THE IMPACT OF OIL PRICE SHOCKS ON ECONOMY: EMPIRICAL EVIDENCE FROM AZERBAIJAN

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Submitted to

Central European University

Department of Economics

In partial fulfilment of the requirements for the degree of Master of Arts

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Budapest, Hungary

2010

Acknowledgement

I want to express my gratitude to all my friends and relatives who were supporting me during the thesis writing period. First of all, I want to thank my family for their never-ending support and understanding, care and love. I also really appreciate Peter Medvegyev for all his helpful academic comments and support. I do hereby send my greetings to my friend Orkhan Najafov with whom I enjoyed two fantastic years and to thank him for his priceless assistance in thesis writing. But, most importantly I want to acknowledge my endless gratitude to my academic supervisor, Professor Gabor Korosi for his understanding and patience, useful comments and advices.

ABSTRACT

Due to the high dependence on oil revenues, oil price fluctuations have a significant impact on the Azerbaijani economy. As such, it is important that we should know the relationship between oil price shocks and the macroeconomy. By applying a VAR approach, this paper assesses empirically, the dynamic relationship between linear and asymmetric oil price shocks and the major macroeconomic variables in Azerbaijan. Granger causality tests and VAR analysis were employed using both linear and non-linear specifications. I find that economy of Azerbaijan is vulnerable to oil price fluctuations. In particular, linear oil price shocks affect inflation and real export significantly. Contrary to previous empirical findings for oil net importing developed countries, oil price fluctuations do not affect industrial output. Surprisingly, I can not identify significant impact of oil price fluctuation on real government expenditures.

Contents

1 Introduction

The present study is motivated by the fact that Azerbaijan relies heavily on crude oil export revenues. Being prone to sharp fluctuations, oil prices have repeatedly been blamed for causing undesirable macroeconomic impacts. For this purpose, it is vital to analyse the effect of these fluctuations on the Azerbaijani economy and trace the channels of transmission of oil price shocks to the Azerbaijani economy.

This paper contributes to the rare literature on the effect of oil price changes on oil exporting transition country. To be more precise, this work is the first detailed study of such kind on the Azerbaijani economy. To date no study, to our knowledge, has been undertaken to estimate these effects on the Azerbaijani economy. Selecting variables in such a way that to capture all spheres of economy and utilizing four specifications of oil price shocks and three analytical tools this paper attempts to empirically examine the impact of oil price shocks on macroeconomic variables. Estimating the consequences of oil price shocks on macroeconomic variables is relevant in the case of Azerbaijan since, as a small open economy, it does not influence the world price of oil. At the same time Azerbaijan is significantly influenced by the oil price fluctuations as an oil exporter.

The finding of this paper is that oil price shocks do matter for Azerbaijan economy. Three econometric tools are applied to the estimated unrestricted six variable VAR models: Granger causality test, impulse response functions and variance decomposition. Four VAR models are built using monthly data for the period between 1999M1 and 2009M12. The specifications are symmetric or linear oil price shocks, positive oil price shocks, negative oil price shock and net oil price increases (NOPI). The last three specifications are used to allow macroeconomic variables to respond differently to positive and negative oil price fluctuations.

The results of the Granger causality test indicate that positive oil price shocks do not Granger cause macroeconomic variables. Negative oil price shocks Granger cause real government expenditure and inflation. The calculated impulse responses exhibits that inflation positively responds to symmetric oil price shocks. However, I could not find any significant impact of symmetric oil price shocks on neither real GDP nor real government expenditures.

The study is organized as follows. The second chapter provides quick overview of country information. In the third chapter literature is reviewed. The fourth chapter describes the data and times series properties of the variables and identifies the specifications of oil price shock. In the next chapter VAR methodology is explained. The sixth chapter presents the empirical results and comparative analysis of results. Conclusion and policy implications are given in the last chapter of thesis.

2 Country Information

After the collapse of USSR, Azerbaijan has completed its post-Soviet transition into major oil based economy. This transition from central planning system to market economy had its difficulties. During the first years of independence Azerbaijan encountered dramatic falls in GDP. Azerbaijan has considerable oil reserves and the economy of the country has fundamentally changed since the increase in oil production and opening of the Baku Tbilisi Ceyhan (BTC) pipeline. Azerbaijan's oil production has increased dramatically since 1997, when Azerbaijan signed the first production-sharing aggreement (PSA) with the Azerbaijan International Operating Company. This rapid increase in oil export caused the GDP to increase. The real GDP was more than 26 percent in 2005 thus reaching record 35 percent in 2006. Such a high GDP growth made Azerbaijan the fastest growing economy in the world. However, increased oil production and exports together with high prices has made Azerbaijan more than ever focused on oil. Currently the oil sector accounts for about 54 per cent of GDP and three quarters of industry. Machinery, chemical industry, construction, and telecommunication sectors which are all non-oil sectors has also grown by about 12 percent, thus reflecting spill over effects from oil and gas.

Due to the huge oil revenues fiscal position of Azerbaijan improved which resulted in increased budget revenues in 2006. Increased budget revenues allowed government to increase public spending particularly in infrastructure investments. In 2004 Azerbaijan had budget deficit of 30 percent mainly due to the construction-related expences of major export pipelines. Once these constructions were over, budget deficit turned into 16 percent surplus in 2006 which was mainly due to the dramatic increases in oil exports.[1] Continued wage increases, large increase in oil exports, and growth in domestic demand have exerted upward

[1] These numbers are taken from the website of European Bank of Reconstruction and Development.

pressure on monetary growth. The result has been a continued increase in inflation, which reached about 11.4 per cent at the end of 2006 and more than 16 per cent in March 2007 from 5.4 per cent at the end of 2005. The real exchange rate appreciated by about 10 per cent per year during the past two years raising concerns about the loss of competitiveness of the non-oil sector.

Foreign direct investments (FDI) play a significant role in Azerbaijani GDP. FDI flows to Azerbaijan increased by 6 times, from $227 million in 2001 to $1,392 million in 2002. FDI is mostly directed to the oil and gas industry. The enormous inflow of the foreign currency into the economy has been important due to the fact that it assisted in stabilization of balance of payments.

Currently, one of the main goals of Central Bank of Azerbaijan is to maintain the balance between exchange rate appreciation and inflation. In addition, Central Bank of Azerbaijan maintains the financial liquidity in order to boost the development of non-oil sector through open market operations.

3 Literature Review

Since the early 1980s a large number of studies using a vector autoregressive (VAR) model have been made on the macroeconomic effects of oil price changes. However, most of these studies were done for oil importing countries, particularly the United States, and revealed that oil price increases negatively affect economic activities. There are ranges of empirical literatures investigating the relationship between economic growth and oil price fluctuations. One of the pioneer works on oil price effects was conducted by Hamilton (1983). Hamilton found out that there was correlation between oil price changes and economic output, this was not result of historical coincidence for the 1948-72 periods and concluded that oil price increases have a negative impact on economic activities. Following Hamilton various empirical studies have come forward to explore the direct and indirect impacts of oil shocks on macroeconomic performance of different economies. Hamilton's results have been confirmed and extended by other researchers. Harrison and Burbidge (1984) constructed VAR models for Canada, Germany, Japan and the United Kingdom and showed that oil price shocks have a significant negative impact on industrial production. Hooker (1996) confirmed Hamilton's result and revealed that the oil price changes exert influence on GDP growth for the period 1948-72. Mork (1989) suggested an asymmetric definition of oil prices and made distinctions between positive and negative oil price changes. Moreover, Mork introduced non-linear transformations of oil prices and created the negative correlation between output growth and oil price increases. Mork has also analyzed Granger causality between both variables. Thus, Mork demonstrated that there is an asymmetry in the responses of macroeconomic variables to oil price fluctuations. According to Mork while negative oil price changes exhibit no significant impact, positive shock negatively affects real GNP. Mork's arguments favor the fact that this happens due to the important role of oil as a means of production. Yet, there is no consensus in these studies to what extent oil price shocks contribute to the US economy. Lee, Ni, and Raati (1995) revised oil price shocks and real US GNP growth over the period 1949-92. They emphasized on the volatility of oil prices, and disclosed Mork's method of separating positive and negative effects relinquishes the effect of oil price shock on real GNP. Lee, Ni, and Raati decided that positive oil price shocks are significantly negatively correlated with real GNP growth; however, negative oil price shocks didn't reveal significant impact. These researches basically suggest that oil price fluctuations and exchange rate volatility have substantial impact on economic activities. The consequences of oil price changes are supposed to be different for oil importing and exporting countries. Thus, oil price increase is good news for oil exporting countries and bad news for oil importing countries. Both supply and demand channels are included in transmission mechanisms through which oil prices exert influences on real economic variables. When it comes to oil exporting countries, it is worth to note works of Mork Olsen and Mysen (1994), Bjornland (2000), Semboja (1994), Ayadi *et.al* (2000), Eltony and Al-Awadi (2001), Raguindin and Reyes (2005), Anshasy *et.al* (2005), Berument and Ceylan (2005), Olomola and Adejumo (2006), Cunado and Perez de Gracia (2004), Farzanegan and Markwardt (2007).

Mork Olsen and Mysen (1994) found out that oil price changes positively affect economy of Norway. In a contrast, oil price fluctuations have a negative impact in the long run for Indonesia and Malaysia. Olomola and Adejumo (2006) checked the effects of oil price shocks on output, inflation, real exchange rate and money supply in Nigeria using quarterly data from 1970 to 2003. Using VAR methodology they demonstrated that oil price volatility has no effect on output and inflation in Nigeria. According to their findings oil price shocks only considerably determine the real exchange rate and money supply in the long run. Olomola and Adejumo arrived to the decision that this may extract the tradable sector, thus leading to the "Dutch Disease". Another research had been done for Nigeria by Ayadi et al (2000). Ayadi et al (2000) examined the effect of oil production shocks for Nigeria over the 1975-1992 periods. The result of this study divulged the positive response of output after a positive oil production shock. Berument and Ceylan (2005) scrutinized how oil price shocks affect the output growth of Middle East and North African countries. Some of these countries are either exporters or importers of oil commodities. They constructed a structural vector autoregressive (SVAR) model over the period of 1960-2003 focus by concentrating on world oil prices and the real GDP. Impulse responses exhibit positive and significant impact of the world oil price on GDP of Algeria, Iran, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia and UAE. As a contrary, for Bahrain, Egypt, Lebanon, Morocco and Yemen they did not find a significant impact on oil price shocks.

Aliyu et al (2009) is one the latest works concentrating on non-linear approach of oil price shocks. They examined the effects of oil price shocks on the real macroeconomic activities of Nigeria. For this purpose they employed Granger causality test and multivariate VAR analysis using both linear and non-linear specifications. Non-linear specifications include two approaches, namely, the asymmetric and net specifications of oil oil price shocks. Aliyu et al (2009) found evidence of both linear and non-linear impact of oil price shocks on real GDP. Particularly, asymmetric oil price increases in the non-linear models are found to have positive impact on real GDP growth of a larger magnitude than asymmetric oil price decreases adversely affect real GDP.

I will talk about methodology employed of this thesis in more detail in the methodology section. I will briefly describe the methods I used in thesis. Similarly to Aliyu et al (2009), I have also used both linear and non-linear specification of oil price shocks. In particular, I employ linear oil price shock, positive oil price shock, negative oil price shock and net oil price increase approach. However, my results completely differ from those obtained by Aliyu et al. Aliyu et al concluded that asymmetric oil price increases in the non-linear models are found to have positive impact on real GDP growth. My models say that neither linear nor non-linear models have a significant effect on real GDP growth.

Following Mork (1989), Lee et al (1995), Hamilton (1996, 2003), Jimenez-Rodriguez (2002), Jimenez-Rodriguez and Sanchez (2004) and more recently, Gounder and Bartleet (2007) all introduced non-linear transformations of oil prices to re-establish the negative relationship between increases in oil prices and economic downturns.

Gounder and Bartleet (2007) investigated oil price shocks and economic growth in Venezuela using the VAR methodology based on quarterly data. The authors analysed the short-run impact of oil price shocks in a multivariate framework which traced the direct economic impact of oil price shocks on economic growth.

Francesco Guidi (2009) investigated the relationship between changes in oil prices and the UK's manufacturing and services sector performances. Before Guidi (2009) very few studies conducted at the sector level. Guidi contributed in that direction. Guidi as well as other authors employed three sets of vector autoregressive models; linear and non linear oil price specifications. From the linear oil price specification VAR model, the impulse response function reveals that oil price movement causes positive effects in both the output of manufacturing and services sector. From the asymmetric specification, it has been found that positive oil price changes negatively affect manufacturing sector, while the services sector does not seem to be affected by increases.

In a recent study by Jin (2008) on the effect of oil price shocks and exchange rate volatility on economic growth, he demonstrates that the oil price increases exerts a negative effect on economic growth of Japan, and China and positive effect on economic growth of Russia. To be more precise, he concluded that 10 percent permanent increase in international oil prices is associated with a 5.16 percent growth in Russian GDP and 1.07 percent decrease in Japanese

GDP. His model was based on the Hamilton's (1983) linear specification, which assumes symmetric oil-real GDP relationship.

The literature on the impact of oil price shocks on developing oil exporting countries is limited. The main focus of research has been on net oil importers and developed countries. Very limited studies have been done to assess the effects of oil price fluctuations on the macro economy of developing countries. My research on effects of oil price shocks on macroeconomic activities of Azerbaijan can be considered as a contribution to this field.

Eltony and Al-Awadi (2001) in their research on Kuwait find that linear oil price shocks are significant in explaining fluctuations in macro economic variables of Kuwait. According to their result oil price shocks significantly affect government expenditures which are the major determinants of the level of economic activity in Kuwait. However, my results suggest that the response of real government expenditure to one standard shock to linear oil price changes is not significantly different from zero. Thus, the null hypothesis of no effect of oil price changes on real government expenditure can not be rejected.

Anshasy et al (2005) examined the impacts of oil price shocks on Venezuela's economic performance over a long period. Unlike previous authors Anshasy et al employ VAR and VECM technique to assess the relationship between oil prices, government revenues, government consumption spending, investment and GDP.

Mohammad Reza Farzanegan and Gunther Markwardt (2007) applied VAR approach and analysed the dynamic relationship between asymmetric oil price shocks and major macroeconomic variables in Iran. Their main finding was contrary to previous empirical findings for oil net importing developed countries. Thus, oil price increases have a significant positive impact on industrial output. They could not identify significant impact of oil price fluctuations on real government expenditure. This result is also similar to mine. I conclude in this thesis that the response of real government expenditure to one standard shock to linear oil price changes is not significantly different from zero. In addition Farzanegan et al (2007) suggested that the response of inflation to any kind of oil price shocks is significant and positive. I also suggest that the impact of oil price shock on inflation in Azerbaijan is relatively persistent and shows the long-run inflationary effects of oil price increases on the Azerbaijani economy.

Detailed description of methodology and definition of oil price shocks will be given in next sections.

4 Data

4.1 Variables' description

In my analysis I make use six macroeconomic variables: real GDP per capita (*rgdp*), real government expenditures (*rgovexp*), real export (*rexport*), real effective exchange rate (*reer*), inflation (*infl*), and data on real oil prices (*roilp*). The sample comprised monthly observations for the 1999:I-2009:IV period for a total of T=131 available observations. By doing so I use a monthly six-variable VAR for each sector considered. Most of the data were extracted from the database of Central Bank of Azerbaijan[2] (CBAR). The proper definition of applicable oil prices is a challenging task. I use oil prices in real terms, taking the ratio of the nominal oil price in US dollars to the US Consumer Price Index. In this analysis, I make use of linear definition of oil prices. Other than that detailed description of three remained definitions of oil price shock is given in the following subsection.

It is worth to note at this point that many economic processes exhibit some form of seasonality. The seasonal variation of series may account for the predominance of its total variance. So analysis that ignores important seasonal patterns will have a higher variance. I could include seasonal dummies to provide proper forecasts; however, including seasonal dummies will enlarge the size of the model. Thus, the other reason of using deseasonalized data instead of seasonal dummies is to avoid excessive size of the model. Therefore, all variables are deseasonalized by Census X12 procedure, with multiplicative adjustment for all variables except inflation for which an additive adjustment is used. Moreover, all variables are

[2] www.cbar.az

expressed in logarithms. Nominal variables (government expenditure, GDP, and export) are converted to real terms by dividing them to CPI.

All variables are included to capture some of the most important transmission through which oil price fluctuations may affect economic activities indirectly. These channels include effects of oil prices on inflation and exchange rate, which then lead to changes in real economic activity.

There are several macroeconomic considerations need to be analyzed before we can include the above mentioned variables. First of all, real GDP per capital have been included because the one of the main targets of this work is to analyze how the GDP of oil exporting country reacts to oil price fluctuations.

The reason of enclosing of Real Effective Exchange Rate (REER) based on the fact that fluctuations of oil prices often lead to an appreciation of the currencies of oil exporting countries, in that perspective, appreciation of AZN (Azerbaijani Manat) may harm the competitiveness of Azerbaijani manufactured goods and services in international markets.

Finally I decided to use the rate of inflation because, according to Darby (1982) and increase in real oil prices is a major cause of inflation both in United States and abroad.

4.2 Oil Price Shocks

The definition of oil price adopted for this study is symmetric and asymmetric oil price fluctuations. The model estimated employs both linear and non-linear oil price transformations to examine short run impacts. Besides symmetric methodology there is also broad literature on asymmetric specification of oil price changes. In this work, I will use

Mork's (1989) *asymmetric specification in* which increases and decreases in the price of oil were introduced as separate variables and Hamilton's (1996) *net specification,* in which the relevant oil prices are used to compare the current oil price with a maximum oil price over the previous year.

As it is shown in Mork (1989), asymmetric specification constructs the positive and negative oil price changes separately.

$$oil\_price_t^{+} = \begin{cases} oil\_price_t & if \quad oil\_price_t > 0 \\ 0 & otherwise \end{cases} \qquad \textbf{(1.1)}$$

$$oil\_price_t^{-} = \begin{cases} oil\_price_t & if \quad oil\_price_t < 0 \\ 0 & otherwise \end{cases} \qquad \textbf{(1.2)}$$

Lilien (1982) developed sectoral shift hypothesis in which these two equations emerges as theoretical foundation. According to Lilien (1982) both positive and negative price changes may cause to modification of marginal product of factor inputs encourage sectoral reallocation of various resources on the supply side of the economy. As I already mentioned non-linear price measures were first developed by Hamilton (1996) and Lee, Ni and Ratti (1995). The motivation for these works was the idea that oil price volatility leads to investment and consumption uncertainty through which oil prices can affect economic growth.

The computation of scaled specification of oil price shocks is done according to Lee et al (1995). The main goal of *scaled oil price* developed by Lee, Ni and Ratti (1995) was to account for the fact that a change in oil prices will have a smaller impact on macroeconomic variables when the volatility of oil prices is high. To consider volatility of oil prices Lee, Ni and Ratti (1995) employed Generalized Autoregressive Conditional Heteroskedasticity (GARCH):

$$o_t = \alpha_0 + \alpha_1 o_{t-1} + \alpha_2 o_{t-2} + \alpha_3 o_{t-3} + \alpha_4 o_{t-4} + \varepsilon_t \qquad \textbf{(1.3)}$$

$$h_t = \gamma_0 + \gamma_1 e_{t-1}^2 + \gamma_2 h_{t-1} \qquad \textbf{(1.4)}$$

$$e_t \,|\, I_{t-1} : N(0, h_t) \qquad \textbf{(1.5)}$$

$$SOPI = \max\left\{ o, \hat{e}_t \big/ \sqrt{h_t} \right\} \qquad \textbf{(1.6)}$$

$$SOPD = \min\left\{ o, \hat{e}_t \big/ \sqrt{h_t} \right\} \qquad \textbf{(1.7)}$$

SOPI here stands for a scaled oil price increase and SOPD for scaled oil price decrease. The recursions to create SOPI use the estimated unconditional variance and its square root, respectively, for the initial values of h_t and $\hat{e}_t$. However, I have not employed scaled oil price measure in my work.

Finally, Hamilton proposed non linear transformation which is called *net oil price increase* (NOPI). [3] In his paper he analyzed adjustments of oil price increases to oil price decreases. According to him NOPI is defined as the amount by which oil prices in quarter t, exceed the maximum value over the previous four quarters, and 0 otherwise: that is:

$$NOPI = \max\{0,\ \mathrm{p}_t - \max[\mathrm{p}_{t-1},\ \mathrm{p}_{t-2},\ \mathrm{p}_{t-3},\ \mathrm{p}_{t-4}]\ \} \qquad \textbf{(1.8)}$$

Again we see here that Hamilton's definition of oil price shock exhibits asymmetric property in the sense that it captures oil price increase-type shocks and does not consider the impact of oil price declines. Earlier evidence that oil price decreases didn't have significant role in US business cycles only strengthens this inspiration. Hence, transformation of price variables in such a method concentrates on those price increases that take place after a period of relative stability, thus putting fewer accents on price fluctuations that come about periods of price volatility.

4.3 Stationarity and Unit Root tests

Before choosing the methodology of the paper to analyze the impact of oil price shocks on macroeconomic activities, I will give brief description of time series properties of the variables. The reason for tests conducted on variables is that there are two aspects of formulating VAR models which are not solved easily. These aspects are the choice of variables to be included into the VAR system and the choice of the lag length p. These choices are made keeping in mind that the model should be as parsimonious as possible.

[3] For detailed explanation see Hamilton, J.D. (1996) "What happened to Oil Price-Macroeconomy Relationship?" Journal of Monetary Economics 38: 195-213.

Lag length decision or so-called information criteria is one of the most important tests that should be done before estimating the model. Every additional variable increases the fit of any regression according to standard regression theory. Thus, it is obvious that VAR(p+1) will fit the data better than a VAR(p). Even though increasing lag will improve the fit of the model, it will cause p*k additional parameters. Therefore, information criteria measures must be estimated as these criteria provide a trade-off between goodness of fit and the number of parameters estimated. Here, in this work, I used two information criteria; Schwarz Bayesian Criterion (SBC) and the Akaike Information Criterion (AIC):

$$SC = \ln|\Sigma| + \frac{pk^2 \ln(T-p)}{T-p}$$
$$AIC = \ln|\Sigma| + \frac{2pk^2}{T-p} \qquad \textbf{(1.9)}$$

Here, p is the number of lag, k is the number of regressors and T is the sample size. Σ is unknown, and can be replaced by the variance covariance matrix of the estimated residuals $\hat{\Sigma}$. It is widely accepted that smaller values of the measure indicated improved models. Enders (2004) stated that these values can be even negative. The lag length which results in the smallest SBC or AIC is then seen as the optimal lag length. If there is ranking conflict between two criteria, SBC tends to choose a more parsimonious model compared to AIC. The results of these tests are presented in Appendix 1.

ADF (Augmented Dickey and Fuller) test and PP test (Philips Perron) are conducted to check stationarity of variables. To be precise, three specifications of each test are carried out: with and intercept, with trend and intercept, and with no trend and no intercept.

1. With intercept: $\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \mu_t$ **(2.0)**

2. Without trend and intercept: $\Delta_t = \alpha_1 y_{t-1} + \mu_t$ **(2.1)**

Francesco Guidi et al (2009) test the following hypothesis:

$$H_0: \ \delta = 0 \text{ (Unit Root)}$$
$$\mathrm{H}_1: \ \delta \neq 0 \qquad \textbf{(2.2)}$$

Conventional t-ratio for δ is used to evaluate the hypothesis:

$$t_\delta = \frac{\hat{\delta}}{se(\hat{\delta})} \qquad \textbf{(2.3)}$$

Here, $\hat{\delta}$ is the estimate of δ. However, Dickey and Fuller (1979) have shown that under the null hypothesis of a unit root, we can not use the conventional t-distribution. In such situation the following can be applied to make decision:

$t_\delta > ADF$ critical value $\longrightarrow$ *not* reject null hypothesis (unit root exists)
$t_\delta < ADF$ critical value $\longrightarrow$ *reject* null hypothesis (unit root does not exist)

Moreover, I have used a Philips-Perron (PP) Test to check stationarity of variables. The null hypothesis that the variable has a unit root is rejected for all specifications of oil price shocks except linear oil price shocks by both tests at the conventional levels. Linear oil price shock has unit root. Log levels of the real effective exchange rate, real government expenditures, real export, real GDP and log of seasonally adjusted inflation are found to be unit root processes. Both tests show that these variables are I(1) processes. This simply means that in the case of the variables that have unit roots both tests reveals that their log differences are stationary.

5 Methodology

5.1 Foundations for VAR Methodology

Whenever, we have several time series, we have to take into account the interdependence between them. There are number of ways to work with multiple time series, one can estimate a simultaneous equations model with lags on all variables. However, doing this, we need to first, classify variables into two categories; endogenous and exogenous. Second, to achieve identification we have to impose some constraints on the parameters.[4] These steps involve difficult justification. As an alternative Sims (1980) suggests the vector autoregression (VAR) approach.

Thus, I will use an unrestricted VAR model to investigate the response of macroeconomic variables to positive and negative innovations in oil prices. The VAR model provides a multivariate approach where changes in its own lags and to changes in other variables and the lags of those variables. In fact, VAR model regresses each variable from a set of variables on its own lagged values together with the lagged values of the other variables. Basically, the VAR framework is conducted to avoid endogeneity concerns. The VAR treats all variables as endogenous and does not impose a priori restrictions on structural relationships. Given that VAR expresses the dependent variables in terms of predetermined lagged variables, it is a reduced form model. Macroeconomic study of oil price shocks can be studied by employing alternative approach. Particularly, structural vector autoregressive models (SVAR) better suits to oil price shocks analysis. SVAR models identify the variance decomposition and impulse response functions by imposing a priori restrictions on the covariance matrix of the structural

[4] Maddala et al (2001)

errors. However, validity of priori restrictions is quite disputable, thus making SVAR models less applicable.

Furthermore, before estimating unrestricted VAR model, I need to decide whether I have to use a VAR model in levels or in first differences. Not all the variables in my model follow a I(0) process. This is quite intuitive as the most time-series variables exhibits non-stationarity patterns. Hamilton (1994) suggests that one option is to ignore the non-stationarity altogether and simply estimate the VAR in levels. The other alternative is consistently to difference any apparently non-stationary variables before estimating the VAR. Other than that it should also be discussed whether an unrestricted VAR should be used where the variables in the VAR are cointegrated. There is number of authors who support the use of a vector error correction model (VECM), or cointegrating VAR in such a situation. Even though 5 of six variables are I(1) process, I decided not to estimate Vector Error Correction models. It has been argued that in the short term, unrestricted VAR perform better than a cointegrated VAR or VECM. The reason for such a conclusion is sample period. In my model, I use short sample, therefore employing VECM instead of unrestricted VAR may cause to reject the null of no cointegration in small samples. The advantages of unrestricted VAR over VECM can be demonstrated by analyzing impulse response functions in cointegrated systems. [5] Naka and Tufte (1997) estimated system of cointegrated variables as a VAR in levels and as a VECM model. VECM estimates perform poorly relative to those from a VAR. Naka and Tufte (1997) through Monte Carlo simulations also concluded that the loss of efficiency in the VAR estimations of cointegrating variables was not critical for the commonly used short horizon. Moreover, Engle and Yoo (1987), Clements and Hendry (1995) and Hoffman and Rasche

[5] Naka and Tufte (1997)

(1996) conclude that when imposed restrictions are true, an unrestricted VAR produces more superior forecast variance than a restricted VEC model on short horizons.

Finally, considering the existence of equilibrium relationships among non-stationary variables in the system and the mentioned discussions about advantages and shortcomings of different VAR frameworks, I decide to employ an unrestricted VAR system.

5.2 Unrestricted VAR

Our unrestricted vector autoregressive model in reduced form of order p is presented in following equation:

$$y_t = c + \sum A_i y_{t-i} + \varepsilon_t \qquad \textbf{(2.4)}$$

Where $c = \{c_1.......c_6\}'$ is the $\langle 6\times 1\rangle$ intercept vector of the VAR, A_i is the i^{th} $\langle 6\times 6\rangle$ matrix of autoregressive coefficients for i=1, 2….p, and $\varepsilon_t = \{\varepsilon_{1,t},.......,\varepsilon_{6,t}\}'$ is the $\langle 6\times 1\rangle$ generalization of a white noise process.

As described in data section, we use six endogenous macroeconomic variables in our system: *roilp, rgovexp, rgdp, inf, reer,* and *rexp* (all in logarithms). The form of unrestricted VAR system in this work is given by[6]:

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[6] Similar methodology was used by Mohammad Reza Farzanegan et al (2007)

$$\begin{bmatrix} roilp \\ rgov\exp \\ rgdp \\ \inf \\ reer \\ r\exp \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \\ c_3 \\ c_4 \\ c_5 \\ c_6 \end{bmatrix} + \mathrm{A(I)} \begin{bmatrix} roilp_{t-1} \\ rgov\exp_{t-1} \\ rgdp_{t-1} \\ \inf_{t-1} \\ reer_{t-1} \\ r\exp_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix} \qquad \textbf{(2.5)}$$

Where A(I) is the lag polynomial operators, error vectors are mean zero.

$E(\varepsilon_i) = 0$ for all t, $E(\varepsilon_t \varepsilon_s) = \Omega$ if s=t and $E(\varepsilon_t \varepsilon_s) = 0$ if $s \neq t$. Here, Ω is the variance-covariance matrix. Errors are not serially correlated but might be contemporaneously correlated. Thus, Ω is assumed to have non-zero off diagonal elements. As pointed out by Hamilton (1994), the VAR system can be transformed into its vector $MA(\infty)$ representation. This transformation mainly serves to analyze impacts of real oil price shocks:

$$y_t = \mu + \varepsilon_t + \psi_1 \varepsilon_{t-1} + \psi_2 \varepsilon_{t-2} + ... \qquad \textbf{(2.6)}$$

Above equation can be re-written as:

$$y_t = \mu + \sum_{i=0}^{\infty} \psi_i \varepsilon_{t-i} \qquad \textbf{(2.7)}$$

With ψ_0 being identity matrix and μ is the mean of the process:

$$\mu = \left\{ I_p - \sum_{i=1}^{p} A_i \right\}^{-1} c \qquad \textbf{(2.8)}$$

The reason of applying moving average representation is generate the forecast error variance decomposition (VDC) and the impulse response functions (IRF).

In this study, the innovations of current and past one-step ahead forecasts errors are orthogonalised using Cholesky decomposition so that the resulting covariance matrix is diagonal. According to this methodology the first variable in a pre-specified ordering has an immediate impact on all variables in the system besides first variables and so on. Thus, pre-specified ordering is vital and can alter the dynamics of a VAR system. We can describe the vector of exogenous variables in the following way:

$$y_t = \{constan t,\ \text{Z1},\ \text{Z2},\ \text{Z3},\ \text{Z4},\ \text{Z5}\} \qquad \textbf{(2.9)}$$

Here, Z1-Z5 represents all other important exogeneous variables during the period of 1998-2009.

Another important issue in the VAR estimation is the lag order selection. Akaike Information Criteria (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion are the most applicable criteria used in lag order selection procedure. Usually, four lags can be included in case of quarterly data or twelwe lags in case of monthly data. Similarly, we can choose the lag order to be one if we have yearly data. In this work traditional criteria often suggest different number of lags; inverse root test indicates stability of all lags tried, but autocorrelation LM test points out the presence of the serial correlation in the errors when 12th lag included. Likelihood Ratio (LR) shows that 11th lag is significant and should be included, however, other criteria such as AIC, and FPE indicates 2nd lag to be included. In the meantime SC and HQ point out 1st lag to be included. These different results lead to the conclusion that VAR does not adequately represent the data generating process. Thus, the approach used here is to choose the minimum number of lags confirming the stability and no serial correlation conditions are satisfied.

In order to access the impact of shocks on endogenous variables, I examine the orthogonalized impulse response functions using Cholesky (dof adjusted) decomposition method suggested by Doan (1992). The reason for orthogonalization is to isolate the underlying shocks in case if errors are immediately correlated. This paper assumes the following ordering of the six variables used in the VAR: real oil price, real gdp, real government expenditure, inflation, real effective exchange rate and real export. Such an ordering is essential because the orthogonalizaton method involves the assignment of contemporaneous correlation only to specific series. That basically means a shock in the second variable affects all variables, except the first one, and is not affected by them; and so on. An impulse response function (IRF) traces the effects of a one-time shock to one of the innovations on current and future values of the endogenous variables. If the innovations are contemporaneously uncorrelated, the interpretation of the impulse response is straightforward.

$$\left\{\begin{matrix} a_{11} & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{matrix}\right\} \left\{\begin{matrix} e^{oil\_price} \\ e^{rgdp} \\ e^{rgov\exp} \\ e^{\inf lation} \\ e^{reer} \\ e^{real\exp ort} \end{matrix}\right\} = \left\{\begin{matrix} \varepsilon^{oil\_price} \\ \varepsilon^{rgdp} \\ \varepsilon^{rgov\exp} \\ \varepsilon^{\inf lation} \\ \varepsilon^{reer} \\ \varepsilon^{real\exp ort} \end{matrix}\right\} \qquad \textbf{(3)}$$

In the ordering of the variables, the real oil price changes are ranked as an exogenous variable. This is especially true in case of Azerbaijan economy. Although Azerbaijan is one of the major suppliers of crude oil to the global markets in the South Caucasian region, its production and export quota are predetermined. Small country assumption can be applied to Azerbaijan case. Moreover, demand for crude oil is mainly determined by global economic tendency, the level of energy utilization by industrialized countries, speculative actions in oil markets and etc. Thus, oil prices are regarded as exogenous for the Azerbaijanian economy.

Significant shocks in oil markets affect contamperaneously the other key macro economic variables in the system.

I choose the real government expenditures as a second variable in this ordering. Government expenditures include recurrent and capital consumptions. Expenditures on government employees and subsidies can be classified as recurrent expenditures, while capital expenditures aim to increase rather than keep stable the physical and material assets of an economy. During 2005-2007, when the first oil boom started, the government of Azerbaijan decided on extraordinarily large expenditure increases aimed at improving infrastructure and raising incomes. Such an exceptional magnitude of government spending shows the role of government. Actually, the role of the government has also been on the increase since 1995 which automatically reflects in the expansion in total government spending. This is due to the fact that the government is the main recipient of oil rents and attempts to distribute them through increases in investments on infrastructure and salaries which blow up government spending. Total government expenditure increased by a cumulative 160 percent in nominal terms from 2005 to 2007 or from 41 percent of non-oil GDP to 74 percent. (Junko Koeda and Vitali Kramarenko, 2008). This large increase in expenditures raised the question whether the current level of expenditure is appropriate and sustainable in long term prospective.

The third variable included in this ordering is real GDP. It is worth to note that industrial production is alse affected instantly by the level of government demand. The positive development in oil prices which automatically results in increases of government expenditures and income per capita. This increase in government expenditure and income pushes the effective demand upward. Moreover, inefficiencies in overall economy, lack of domestic supply, time lags in response to increased demand may lead the consumer prices upward resulting in inflation.

Eventually, increase in inflation results in real effective exchange rate appreciation. The relative prices of non-tradable goods to tradable goods are measured by the real effective exchange rate which is defined as a weighted real exchange rate index. Whenever domestic prices increase the relative prices of non-tradable goods will increase, while prices abroad remain unchanged. This would result in loss of competitiveness of an economy. In this study, I assume that a shock in real effective exchange rate contemporaneously affects real export in Azerbaijan.

Runkle (1987) suggests reporting impulse response functions with standard error bands. As an indication of significance, I have estimated 95% confidence intervals for the IRF's. These confidence bands are obtained from 1000 draw Monte Carlo simulations. The middle lines in the figures represent the impulse response function while the bands stand for the confidence intervals. The null hypothesis that there is no effect of oil price shocks on other macroeconomic variables cannot be rejected if and only if the horizontal line falls into the confidence interval.

Thus, the impulse response functions illustrate the qualitative response of the variables in the system of shocks to real oil prices. However, we need a variance decomposition to indicate the relative importance of these shocks. It tells us how many unforeseen variations of the variables in the model are explained by different shocks. To get this, I considered the n-step ahead forecast of a variable based on information at time t. Here, I applied four sets of variance decompositions for symmetric, asymmetric (positive and negative formations of oil prices), and NOPI (net oil price increase) formations of oil prices.

The computation of variance decomposition also requires identification. The identification is achieved by imposing the same structure as in the case of impulse responses. Again, the standard errors are also calculated via Monte Carlo simulations with 1000 repetitions

6 Empirical Results

In this section, I will discuss empirical results and analysis of the VAR model. Particularly, I will analyze effects of oil price shocks on the macroeconomy of Azerbaijan by using three analytical tools: Granger causality, impulse response functions and variance decomposition. Additionally, the results will be compared to those of other papers.

It is worth to note that when lower triangular Cholesky decomposition is employed, changing orderings of variables for impulse responses and variance decompositions can give different results. For robustness test we make use of an alternative ordering which is based on VAR Granger Causality: oil price shock, inflation, GDP growth, real export, real government expenditure and real effective exchange rate.[7] Even though I presented results of each specification of oil price shocks, the conclusion and policy implications will be mainly based on the linear oil price shock model. Based on the principles stated on the methodology part for each model I include two lags.

The results for Granger causality test for the variables are presented in Appendix II. It has been found that positive oil price shocks do not Granger cause macroeconomic variables. The Granger causality test also shows that there exists causality between oil price changes and government expenditure as well as between oil price changes and inflation in the case of negative oil price shocks. For the case of NOPI specification I have found that NOPI specification of oil price shocks does not Granger cause any of the macroeconomic variables. Tests for symmetric oil price shocks model indicates that symmetric oil price shocks Granger cause significantly inflation (at 1% significant level). This finding more likely implies that monetary stability in oil exporting transition economy is more sensitive to past oil price

[7] Jimenez-Rodriguez (2007) replaced real effective exchange rate at the end, explaining this by the fact that real exchange rate as an asset price should be contemporaneously affected by all macroeconomic variables.

movements in both direction and in all specifications of oil price shocks except for positive oil price shocks. Another findings for symmetric oil price shocks is that symmetric oil price shocks can significantly help predicting real effectice exchange rate (at 5% significant level). Surprizing result is that almost all specifications of oil price shocks do not Granger cause GDP.

Based on the results of the tests, I can confirm that past movements of negative oil price changes, and symmetric oil price changes forecasts current movements in inflation. For a prediction of real effective exchange rate only symmetric oil price changes can be used and changes in real export can be best explained using again symmetric oil price shock model.

6.1 Impulse Response functions: Linear Specification

Under this section I examine the effects of oil prices macroeconomic variables using orthogonalised impulse response functions for the linear, net and non-linear specifications of the model. Figure 1 shows IRFs base on one standard deviation shock to linear specification of oil price shock. For real GDP growth and real government expenditures the null hypothesis of no effect of oil price changes on GDP cannot be rejected at the five percent level. Based on Monte Carlo confidence bands I can judge that response of GDP is insignificant. The response of inflation to innovations in oil prices is significantly positive. This response is completely significant within a year. Response of inflation to oil price shock gradually rises from initial level to 0.004 percent during the first three months following the shock. In the first quarter the increase in inflation above its initial level reaches 0.0045 percent in linear specification. After half year the impact gets to 0.005 percent and stays at constant 0.005 percent exactly one year after the shock. This suggests that the impact of oil price shock on inflation in Azerbaijan is relatively persistent and shows the long-run inflationary effects of oil price increases on the

Azerbaijani economy. Such a response can be defined as a "spending effect".[8] Spending effect can also be explained by AD-AS model. Azerbaijan is an oil exporting country and oil price increases result in speedy increase of government spending. Thus, spending effect occurs because higher oil prices lead to higher wages in the oil related sectors. Increase in income distribution takes place, thus, increasing power of purchase and demand in the economy. While oil prices are exogenous and only international markets may determine price of oil, the price of non-tradable sections like services is determined within the national market. Push demand inflation in non-tradable sections emerges due to the fact that some fraction of increased demand is shifted to this sector. Here, we explicitly assume that there is no trade-off between tradeable and non-tradeable sectors. Hence, we do not have to take account for transfer of workers from oil sector to non-oil sector.

Another important channel is the effect of oil price shock on the level of real exchange rate. However, the response of real effective exchange rate to linear oil price shocks is only significant in the first month following the shock. As shock happens real effective exchange rate falls by 0.004 percent below its initial level, but after that I observe a positive response and increasing trend of this variable. As a net exporter of oil, Azerbaijan's real effective exchange rate appreciates starting from the first quarter. This may lead to higher inflow of foreign exchange into the economy which was actually the case in the early 2000s. Foreign direct investments to the economy are a positive sign, but, it still has serious drawbacks and implications on real economic activities due to the reliance of the economy on foreign inputs. Starting from the first quarter real effective exchange rate appreciates in increasing temp, thus

[8] Corden (1984) explains both short run and long run inflationary effects of oil price increases within the "resource movement" and "spending effect" framework. According to Corden resource movement takes place when the production factors such as labor can easily move between oil and non-oil sectors. In such a way, oil price increases lead to absorbtion of labor from other sections of economy. Labor qualification between oil and non-oil industries are not similar and oil industries require high capital intensity, therefore, resource movement can not be related to Azerbaijan case.

reaching 0.009 percent at the end of the year following the shock. This could be a sign of the "Dutch Disease"in the long run after oil price shock. "Dutch Disease" can lead to reduction in the competitiveness of the tradable sector of Azerbaijani economy. However, the response of this variable is not significant.

The response of real government expenditure to one standard shock to linear oil price changes is not significantly different from zero. Thus, the null hypothesis of no effect of oil price changes on real government expenditure can not be rejected. This is quite challenging result, as it is totally contradicts with my initial assumption. However, this can be explained by the fact that Azerbaijan government has established State Oil Fund of Azerbaijan (SOFAZ) in 1999 in order to save large part of the windfall oil revenues in an oil fund.[9] The main goals of Fund are to achieve macroeconomic stability, decrease dependence on oil revenues and stimulate the development of non-oil sector. Fund uses only part of oil revenue to finance the capital expenditures, major national scale projects to support socio-economic growth. Fund accumulates and preserves oil revenues for future generations, therefore, it can be concluded that Fund has an effective mechanism for oil wealth management. As we have seen above, real effective exchange rate has a positive response and increasing trend, however is not significant. This is against to our beliefs about "Dutch Disease". According to "Dutch Disease" we expect significant appreciation of real effective exchange rate in the case of positive oil price shocks. This phenomenon can be explained by the role of Fund stated above. Hence, the establishment of oil stabilization fund and controlling government expenditures helped government to successfully save unexpected oil revenue increases for next generations. By controlling government expenditures Fund could successfully tackle with possible appreciation in effective exchange rate.

[9] http://www.oilfund.az/az

Finally, based on Monte Carlo confidence bands I can judge that response of the real export to one standard shock to linear oil price changes is significant. However, I have to include that this response becomes significant only after third month following the shock. In the third month at the time when response becomes significant, real export reaches its maximum; 0.91 percent. In the long run real export experiences a decrease to its initial level, though this decrease still remains significant in the long run.

6.2 Impulse Response Functions: Asymmetric and Net Specification

The impulse responses for the non-linear or asymmetric and net oil specifications are presented in Figures 2-4. Within NOPI specification none of the variables has signicant responses to net oil price increases. Based on Monte Carlo confidence bands it can be concluded that the response of the inflation, real government expenditure, real effective exchange rate, real export, real GDP growth to one standard shock net oil price increases is not significant and the null hypothesis of no effect of oil price changes on macroeconomic variables can not be rejected at the 5 percent level.

Under asymmetric shocks inflation again is significant, and has the similar pattern to those of under symmetric. Thus, in the third month following the shock inflation reaches its maximum 0.002 percent. Starting from the first quarter this increase weakens and becomes insignificant and dies out completely within the year after the shock. The response of real effective exchange rate to is worth to describe in detail. In Appendix III, Figure 2, I demonstrate the responses of variables to negative changes in real oil prices. The most interesting pattern here is the response of real effective exchange rate. Even though it is insignificant during the whole period, the response of the real effective exchange rate to a decreasing real oil prices is negative. It reaches its minimum in the first month as soon as shock happens. Decrease in real effective exchange rate can be explained by the fact that government had approved export-friendly policies to relieve the impact of declining oil prices. In addition, government stimulates non-oil sections to improve their competitiveness. Thus, reduction in real effective exchange rate leads to improvement in competitiveness in non-oil sections. The responses of other variables to negative oil price shock are not significant.

6.3 Variance Decomposition Analysis

In this section I will attempt to give the forecast error variance decomposition analysis for all four models: linear, non-linear or asymmetric and net oil price specifications. Variance decomposition tells us how many unforeseen changes or variations of the variables are explained by different shocks.

Tables 1-5 demonstrate the variance decomposition of the VAR model. As I have expected contributions of symmetric oil price shocks and the other specifications of oil price increases particularly both non-linear models and net oil specifications to GDP growth variation are not statistically significant during all ten months given any significance level[10]. For inflation, negative oil price shocks account for approximately 10 percent of its variation in the third period, remains significant to the end of the tenth period and increases to 14 percent. In order words, in the tenth period for inflation negative oil price shocks account for 14 percent of its variation. Contributions of symmetric oil price shocks to inflation variation are statistically significant at 10 percent only starting from third period and accounts for 9.93 percent of its variation increasing to 23 percent in 10 periods after shock. This high inflationary pressure results from increased spending which comes from solely oil revenues.

[10] Dotsey and Reid (1992) revealed that 5-6 % of variations in GNP can be explained by oil prices, and according to Brown and Yucel (1992) variations in output are poorly explained by oil prices.

For real effective exchange rate the contribution of none of the models are statistically significant during all ten months.

The other important aspect of the symmetric oil shock can be seen in the effects on real export fluctuation. Linear or symmetric oil price shock explains for about 4.4 percent of fluctuations in the real export in the third month after shock, increasing to about 11.6 in the 10^{th} month after the shock.

Considering the results of all specifications, I claim that the contribution of oil price decreases and symmetric oil price shock is quite large in the variation of inflation in Azerbaijan. Its average shares are 9 percent. Seemingly, in all cases, the oil contribution to variations of inflation and real export is significant mostly from the third month.

6.4 Comparative Analysis of Results

In this section I will compare the empirical results of this thesis with the results of two other papers. Particularly I will make comparative analysis of results of Aliyu et al (2009) on Nigeria (oil exporter country), and Mohammad Reza Farzanegan et al (2007) on Iranian economy.

Mohammad Reza Farzanegan et al (2007) shows that due to the high dependence on oil revenues, oil price changes impacts Iranian economy. Historically empirical findings indicate that oil price increases have a significant positive effect on industrial output for oil importing countries. Farzanegan et al (2007) reveals that there is no significant impact of oil price changes on real government expenditures. Farzanegan also indicates that the response of real imports and the real effective exchange rate to asymmetric oil price shocks are significant. In addition Farzanegan and Markwardt state that the response of inflation to any kind of oil price shocks is significant and positive. In my thesis I found that positive oil price shocks do not Granger cause macroeconomic variables. However, the Granger causality tests of my work exhibits that there is causality between oil price changes and government expenditure as well as between oil price changes and inflation in the case of negative oil price shocks. For the case of NOPI specification I have found that NOPI specification of oil price shocks Granger causes government expenditures and inflation. Tests for symmetric oil price shocks model indicates that symmetric oil price shocks Granger cause significantly inflation (at 1% significant level). In addition the response of inflation to innovations in oil prices is significantly positive. This response is completely significant within a year. Thus, my result is in line with Farzanegan et al (2009) that in oil exporting countries oil price shocks positively affect inflation. I concluded that impact of oil price shock on inflation in Azerbaijan is relatively persistent and shows the long-run inflationary effects of oil price increases on the Azerbaijani economy. I explained this phenomenon based on the studies of Corden (1984). Corden explains both short run and long run inflationary effects of oil price increases within the "resource movement" and "spending effect" framework. Farzanegan uses the same "spending effect" to analyze the consequences of oil price shocks. Farzanegan and Markwardt also failed to identify a significant impact of oil price fluctuation on real government expenditures. In my thesis I have got similar result. This result is quite challenging as I expected to see the impact of positive oil price shock on real government expenditures. During 2005-2007, when the first oil boom started, the government of Azerbaijan decided on extraordinarily large expenditure increases aimed at improving infrastructure and raising incomes. Such an exceptional magnitude of government spending shows the role of government. Thus, before running tests I hoped to get positive changes in real government expenditures. However, impulse response functions analysis indicates that the null hypothesis of no effect of oil price changes on real government expenditure can not be rejected.

Farzanegan et al (2007) got the same result. They explained this with the increased role of government policy of saving a large part of the windfall oil revenues in an oil stabilization fund starting from 2000. Similar patterns can be observed in my thesis as well. Azerbaijan government has also established State Oil Fund of Azerbaijan (SOFAZ) in 1999 in order to save large part of the windfall oil revenues in an oil fund. SOFAZ uses them to finance national scale projects and pay back external debts. SOFAZ avoids spendings for current expenditures thus creating effective mechanism for management of oil revenues. Finally, Farzanegan et al (2007) reveals that the response of the real effective exchange rate to asymmetric oil price shocks are significant. In a contrary, my thesis work revealed that the responses of real effective exchange rate based on Monte Carlo confidence bands are not significant under neither linear nor non-linear oil price shocks. However, I presented the results of responses of real effective exchange rate to show that these results are contrary to priori expectations of encountering “Dutch Disease”. The establishment of SOFAZ in Azerbaijan controls government expenditure and partly absorbs the unexpected oil revenue increases and possible appreciation in effective exchange rate.

Aliyu (2009) employed Granger causality tests and multivariate VAR analysis using both linear and non-linear specifications. Aliyu (2009) found evidence of both linear and non-linear impact of oil price shocks on real GDP growth. Aliyu (2009) states that asymmetric oil price increases in the non-linear models have larger positive impact on real GDP growth than asymmetric oil price decreases adversely affects real GDP. In my thesis, Granger causality tests and impulse response functions analyzes leads to the conclusion that in both short run and long run the null hypothesis of no effect of oil price changes on GDP cannot be rejected at the five percent level. Based on Monte Carlo confidence bands I can judge that response of GDP is insignificant.

7 Conclusions and Policy Implications

This thesis concludes that oil price shocks really matter for Azerbaijan. Therefore, policy makers of Azerbaijan should account for oil price fluctuation while making decisions on monetary and fiscal policies.

Linear oil price shock Granger causes inflation, have a positive effect on it and play a significant role in its variation. The impact of oil price shock on inflation in Azerbaijan is relatively persistent and shows the long-run inflationary effects of oil price increases on the Azerbaijani economy. I defined this result as a "spending effect". As Corden (1984) and Farzanegan et al (2007) explained, "spending effect" occurs due to the fact that higher oil prices guide to higher labor compensation or incomes in the oil related sectors. This increase in wages raises the aggregate purchasing power and aggregate demand in the economy. Tradeable sections include oil and manufacturing sectors and the price of these sections pre-determined in the international markets. However, the price of non-tradeable sections which include services industry is endogenous and determined within the domestic market. Part of increased aggregate demand shifts to non-tradeable section, thus resulting in push-demand inflation in this section. It is worth to note that here I assumed the immobility between tradeable and non-tradeable sectors. If that was not the case, then we would encounter transfer of workers from oil and manufacturing section to booming service section. So, in the case of immobility between tradeable and non-tradeable sectors the supply of services remains constant, even though the price of services increases.

Unexpectedly the response of real government expenditure to one standard shock to linear oil price changes is not significantly different from zero. Thus, the null hypothesis of no effect of oil price changes on real government expenditure can not be rejected. During 2005-2007, when the first oil boom started, the government of Azerbaijan decided on extraordinarily large expenditure increases aimed at improving infrastructure and raising incomes. However, Fund uses only part of oil revenue to finance the capital expenditures, major national scale projects to support socio-economic growth. Fund accumulates and preserves oil revenues for future generations, therefore, it can be concluded that Fund has an effective mechanism for oil wealth management. This can explain why response of real government expenditure to one standard shock to linear oil price changes is not significantly different from zero.

The fact that the responses of real effective exchange rate to oil price changes are not significant can be explained due to the fact that Central Bank of Azerbaijan employs fixed exchange rate regime. Real effective exchange rate has a positive response and increasing trend in case of linear oil price shock, however, the response of real effective exchange rate to linear oil price change is still not significant. The response of real exchange rate remain insignificant in the case of positive oil price shock and even more we observe initial decrease in real effective exchange rate. Starting from the third month, responses to innovations in positive oil prices begin to increase, and then gradually completely dies out. This is against to our beliefs about “Dutch Disease”. According to “Dutch Disease” we expect significant appreciation of real effective exchange rate in the case of positive oil price shocks. The role of State Oil Fund of Azerbaijan is magnificient here. The establishment of oil stabilization fund and controlling government expenditures helped government to successfully save unexpected oil revenue increases for next generations. By controlling government expenditures Fund could successfully tackle with possible appreciation in effective exchange rate.

The response of industry output in all specifications is not significant. Seemingly, additional researches have to be conducted in order to reveal this phenomenon. Studies done before Hamilton (2003) and Jimenez-Rodriguez and Sanchez (2004) find that for developed economies impact of positive oil price shocks on real GDP growth is much larger than impact of negative shocks. Thus, increases in oil prices leads to significant reduction in domestic output, while decreases in oil prices cause only marginal effect in industrial economies. In my thesis work, I revealed that Azerbaijan as a developing country and net oil exporter exhibits that both positive and negative oil price changes and linear oil price fluctuations does not have a significant affect on the gross output. This result is quite challenging and requires more detailed research to find out what are the side effects.

The overall performance of the Azerbaijani monetary and fiscal authorities is adequate. The possible policy implication for the Azerbaijani government is to increase transparency within the State Oil Fund of Azerbaijan and to decrease the influence of the government to Fund to provide efficient and sound mechanism of Fund. Oil revenues can lead to the wealth of the nation and at the same time to threaten the future generations in Azerbaijan. Nonetheless, oil is the nation's treasure, and therefore, the best practises for windfall oil funds management must be taken into account by the policymakers of the Azerbaijan.

8 References

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9 Appendix I

9.1 *Results of Unit Root Tests Oil Price Shocks*

Variables	ADF Test (p values in cells)			
	H0: a variable has a unit root			
	None		constant	
	level	1st dif	level	1st diff
Oil price shock	0.8280	0.0000	0.6674	0.0000
Oil price shock+	0.0006	0.0000	0.0000	0.0000
Oil price shock-	0.0000	0.0000	0.0000	0.0000
NOPI	0.0002	0.0000	0.0004	0.0000

Variables	PP Test (p values in cells)			
	H0: a variable has a unit root			
	None		constant	
	level	1st dif	level	1st diff
Oil price shock	0.7858	0.0000	0.4932	0.0000
Oil price shock+	0.0000	0.0001	0.0000	0.0001
Oil price shock-	0.0000	0.0001	0.0000	0.0001
NOPI	0.0002	0.0000	0.0000	0.0001

9.2 Macroeconomic variables of Azerbaijan

Variables	ADF Test (p values in cells) H0: a variable has a unit root			
	None		constant	
	level	1st dif	level	1st diff
Inflation	0.9999	0.0000	0.9998	0.0000
Real GDP	0.9925	0.0000	0.9119	0.0000
Real Government Expenditure	0.9905	0.0000	0.5200	0.0000
Real Effective Exchange Rate	0.9047	0.0000	0.8937	0.0000
Real Export	0.8762	0.0000	0.6520	0.0000

Variables	PP Test (p values in cells) H0: a variable has a unit root			
	None		constant	
	level	1st dif	level	1st diff
Inflation	1.0000	0.0000	0.9984	0.0000
Real GDP	0.9952	0.0000	0.8987	0.0000
Real Government Expenditure	0.9273	0.0000	0.1559	0.0001
Real Effective Exchange Rate	0.8563	0.0000	0.7829	0.0000
Real Export	0.8186	0.0000	0.0005	0.0001

9.3 Appendix II – Granger Causality Tests

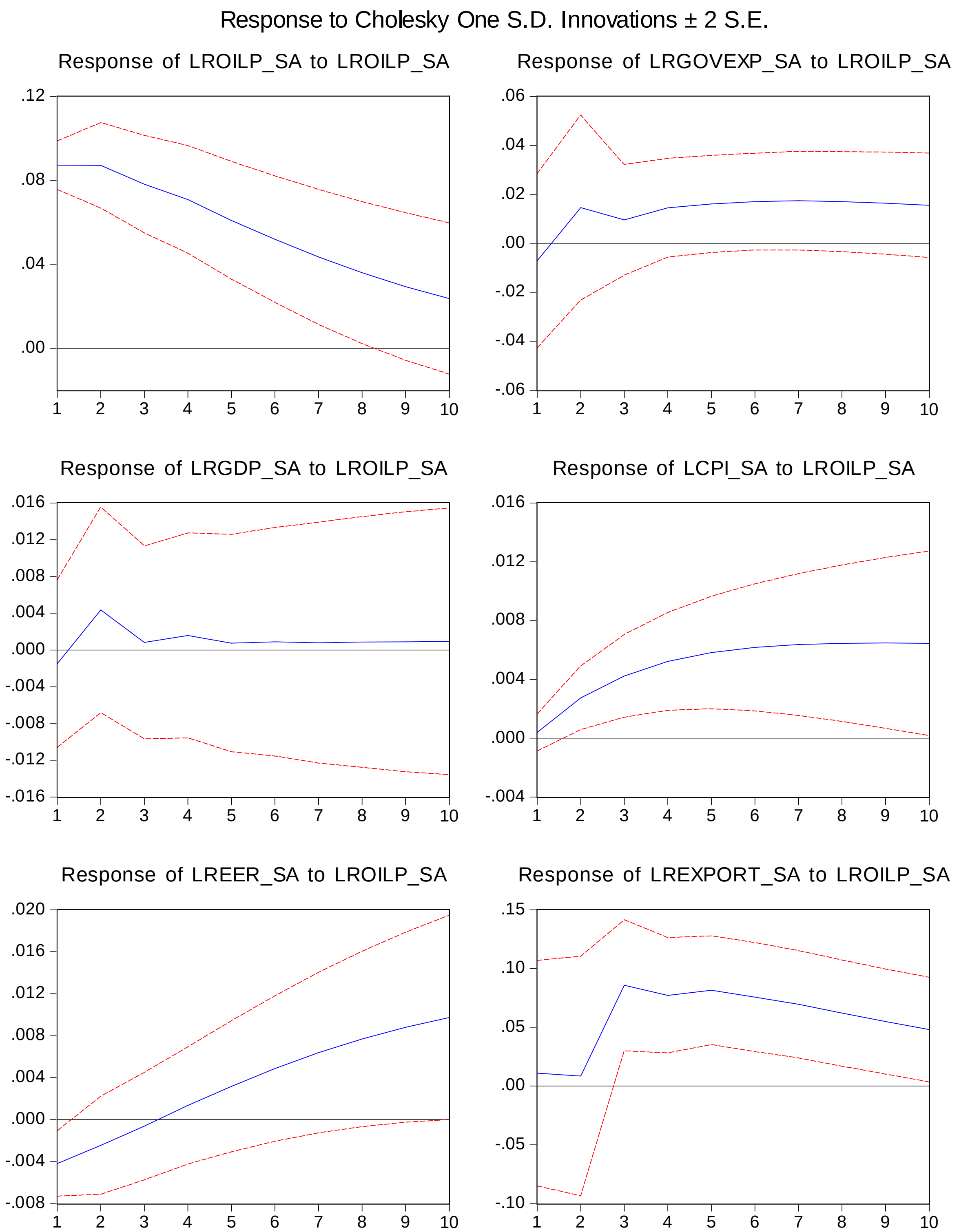
VAR Granger Causality/Block Exogeneity Wald Tests

H0: an oil price does not Granger cause a dependent variable

Dependent variable	Oil Price shock	Oil Price Shock+	Oil Price Shock-	NOPI
		p value		
Real GDP Growth	0.3032	0.6853	0.8598	0.2356
Real Government Expenditures	0.3109	0.5019	0.0855	0.1839
Inflation	0.0011	0.5825	0.0126	0.6832
Real Effective Exchange Rate	0.0183	0.9918	0.8577	0.1299
Real Export	0.0023	0.3465	0.2549	0.8843

9.4 Appendix III – Impulse responses

Figure 1 - Symmetric oil price shock



Note: lroilp_sa=real oil price, lreer_sa=real effective exchange rate, lrexport_sa=real export, lcpi_sa=inflation, lrgovexp_sa=real government expenditure, lrgdp_sa=real gdp growth

Figure 2 - Positive Oil Price Shock

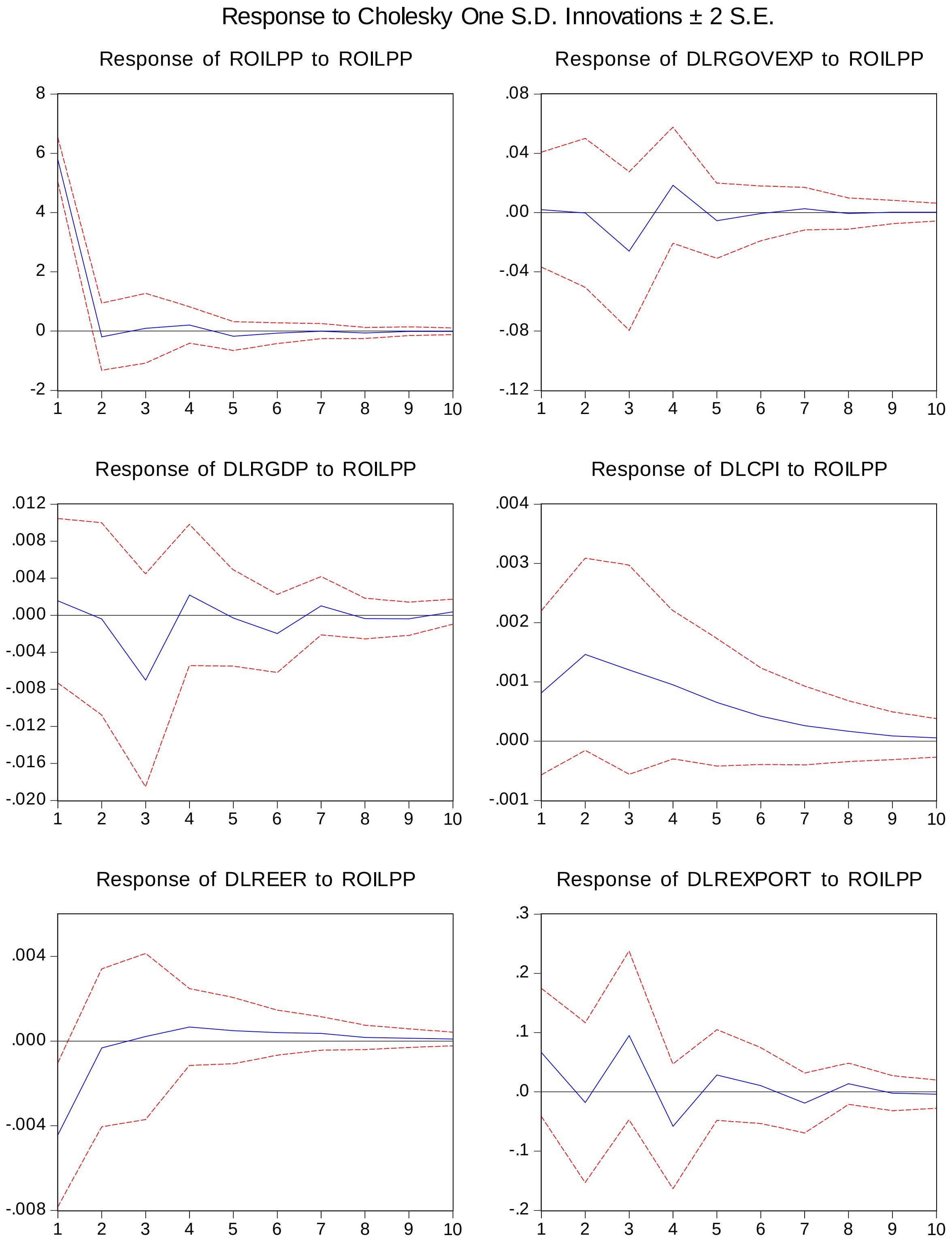


Figure 3 - Negative Oil Price Shock

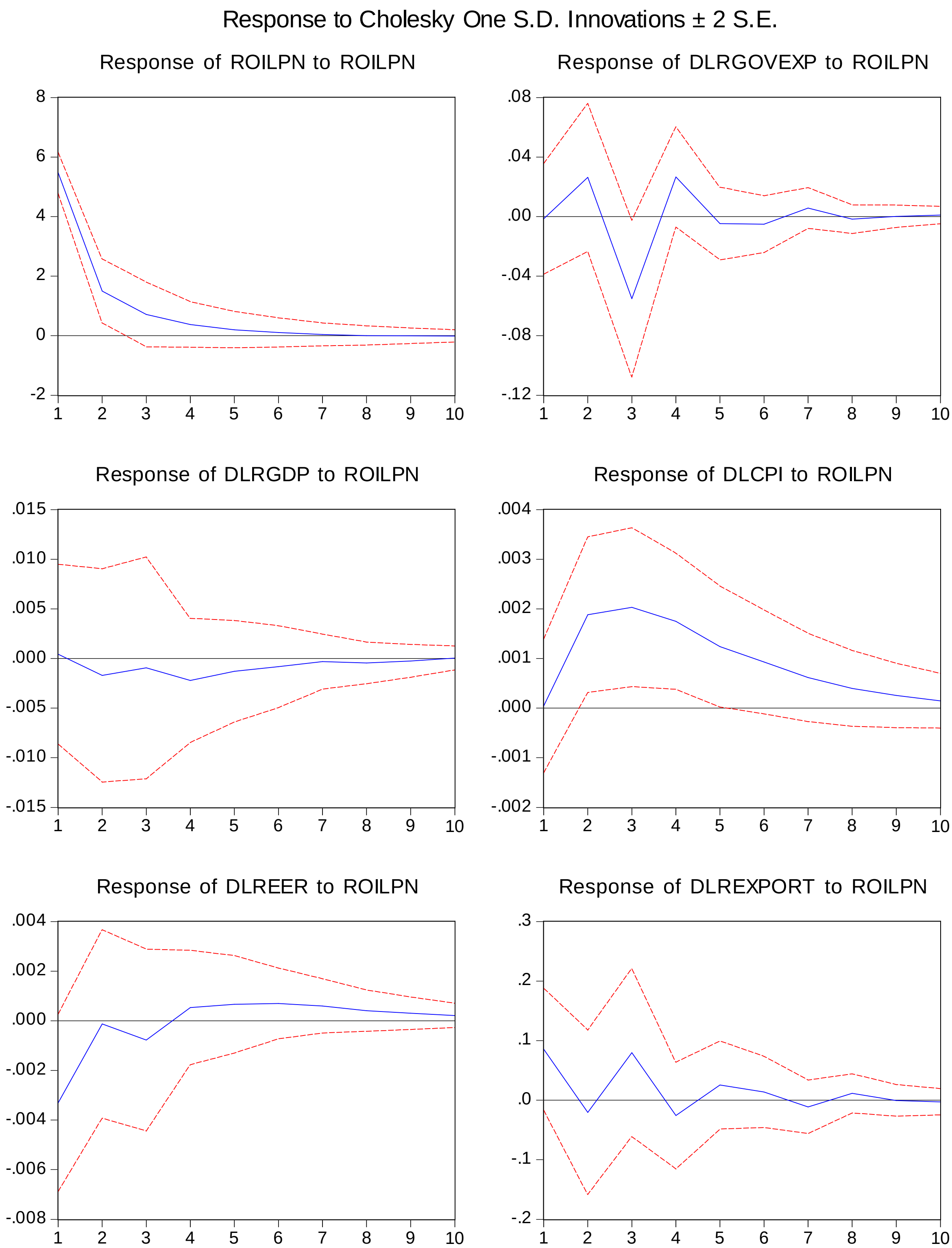
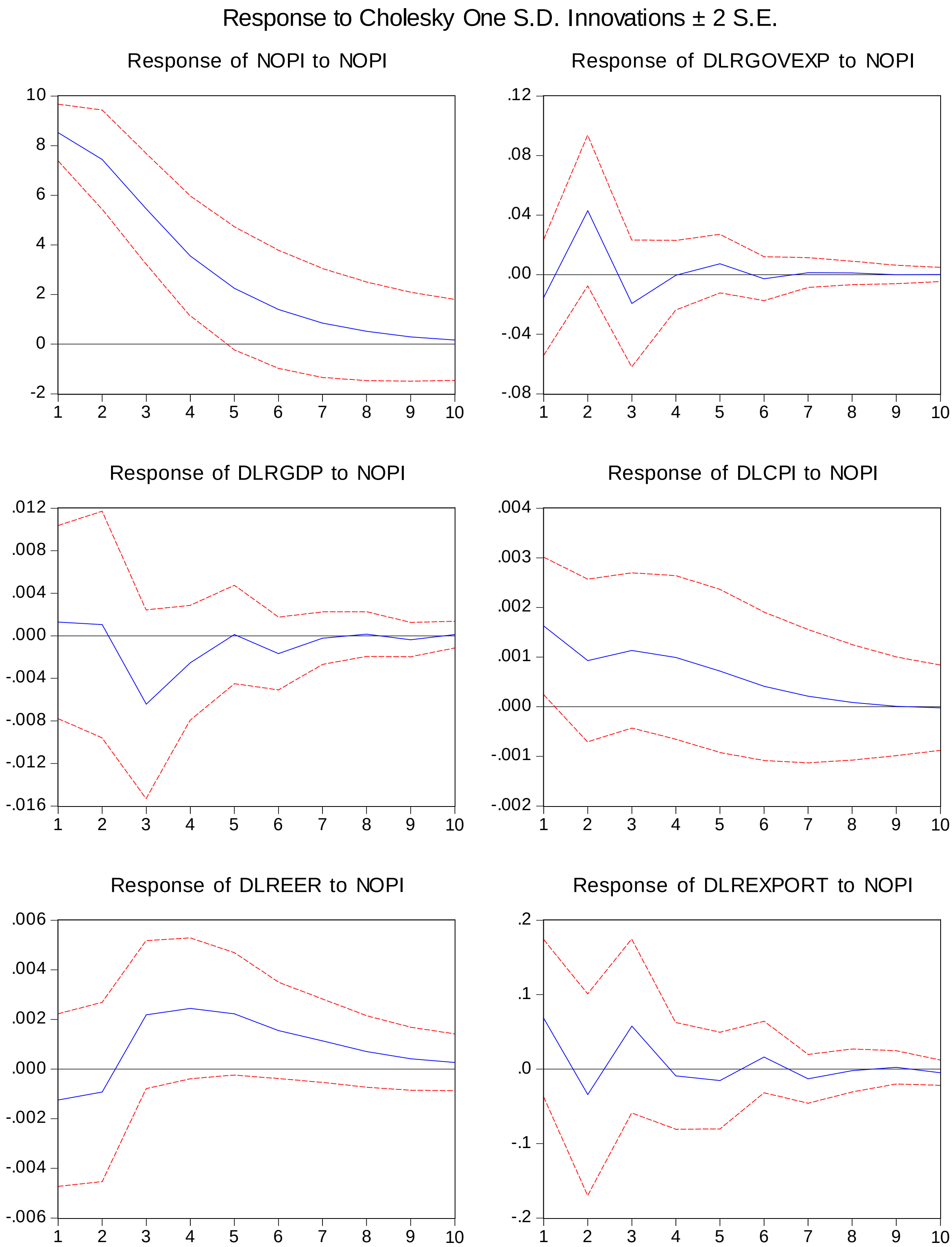


Figure III - Net Oil Price Increase



Appendix IV – Variance Decomposition

Variance Decomposition of Inflation

Period	Oil Price Shock	Oil Price Shock+	Oil Price Shock-	NOPI
	Variance Decomposition of Inflation			
1	0.311728	1.146070	0.003309	4.549059
	(1.43030)	(2.03376)	(1.18588)	(3.78968)
2	5.561239	3.779771	5.057495	4.747474
	(4.25633)	(3.85397)	(3.84103)	(4.08796)
3	9.931966	4.981928	9.439419	5.645376
	(6.08004)	(4.62248)	(5.61965)	(4.69063)
4	13.47622	5.701445	12.24556	6.401035
	(7.31110)	(5.16035)	(6.73438)	(5.30438)
5	16.25487	6.016011	13.49260	6.780646
	(8.25007)	(5.43976)	(7.28999)	(5.76928)
6	18.43269	6.146407	14.18726	6.885180
	(9.02067)	(5.58639)	(7.61313)	(6.07430)
7	20.11945	6.195915	14.48601	6.898371
	(9.69155)	(5.65128)	(7.78980)	(6.27664)
8	21.39509	6.216340	14.60566	6.892544
	(10.2932)	(5.68738)	(7.88824)	(6.41373)
9	22.32347	6.222317	14.65603	6.887535
	(10.8377)	(5.70624)	(7.94591)	(6.50575)
10	22.95757	6.224477	14.67237	6.885719
	(11.3301)	(5.71794)	(7.97959)	(6.57369)

Variance Decomposition of Real GDP Growth

Period	Oil Price Shock	Oil Price Shock+	Oil Price Shock-	NOPI

Variance Decomposition of Real GDP Growth				
1	0.086450	0.102791	0.007701	0.070491
	(1.22675)	(1.19513)	(1.09870)	(1.21564)
2	0.628931	0.082050	0.096280	0.086438
	(1.87390)	(1.48576)	(1.46579)	(1.70187)
3	0.478509	1.554440	0.119678	1.322804
	(1.81823)	(2.64493)	(1.79309)	(2.45094)
4	0.448570	1.650624	0.259416	1.469451
	(2.04477)	(2.83531)	(1.81828)	(2.40591)
5	0.399021	1.628351	0.303684	1.449549
	(2.23029)	(2.80408)	(1.81306)	(2.37438)
6	0.371211	1.733216	0.322369	1.524522
	(2.47734)	(2.84439)	(1.83326)	(2.43166)
7	0.349867	1.759427	0.324801	1.523338
	(2.75529)	(2.87017)	(1.83706)	(2.43159)
8	0.336414	1.759707	0.330005	1.521757
	(3.06336)	(2.86428)	(1.83817)	(2.42811)
9	0.327310	1.763232	0.331626	1.525184
	(3.38726)	(2.86395)	(1.84190)	(2.43307)
10	0.321512	1.767003	0.331652	1.525422
	(3.71830)	(2.86845)	(1.84345)	(2.43478)

Variance Decomposition of Real Export

Period	Oil Price Shock	Oil Price Shock+	Oil Price Shock-	NOPI
Variance Decomposition of Real Export				
1	0.041911	1.321473	2.204719	1.373548
	(1.20646)	(2.12829)	(2.70222)	(2.07550)

2	0.066922	0.934787	1.512672	1.120003
	(1.67869)	(1.97575)	(2.38291)	(2.08346)
3	2.529145	2.506141	2.563900	1.644638
	(2.16800)	(3.02407)	(3.21426)	(2.49552)
4	4.409824	2.968016	2.567906	1.588552
	(2.76122)	(3.38238)	(3.21105)	(2.37444)
5	6.399412	2.998096	2.588095	1.582290
	(3.41068)	(3.30897)	(3.13699)	(2.37023)
6	8.026013	2.988597	2.598031	1.615413
	(4.01205)	(3.30395)	(3.16257)	(2.41006)
7	9.345291	3.039239	2.611239	1.639893
	(4.52338)	(3.35117)	(3.16333)	(2.40579)
8	10.35860	3.062306	2.625273	1.637575
	(4.94019)	(3.35893)	(3.16195)	(2.40621)
9	11.12360	3.059849	2.622672	1.637577
	(5.27885)	(3.35665)	(3.16209)	(2.40869)
10	11.68706	3.061395	2.623177	1.641402
	(5.55217)	(3.36021)	(3.16197)	(2.40813)

Variance Decomposition of Real Government Expenditure

Period	Oil Price Shock	Oil Price Shock+	Oil Price Shock-	NOPI
	Variance Decomposition of Real Government Expenditure			
1	0.130349	0.008318	0.004986	0.523949
	(1.19442)	(1.12570)	(1.09756)	(1.53938)
2	0.659369	0.005311	1.002031	2.887466
	(2.09980)	(1.53635)	(2.19787)	(3.23196)
3	0.841468	0.892630	4.945968	3.223399
	(2.10375)	(2.67348)	(4.64484)	(3.61041)
4	1.311099	1.325530	5.809501	3.207613

	(2.41774)	(3.30651)	(5.11072)	(3.54672)
5	1.870726	1.349837	5.768389	3.237315
	(2.68822)	(3.37993)	(5.06752)	(3.50507)
6	2.466584	1.344686	5.772332	3.232938
	(3.01616)	(3.37481)	(5.06785)	(3.49603)
7	3.056159	1.352709	5.810090	3.234111
	(3.34308)	(3.38718)	(5.08882)	(3.48892)
8	3.579683	1.352911	5.812106	3.233940
	(3.65882)	(3.38725)	(5.08710)	(3.48095)
9	4.029328	1.352701	5.810244	3.232826
	(3.95079)	(3.38788)	(5.08287)	(3.47634)
10	4.393461	1.352689	5.810906	3.232659
	(4.21929)	(3.39009)	(5.08338)	(3.47510)

Variance Decomposition of Real Effective Exchange Rate

Period	Oil Price Shock	Oil Price Shock+	Oil Price Shock-	NOPI
Variance Decomposition of Real Effective Exchange Rate				
1	5.510344	5.246537	2.932171	0.431393
	(4.04956)	(3.93728)	(3.08220)	(1.83396)
2	3.762121	5.131976	2.854022	0.651821
	(3.70148)	(3.88786)	(3.13063)	(2.23955)
3	2.560136	4.990260	2.923911	1.874858
	(3.12544)	(3.86455)	(3.25961)	(2.44621)
4	2.052096	5.050694	2.965591	3.363883
	(2.55257)	(3.80259)	(3.25499)	(3.19965)
5	2.250101	5.082457	3.058450	4.552070
	(2.50267)	(3.78204)	(3.23582)	(3.84563)
6	3.051524	5.109379	3.170132	5.120399

	(3.13673)	(3.77258)	(3.23346)	(4.21284)
7	4.294068	5.132799	3.251720	5.419231
	(4.13028)	(3.76898)	(3.24271)	(4.42163)
8	5.817758	5.137546	3.289844	5.532777
	(5.21540)	(3.76838)	(3.25030)	(4.53247)
9	7.491802	5.140742	3.310715	5.570435
	(6.27314)	(3.76866)	(3.25743)	(4.59433)
10	9.220781	5.142475	3.321230	5.585517
	(7.26072)	(3.76910)	(3.26318)	(4.63606)

Cholesky ordering: Specification of oil price shock, Inflation, Real GDP Growth, Real Export, Real Government Expenditure, Real Effective Exchange Rate.

Standard Errors: Monte Carlo (1000 repetitions)