

# Impact of Oil Price Shocks on the Sri Lankan Economy: A Vector Auto Regression Assessment

Nisal Herath<sup>1</sup>

## ABSTRACT

*Oil price shocks have the potential to slow down the economic growth and create inflationary pressures in oil importing small economies. A vector auto regression (VAR) model, augmented by Toda and Yamamoto procedure, was estimated using monthly data from 2000-2013 to examine the impacts of oil price shocks on Sri Lankan economy. The results indicate that linear oil price shocks affect GDP, foreign reserves and interest rate. Positive oil price shocks affect foreign reserves and the interest rate, while negative oil price shocks affect GDP, interest rates and exports. Oil price decreases have larger and quicker impacts on GDP. Thus, there is evidence for presence of asymmetric oil price impacts in Sri Lankan economy. No evidence to show that oil price shocks cause inflation. As such, the government has the ability to employ expansionary monetary policy to avoid stagflation during high oil price periods. Overall, the results indicate that the economy has a certain degree of insulation from international oil price increases. In addition, energy policy has also contributed to insulate the economy from oil price shocks through reduction in energy intensity.*

## Introduction

Sri Lanka imports 100% of the crude oil used in the country. Oil import expenditure comprised of approximately 20% of the total imports bill. While the gross oil subsidy is about 2.1% of GDP, the revenue from indirect fuel tax as 1.2% of GDP and therefore the net oil subsidy is about 0.9% of GDP in 2008 (Naranpanawa and Bandara, 2012). Transport, power, industry, commerce and agriculture as well as household sectors depend on oil and petroleum related products. Sri Lanka, being a small economy, is a price taker in the international oil market. As such, it is important to understand how oil price fluctuations affect economy of Sri Lanka. Oil price volatility originates from supply constraints, geopolitical uncertainties, refinery capacity constraints, wars and demand growth fluctuations (Kesicki, 2010). Sri Lanka, like many other countries, employs price regulatory measures to insulate the economy from international oil price volatilities. Subsidies are provided to

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<sup>1</sup> Research Assistant, Institute of Policy Studies, Colombo, Sri Lanka. Author acknowledges the useful comments by Dushni Weerakoon, Deputy Director and Fellow, Institute of Policy Studies, Sri Lanka, but assumes responsibility of any errors.  
Email: nisal@ips.lk

ensure that: the poor have access to kerosene; affordable public transport and essential food and other cargo transportation through low priced diesel; and industries have access to electricity and other required energy sources.

The government sets the base price of petroleum products through the Ceylon Petroleum Corporation, which imports and refines crude oil and sets uniform prices across the country. Until 2002, production, importation and distribution were only done by the Ceylon Petroleum Corporation (Gillingham *et al.*, 2006). Lanka India Oil Corporation entered the market in 2002 as the other major supplier. A pricing formula was adopted in 2002 which was abandoned in 2004 and was revived again in 2007 only to be scrapped two months later in 2007 (Kojima, 2013). The Value Added Tax (VAT) on gasoline was reduced from 15% to 5% in January 2008 only to be increased to 12% in January 2009. The Ceylon Petroleum Corporation froze prices between December 2009 and April 2011. Duties such as the Social Responsibility Levy and VAT on gasoline imports were removed in 2010. Government increased the prices of gasoline by 9% and diesel by 37% in February 2012. Thus, retail oil prices change frequently while a price insulation policy is in place.

Despite the existence of price insulation policy, oil import policies can have significant impact on the economy. Ceylon Petroleum Corporation signed contracts to hedge parts of the oil imports in 2007 (Kojima, 2013). The hedging contracts were beneficial when international oil prices were increasing, but became costly as international oil prices decreased. The treasury had been exposed to approximately USD 464 million, 0.8% of 2012 GDP, in liabilities from five different banks due to 2007 hedging contracts. The treasury issued Sri Lanka Rs. 55 billion worth of treasury bonds in January 2012 to settle debts of Ceylon Petroleum Corporation (Central Bank Sri Lanka, 2012).

An oil price increase can shift the aggregate supply curve upwards, reduce national output and create inflationary pressures in the economy. The impact of an oil price shock on the economy depends on the size of the shock, persistence of the shock, dependency of the economy on energy and fiscal and monetary policy responses (Roubini and Setser, 2004). As a small open economy, Sri Lanka can be vulnerable to oil price shocks which can affect economic development. Understanding the impacts of oil price shocks on key macroeconomic variables and dynamics of the responses can help formulate policy responses against negative economic impacts of oil price shocks. As such, it is important to investigate impact of oil price shocks on the economy.

This study examines and quantifies the relationship between oil prices and macroeconomic indicators such as GDP, inflation, interest rate, exports,

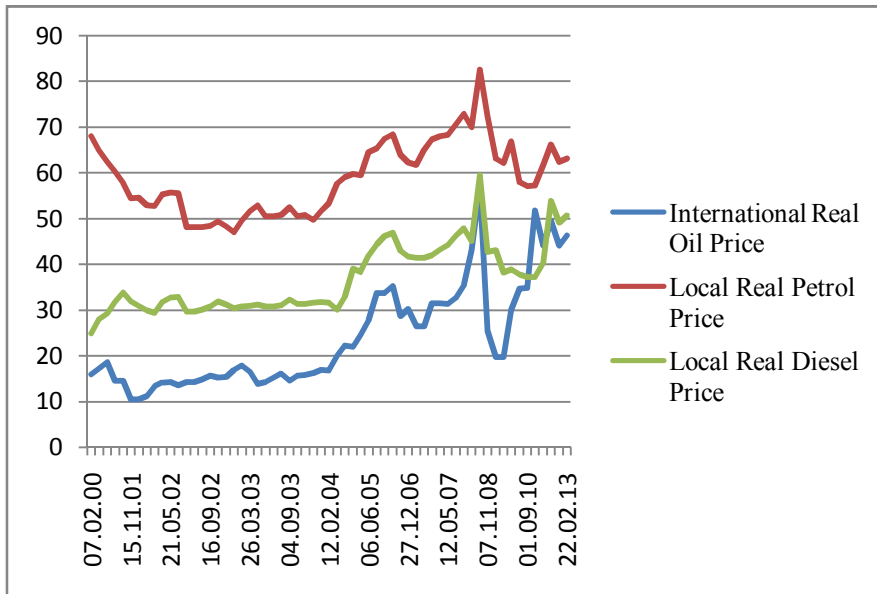
exchange rate and foreign reserves. As shown in the section 3, there is no consensus on the impact oil price shocks as they vary from country to country and also from time to time. The impacts of oil price shocks on Sri Lankan economy have not been previously examined. This study uses a Vector Auto Regression (VAR) model augmented by Toda and Yamamoto procedure to examine the direction of causality, magnitude of the impacts and the dynamic nature of responses. Also, both linear and asymmetric impacts of oil price shocks have been examined.

The paper is organized as follows: Section 2 describes the changes in oil prices, money supply and inflation. Section 3 presents a literature review on macroeconomic impacts of oil price shocks. Section 4 discusses the methods and data. Section 5 shows the results which include Granger causality results, the Generalized Impulse Response Functions and results of Variance Decomposition. Section 5 also includes a discussion of the overall results, while Section 6 presents the conclusion.

### **Oil Prices, Money Supply and Inflation in Sri Lanka - 2000-2013**

It is important to look at the economic situation in country while analysing the effect of oil prices on the economy of Sri Lanka. This section examines changes in the average petrol and diesel prices, international oil prices, broad money (M2b) and Colombo Consumer Price Index (CCPI) during 2000-2013 period. Both diesel and petrol prices generally follow the international oil prices. Due to the price regulatory measures of the government, the price of petrol does not fluctuate as much as the international oil prices (Figure 1). However, when there was significant international oil price increases in 2007-2008, the petrol price had increased drastically and then fell drastically following international oil prices. As previously mentioned, the significant oil price increases had caused the Ceylon Petroleum Corporation to hedge against oil price increases, but this proved detrimental when international oil prices had subsequently decreased. The price then has gradually increased until the end of the period 2013.

Figure 1: Global oil price and local petroleum product prices 2000-2013

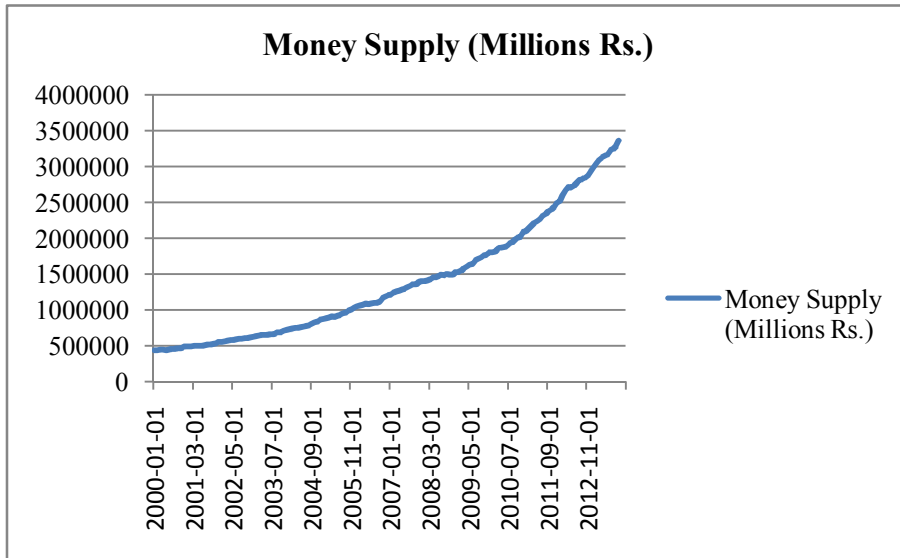


Note: Local prices are in Rs. per litre (2002 base year).  
International price is in US \$ per barrel (1982 base year).

Diesel price show much smaller changes compared to price of petrol when international oil price changes. For example, diesel price remain around Rs. 30 from April 2001 to August 2004 while international price almost double for the same period. Diesel prices increase less than international price increase, when prices increase. Similarly, diesel prices do not drop sharply when international price decreases. Government maintain higher prices during international price declining periods to recover the losses during high oil price periods. These observations indicate that there is an insulation policy against oil price volatility in Sri Lanka.

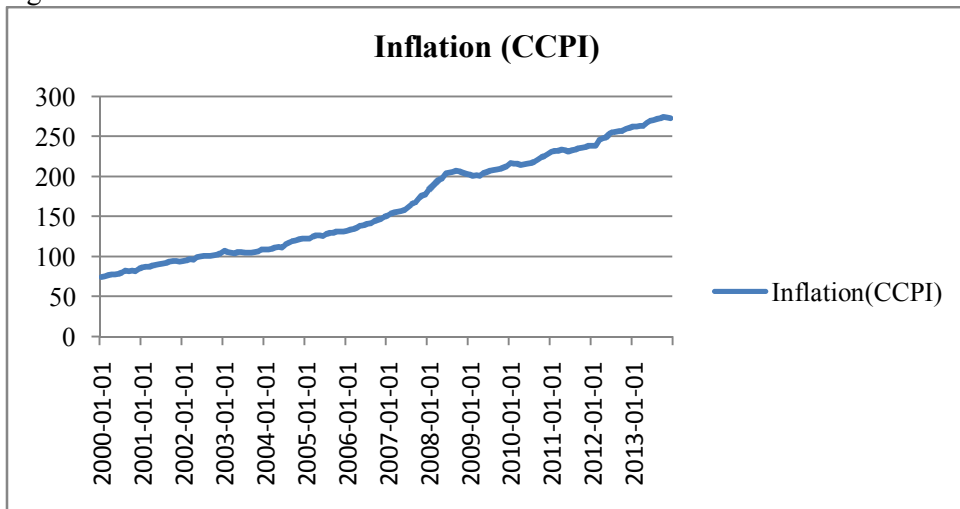
The money supply is indicative of the monetary policy in the country. There had only been small increase in the money supply until around up to 2006; money supply doubled from January 2000 to July 2006. Since then the money supply has increased at a faster rate (Figure 2); it increased by about 3.5 fold from July 2006 to January 2013. Sharpest increase in money supply starts in 2008. This significant increase in money supply may be a policy response to international oil prices increase in 2007. Moreover, financing the last phase of the civil war may have contributed to money supply increase. The sharp increase in money supply around 2012 could be also due to the payments associated with hedging contracts.

Figure 2: Broad money supply 2000-2013



Inflation appears to follow a linear trend during 2000-2013 periods. There had been a short spike in inflation around 2008. Afterwards, there had been a slight deflation, but the index has increased since then. It seems that inflation does not follow the same pattern of oil price fluctuations.

Figure 3: Colombo Consumer Price Index 2000-2013



## Literature Review

There are number of previous studies which examined the relationship between oil prices and macro-economic indicators. As oil prices heavily influence the production process, oil price volatility affects output and inflation (Loungani, 1986). There are six transmission channels through which oil price shocks can affect the economy: uncertainty effects; supply side shock effects; sector adjustment effects; wealth transfer effects; real balance effects; and inflation effects (Ghos and Kanjilal, 2014). When there is uncertainty about future oil prices, firms postpone investment expenditure and there are decreased investment incentives from different sectors of the economy (Bernanke, 1983). Uncertainty also arises on consumption demand due to product pricing associated with supply side shocks (higher production costs). Oil price shocks also can lead to a decrease in aggregate employment as there are rigidities on movement of workers from negatively affected sectors to positively affected sectors (Hamilton, 1988). This results in different adjustment in different sectors and wealth transfer effects. Higher oil prices also deteriorate the terms of trade in oil importing countries resulting real balance effects (Dohner, 1981). Oil price increases can cause cost-pushed inflation and oil and related products are inputs to many outputs in an economy.

Hamilton (1983) in his pioneering study showed that there is a negative relationship between oil prices and macroeconomic variables. Crude oil prices have a significant impact on output even more than that of monetary and fiscal policies in phase of recovery from recession during 1960s and 1970s up to 1982 (Gisser and Goodwin, 1986). Studies that have found that there is an asymmetric relationship between oil price and macro-economic indicators; positive and negative oil price shocks have different impacts (Mork, 1989; Lee *et al.*, 1995). Bernanke *et al.* (1997) showed that incorrectly employed monetary policies can aggravate the effect of oil price shocks. When monetary policy is unchanged, an asymmetric relationship between oil price shocks and economic recessions exists (Balke *et al.*, 2002).

After 1973, oil prices no longer satisfy Granger causality in US economy (Hooker, 1996). The lack of causality can be explained by more flexible labour markets, more credible anti-inflationary policies in recent times and energy efficiency improvement and resultant less energy intensity of the economy (Blanchard and Gali, 2007). After 2003, the changes may be due the endogenous responses of real oil prices to global economic conditions (Hamilton, 2005; Woodford, 2007). There has not been a consensus on the relationship between oil price shocks and macro-economic indicators. However, in the case of developed countries there appears to be a negative

relationship between crude oil prices and economic growth (Bhat *et al.*, 2014).

The developing country studies on the subject have not been conclusive. In the case of the Philippines, the impulse response function for the linear oil price specification shows that oil price shocks lead to continued declines in real GDP, but the nonlinear specification shows that only oil price decreases affects macroeconomic variables (Raguindin and Reyes, 2005). In Nigeria, which is an oil producing country, oil price shocks do not significantly affect macroeconomic indicators, but negative oil price shocks affects GDP and the real exchange rate (Iwayemi and Fowowe, 2011). Similarly, in the case of Iran, positive and negative oil price shocks affect inflation and there was evidence of Dutch disease (Farzanehan and Markwardt, 2009). In Thailand, the causality is unidirectional from oil price volatility to investment, unemployment rate, interest rate and trade balance, but volatility has an impact only in the shorter time horizon (Rafiq *et al.*, 2009). In a study done on six Asian countries that includes Malaysia, Singapore and Thailand, oil price shocks have a significant impact on economic activity and inflation in the short-term, particularly when variables are defined in the local currency (Cunado and Gracia, 2005).

In India, GDP and inflation both increase with a decrease in oil prices, with the largest impact occurring in the second month and disappearing completely after about 8 to 10 months (Bhat *et al.*, 2014). Also, in India Granger causality was found from oil price shocks to inflation and foreign exchange reserves in both linear model and nonlinear models. In a nonlinear model, Granger causality is found from real oil price decrease to inflation. Also, negative oil price volatility affects inflation and interest rate. Net oil price increases in India affects inflation and net oil price decrease affects exchange rate (Ghos and Kanjilal, 2014). In Pakistan, crude oil prices significantly contribute to the variability of real exchange rate and the long term interest rate, and oil price shocks have significant impacts on money supply and short term interest rate (Jamali *et al.*, 2011). There have not been similar time series studies which have looked at the effects of oil price shocks in Sri Lanka. However, using a computable general equilibrium (CGE) model, high oil prices were found to decrease real GDP by 4.16%, real imports by 8.45% and increase exports by 2.85% (Naranpanawa and Bandara, 2012).

## **Methodology and Data**

A Vector Autoregression (VAR) model has been used to examine the impact of oil price shocks on the Sri Lankan economy. The data used includes monthly data for GDP, inflation, interest rate and crude oil prices from January 2000 to December 2013. As a proxy for GDP, Index of

Industrial Production (FIIP) has been used. Inflation was measured using Colombo Consumers' Price Index (CCPI). As a proxy for interest rates, Average Weighted Prime Lending Rate (AWPR) has been used. Also, real exports, Real Effective Exchange Rate (REER) and Real Foreign Reserves data has been used. Real oil prices are an average of the UK Brent, West Texas Intermediary and Dubai grade crude oil prices adjusted to be in real dollar terms. The variables international oil price, GDP, inflation, interest rate, exports, exchange rate and foreign reserves will be referred to as OP, gdp, inf, int, ex, er and res respectively.

Three nonlinear transformations of oil prices have been used. Asymmetric oil prices are defined to differentiate between positive and negative changes (Mork, 1989).

$$\text{Real Oil Price Increase (ROPI)}_t: \text{ROPI}_t = \max [0, OP_t] \quad (1)$$

$$\text{Real Oil Price Decrease (ROPD)}_t: \text{ROPD}_t = \min [0, OP_t] \quad (2)$$

Net Oil Price increase (NOPI) is defined as percentage increase of oil prices only if the price of the current month exceeds the oil price of the previous twelve months (Hamilton, 1996). Net Oil Price decrease (NOPD) is defined similarly with percentage decrease of oil prices only if the price of the current month is less than the price of the previous twelve months.

$$\text{NOPI}_t = \max [0, OP_t - \max (OP_{t-1}, OP_{t-2}, OP_{t-3} \dots \dots OP_{t-12})] \quad (3)$$

$$\text{NOPD}_t = \min [0, OP_t - \min (OP_{t-1}, OP_{t-2}, OP_{t-3} \dots \dots OP_{t-12})] \quad (4)$$

Fluctuations of oil price movements may have different impacts on real GDP as compared to stable oil price movements (Lee *et al.*, 1995). As such, a transformation of the oil price by an AR(12)-GARCH(1,1) has been used to capture the different impacts.

$$OP_t = \text{const} + \sum_{i=1}^{12} \beta_i OP_{t-i} - 1$$

$$\varepsilon_t = v_t \sqrt{h_t} v_t \sim N(0,1)$$

$$h_t = \lambda_0 + \lambda_1 \varepsilon_{t-1}^2 + \lambda_2 h_{t-1}$$

$$\text{AGP}_t = \max(0, \frac{\varepsilon_t}{\sqrt{h_t}}) \quad (5)$$

$$\text{AGN}_t = \max(0, \frac{\varepsilon_t}{\sqrt{h_t}}) \quad (6)$$

The Vector Auto Regression (VAR) models have been widely used in the literature to study relationship amongst macroeconomic variables (Brown and Yucel, 2002). The VAR model in this study will contain seven endogenous variables transformed oil prices (OP), GDP (gdp), inflation (int), interest rate, exports (ex), real effective exchange rate (er) and foreign reserves (res). Typically for Granger causality, the Wald statistic may lead to



nonstandard limiting distributions depending upon the cointegration properties of a VAR (Lutkepohl, 2004). However, the Toda and Yamamoto procedure fixes the singularity problem by augmenting VAR model with the maximum order of integration of the variables (Toda and Yamamoto, 1995). The procedure has advantages of avoiding bias associated with unit roots and cointegration tests as it does not require pre-testing of cointegrating properties of the VAR which can lead to loss of long run information (Clark and Mizra, 2006). On the other hand there are disadvantages of inefficiency and loss of power due to over-fitting and the asymptotic distribution may be poor from small sample sizes (Kuzozumi and Yamamoto, 2000). In the Toda and Yamamoto procedure, a VAR (p + d) model is estimated where d is the maximum order of integration of the variables and p is the order of original VAR. If the order of the time series X and Y are equal and the maximum order of integration is d then Toda and Yamamoto procedure can be described as:

$$\begin{aligned} X_t &= \alpha_0 + \alpha_i \sum_{i=1}^p X_{t-i} - 1 + \alpha_d X_{t-d} + \beta_j \sum_{j=1}^p Y_{t-j} + \beta_d X_{t-d} + \mu_t \\ Y_t &= \alpha'_0 + \alpha'_i \sum_{i=1}^m X_{t-i} - i + \alpha'_d X_{t-d} + \beta'_j \sum_{j=1}^n Y_{t-j} - j + \beta'_d Y_{t-d} + \nu_t \end{aligned}$$

The modified Wald (MWALD) for the Toda and Yamamoto procedure of the time series X and Y statistics have an asymptotic Chi-square distribution with p degrees of freedom regardless of unit roots and cointegrations. (Toda and Yamamoto, 1995).

## Results and Discussion

Prior to estimating the VAR model and checking Granger causality, the stationarity of the variables was tested to identify the maximum order of integration (d) of the variables. Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test were used to examine the presence of unit roots. Table 1 and Table 2 present the results of the unit root tests. The results show that the series are a mix of integration of order zero, I(0), and integration of order one, I(1). Most of the variables in Table 1 are of I(0), but the variables in Table 2 are of I(1). As such, the value used for the order of integration in this case would be 1. The optimal lag length (p) of the VAR was found using the Likelihood-Ratio test for the VAR.

Table 1: Results of unit root tests, Linear oil prices

Variable	At Level			First Difference		
	ADF	PP	KPSS	ADF	PP	KPSS
gdp	0.18 (0.97)	-0.60 (0.87)	1.58 0.46	-10.88*** (0.00)	-26.77*** (0.00)	0.06** 0.46
int	-2.42 (0.14)	-1.90 (0.33)	0.17** 0.46	-3.82*** (0.00)	-9.62*** (0.00)	0.08** 0.46
res	-0.92 (0.78)	-0.52 (0.88)	1.39 0.46	-6.03*** (0.00)	-13.89*** (0.00)	0.09** 0.46
er	-0.52 (0.88)	-0.63 (0.86)	1.33 0.46	-10.27*** (0.00)	-9.72*** 0.00)	0.13** 0.46
ex	0.00 (0.96)	-3.55 (0.01)	1.51 0.46	-3.38** (0.01)	-22.73*** (0.00)	0.22** 0.46
inf	0.87 (0.99)	0.82 (0.99)	1.62 0.46	-5.92*** (0.00)	-9.46*** (0.00)	0.22** 0.46
OP	-1.79 (0.39)	-1.65 (0.45)	1.39 0.46	-8.52*** (0.00)	-8.57*** (0.00)	0.03** 0.46

Notes: Probability values in Parentheses, \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Table 2: Results of unit root tests, Asymmetric oil prices

Variable	At Level			First Difference		
	ADF	PP	KPSS	ADF	PP	KPSS
ROPI	-10.47*** (0.00)	-10.53*** (0.00)	0.53* 0.46	-11.63*** (0.00)	-67.53*** (0.00)	0.09** 0.46
ROPD	-7.27*** (0.00)	-7.27*** (0.00)	0.16** 0.46	-17.30*** (0.00)	-31.35*** (0.00)	0.10** 0.46
NOPI	-10.15*** (0.00)	-10.19*** (0.00)	0.16** 0.46	-11.39*** (0.00)	-58.64*** (0.00)	0.10** 0.46
NOPD	-7.72*** (0.00)	-6.21*** (0.00)	0.06** 0.46	-10.94*** (0.00)	-54.92*** (0.00)	0.50* 0.46
AGP	-12.29*** (0.00)	-12.30*** (0.00)	0.33** 0.46	-11.91*** (0.00)	-71.89*** (0.00)	0.08** 0.46
AGN	-10.48*** (0.00)	-10.48*** (0.00)	0.06** 0.46	-10.35*** (0.00)	-68.00*** (0.00)	0.19** 0.46

Notes: Probability values in Parentheses, \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

### *Granger Causality*

Granger causality tests examine whether lagged values of one variable help predicting another variable (Stock and Watson, 2001). Granger causality results of the linear oil prices are given in Table 3. The linear causality shows that oil prices affect GDP, foreign reserves and interest rates. As Sri Lanka is a small oil importing economy, the effects on foreign reserves and exchange rate are understandable. However, oil prices do not affect inflation, exports and exchange rate. This limited causality between oil price and inflation, exports and exchange rate is probably due to the insulation policies of the government. The fact that oil price shocks do not affect inflation allows the government to employ expansionary monetary policy instruments during positive oil price shocks to avoid the economy going to recessions. Unsurprisingly, macroeconomic variable do not affects oil prices. There is also considerable granger causality between the different macroeconomic variables. But these causalities are not discussed in the paper because paper focuses on the impacts of oil prices on the economy.

Table 3: Granger causality, Linear oil prices

Regressor	Dependent Variable in Regression						
	OP	inf	gdp	res	int	ex	er
OP		10.86 (0.21)	14.18* (0.08)	15.77** (0.05)	16.24** (0.04)	10.36 (0.24)	3.76 (0.88)
inf	7.99 (0.43)		24.47*** (0.00)	8.70 (0.37)	7.37 (0.50)	6.50 (0.59)	10.89 (0.21)
gdp	7.73 (0.46)	6.36 (0.61)		13.18 (0.11)	25.55*** (0.00)	5.89 (0.65)	12.83 (0.12)
res	8.47 (0.39)	4.32 (0.83)	7.40 (0.49)		7.31 (0.50)	5.95 (0.65)	2.60 (0.96)
int	1.54 (0.99)	6.61 (0.58)	3.85 (0.87)	11.57 (0.17)		15.33** (0.05)	9.52 (0.30)
ex	6.85 (0.55)	2.47 (0.96)	16.73** (0.03)	11.16 (0.19)	13.95 (0.08)		15.53* (0.05)
er	6.88 (0.55)	3.90 (0.87)	8.41 (0.39)	6.02 (0.64)	5.65 (0.69)	18.44** (0.02)	

Notes: Probability values in Parentheses, \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Table 4: Granger causality, Asymmetric oil prices

Regressor	Dependent Variable in Regression					
	inf	GDP	Reserves	Int	Ex	REER
ROPI	9.47 (0.30)	4.01 (0.86)	14.13* (0.08)	12.04 (0.15)	9.77 (0.28)	3.18 (0.92)
ROPD	10.85 (0.21)	30.19*** (0.00)	10.50 (0.23)	17.36** (0.03)	19.59** (0.01)	5.54 (0.70)
NOPI	14.55 (0.20)	3.78 (0.98)	13.42 (0.27)	21.60** (0.03)	12.58 (0.32)	9.18 (0.60)
NOPD	18.73** (0.04)	30.79*** (0.00)	10.15 (0.43)	14.61 (0.15)	19.65** (0.03)	8.98 (0.53)
AGP	10.36 (0.24)	4.92 (0.77)	18.18** (0.02)	18.78** (0.02)	9.44 (0.31)	3.25 (0.92)
AGN	10.89 (0.21)	20.95** (0.01)	10.62 (0.22)	20.14** (0.01)	14.17* (0.08)	4.20 (0.97)

Notes: Probability values in Parentheses, \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Table 4 shows the Granger causality between asymmetric oil price changes and the different macroeconomic indicators. The real oil price increase (ROPI) only affects foreign reserves. On the other hand, real oil price decrease (ROPD) affects GDP, interest rates and exchange rate. Similarly, net oil price increase (NOPI) only affects the interest rate, net oil price decrease (NOPD) affects inflation, GDP and exports. Thus, there is evidence on the existence of asymmetric impacts of oil prices in Sri Lankan economy. The different effects of the positive and negative oil price shocks may be due to the success of governmental macroeconomic policies. During periods of positive oil price shocks, the government generally uses monetary and fiscal policies to minimize the negative impacts on the economy. However, during negative oil price shocks, the government may relax these policies and let the economy experience positive effects of low oil prices. However, the subsidies provided during the high oil price periods limits governmental ability to fully benefits from lower oil prices because it has to maintain high oil prices to recover from the losses experienced during high oil price periods. Overall, the results show that oil price increase during 2000-2013 period have had limited impact on the Sri Lankan economy.

The results for AGN show that asymmetric oil price decrease affects GDP, interest rates and exports. On the other hand, the results for AGP show that asymmetric oil price increase affects interest rates and foreign reserves. As shown in the Table 5, macroeconomic variables do not cause oil price changes. These non-surprising results confirm the overall quality of data and the reliability of results.

Table 5: Reverse Granger causality, Asymmetric oil prices

Regressor	Dependent Variable in Regression					
	ROPI	ROPD	NOPI	NOPD	AGP	AGN
Inflation	10.57 (0.23)	7.78 (0.45)	11.29 (0.42)	13.09 (0.22)	6.49 (0.59)	10.68 (0.22)
GDP	5.24 (0.73)	7.63 (0.47)	16.31 (0.13)	3.09 (0.98)	4.55 (0.80)	4.51 (0.81)
Reserves	3.63 (0.89)	9.48 (0.30)	5.07 (0.93)	12.89 (0.23)	4.98 (0.76)	2.84 (0.94)
Interest	4.63 (0.80)	12.21 (0.14)	6.32 (0.85)	16.53* (0.09)	2.66 (0.95)	9.39 (0.31)
Exports	5.47 (0.71)	4.79 (0.78)	14.26 (0.22)	12.57 (0.25)	11.01 (0.20)	4.00 (0.86)
REER	10.90 (0.21)	6.30 (0.61)	16.07 (0.14)	13.16 (0.21)	7.53 (0.48)	5.45 (0.71)

Notes: Probability values in Parentheses, \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

The results indicate that macroeconomic impacts of oil price shocks are limited in Sri Lankan economy for the period of 2000-2013. This may support Hooker (1996) hypothesis that relationship between oil price and economic performances has broken down after the 1980s. As per Blanchard and Gali (2007) explanations, labour market flexibility is growing with private sector expansion and there was a concerted effort to curb inflation in recent times in Sri Lanka. Moreover, energy intensity also has decreased as shown in Table 6. Sri Lanka economic growth is not linked to energy intensive industrial expansion. That has enabled the country to grow while reducing the energy intensity.

Table 6: Energy Intensity in Sri Lanka

	Units	1992	1996	2000	2004	2008	2012
Total Energy Use	Thousand TOE	5,347.3	6,065.9	7,224.4	7,984.5	7,879.0	9,896.5
GDP	1982 million US\$	9,703	13,898	16,596	20,663	19,980	25,878
Energy Intensity	TOE per \$1 million GDP	551	436	435	386	394	382

TOE = Tons of oil equivalent

Source: Adapted from Sustainable Energy Authority

### *Generalized Impulse Response Functions*

This section discusses the dynamics of the relationship between the variables in the VAR model. Figures 4 through 6 show the impulse response functions of linear oil prices, while Appendix A shows the impulse response functions of asymmetric oil prices. The impulse response functions trace out current and future values of the variables to a unit change in the current value of one of the VAR errors. The standard errors shown in dotted lines. A general assumption on impulse response is that error causes changes in other variable returns to zero in subsequent periods and all other errors are equal to zero.

Figure 4: Impulse response function for reserves

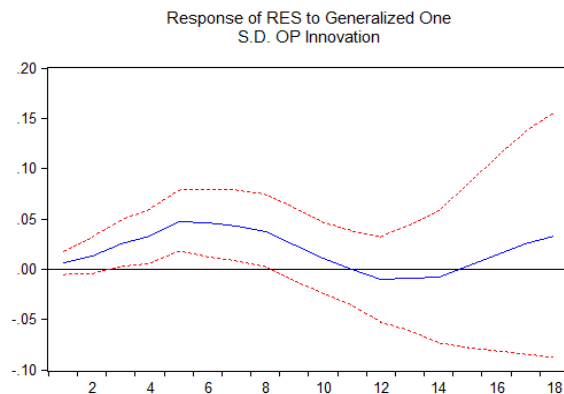


Figure 5: Impulse response function for interest rate

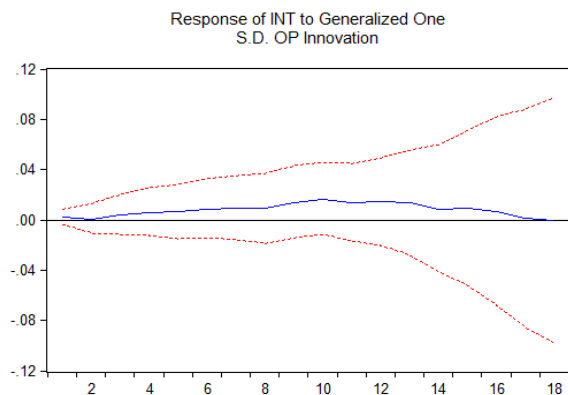


Figure 6: Impulse response function for GDP

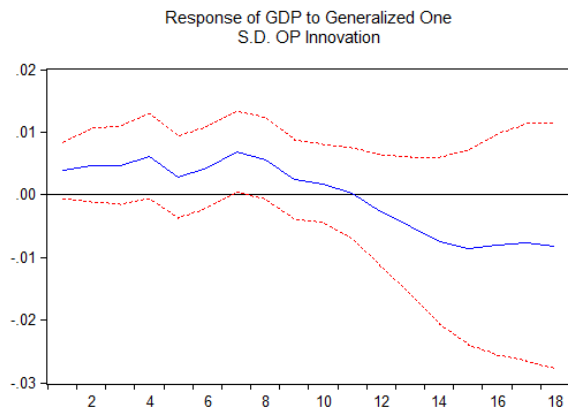


Figure 4 - Figure 6 show the changes in reserves, interest rate and GDP, respectively, to a one percentage point change of oil price. The results show that the largest impact oil price change occurs in GDP. The maximum value occurs in the seventh month after the shock. After the seventh month the impact decreases and becomes negative and then approaches zero. The maximum impact for foreign reserves occurs in the fifth month, and afterwards it fluctuates and eventually approaches zero. The maximum impact for interest rates is in the tenth month, and afterwards approaches zero. Understandably, foreign reserves react quickest as the impact of oil price shocks directly impacts the import bill. Interest rates and GDP work through

various economic interactions, so impacts occur slowly. The dynamics of asymmetric oil price shocks are shown in Appendix 1. The asymmetric oil price impacts are quite similar to those of linear impacts.

The generalized impulse response function for ROPI shows that the largest impact on foreign reserves is observed in the fourth month after the shock. Subsequently, there is fluctuation around zero. The generalized impulse response functions for ROPD show that the largest impact has been observed for exports. The maximum impact occurs in the eighth month after the shock. Afterwards, the impact decreases, becomes negative and eventually approaches zero. The maximum impact for GDP occurs in the third month, and afterwards it fluctuates and eventually approaches zero. The maximum impact for interest rates occurs in the sixth month, and afterwards it fluctuates and eventually approaches zero.

The results for NOPI show that the largest negative impact on interest rates is observed in the eleventh month after the shock. After the eleventh month the impact decreases, becomes negative and eventually approaches zero. On the other hand, the generalized impulse response function for NOPD shows that the largest impact occurs in exports. The maximum impact occurs in the seventh month after the shock. Subsequently, the impact decreases, becomes negative and then approaches zero. The maximum impact for GDP occurs in the third month, and afterwards fluctuates and eventually approaches zero. The maximum impact for inflation is in the third month, and afterwards the impact fluctuates and eventually approaches zero.

The generalized impulse response function for AGP shows that the largest impact on interest rates is observed in the sixteenth month after the shock. The shock is quite minor and eventually decreases. Similarly, the shock associated with foreign reserves is small and has largest impact in the fourth month and thereafter fluctuates around zero. The generalized impulse response function for AGN shows that the largest impact has been observed for GDP. The maximum value occurs in the third month after the shock. After the third month the impact decreases, becomes negative and then approaches zero. Although the maximum impact for interest rates is small and does not deviate far from zero, the maximum impact for foreign reserves is in the sixth month and afterwards fluctuates and eventually approaches zero.

### ***Variance Decomposition***

This section presents the results of variance decomposition, which show the percentage of the variance of the error in a variable due to a specific shock at given time horizon. Table 7- Table 12 show variance decomposition of GDP, inflation and reserves with selected oil price variables. The results



show that there is considerable interaction among macroeconomic variables. However, even after 12 months, own shocks explain most of the forecast error variance. Appendix B provides the results of variance decomposition for different oil price variables. The variance decomposition for linear oil price shows that most of the forecast error variance is due to its own shocks. This also confirms the fact that Sri Lanka is a small economy and cannot influence oil prices.

Table 7: Variance decomposition for GDP – linear oil price

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	OP	res	int	inf	gdp	ex	er
1	1.88	0.10	0.01	0.53	97.48	0.00	0.00
6	9.01	4.94	8.38	4.86	70.36	0.74	1.71
12	10.71	6.18	19.26	6.59	51.56	0.91	4.78

Table 8: Variance decomposition for inflation – linear oil price

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	OP	res	int	inf	gdp	ex	er
1	5.28	0.21	0.07	94.43	0.00	0.00	0.00
6	24.83	0.90	5.66	62.83	4.37	0.94	0.46
12	22.01	0.98	14.27	53.98	6.64	1.61	0.50

Table 9: Variance decomposition for reserves – linear oil price

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	OP	res	int	inf	gdp	ex	er
1	0.65	99.35	0.00	0.00	0.00	0.00	0.00
6	17.56	77.64	0.77	1.73	0.41	1.24	0.66
12	18.55	61.11	4.84	3.49	3.09	4.59	4.34

In the case of linear oil prices, approximately 52% of the error in the forecast of GDP is explained by its own shocks even after 12 months, while the other macroeconomic variables explain about 38%. Amongst macroeconomic variables, interest rate explains the highest amount (19%) of error in the forecast of GDP. Linear oil prices explain only about 11% of the error in GPP forecast. For inflation, its own shocks explain about 54% of the

error in the forecast while oil price explain about 22% of the error in the forecast. Again, interest rate, among the macroeconomic variables, has the highest explanatory power in error of the forecast of inflation. In case of reserves, own shocks and oil price explain the majority of the error in the forecast.

Table 10: Variance decomposition for GDP - NOPD

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	NOPD
1	0.50	11.13	88.37	0.00	0.00	0.00	0.00
6	1.81	11.28	65.59	6.19	5.61	8.08	1.46
12	3.37	11.64	57.94	6.24	8.40	8.92	3.49

Table 11: Variance decomposition for inflation - NOPD

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	NOPD
1	2.91	1.57	0.23	95.29	0.00	0.00	0.00
6	0.83	2.67	8.33	82.37	1.20	3.81	0.79
12	2.36	3.36	18.27	65.48	3.54	4.41	2.59

Table 12: Variance decomposition for reserves - NOPD

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	NOPD
1	3.09	3.46	0.47	4.13	2.88	85.99	0.00
6	4.80	1.62	4.90	8.10	4.15	74.78	1.65
12	3.44	2.11	16.98	7.43	5.00	58.19	6.85

Variance decomposition with asymmetric oil prices shows similar results. Net oil price decrease (NOPD) only explain about 3.5%, 2.6% and 6.8% of error in the forecast of GDP, inflation and reserves after 12 months respectively. Macroeconomic variables jointly explain about 49% of error for GDP forecast, 35% of error forecast for reserves and 32% for inflation. In case of GDP, next to its own shocks, exchange rate best explains the remainder of error in the forecast. For inflation, after accounting for its own shocks, GDP best explains the remainder of error in the forecast. In case of

reserves, its own shocks explain the bulk of the error in the forecast while GDP explain considerable portion of the remainder of the variance of the error. The high explanatory power of macroeconomic variables, particularly exchange rate and interest rate, is also an indication that monetary policy can be employed when there are oil price shocks.

## **Discussion**

Overall, the results suggest that oil price shocks have limited impacts on the Sri Lankan economy. With linear oil price variable, price shocks affect GDP, interest rate and reserves, but do not affect inflation and other macroeconomic variables. According to economic theory, interest rate can affect inflation, but in this case none of the variables, except NOPD, seem to affect inflation. Predictably, Sri Lankan economic indicators do not affect international oil prices. The results of asymmetric oil prices are more revealing. A positive oil price shock affects foreign reserves and the interest rate. A negative oil price shock has a bigger impact on the economy as they affect GDP, interest rates and exports. Thus, the results suggest that the Sri Lankan economy is insulated from the international oil price increases to a certain extent. The government has the ability to employ monetary expansionist policies without worrying about additional inflationary pressures on the economy.

In addition to the government's price regulatory policy, energy policies seem to have an impact on insulating the economy from oil prices shocks. Energy intensity in the Sri Lankan economy has declined substantially over the period considered in this study. It declined from 551 TOE per unit of GDP to about 382 TOE per unit of GDP. This decline has decoupled energy use and economic growth to some extent. Dependency of the Sri Lankan economy more on services sector and less energy intensive sector for its growth has produced this result. In addition, flexibilities of the labour markets and concerted efforts of the government to curb inflation may have contributed to the reduction of the impacts of oil price shocks on the economy.

Sri Lanka also use state-to-state deals with the government of Iran, Saudi Arabia, United Arab Emirates and Malaysia (Sustainable Energy Authority, 2007). These state-to-state deals further insulate the Sri Lankan economy from international oil price volatility as there were concessions for oil imports. Having state-to-state deals is equivalent to having a negative oil price shock. The results show that such a deal would be beneficial for the country as there are increases in GDP and exports. The oil price regulatory policy takes away the negative effects of increased international oil prices while maintaining the benefits of decreased international oil prices.

In 2012, there were sanctions on Iranian oil exports (Harmer, 2012). This meant that Sri Lanka had to find other sources for importing oil. The results show that Sri Lanka had to use up increased amounts of foreign reserves to acquire oil imports. This is equivalent to a positive oil price shock, but only economy experienced limited impact as results of this paper show that oil price increases (ROPI and NOPI) do not affect GDP and inflation. However, there can be indirect effects because ROPI and NOPI affect reserves and interest rate.

Interestingly, both negative and positive oil price shocks affect the interest rate in Sri Lanka in opposite directions. A positive oil price shock increased the interest rate, while a negative oil price shock decreased the interest rate. This response is expected as the interest rate is another method of insulating the economy and dealing with the decreases in foreign reserves. Generally, impacts of oil prices on inflation are transmitted to the economy through increased interest rates (Cognigni and Manera, 2008). Even though the NOPI cause changes in interest rate, both linear and asymmetric oil prices do not show granger causality with inflation. Therefore, there is no evidence that the impacts of oil price are transmitted through interest rate to affect inflation in Sri Lankan economy during 2000-2013.

The dynamics of the linear oil price impacts show that foreign reserves reaches the maximum impact in a short amount of time, whereas the impacts for GDP and interest rate take longer time to reach maximum level. In terms of magnitude, the largest impact of oil price decrease has been observed in GDP. The dynamics of asymmetric oil price shocks are quite similar to those in the linear oil price shocks. Only oil price decreases affect GDP and response of GDP is quick for oil price decreases, compared to the interest rate changes. In small economy that depends on oil importation, changes in foreign reserves reacts quickly to oil price shocks. Impacts on GDP and interest rate are transmitted through various channels, consequently changes in these variables take more time to reach the maximum.

## **Conclusion**

This study examines the impact of oil price shocks on Sri Lankan economy using monthly data from 2000 to 2013. It examines both linear and nonlinear impacts of oil price shocks in the Sri Lankan economy. A Vector Auto Regression (VAR) model augmented with Toda and Yamamoto procedure was estimated to examine the direction of causality, magnitude of the impacts and the dynamic nature of responses. The linear oil prices affect GDP, foreign reserves and interest rate. A positive international oil price shock affects foreign reserves and the interest rate, while a negative international oil price shock affects GDP, interest rates and exports.

Asymmetric oil price shocks show that oil price decreases have larger and quicker impacts on the economy. Oil prices, mainly oil price decreases, affect the GDP. Impact of oil price decrease is larger as well as quicker. In the case of linear oil prices, which include both oil price increase and decrease, the maximum impact on GDP takes place 7 months after the shock. In case of oil price decrease, the maximum impact occurs within 2-3 months. Both linear and asymmetric oil prices do not affect inflation. This lack of impact on inflation allows the government to employ expansionary monetary policy during positive oil price shocks to avoid recessions. The forecast error variance decomposition shows considerable interaction amongst macroeconomic variables. The overall results indicate that the economy has a certain degree of insulation from international oil price increases due to price regulatory policy of the government. Additionally, energy policy has also contributed to insulate the economy from oil price shocks through reduction in energy intensity in the economy.

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## Appendix A: Generalized Impulse Response Functions - Asymmetric Oil Price Shocks

Figure A.1: Impulse response function of reserves -AGP

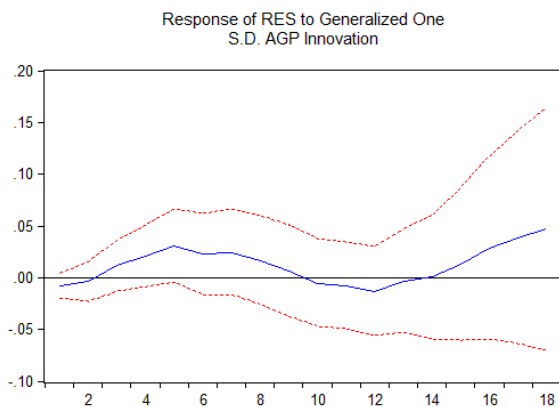


Figure A.2: Impulse response function on interest rate - AGP

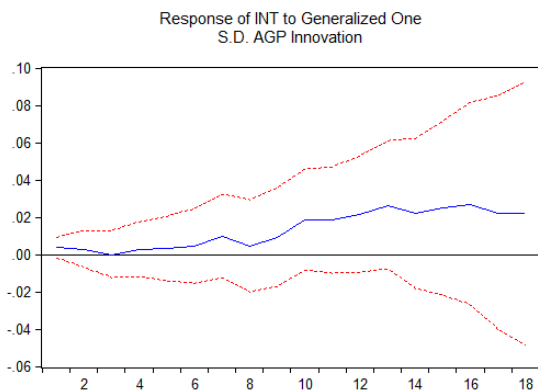


Figure A.3: Impulse response function of interest reserves - AGN

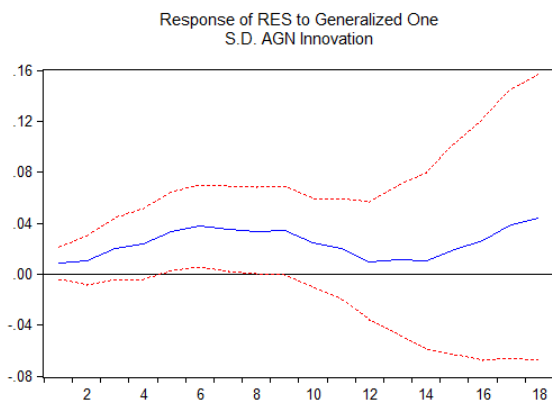


Figure A.4: Impulse response function on interest rate - AGN

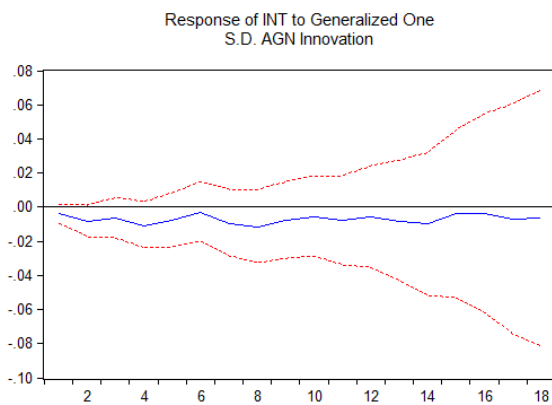


Figure A.5: Impulse response function of GDP - AGN

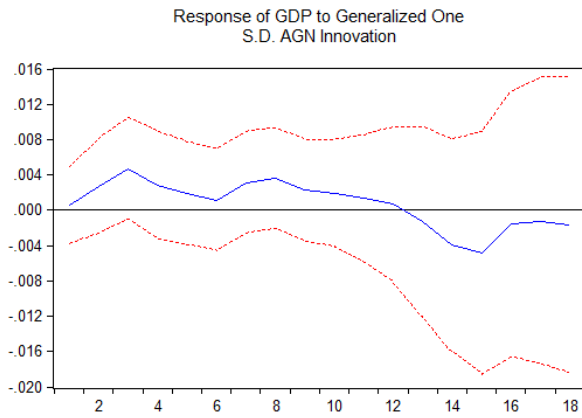


Figure A.6: Impulse response function of interest rate - NOPI

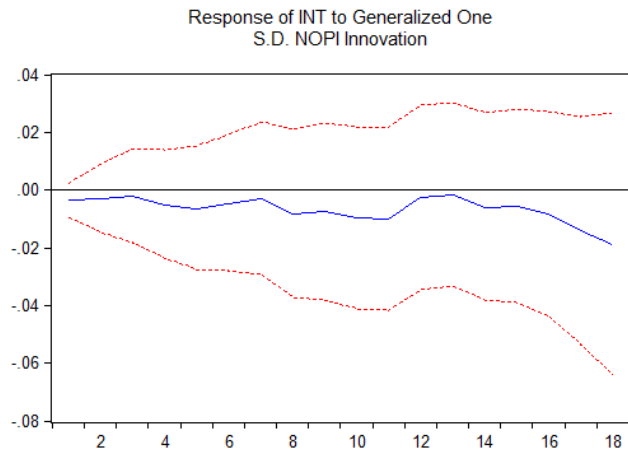


Figure A.7: Impulse response function of GDP - NOPD

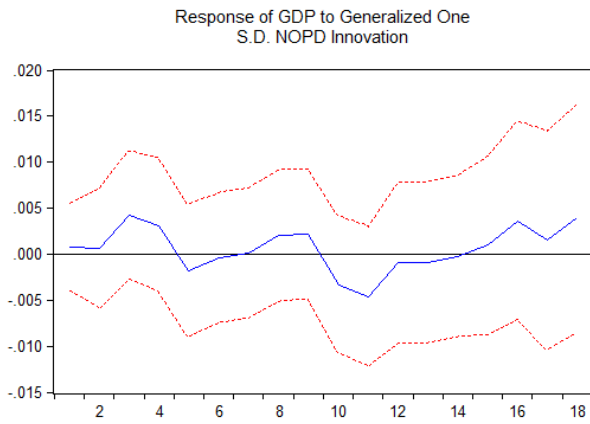


Figure A.8: Impulse response function of exports - NOPD

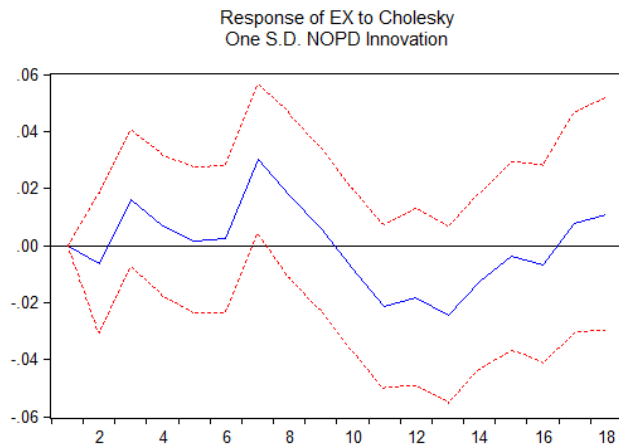


Figure A.9: Impulse response function of inflation - NOPD

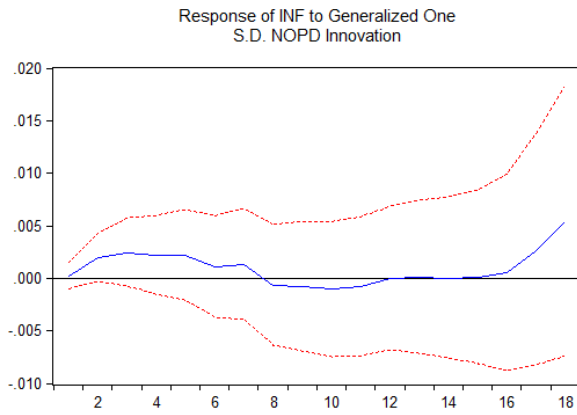


Figure A.10: Impulse response function of reserves - ROPI

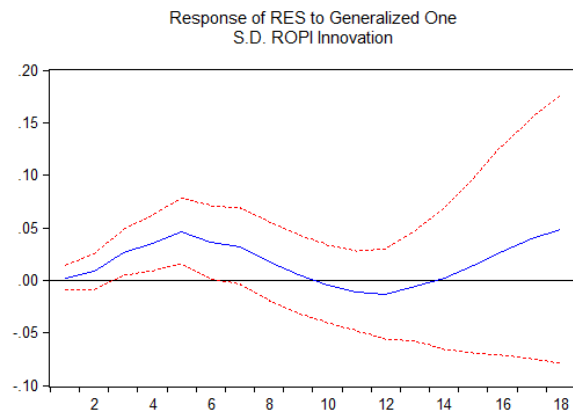


Figure A.11: Impulse response function of interest rate - ROPD

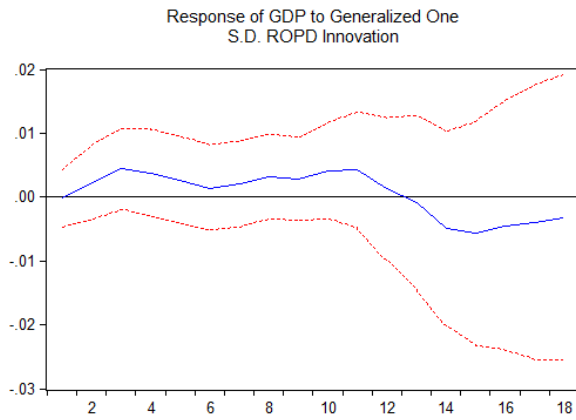


Figure A.12: Impulse response function of interest rate - ROPD

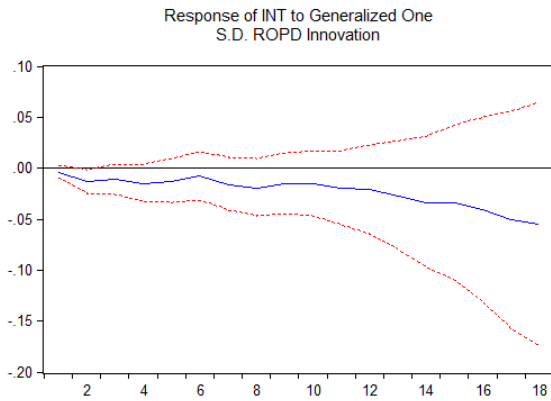
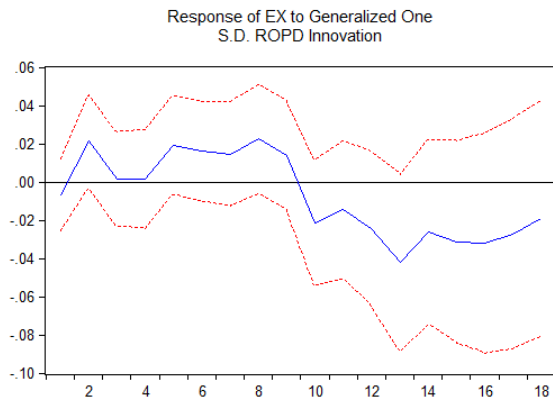


Figure A.13: Impulse response function of interest rate - ROPD



**Appendix B: Variance Decomposition Results for Oil Price Variables**

Table B.1: Variance decomposition for oil price - linear impact

Forecast Horizon	Variance Decomposition (Percentage Points)						
	OP	res	int	inf	gdp	ex	er
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00
6	67.13	6.70	8.04	5.59	6.80	4.27	1.46
12	56.30	8.82	9.57	9.45	8.25	5.68	1.93

Table B.2: Variance decomposition for oil price - AGN

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	Inf	int	res	AGN
1	4.19	0.02	0.13	7.52	2.69	0.21	85.24
6	4.16	3.59	6.03	11.52	15.36	5.62	53.73
12	7.66	5.81	7.61	19.38	14.13	5.68	39.72

Table B.3: Variance decomposition AGP

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	AGP
1	0.20	1.40	1.10	5.44	0.44	0.00	91.43
6	1.50	3.37	2.99	9.87	7.42	0.00	74.86
12	3.82	6.28	6.08	9.02	12.35	0.00	62.44

Table B.4: Variance decomposition MN

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	ROPD
1	6.22	0.74	0.15	3.50	1.65	0.00	87.73
6	4.78	3.73	11.78	6.43	7.70	0.00	65.59
12	14.52	4.72	11.34	13.19	16.10	0.00	40.13



Table B.5: Variance decomposition MP

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	ROPI
1	0.00	0.08	3.47	4.96	0.92	0.00	90.57
6	1.73	4.01	4.09	11.47	5.35	0.00	73.36
12	2.94	8.01	4.65	11.96	13.25	0.00	59.18

Table B.6: Variance decomposition NOPD

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	NOPD
1	1.95	0.44	0.02	0.22	0.00	11.66	85.72
6	2.00	3.14	18.93	1.68	2.39	17.28	54.58
12	6.20	4.34	17.08	8.32	5.54	14.90	43.63

Table B.7: Variance decomposition NOPI

Forecast Horizon (months)	Variance Decomposition (Percentage Points)						
	er	ex	gdp	inf	int	res	NOPI
1	3.85	0.00	0.04	1.13	0.70	0.93	93.34
6	8.13	3.23	2.76	12.38	7.55	1.47	64.48
12	8.90	5.80	3.19	11.00	11.56	5.49	54.07