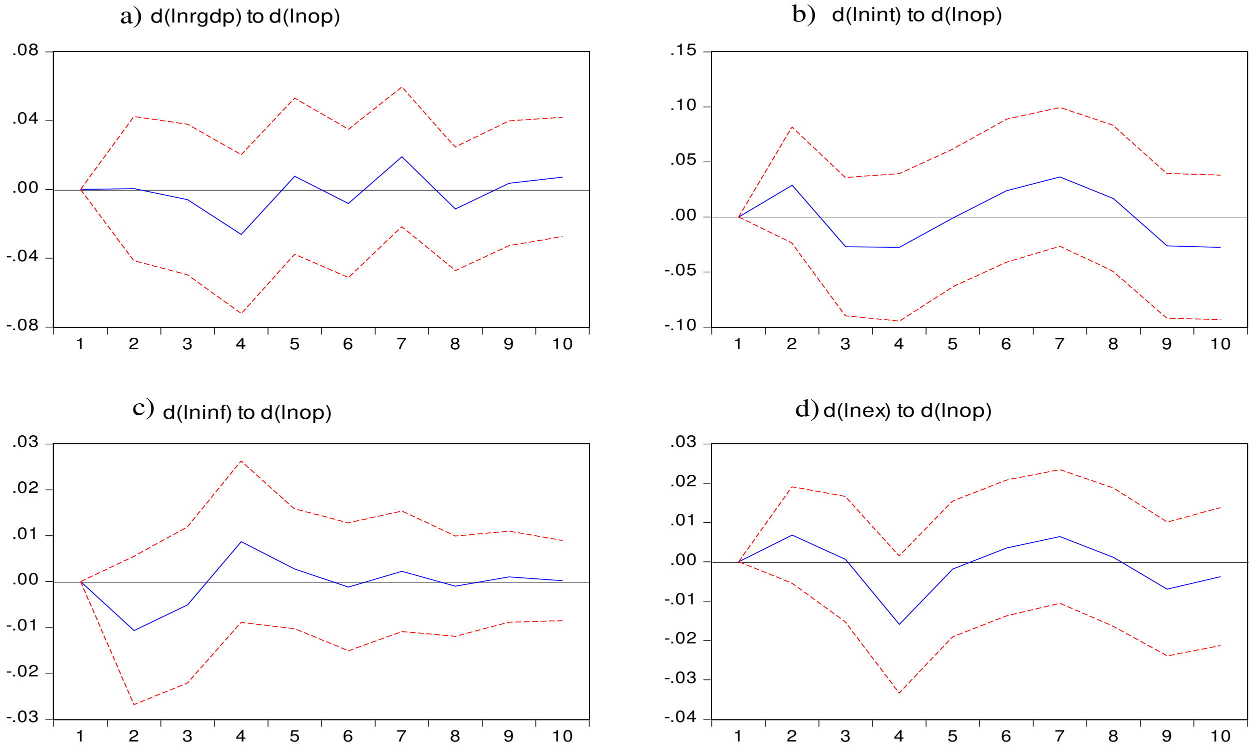


Figure-3 presents impulse responses of study variables i.e. real GDP, interest rate, inflation and real exchange rate of Bangladesh. The impulse response function of real GDP is insignificant for first two time horizons, and then it is observed for about up to fifth time horizon (Fig. 3a). After sixth time horizon real output starts going up and attains its peak at seventh time horizon after which it again moves downward for until eighth period. After eighth time horizon it begins to rise, which shows expansionary phase in Bangladesh economy in long run. This advocates that oil price has short term adverse influence on Bangladesh output. At the outset, the reaction of interest to shock of oil price is significantly affirmative over first to second time horizon, after that it goes down swiftly and becomes stagnant between third and fourth time horizon (Fig. 3b). After fourth time horizon interest rate begins to increase slowly and stretches its maximum point at seventh time horizon after which it again falls and becomes stagnant after ninth time horizon. This result shows that economy experiences contractionary impact after inflationary oil price shock (Kim and

Roubini, 2000). The shock of oil price has noteworthy adverse effect on inflation for first three time horizons, and then price level goes up and attains its peak at fourth time horizon (Fig. 3c). After fourth time horizon inflation starts declining slowly and becomes insignificant eighth time horizon. This shows that oil price shock does not affect price level in Bangladesh in long run but in short run. The response of real exchange to oil shock is statistically significant and observed more volatile throughout longer horizon (Fig. 3d). Initially, currency appreciates up to second time horizon, and then it starts depreciating and hits its lowest level at fourth period after which it begins to rise and achieves its maximum level at seventh time horizon. After seventh time horizon the response of real exchange rate again goes down and remains negative longer horizon. This result suggests that real exchange of Bangladesh is affected by shock of oil price in both short and long run.

Figure-4 Sri Lanka

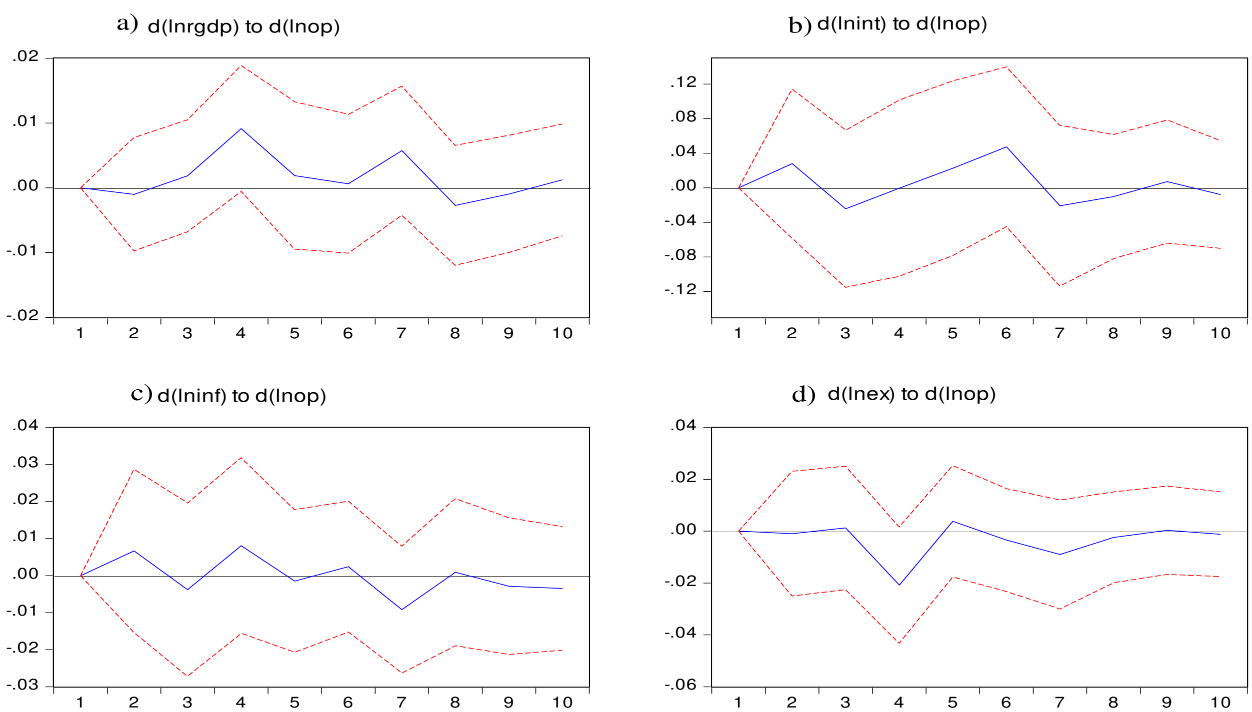
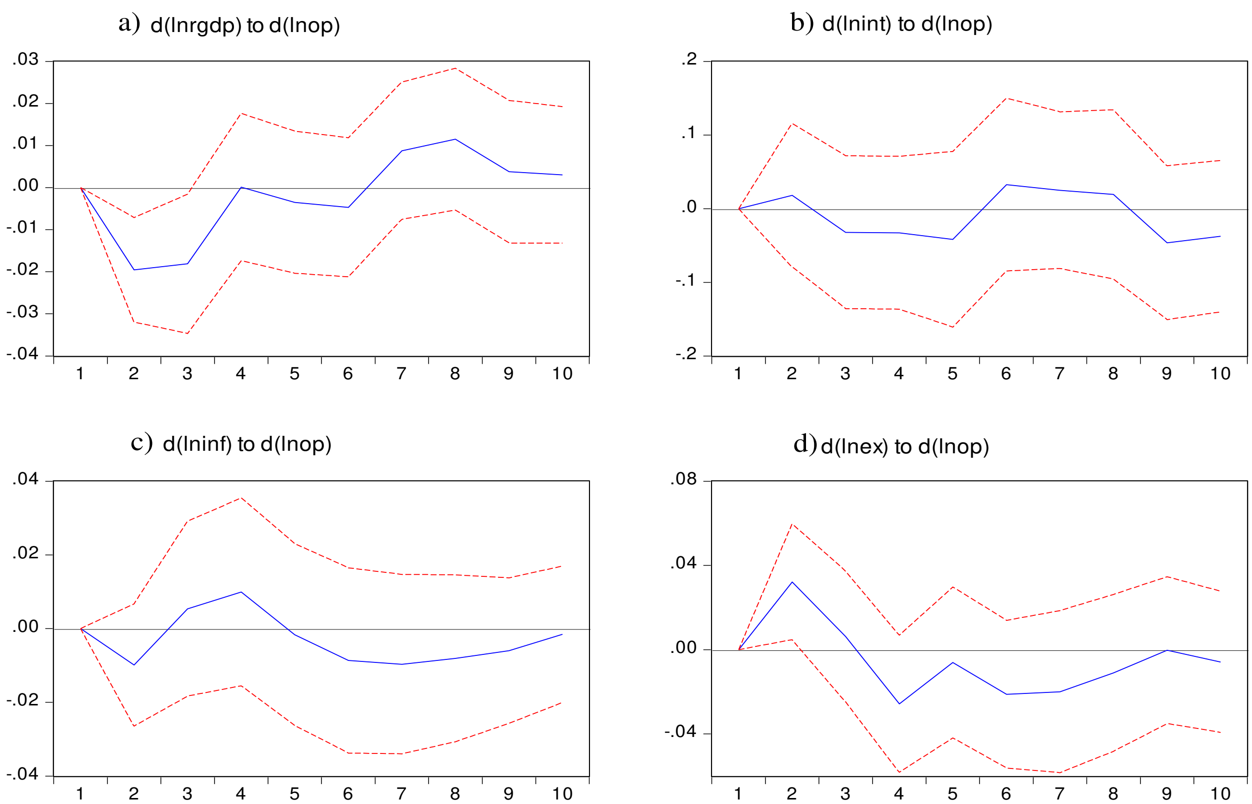


Figure-4 shows impulse responses of macroeconomic variables of Sri Lanka to oil price shock. The response of real output to oil price shock is initially observed negative for up to second time horizons, and then it starts increasing and remains significant positive for until seventh time horizon (Fig. 4a). After seventh period output begins to decrease and hits its bottom level at eighth time horizon after which it again goes up and shows positive response in long run. This result shows immediate negative effect of oil price on Sri Lankan real output after that economy responds positively to oil shock. The possible reason of this positive output could be that Government may provide subsidy on oil importing in Sri Lanka. The interest rate responds positively to oil price shock up to second time horizon, and then it declines rapidly (Fig. 4b). After third time horizon interest rate starts rising and attains its peak at sixth period after which it decreases second time until seventh time horizon. The response of interest rate is statistically significant and more volatile throughout the tenth-time horizons. However, after ninth time horizon it responds negatively to shock. It may be concluded that Sri Lankan economy undergoes expansionary phase after inflationary oil price shock.

As anticipated, inflation goes up succeeding oil price shock, and then it falls after second time horizon (Fig. 4c). The inflation impulse response function is observed statistically significant over whole epoch. It indicates that shock of oil price has inflationary effect on Sri Lankan economy in short-run. In the beginning, the comeback of real exchange rate is found insignificant for first three time horizons, and then it becomes significant negative almost after third to eighth time horizon (Fig. 4d). After eighth time horizon oil price shock effect on real exchange rate turns into insignificant in long run. This result shows that oil price shock causes to depreciate Sri Lankan currency in only short turn.

To our knowledge, this is the first study that analyzes the dynamic response of real output, interest rate, inflation and real exchange rate to oil price shock in case of Bhutan (Fig.5). It is observed from (Fig. 5a) that shock of oil price has substantial adverse effect on real GDP, which continues up to around seventh time horizon. After seventh time horizon response of real output becomes positive and reaches its maximum at eighth time horizon, and then it remains stagnant in long run. The response of interest rate shows that interest rate increases after oil price shock up to second time horizon, and then it declines and responds negatively until sixth time horizon (Fig. 5b). After sixth time horizon, the response of interest rate turns into positive till eighth time horizon after which it starts declines and remains negative in longer horizon. This implies that shock of oil price has significant influence on interest rate in both short-run and long term.

Figure-5 Bhutan



The response of price level falls and hits bottom level at second time horizon (Fig. 5c). This finding shows that decrease in price level and output may be because of adverse demand effect coming from delayed in purchasing of consumers' and business goods. After second time horizon, inflation starts rising and achieves its peak at fourth period. It begins to decrease slowly after fourth time horizon and remains significant negative over longer horizon. It may be concluded that oil price has significant immediate and as well as long run impact on inflation in Bhutan. The real exchange rate appreciates at once after oil price shock up to second time horizon, and then it starts declining and strikes bottom at fourth time horizon (Fig. 5d). However, after third time horizon real exchange rate shows significant negative response over long period of time. This implies that currency of Bhutan suffers from depreciations due to oil price shock in both short run and long run. In nut shell, oil price shocks affect all four macroeconomic variables of five SAARC realms (India, Pakistan, Bangladesh, Sri Lanka and Bhutan) in short run as well as in long run except inflation and real exchange rate of Bangladesh and Sri Lanka respectively. Moreover, these SAARC countries may not face same oil price shocks because of differences in their sector arrangements and distinctive positions as oil-importer.

4.1.Variance Decomposition Analysis

The results of variance decomposition for real GDP, inflation, interest and real exchange rate over period of ten time horizons is shown in (Table 2). Since this investigation is intended to examine particularly oil price shocks' impact on real GDP, inflation, interest and real exchange rate, therefore discussion is restricted to the forecast error variances only interpreted by oil price changes. The estimated effects reveal that oil price shocks explain unlike variations in the variables under study in case of five SAARC economies. The shock of oil price accounts for 4-12.9%, 16-24.8%, 20-30% and 1.2-21% of variation in real output, inflation, interest rate and exchange rate respectively variation over the period of 10-time horizons horizon in case of India. In respect to Pakistan, variations in real GDP, inflation, interest rate and exchange due to oil price shock are 6-12%, 8-15%, 14.6-24% and 1-5% correspondingly during period of ten time horizons. It implies that oil price innovations have significantly influence on these four macroeconomic variables over the longer period, in case of Pakistan.

Table 2: Variance Decomposition of $lnop_t$

	Period	$lnrgdp_t$	$lninf_t$	$lnint_t$	$lnex_t$
India	1	0.260	16.186	26.931	1.285
	2	5.235	22.579	24.145	1.557
	3	4.692	23.429	20.524	7.514
	4	4.1595	22.991	30.159	10.422
	5	3.989	23.565	26.953	10.669
	6	11.927	25.443	28.714	19.568
	7	12.229	25.603	28.576	21.635
	8	12.265	25.210	30.103	21.803
	9	12.399	24.923	29.750	21.265
	10	**12.959**	**24.871**	**30.159**	**21.260**
Pakistan	Period	$lnrgdp_t$	$lninf_t$	$lnint_t$	$lnex_t$
	1	1.271	8.305	16.365	0.372
	2	6.817	7.890	24.143	1.469
	3	11.448	15.889	14.640	1.533
	4	11.004	14.340	15.552	3.1633
	5	12.244	14.404	14.694	5.120
	6	12.267	15.115	15.005	5.2170
	7	12.180	15.050	15.567	5.205
	8	12.245	14.982	15.527	5.289
	9	12.231	15.008	15.525	5.3107
	10	**12.213**	**15.015**	**15.554**	**5.318**
Bangladesh	Period	$lnrgdp_t$	$lninf_t$	$lnint_t$	$lnex_t$
	1	1.062	4.070	21.529	1.585
	2	2.428	9.026	19.814	7.958
	3	2.310	8.342	21.150	8.316
	4	2.169	8.292	22.949	11.279
	5	2.370	8.201	21.677	10.932
	6	2.460	8.333	22.256	11.710
	7	2.929	8.288	22.064	11.738
	8	2.950	8.287	21.965	11.758
	9	3.020	8.283	21.988	11.806
	10	**3.035**	**8.305**	**21.943**	**11.782**

	Period	$lnrgdp_t$	$lninf_t$	$lnint_t$	$lnex_t$
Sri Lanka	1	6.774	2.366	4.732	2.072
	2	6.223	8.716	12.424	2.113
	3	4.932	7.427	9.096	2.128
	4	27.058	7.444	9.203	24.195
	5	26.124	7.784	9.044	24.029
	6	25.677	7.554	14.283	22.784
	7	29.116	10.372	13.693	23.229
	8	29.153	10.367	13.604	23.266
	9	28.448	10.351	13.117	23.157
	10	**28.134**	**10.809**	**13.052**	**23.071**
Bhutan	**Period**	$lnrgdp_t$	$lninf_t$	$lnint_t$	$lnex_t$
	1	0.048	22.458	7.068	4.644
	2	27.339	31.445	5.482	14.618
	3	30.767	25.625	9.150	12.295
	4	30.345	24.785	6.956	30.700
	5	30.525	24.026	8.850	28.896
	6	30.088	24.129	9.791	30.583
	7	32.664	24.613	8.354	32.659
	8	35.119	24.962	8.020	33.448
	9	35.203	25.057	10.493	32.278
	10	**35.553**	**24.972**	**9.800**	**32.480**

However, with respect to real output 1-3% variation is explained by oil price shock during whole period in Bangladesh, which may not be significant. On the other hand, oil price shock explains about 4-8%, 19-21% and 8-11% of forecast error variations in inflation, interest rate and real exchange rate during 10 time horizons period in Bangladesh, which is significant. Similarly, 5-28% of variance in real GDP in Sri Lanka is due to oil price shock, while it causes 2-10%, 4-13% and 2-23% of changes in inflation, interest rate and real exchange rate in that order over period ten time horizons. Lastly, oil price shock induces around 27-35% of variation in real output in Bhutan and it also explains about 22-31% of fluctuations in inflation during the entire horizon. Oil price shock also accounts for 7-10% and 4-32% of variance in interest rate and real exchange rate respectively throughout the ten-time horizon horizon. Moreover, the impulse response and especially variance decomposition effects ratify that shocks of oil price have significant impact on real output, inflation, interest rate and real exchange rate almost in five SAARC countries. The possible reason of that may be these five economies are not competent in their exports, and any negative impact of oil price on exchange rate, inflation and output may cause their export demand to decrease. On the other hand, these five countries may be unable to attract FDI, which leads to a decrease in investment and ultimately a fall in aggregate output. So, this study suggests that shocks of oil price have both short and long run impact on macroeconomic variables of five SAARC countries.

5.Conclusion and Policy Implication

This study investigates the effect of oil price shocks on the four macroeconomic variables i.e. real output, interest rate, inflation and real exchange rate of five SAARC countries (India, Pakistan, Bangladesh, Sri Lanka and Bhutan) applying Structural Vector Autoregressive (SVAR) model over the period of 1982 to 2014. The results of cointegration analysis confirms that the variable are cointegrated and influence each other in the long-run path. Furthermore, it is also revealed that shocks of oil price affect the output, interest rate, inflation and exchange rate in five SAARC nations in short run and as well as in the long run except inflation and exchange rate in Bangladesh and Sri Lanka respectively, as indicated by impulse response functions. On the other hand, results of variance decompositions also state that oil price shocks significantly explain variation in all four macroeconomic variables of SAARC countries except real output in Bangladesh. All in all, findings of this study imply that oil price shocks have significant impact on economies of five SAARC countries in both short and long run. However, it is observed that each country in a study group responds differently to oil price shock. Dissimilarities in results of these five SAARC countries may be attributed to their policies, macroeconomic essentials, sector formations and heterogeneity across countries.

This research provides some policy suggestions for five SAARC countries. Firstly, almost all macroeconomic variables (real GDP, interest rate, inflation and real exchange rate) under study experience significant changes due to oil price shocks in short and long horizons, so each country should take pragmatic measures to avoid exogenous impacts of oil prices. Secondly, as these five SAARC economies under consideration are oil-importing nations, they use conventional energy (oil and gas) for their production so high oil prices have negative impacts on their economies, which shows red signals to foreign investors. For that reason, SAARC countries should devise their energy consumption policy and adopt new technologies that use alternative energy so that they can facilitate and attract domestic and as well as foreign direct investments in the region.

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