Macroeconomic Effects of Crude Oil Price Movements: The Case of Nigeria

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ABSTRACT

Since the beginning of the 20th century till date, crude oil has played a major role as an indicator of economic growth, due to its immeasurable importance in supply of energy demand of the entire world. Over more than four decades, Nigeria has been an important crude oil exporter, her primary product. Crude oil production and export since 1957 has brought a tremendous change to the economy of Nigeria, contributing a large share to the gross domestic product of the country. As reported in Hamilton (2008), high and fluctuating oil prices have become an inevitable result of recent world developments such as strong growth in demand, contribution of scarcity rent and OPEC monopoly pricing. In the light of these, it is of interest to investigate how the Nigerian economy which is heavily dependent on the export of its primary product will be affected by such trends in the world. For the purpose, the study seeks to analyze various economic impacts caused by international fluctuations in crude oil prices on the Nigerian economy between1994Q.1 -2013Q.4 using quarterly data. Output growth and inflation variables have been used to reflect the state of the economy while money supply will capture the monetary policy response to real crude oil price movements. The analysis employs structural VAR methodology. The empirical results suggest a negative relationship between inflation and oil price shock and its volatility over the sample period while response of monetary policy is insignificant. However, both unexpected price shock and volatility imposes a positive impact on the Nigerian output which later may destabilize the economy.

Keywords: SVAR, inflation, money supply and crude oil price.

ÖZ

Yirminci asrın başından günümüze dek, ham petrol, dünya enerji talebinin karşılanmasındaki rolü nedeniyle, ülkelerin ekonomik büyüme göstergeleri arasında önem kazanmıştır. Dört asrı aşkın bir süreden beri, Nijerya'nın en önemli üretimi olan petrol, ihracat yapısında da en üst sırada yer almıştır. 1957 yılından beri ham petrol üreticisi ve ihracatçısı olan Nijerya'nın ekonomisi, bu sayede değişim göstermiş ve petrol geliri gayri safi milli hasıla (GSMH) içinde önemli bir paya sahip olmuştur. Hamilton'nun (2008) belirttiği üzere, gerek petrola olan küresel talebin artması, gerekse, kaynakların azalıyor olması ve rant ile OPEC ülkelerinin tekel fiyatlaması gibi dünyadaki en son gelişmeler sonucunda, petrol fiyatlarındaki yüksek seyir ve dalgalanmalar kaçınılmaz olmuştur. Bu çerçevede, ekenomisi petrol ihracına bağimlı olan Nijerya'nın, sözkonusu gelişmelerden nasıl etkilenmekte olduğu, çalışmanın ilgi odağı olmuştur. Çalışmada, uluslararası petrol fiyatlarındaki artış ve dalgalanmaların, 1994Q.1 – 2013Q.4 döneminde Nijerya ekonomisi üzerindeki etkileri yapısal VAR (SVAR) yaklaşımı uygulaması ile araştırılmıştır. Nijerya ekonomisi için makroekonomik göstergeler olarak büyüme ve enflasyon, para politikasının tepkisini ölçmek amacıyla ise para arzı kullanılan değişkenler olmuştur. Elde edilen ampirik bulgulara göre, petrol fiyatlarındaki artış ve dalgalanma, Nijeryadaki enflasyonun azalmasına neden olurken, para politikasını etkilememektedir. Dünya petrol fiyatlarındaki artış ve dalgalanma ekonomik büyümeyi olumlu etkilemekle birlikte, ileride ekonomide dengesizliğe neden olabileceği sonucuna varılmıştır.

Anahtar Kelimeler: SVAR, enflasyon, para arzı ve ham petrol fiyatı.

DEDICATION

Dedicated to my Late father Prince S.O Sulaman and Late mother Mrs O.A Sulaiman

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Chapter 1

INTRODUCTION

Since the beginning of the 20th century till date, crude oil has played a substantial role as an indicator of economic growth, due to its immeasurable importance in supply of energy demand of the entire world. Over more than four decades, Nigeria has been one of the major crude oil exporter her primary product. Crude oil production and export since 1957 has brought tremendous change to the economy of Nigeria, contributing a large share to the Gross Domestic Product (GDP) of the country. During the last two decades, due to international integration of markets as a result of financial liberalization and globalization, economies of some countries such as China, India and others located in Asian recorded fast growth rates which imposed added pressure in the world for production of more energy resources. As Hamilton (2008) reported, fluctuations in oil prices have become an inevitable result in current world development and some of the factors that determine the price rise include strong growth in demand, scarcity of resources, rent and OPEC monopoly pricing. In recent years since around 2000, the price of crude oil has shown more volatility encouraging new and further studies to investigate the possible relationship between macroeconomic activity and oil price movements.

Oil price shock is dated back to the early 1970's when sudden change in oil price was thought to have resulted in recession in the United State of America and some of the top European Economies (Mork 1989). Crude oil price changes started in May,

3rd 1970 when there was a shortage in the world supply and these fluctuations continued until the end of 1974. This attracted many researchers to analyze the impact of crude oil price shock on the economies of different countries. These movements in oil price have shown substantial effect on the economies of both importing and exporting countries (Hamilton;1988, Lee, Kiseok, Shawn Ni, and Ronald A. Ratti (1993).

Crude oil production started in Nigeria in the 1950's with about 2000 barrels of oil produced per day (Lukas and Oyewole 2000). Nigeria joined Organization of Oil Exporting Country (OPEC) in 1970 and as a result of increased demand for oil, production in Nigeria has grown significantly over the years. As an exporter of crude oil, shocks to price of oil may also affect and destabilize the economy of Nigeria. There have been many researches investigating the possible impacts of oil price movements on the Nigerian economy. However, findings of earlier research have yielded different results depending on the choice of the variables representing the state of the economy and the sample period selected.

1.1 Aim of the study

The aim of this study is to analyze various economic impacts of recent oil price increase and its volatility on the Nigerian economy within the new globalization framework of increased demand and scarce resources. For the purpose, most recent data at quarterly frequency is used from 1994Q1-2013Q4. Structural vector autoregressive (SVAR) model is employed using output growth and inflation to reflect the state of the economy while changes in money supply will capture the monetary policy response to oil price shocks and variability. The SVAR forecast impulse response analysis and forecast error variance decomposition will be utilized

in explaining the short and long run impacts of oil price movements over the sample period. The results of the study will be compared with earlier work for a better understanding of the implications of oil price movements needed for policy recommendations.

1.2 Structure of the study

The remaining part of the research work is structured as follows; Chapter two will summarize the theoretical and empirical literature that shows the impact of crude oil price movement on countries' economic performances. Chapter three will show the history of oil discovery and its contribution to the Nigerian economy. Chapter four will focus on the data and the SVAR model used. Chapter five will present the empirical results and chapter six will be on conclusions and policy recommendations.

Chapter 2

LITERATURE REVIEW ON MACROECONOMIC EFFECTS OF CRUDE OIL PRICE MOVEMENTS

The role of movements in crude oil prices in the world and how they affect the economies of developed and developing countries cannot be over emphasized. Numerous studies over the years explored how oil price movements may affect economies and have shown considerably different links that may exist between oil price and fundamental economic variables. This chapter will present a comprehensive review of different transmission channels by which oil price movements and volatility may impact an economy. A conceptual framework of each facet of price movement around the world will also be explored including various empirical findings and conclusions.

2.1 Transmission Channels of Crude oil Price Movements

Theoretically, different channels have been established through which energy price movements may affect the macroeconomic activities. First channel is the real balances channel which puts forward that increases in the world oil prices pushes inflation upward and in turn, reduces the amount of real balances in the economy. In case of an increase in oil price, the domestic prices respond by rising e.g. increase in cost of transportation or a rise in the price of a commodity for which crude oil is an input. This will lead to reduction of real balances in the economy, a reduction in the amount of saving and an increase in interest rate. Thus, a decline in real balances in the system was a major contributor to recession (Hamilton; 1999).

Secondly, counter inflationary monetary policy which can result as a response to crude oil price shock lead to a fall in output (Bohi 1991, Bernanke, Gertler and Watson 1997). Government can react to an increase in oil price through the use of contractionary monetary policy to avoid inflation. This can lead to an increase in interest rate or a decrease in money supply which will in turn slow down economic activity. A reduction in the rate of production growth will lead to a decrease in real wages and consequently an increase in both unemployment and inflation. These are the consequences of the monetary policy channel.

Third, according to demand side channel, terms of trade between net oil importers and net oil exporters is affected (Dohner 1981). In response to rise in oil prices, revenue is transferred from net oil importing countries to net oil exporting countries such as Nigeria. This will deteriorate the terms of trade (TOT) of oil importing country while improve that of the exporting country. Thus, a positive movement in the oil price will affect consumers' aggregate demands in exporting and importing countries. As a result, this will bring a decrease in consumer demand in oil importing countries and vice versa in exporting countries. However, the initial impact of revenue transfer may be offset later due to increase in import demand of an oil exporting country. (Fred and Shulze 1975, Ferderer 1986)

Forth is the uncertainty channel explained by Bernanke (1983) and this refers to economic decisions which are "irreversible". These irreversible decisions will attract huge cost if attempted to be reversed. He moved on by explaining that when firms are faced with decision on irreversible project whose production depends on the crude oil price, it is economical for such decision not to be taken unless there is

reliable information on oil price. Subsequently, investment depends on the availability of reliable information. Ferderer (1996) noted that the uncertainty in the price of oil has more important and economic effect than movement in the price of oil. He noted in his study that there is loss of return because of delayed investment which further leads to decrease in output level.

Fifth, sectoral resource allocation channel is another means through which oil price volatility is transmitted through the economy and this was first proposed by Lilien (1982) and also investigate by Hamilton(1988). Hamilton (1988) shows that price shocks may increase unemployment because in specialized sectors labor cannot move to other sectors. Thus, workers of affected industries wait for improved conditions in order to be employed by their formal industries instead of searching for employment in less affected industries (Lilien 1982; Loungani 1986; Hamilton 1988). Finally, price rise of an important input, oil, will increase prices of all goods leading to reduction in potential output that is the supply-side shock. (Barro 1984, Brown and Yücel, 1999)

2.2 Empirical Literature

Many empirical studies have been performed for different countries ranging from developed and developing countries, net oil importing and exporting countries as well as for the case of Nigeria. A summary of some main findings will be presented in this section.

2.2.1 Oil Price Movement and Macroeconomic Activity in Developed Countries

After the oil price shocks that was experienced in the 1970's, Hamilton (1983) studied the likely correlation which might exist between oil price movements and the US economy. In his research he discovered some degree of relationship between the

price of oil and economic activity that may be represented by macroeconomic fundamentals such as GDP, unemployment, wages, interest rate etc. The findings of his research work highlighted that recession could have been a result of hike in the price of crude oil. However, three factors were believed to have contributed to recession: volatility in oil price, the use of monetary policy to fight inflation during the crises period that rocked Bretton woods system in 1973, the real effect of the imposition and elimination of different price controls during 1971-1975. For instance, the table below shows different events that gave rise to higher oil prices and the dates of recession that followed.

Table 1: Events leading to oil price increase

Business cycle peak	Events associated with major oil price increase
November 1973	October war and oil embargo (October 1973 – Early 1974)
January 1980	Iranian revolution (October 1978 – February 1979)
July 1981	Outbreak of Iran – Iraq war (September 1980)
July 1990	Invasion of Kuwait (August 1980)
March 2001	OPEC meeting (March 1999)

Source: Jimenez Rodriguez (2004)

Further research work by Hamilton (1988, 1996, and 2008) supported his initial conclusion that there exists some correlation between economic activity and changes in the level of crude oil price.

In addition to the above mentioned studies of Hamilton, some other studies performed on the US economy includes Gisser and Goodwin (1986) which showed

that there was correlation between increase in the price of oil and the US output during 1961-1982, and also confirmed that this impact was more than those generated by fiscal and monetary policy. Another major contribution of this study was that oil price movement is exogenous and cannot be predicted by monetary and fiscal policy.

Some other studies investigated the economic response of European and seven OECD countries. An earlier study by Mork and Olsen (1994) considered the OECD countries including the United States, Canada, West Germany, Japan, France, Norway and the United Kingdom .The study investigated the relationship between oil price movements and GDP in these countries by introducing positive and negative oil price shocks as separate variables into their model to investigate their asymmetric impact on GDP growth. They discovered that in all these countries a negative relationship exist between these two indicators except those of Norway which shows a positive correlation. The conclusion was that, overall, there was evidence of asymmetric relation between these two factors.

2.2.2 Oil Price Movement and Macroeconomic Activity in Developing countries

Cunado and Gracia (2005) investigated the possible relationship between energy price and macroeconomic activities using data including developing Asian countries, such as South Korea, Malaysia, Singapore, Philippines and Thailand. Oil price changes were introduced into the model with different currencies, local and international. The result was more significant with higher economic impact when the oil price was in local currency than when it was denominated in USD.

To further the studies on developing countries, Marcelo Gozali (2010) examined the impact of oil price shocks and volatility on the economy of Indonesia. This study was

carried out by using the whole sample period of 1990-2008 which had been then restricted to cover only 1999 to 2008 because of structural breaks in the data during the Asian Financial crises. It was discovered in the study that the economy of Indonesia which is a developing and oil exporting country responded to crude oil price shock and volatility with significant positive effect seen in government consumption and investment. Another study is by Ito, (2010) which explored the effects of oil prices on the real economic variables in Russia which is an important oil exporting country. The study employed a VAR methodology using quarterly data and concluded that oil price rise increased both GDP growth and inflation and depreciated the exchange rate for the sample period of 1994Q.1-2009Q.3

2.2.3 Empirical analysis on Nigeria

Several researches have estimated the possible relationship between the crude oil movements and macroeconomic activity for Nigeria which yielded different results. The initial study on Nigeria was by Ayadi (2005) using VAR approach and data covering the period of 1980 to 2004. In his study, oil price were expected to have an impact on real exchange rate which would influence the industrial production. However, according to his findings, industrial production in Nigeria had no significant response to the movement in price of oil during the period of research. Umar and Abdulhakeem (2010), estimated the possible effects on four major economic variables, namely, real GDP, consumer price index, unemployment and money supply. They have also employed a VAR model covering 1970 – 2008. The study concluded that the response was different from other findings on Nigeria; GDP and unemployment indicated positive response to oil price shock and money supply showed significant but negative response while consumer price index did not respond to oil price shock.

In an extensive empirical study, Damachi (2012) investigated the effects of oil price shock and fluctuations on key macroeconomic variables, GDP, exchange rate, CPI, and policy interest rate in Nigeria by employing a SVAR methodology over different sample periods due to structural changes in the Nigerian economy during the whole sample period of January 1970 and May 2011. The author considered alternative ranges of sample periods as before and after 1986, 1995 and 2000 due to the introduction of structural adjustment program (SAP) in 1986, float exchange rate regime in 1995 and the civilian political regime in 2000. He found out that money supply responds positively to oil price shock but this relationship disappear for the restricted periods after 1995 and 2000. GDP increased initially in response to crude oil price shock with an appreciation of domestic currency during these periods. A more recent study is by Omojolaibi (2013) who also used a SVAR model to investigate impacts of oil price innovations on domestic price, output and money supply in Nigeria between 1985Q1 and 2010Q4. The results of this work shows that money supply and GDP growth responded positively to the shock in the price of crude oil: However, oil shock had a negligibly small effect on consumer price index in Nigeria. On the other hand, Oyeyemi (2013) estimated a multiple regression model for 1979-2010 and reported that even a small shock in the world oil price would impose a long-term impact on the Nigerian growth rate.

According to the above empirical studies, among others, on Nigeria, one can conclude that findings are mixed depending on the sample period under study and the variables used to proxy the state of the economy. Since the empirical literature of oil price shocks on Nigeria suggest starting the samples as early as 1970s or 1986, based on world oil price jumps during these periods, most studies as mentioned above selected sample periods including these dates. However, the Nigerian economic

history involved some structural changes over these long sample periods. This might be the reason for the various differences in the empirical findings. This thesis research analyzes the impacts of the recent price shocks and volatility on the Nigerian economy by taking into account any structural shifts in the structure of the economy. Also, the study compares the results with earlier ones on Nigeria.

Chapter 3

HISTORICAL BACKGROUND OF OIL SECTOR IN THE NIGERIA

With the vast wealth believed to be generated from crude oil, poverty rate in Nigeria is still outrageous, with about 63% of the entire population living below 1$ per day. This has been referred to in many literatures as “resource curse” which means coexistence between natural resource commodity and poverty. Nigeria has benefited from spike in oil prices which has brought about an increase in inflow of foreign currency. Reportedly, Federal Reserve has increased as a result of current account surplus. However, just a few in the population has benefited from this surplus: the World Bank report (2006) estimated that about 80 percent of the oil benefit is been enjoyed by one percent of the country’s population. Considerable amount of the fund generated by crude oil has been used by the Nigerian government to pay for outstanding liabilities. Aside from oil, other sector has enjoyed no visible development. Agriculture which was the mainstay of the Nigerian economy before the discovery of crude oil has plummet. Infrastructural development over the years has also decreased and the Nigeria had low human capital which had been rated to be the 151 out of 177 countries in the United Nation.

In 2003-2007, economic reform programs were established and implemented. The major one which was National Economic Empowerment Development Strategy (NEEDS) was established to increase the dwindling standard of living of the Nigerian economy. This was meant to be achieved through economic stability,

transparency, liberalization, privatization, deregulation, accountability and transparency. It was aimed to help diversify the economy which was exclusively depending on the export of crude oil. Some of the other targets of the program include increasing productivity of the agricultural sector, increase in industrial capacity utilization and competiveness in the non-energy sector of the economy. To achieve this, corruption was targeted which was believed to be the main drawback of development. Corruption over the years has increased the level of inequality with an increase of about 0.43 to 0.49 during 2004-2009.

Nigeria began to solely depend on crude oil during the 1970 oil boom and this led to abandonment of other sectors. As at 2000, energy exportation which includes gas and crude oil contributed about 83% to the Federal Government earnings. Increase in ill distributed oil wealth led to increase in poverty with majority of the country's youth migrating to look for white collar jobs. Due to this trend, the human capital level decreased even more than what it used to be in the 1970s. It has further been established that low human capital development, political instability and unconducive business environment has discouraged foreign investors from investing in the non-oil sectors of the economy.

Nigeria joined OPEC (Organization of Petroleum Exporting Counties) in 1971. OPECs main objective is to maintain a unified accepted petroleum policy among member countries and ensure price stability. Since joining OPEC, Nigerian oil reserve has grown with estimation of around 35 billion barrels and natural gas reserve of over 100 trillion fti, production of crude oil was averaging 2.2 million barrels in 2001. This production capacity has been unstable as a result of severe instability recorded in production in some of the oil producing regions in Niger Delta

(Odularo 2007). With this in mind the Nigerian government has implemented many developmental programs, with many of them not achieving the objective in which they have been established. Example is the formation of Niger Delta Developmental Commission (NDDC). This was aimed at alleviating poverty, provision of basic infrastructural amenities, disease control and maintaining sustainable development across the oil producing region. In support of the government establishments, multinational oil companies such as Chevron, ExxonMobile, Total etc. have also set up their own programs to increase socio-economic growth in this rural locality. Nigeria's exports crude oil to many countries both in Africa and outside of Africa. The U.S is the largest importer of Nigerian crude oil, importing about 40 percent of its total oil production. The table below shows the principal trading partners in 2000.

Table 2: Oil export partners of Nigeria (millions of US Dollars)

COUNTRY	**EXPORTS**	**IMPORTS**	**Net Export**
United Statee	16,615	964	15,661
India	5,664	288	5,376
Spain	3,390	110	3,102
France	2,395	470	1,925
Italy	1,615	394	1,221
Cote d'Ivoire	1,217	n.a.	n.a.
Brazil	964	259	705
Netherlands	366	364	2
China (inc. Hongm Kong)	203	492	-289
Germany	162	859	-697
United Kingdom	10	1,091	-1,081

Source: Odularu (2007)

No physical development has been contributed with the large exportation of crude oil. Distortions have been generated in the economy due to inequality in the sharing of oil revenues with estimated increase in poverty level. Large chunk of government revenue is converted to foreign exchange to import commodities from rest of the world to meet the daily needs of domestic consumers. Production of commodities by domestic companies have dwindled due to erratic power supply, fuel supply and cost of input importation therefore leading to decrease in industrial capacity utilization. Many of the struggling domestic companies would have folded if not for availability of cheap labor. Over the years companies like textiles and pharmaceuticals have lost their competitiveness.

3.1 History of Oil Sector in Nigeria

In 1956, oil was discovered in Oloibiri in Niger Delta in Nigeria. Oil discovery breakthrough was by shell-BP, which as at that time was the sole concessionaire. First oil production capacity was about 5,100 barrels per day and this was in 1958. In 1960, rights to extract crude oil were giving to other multinational companies, extending exploration to offshore and onshore regions in 1965. In 1970, Nigeria reaped from the increase in oil prices; this was just after the Biafran war. In 1971 Nigeria became part of OPEC and in 1977 the Nigerian National Petroleum Company (NNPC) was formed. The formation of NNPC was to maintain Nigerian government control over the oil sector which before that time was dominated by foreign investors. After oil discovery, there has been a steady increase in production across oil producing regions. By the late 1960's and early 1970's, oil production has increased to about 2 million barrel per day. In 1980's, there was a brief reduction in production due to instability in government structure, which was later turned around in 2004 when Nigeria produced its largest oil product of about 2.5 million barrel per

day (bpd). Different government developmental strategies are being put in place to enable an increase to 4 million bpd by the year 2020.

In 1967, there was an outbreak of civil war in the oil producing regions, the unrest lasted for three years and it ended in1970. There was a huge infrastructural damage during the three years civil war, many of which was reconstructed with the oil revenues generated from oil spike in the 1970s. The oil boom in 1970s which was referred to as "oil price shock" was of significant benefit to Nigeria through the 1970's and the early 1980's. This later led to "resource curse" due to government mismanagement, long year of ruling by military government. The impact generated during this time attracted many scholars in the field of economics. Many reserachers investigated the relationship between oil prices increase and its macroeconomic consequences.

3.2 Oil Sector Performance in Nigeria

Oil sector in Nigeria can be divided into 3 main sub sections which are the upstream, downstream and gas. The upstream sector which is also known as exploration and production sector is responsible for searching, locating and extracting crude oil from this reserve. The downstream sector is responsible for the distribution and the direct supply of crude oil product to the final consumers. Distribution of refined petroleum product has been a great challenge to the Nigerian government thereby necessitating deregulation of the downstream sector in 2003. The NNPC protects the government interest in the oil sector with different stakes in the Joint venture with multinationals. The Nigerian government has about 60% stake in most of the oil extracting companies such as Total, Elf, Chevron, Texaco and Exxon mobile and about 55% stake in Shell which is responsible for the largest crude oil extraction. Due to its immense dependent on crude oil the Nigerian economy has been exposed to the

vagaries in the international oil market, as it will be duly observed in the sections that follow. With the large crude oil production of over 2 million barrels per day, the Nigerian economy depends on the importation of refined crude oil product to meet its growing domestic demand. Since 1960, four different refineries were built in different locations around the country to meet the domestic demand. However, full capacity production by these refineries has been jeopardized by selfish rent seekers who profit from importation of refined crude oil product (Odularu; 2007). Listed in the table below are all the refineries, there location and production capacity.

Table 3: Production Capacity of Nigerian Oil Refineries

YEAR OF COMMISSION.	LOCATION OF REFINERIES.	INTSTALLED AND EXTENDED PRODUCTION CAPACITY.
1965	Port Harcourt	35,000 bpd with expanded capacity of 60,000bpd
1978	Warri	100,000 bpd which was later expanded to 125,000bpd in 1986
1980	Kaduna	100,000 bpd and was later upgrade to 110,000 in 1986
1989	Port Harcourt	150,000 bpd

Source: Odularu(2007)

Production capacity of all the four refineries is estimated to be 445,000 bpd, which is lower than the quantity demanded in the domestic market but none of these refineries is producing at its installed capacity level necessitating an inevitable importation of crude oil end product e.g. premium motor spirit. More often than not, Nigeria has generated excess revenue in the oil sector and this has caused distortion in the domestic environment.

3.3 Contributions of the Oil Industry

The oil sector has been of immense benefit to the Nigerian economy since its discovery in 1956. One of the major contributions is employment opportunities. This has generated a lot of professional jobs compared to the jobs available before the discovery of crude oil. Another major contribution is the increase in the Nigerian gross domestic product. The federal government revenue has been on an increase since the oil discovery. A large percentage of the federal government revenue is obtained from crude oil export since it dominated the Nigerian export industry. Some of the other major contributions are local expenditure on goods and services, contribution to energy supply etc. With huge export of crude oil and the revenue generated from it, Nigeria's rate of economic growth hasn't been significant compared to other oil exporting countries. This has prompted researches including this into investigating the effect of oil price movement on the Nigerian economy. The oil sector has been of immense benefit to the Nigerian Economy since it was discovered in 1956 contributing a large share to the country's GDP. The table below shows the share of crude oil to the real GDP from 2005 to 2013.

Table 4: Crude Oil Share of Real GDP

Year	Crude Oil share of GDP (%)
2005 Q4	22.4
2006 Q4	20.2
2007 Q4	18.0
2008 Q4	15.8
2009 Q4	14.9
2010 Q4	14.9
2011 Q4	14.4
2012 Q4	12.6
2013 Q4	11.7

Source: Central bank bulletin 2005

Chapter 4

DATA AND METHODOLOGY

4.1 Data and the Methodology

The methodology employed in this analysis is the Structural Vector Autoregressive (SVAR) modeling. In other to investigate the structural relationships between the oil price shocks, oil price volatility and the economic activity of Nigeria, the construction of the model is based on two channels of transmission that pays attention to the role of money in the transmission mechanism. The first is the real balances channel and the second one is the monetary policy channel. Accordingly four variables used are crude oil price, inflation, output growth and money supply. Crude oil price is the Brent oil price denominated in US dollars. Output growth is measured by using the gross domestic period (GDP) which reflects the economic performance of the country. The other variables used in this analysis include consumer price index (CPI), money supply (M2). Money supply is used to capture the response of the monetary policy to any oil price or volatility shock, if any. Inflation is calculated using the CPI index because according to economic theory, any oil price movement is expected to affect the domestic prices directly which in turn will impact the state of the economy. The variables are converted into logarithm form and all are in US dollars. The data is obtained from international monetary fund data stream. For the purpose of this analysis, quarterly time series data for the period between 1994.Q1 to 2013.Q4 is used. The analysis is not extended backward prior to 1994 because the Nigerian economy experienced several political and economic

instabilities prior to this date. The oil price volatility variable is constructed by estimating a GARCH(1,1) model using Brent oil price at the monthly frequency, for which the conditional variance equation is specified as

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 \qquad \text{eq. (1)}$$

The conditional mean equation of the GARCH(1,1) model included a dummy variable taking the value of 1 for the period December 2006 - August 2008 to inclusive in order to capture the impacts of the global financial crisis. The estimated conditional variance is then converted to three-month frequency to match the quarterly data.

. 4.2 Structural VAR Methodology

Dynamic interactions between variables can be analyzed by examining the impulse of one variable on others in the VAR system. However, VAR models are difficult to interpret as they are a set of 'reduced form' equations that do not reflect any economic structure and therefore, the parameters do not have economic meaning. Therefore, the used methodology is structural VAR (SVAR) proposed by Sims (1981, 1986), Bernanke (1986), and Shapiro & Watson (1988) where the focus is on the errors of the system. The idea is to identify the relationship between the reduced form residuals and the structural shocks, $Au_t = B\varepsilon_t$ where u_t is the reduced form disturbances and ε_t are the unobserved structural shocks and A and B are the (K x K) matrices of coefficients, K representing the number of variables.

The procedure involves first estimating a VAR model which in general case is written as

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + u_t \qquad \text{eq. (2)}$$

where u_t is the reduced form error. The structural VAR form of (eq.1) is

$$A\Delta Y_t = \Gamma^*_1 \Delta Y_{t-1} + \ldots + \Gamma^*_{p-1} \Delta Y_{t-p+1} + B\varepsilon_t \qquad \text{eq. (3)}$$

where Γ^* are the structural parameters to be estimated and difference operator is denoted as Δ, ε_t are shocks or structural innovations that have zero mean with variances of 1 and $B\varepsilon_t = \upsilon_t$ is the structural error with zero mean, white noise, time invariant covariance matrix. The structural shocks have to be mutually uncorrelated (orthogonal) so that one can consider the dynamic impact of a shock which are treated as exogenous variables. Since shocks are not directly observed, they are to be identified using the relationship with the reduced form residuals. This necessitates imposing restrictions on matrix A or matrix B (or both) in order to identify and estimate them. In this study, a triangular recursive identification is used such that the first shock has contemporaneous effect on the second, third and next variables, while the second shock affects the first variable only with a lag but will impact other variables contemporaneously. This means that ordering of the variables is important. In this study, the variables are y_t = (oil price, inflation, M2, gdp) where oil price is oil price change or alternatively oil price volatility estimated by the GARCH(1,1) model. After estimating the SVAR model in the second, step SVAR impulse responses and forecast error variance decompositions are derived to investigate the impacts of the oil price shock and the volatility shock on the economy. The impulse response confidence intervals are computed using Effron & Hall confidence intervals with 2000 bootstarp replications.

4.3 The Unit Root Test

In order to set the model appropriately, there is a need to check if the series are stationary or not. To achieve this, the augmented Dickey Fuller (ADF) test (Fuller 1976, Dickey and Fuller 1979) will be conducted to ensure the stochastic properties do not explicitly depend on time. Generally, the test can be represented as shown below.

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t, \quad \text{eq. (4)}$$

for testing $H_0 : \gamma = 0$ (there is a unit root or the series is nonstationary) against $H_1 : \gamma < 0$ (there is no unit root or the series is stationary) for which the critical values are non standard and have been constructed by Dickey and Fuller (1976). In equation (4) above, α is a constant, β is the coefficient of time trend and p represents the order of autoregressive process. There are three different forms in which ADF test can be executed; by including the trend variable and the consant, by including only the constant or excluding both the trend variable and also the constant.

If there is some break or structural shift in the data generating process, the unit root test will yield misleading results which necessitates that to be taken into account. Saikkonen and Lütkepohl (2002) and Lanne, Lütkepohl and Saikkonen (2002) propose unit root tests by estimating the deterministic term with the inclusion of the shift function and adjusting the series by subtracting the deterministic term before performing the ADF test. Addition of a shift function to the deterministic term of the data generating process can take various forms as a simple shift dummy variable defined as $d_{1t} = 0 \quad t < T_B$ and $d_{1t} = 1 \quad t \geq T_B$ and differencing of this shift

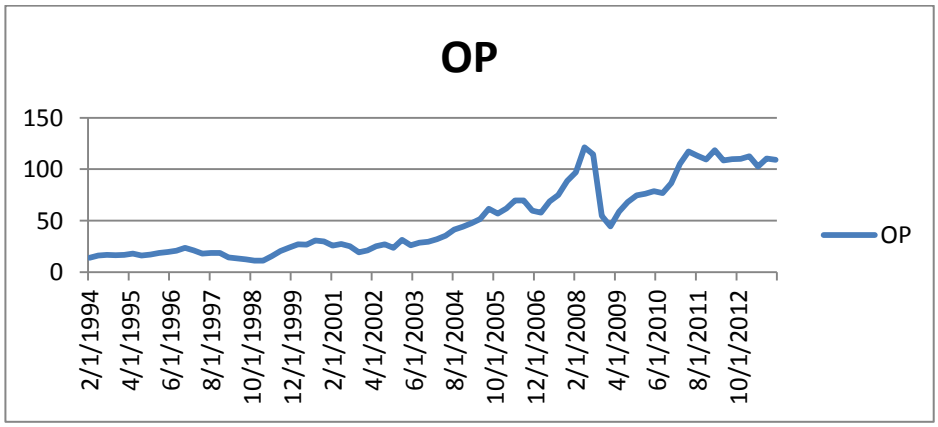
dummy will result in an impulse dummy. In the case of a one time shift at T_B, the shift function may include an exponential distribution function or a rational function offered in JMulTi.

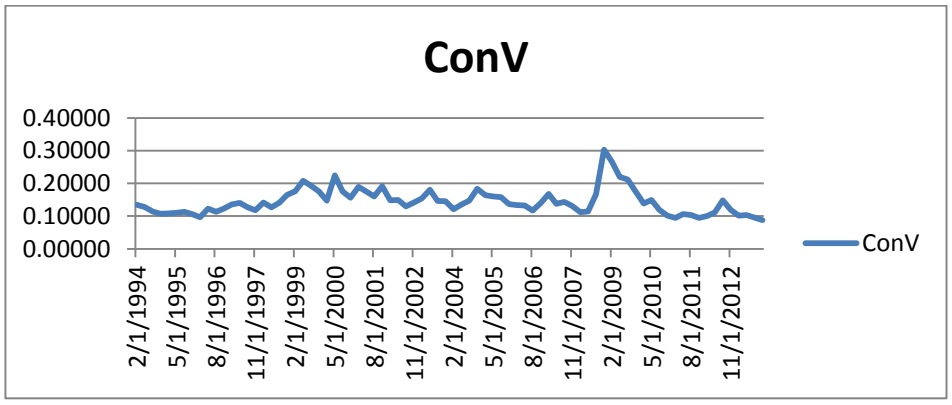
Chapter 5

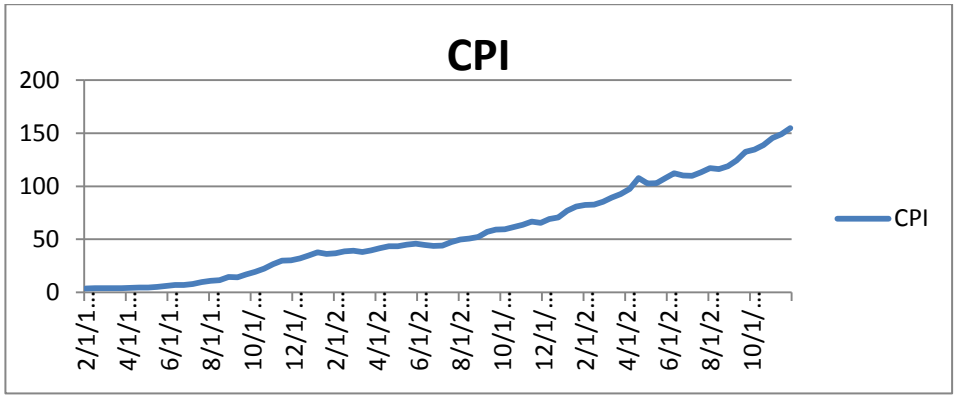
EMPIRICAL RESULTS

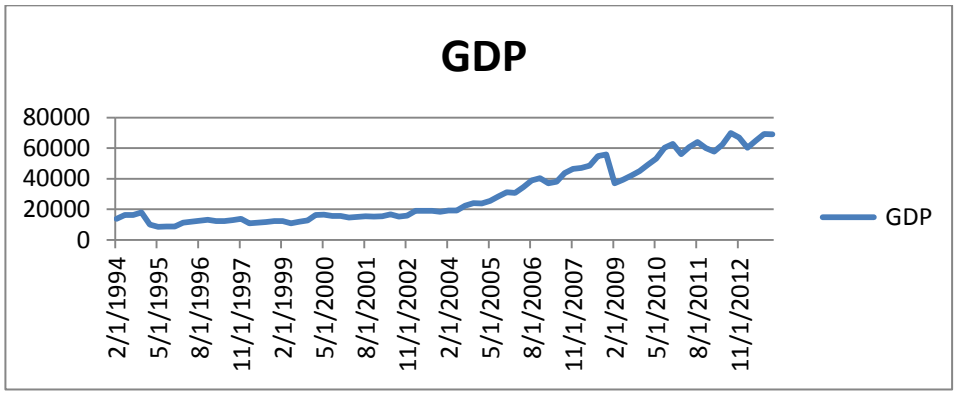
5.1 Empirical Results

Over the sample period, all the series have an increasing trend as observed in the Figure 1 below. Furthermore, the plot of oil price volatility clearly shows increase in the volatility as from 1999. Oil price variable exhibits a sharp rise in 2007 and 2008 which after a fall starts peaking up again in mid-2009. Gross domestic product (GDP) also is observed to have increasing variability.









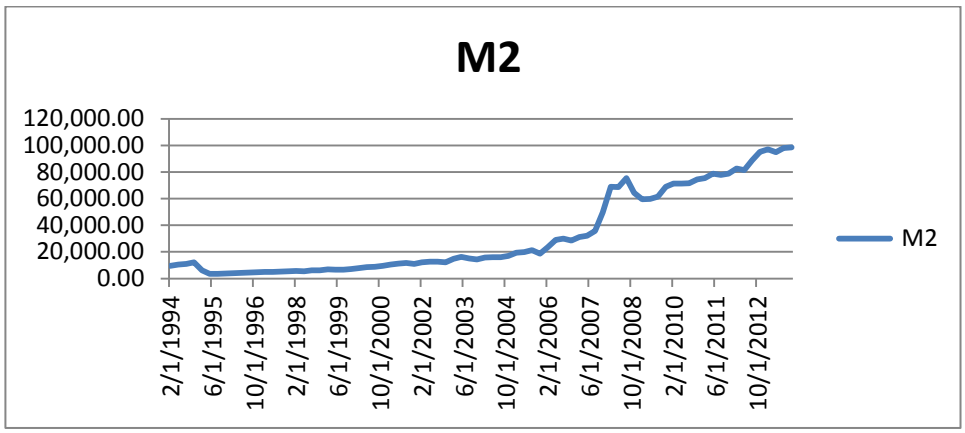


Figure 1: Oil Price, Oil Price Volatility, GDP, CPI and M2 (1994Q1-2013Q4)

The unit root tests have been conducted by including a constant, trend, seasonal dummies and appropriate shift dummy in the deterministic term. The lag length is determined by Akaike Information criteria (AIC) and Hannan Quin criteria (HQ). The unit root test results are presented in Table 6 which have indicated that all the

variables except the conditional volatility are I(1) while the conditional volatility series is already I(0). Therefore, the first differenced of the logarithms of the variables for oil price (OP), GDP, M2 and CPI have been used in the analysis.

Table 5: Unit Root Tests with Structural Breaks

Variable	Lag	Break date	Deterministic term	ADF test Statistic	Critical values		
					1%	5%	10%
LCPI	0	1999 Q3	sd	-8.89	-3.48	-2.88	2.58
M2	3	1996 Q1	sd	-4.87	-3.48	-2.88	2.58
LGDP	1	1995 Q3	sd	-9.88	-3.48	-2.88	2.58
CVOL	0	2008 Q4	id	-3.04	-3.48	-2.88	2.58
LOP	0	2008 Q4	id	-7.64	-3.48	-2.88	-2.58

Note: A constant, trend and seasonal dummies are included in the deterministic term of all the equations.In addition, 'sd' stands for shift dummy and 'id' stands for impulse dummy in the deterministic term.

5.2 Real Balances Channel Model

As explained before, several channels have been proposed to explain the negative correlation between oil prices and economic activity. Two of the channels focus on money. One is the real balances channel and the other one is the monetary policy channel. (Ferderer, 1996). The first and second models are based on the real balances channel according to which oil price rise increases inflation which in turn, reduces the amount of real balances in the economy leading to reduced output and recession through monetary channels. Based on this argument, the variables are ordered as change in oil price (dP_{oil}), inflation (dcpi) change in money supply (dM2) and output growth (dgdp). Therefore, the SVAR model impulse responses are derived by ordering the variables as to reflect the real business channel as y_t= (P_{oil}, inf, M2, GDP) which is specified as Model 1. The second model, Model 2, alternates the

conditional volatility for the change in oil price. For both models, the VAR lag is propsed to be 3 by Akaike Information criterion (AIC) and Final Prediction Error and 0 by Hannan-Quinn criterion and Schwarz criterion. We used 3 lags to take into account any correlation. Since some estimated coefficients have been statistically not significant, a subset VAR model was estimated with the deterministic component including a constant, trend and seasonal dummies.

5.3 Monetary Policy Channel Model

According to the monetary policy channel, monetary policy will respond to the rise in the price of oil to avoid inflation, thus either interest rate increase or money supply decreases which will ultimately have a negative impact on output. Accordingly, the same variables are involved to represent the monetary policy channel. However, we estimate changing the order of the variables as y_t= (P_{oil}, M2, inf, GDP) to check for the robustness of the estimated impulse response functions mentioned as Model 3 and the replacemenet of the oil price by its volatility is named as Model 4. The choice of the lag length and the subset VAR specification is same as explained above. The diagnostic checks for the residuals are the portmanteau test with adjusted test statistics, LM test for correlation as well as the univariate and multivariate ARCH tests which indicate no correlation and no ARCH effects in the residuals. The stability test is the sample split test which is based on the covariance matrix of the residuals which tests whether the covariance matrix is constant and white noise. All tests satisfy the requirements for estimating an adequate model which are presented in the appendix.

Before specifying and estimating the VAR model, GARCH(1,1) is estimated using log differenced monthly Brent oil price index as explained in section 4.1. Table 6

presents the estimated model with the Ljung-Box Q statistics on the standardized and the squared standardized residuals and the ARCH LM-test with their *p*-values which indicate that the estimated model is appropriate.

Table 6: GARCH(1,1) Estimation Results

Parameters	Coefficients	t-value	p-value
CrD (M)	0.034818	2.069	0.0397
AR (1)	0.115155	1.690	0.0923
ARCH (Alpha 1)	0.162348	2.923	0.0038
GARCH (Beta 1)	0.790755	14.65	0.0000
Statistics on Standardized Residuals and their *p*-values in parenthesis Q (5) = 1.2118 (0.876) Q (10) = 12.4546 (0.188) Q (20) = 28.7504 (0.070) Statistics on Squared Standardized Residuals and their *p*-values in parenthesis Q^2 (5) = 1.131 (0.769) Q^2 (10) = 6.123 (0.633) Q^2 (20) = 14.727 (0.68)			
ARCH 1-2 test : F(2,232) = 0.358 (0.699) ARCH 1-5 test: F(5,226) = 0.215 (0.956) ARCH 1 – 10 test: F(10,216) = 0.553 (0.850)			

5.4 SVAR Impulse Response Functions

Figure 2 shows the accumulated impulse responses to one standard deviation unexpected shock to an oil price derived from Model 1. As seen from the figures, a positive shock to oil price contemporaneously affects inflation negatively. According to economic theory, an increase in oil price is expected to increase the price level in an economy as the price rise in oil will be reflected to all the prices. However, this

result may be expected to be the opposit for an oil exporting country such as Nigeria, which the case is confirmed. Furthermore, output responses to an oil price shock

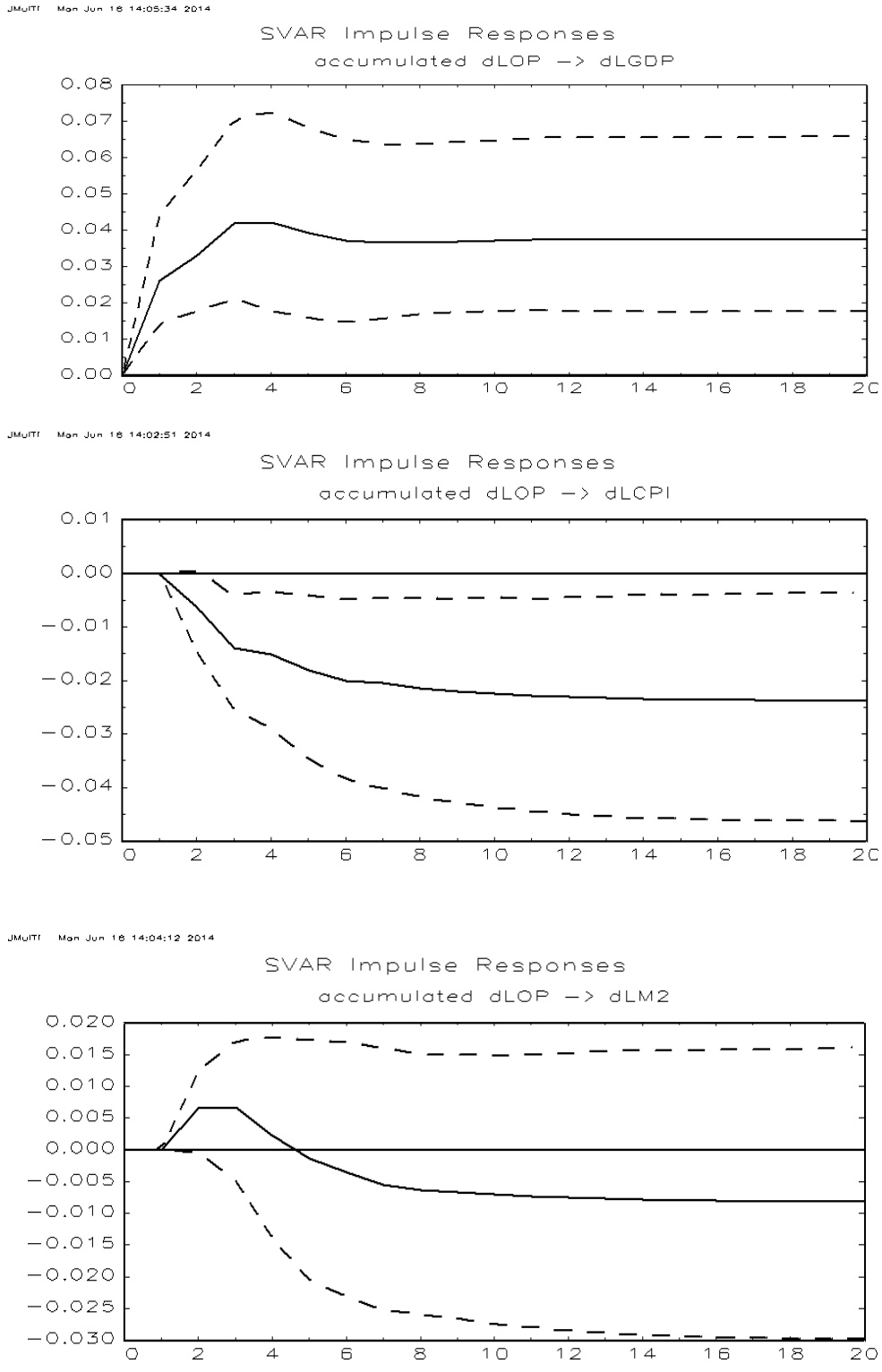
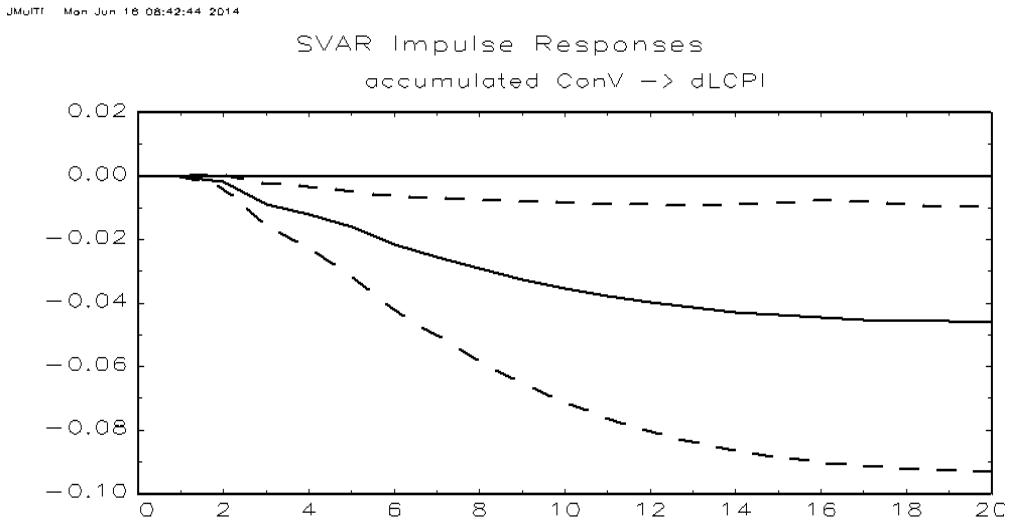
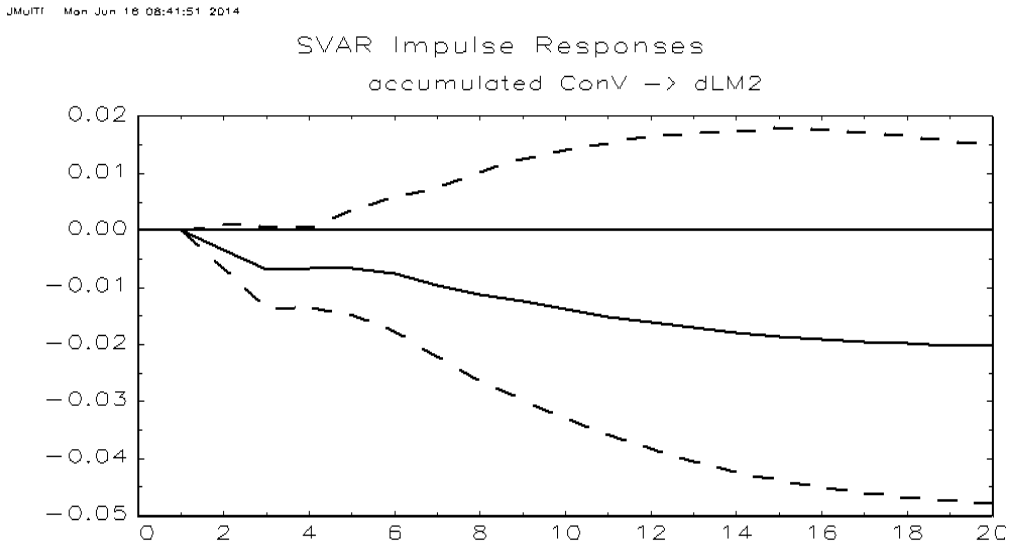


Figure 2. Accumulated SVAR Impulse Responses to Oil Price Shock

positively which may be interpreted as an improvement of the economy due to higher oil export revenue. On the other hand, respond of money supply to an unexpect positive oil price shock is not significant not verifying the monetary policy channel. The impulse responses obtained by alternating the order of the money supply and inflation variables, named as Model 3 produced very similar results confirming the robustness of the estimates. The corresponding graphs are provided in the appendix.The Figure 3 below presents the accumulated SVAR impulse responces to one standard deviation shock to the conditional volatility of the price of oil obtained from Model 2.





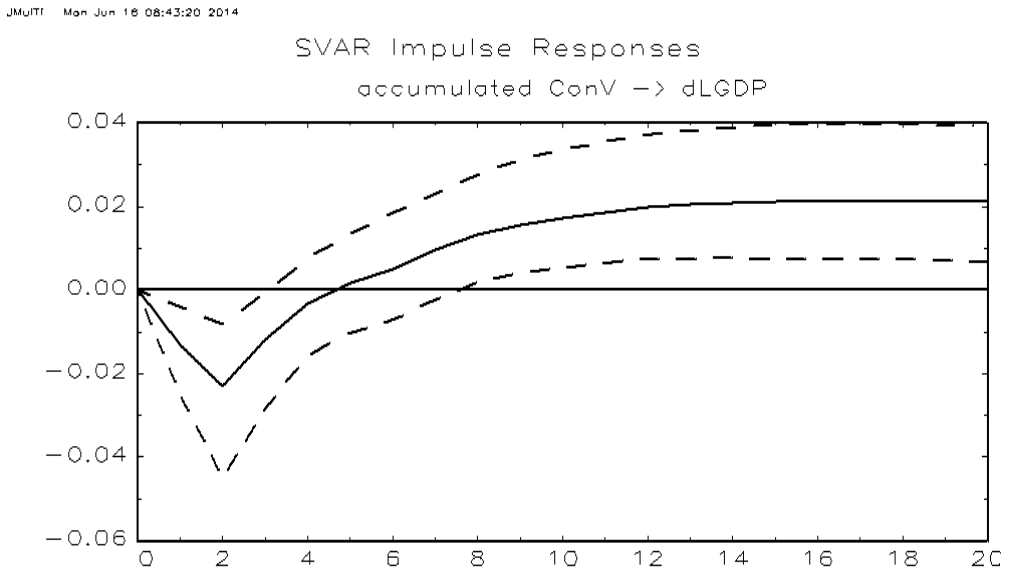


Figure 3: Accumulated SVAR Impulse Responses to Oil Prices Volatility Shock

The results indicate very similar conclusions as the impacts if the oil price shock on the Nigerian economy except that the respond of output to volatility shock is initially significantly negative but at longer lags becomes positive and significant. This may be explained by an initial reduction in world demand to oil due to uncertainty in oil price that might be a result of intertemporal substitution of oil use. However, the

positive impact outweights the negative impact on the economy. The IRs using Model 4 by alternating the order of the variables produces similar results.

5.5 SVAR Forecast Error Variance Decompositions

This section considers the forecast error variance decomposition (FEVD) as an alternative tool to interpret the results of the SVAR model which shows proportion of the contribution of one variable to explain the *h*-step forecast error variance of another variable where *h* represents the time horizon. Here, the interest is what proportion of output, inflation and M2 is explained by oil price and oil price volatility. The proportions of forecast error in output is explained by 6% of oil price at lag 2 (i.e in 6 months) and 7% at lag 3. This proportion is 5% at lag 4 for inflation. On the other hand, 3% of forecast error in output is explained by oil price volatility at lag 4 which increases to 4% at longer horizons. For the forecast error in inflation the proportions explained by volatility are 3% at lag 4 which increases to 6% at lag 8 (2 years). The contribution of oil price and volatility to forecast error variance is M2 is nill or negligibly small which therefotr not presented in the table below.

Table 7: SVAR Forecast Error Variance Decomposition

Forecast horizon (number of lags)	dLGDP accounted for by dLOP	dLCPI accounted for by dLOP	dLGDP accounted for by CVol.	dLCPI accounted for by CVol.
2	0.06	0.00	0.01	0.00
4	0.07	0.05	0.03	0.03
6	0.07	0.05	0.04	0.04
8	0.07	0.06	0.04	0.06

Chapter 6

CONCLUSION

6.1 Concluding Remarks and Recommendations

The oil prices which started to rise again since 1999 have been observed to be the consequences of the recent developments arising from stronger demand for oil and scarcity of natural oil resources. The time-varying variations in oil prices have also been on an increasing trend over this period. Nigeria being a major crude oil producer and exporter may be exposed to the adverse effects of such developments. Within this framework, the thesis work aims to investigate whether unexpected oil price rises and uncertainties have any impact on oil exporting country Nigeria, which is heavily dependent on oil export. Furthermore, the study also explores whether monetary policy responds to any oil price shock or its uncertainty. The results of the study which selects a sample that is the most updated and free of important structural changes in the Nigerian economic history will be compared with the findings of similar empirical work on Nigeria to shed light on varying conclusions arrived at about the impacts of the oil price movements.

These issues are investigated by employing a SVAR approach in constructing impulse response functions. The results of the study suggest that, Nigeria's economic growth is positively affected from oil price rises and oil price uncertainty, in terms of higher output which is in support of other findings for Nigeria such as Abdulhakeem (2010), Damachi (2012) and Omojolaibi (2013). On the other hand, the impulse

response analysis suggests that inflation is negatively affected from one standard deviation shock in oil price. This is contrary to what is reported in Abdulhakeem (2010) which found out that CPI did not respond to oil price shocks during his period of study. However, Omojolabi (2013) reported that oil price innovation has a dominant positive effect on consumer price index. Furthermore, in this study, impulse responses of monetary policy to either the oil price increase or volatility is found to be statistically insignificant. However, Abdulhakeem (2010) reported a negative response while Damachi (2012) reported a positive response for the period of 1986 – 2000 which disappeared for the restricted sample of 1995 – 2000. This coincides with the period of this thesis in which money supply did not react to crude oil price shock nor the price volatility supporting findings of Demachi(2012). Our results also make it clear that period of sample of study is an important factor for arriving at different conclusions in the empirical studies on Nigeria on the subject matter.

Based on the FEVD, output and inflation in Nigeria is affected by the movements in the price of oil at longer horizon which provides evidence supporting the proposition by Oyeyemi (2013) that small shocks in oil price can impose a long-run effect on output. This may imply that output increases due to increase in oil export revenue may ultimately lead to increased demand for imports since Nigeria's industry is dependent on imported raw materials. Another reason may be because of increase in consumption that may also induce a higher import demand for Nigeria. To avoid any form of instability that may occur in future, the Nigerian government should diversify the economy by paying more attention to the development of other sectors of the economy such as manufacturing, tourism and agriculture. This way, the sole

dependency on crude oil revenue will be significantly reduced. Also, since monetary policy did not respond to oil price shock and its volatility, this may imply that monetary policy is not strong enough to alleviate the adverse effects of these exogenous shocks on the Nigerian economy. Thus, more attention should be paid to monetary policy design which can be used to stabilized the economy in case of unpredictable crude oil price movements.

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APPENDIX

VAR MODEL STATISTICS

sample range: [1995 Q1, 2013 Q4], T = 76

Log Likelihood: 4.648621e+02
Determinant (Cov): 5.718551e-11

Covariance:
 4.934077e-04 -2.277740e-04 1.921917e-04 6.511095e-05
-2.277740e-04 1.309002e-02 3.277740e-05 7.804759e-03
 1.921917e-04 3.277740e-05 1.440370e-03 -1.953572e-04
 6.511095e-05 7.804759e-03 -1.953572e-04 1.134132e-02

Correlation:
 1.000000e+00 -8.962537e-02 2.279789e-01 2.752449e-02
-8.962537e-02 1.000000e+00 7.548614e-03 6.405565e-01
 2.279789e-01 7.548614e-03 1.000000e+00 -4.833488e-02
 2.752449e-02 6.405565e-01 -4.833488e-02 1.000000e+00

AIC: -2.282156e+01
FPE: 1.229510e-10
SC: -2.193220e+01
HQ: -2.246613e+01

SVAR FORECAST ERROR VARIANCE DECOMPOSITION

Proportions of forecast error in "dLGDP"
accounted for by:

forecast horizon	ConV	dLM2	dLCPI	dLGDP
1	0.00	0.00	0.00	1.00
2	0.01	0.00	0.00	0.98
3	0.02	0.00	0.00	0.98
4	0.03	0.00	0.00	0.96
5	0.04	0.00	0.00	0.95
6	0.04	0.01	0.00	0.95
7	0.04	0.01	0.00	0.95
8	0.04	0.01	0.00	0.94
9	0.04	0.01	0.00	0.94
10	0.04	0.01	0.00	0.94
11	0.04	0.01	0.00	0.94

```
       12                  0.04        0.01        0.00
0.94
       13                  0.05        0.01        0.00
0.94
       14                  0.05        0.01        0.00
0.94
       15                  0.05        0.01        0.00
0.94
       16                  0.05        0.01        0.00
0.94
       17                  0.05        0.01        0.00
0.94
       18                  0.05        0.01        0.00
0.94
       19                  0.05        0.01        0.00
0.94
       20                  0.05        0.01        0.00
0.94
```

```
VAR ESTIMATION RESULTS
endogenous variables:     dLOP dLM2 dLCPI dLGDP
exogenous variables:
deterministic variables:  CONST S1 S2 S3 TREND
endogenous lags:          3
exogenous lags:           0
sample range:             [1995 Q1, 2013 Q4], T = 76

modulus of the eigenvalues of the reverse characteristic
polynomial :
|z| = ( 1.5191     1.5191     1.3570     1.8322     1.8322
1.6678     1.6678     2.3299     2.3299     3.1262     )
Legend:
=======
              Equation 1   Equation 2  ...
-----------------------------------------
Variable 1 | Coefficient          ...
           | (Std. Dev.)
           | {p - Value}
           | [t - Value]
Variable 2 |         ...
...
-----------------------------------------


Lagged endogenous term:
=======================
               dLOP      dLM2     dLCPI     dLGDP
```

```
-------------------------------------------------
dLOP (t-1)|    0.256       ---       ---     0.211
          |   (0.102)     (   )     (   )   (0.063)
          |   {0.012}     {   }     {   }   {0.001}
          |   [2.511]     [   ]     [   ]   [3.352]
dLM2 (t-1)|      ---     0.209    -0.101       ---
          |     (   )   (0.095)   (0.040)     (   )
          |     {   }   {0.028}   {0.011}     {   }
          |     [   ]   [2.191]  [-2.534]     [   ]
dLCPI(t-1)|    0.578     0.339       ---       ---
          |   (0.324)   (0.232)     (   )     (   )
          |   {0.074}   {0.145}     {   }     {   }
          |   [1.786]   [1.458]     [   ]     [   ]
dLGDP(t-1)|   -0.230     0.254     0.176       ---
          |   (0.141)   (0.103)   (0.050)     (   )
          |   {0.102}   {0.014}   {0.000}     {   }
          |  [-1.633]   [2.462]   [3.522]     [   ]
dLOP (t-2)|      ---       ---    -0.088       ---
          |     (   )     (   )   (0.031)     (   )
          |     {   }     {   }   {0.004}     {   }
          |     [   ]     [   ]  [-2.853]     [   ]
dLM2 (t-2)|      ---    -0.230       ---       ---
          |     (   )   (0.081)     (   )     (   )
          |     {   }   {0.005}     {   }     {   }
          |     [   ]  [-2.838]     [   ]     [   ]
dLCPI(t-2)|      ---     0.288     0.207       ---
          |     (   )   (0.202)   (0.083)     (   )
          |     {   }   {0.153}   {0.012}     {   }
          |     [   ]   [1.428]   [2.506]     [   ]
dLGDP(t-2)|      ---       ---       ---       ---
          |     (   )     (   )     (   )     (   )
          |     {   }     {   }     {   }     {   }
          |     [   ]     [   ]     [   ]     [   ]
dLOP (t-3)|      ---       ---    -0.043     0.075
          |     (   )     (   )   (0.030)   (0.063)
          |     {   }     {   }   {0.145}   {0.238}
          |     [   ]     [   ]  [-1.458]   [1.181]
dLM2 (t-3)|   -0.307       ---       ---    -0.175
          |   (0.109)     (   )     (   )   (0.072)
          |   {0.005}     {   }     {   }   {0.014}
          |  [-2.825]     [   ]     [   ]  [-2.449]
dLCPI(t-3)|      ---       ---     0.347       ---
          |     (   )     (   )   (0.089)     (   )
          |     {   }     {   }   {0.000}     {   }
          |     [   ]     [   ]   [3.903]     [   ]
dLGDP(t-3)|      ---       ---       ---       ---
          |     (   )     (   )     (   )     (   )
          |     {   }     {   }     {   }     {   }
          |     [   ]     [   ]     [   ]     [   ]
-------------------------------------------------


Deterministic term:
===================
              dLOP      dLM2     dLCPI     dLGDP
-------------------------------------------------
```

```
CONST    |   -0.105    -0.088       ---       ---
         |   (0.054)   (0.034)     (   )     (   )
         |   {0.054}   {0.009}     {   }     {   }
         |  [-1.926]  [-2.600]     [   ]     [   ]
S1    (t)|    0.098     0.044     0.042    -0.079
         |   (0.048)   (0.033)   (0.011)   (0.026)
         |   {0.041}   {0.182}   {0.000}   {0.003}
         |   [2.045]   [1.334]   [3.738]  [-2.968]
S2    (t)|    0.078       ---     0.076       ---
         |   (0.045)     (   )   (0.013)     (   )
         |   {0.080}     {   }   {0.000}     {   }
         |   [1.750]     [   ]   [6.022]     [   ]
S3    (t)|    0.059       ---     0.067       ---
         |   (0.042)     (   )   (0.011)     (   )
         |   {0.156}     {   }   {0.000}     {   }
         |   [1.417]     [   ]   [6.108]     [   ]
TREND(t)|    0.001     0.002    -0.001     0.001
         |   (0.001)   (0.001)   (0.000)   (0.000)
         |   {0.115}   {0.003}   {0.000}   {0.003}
         |   [1.574]   [2.941]  [-3.574]   [2.948]
```

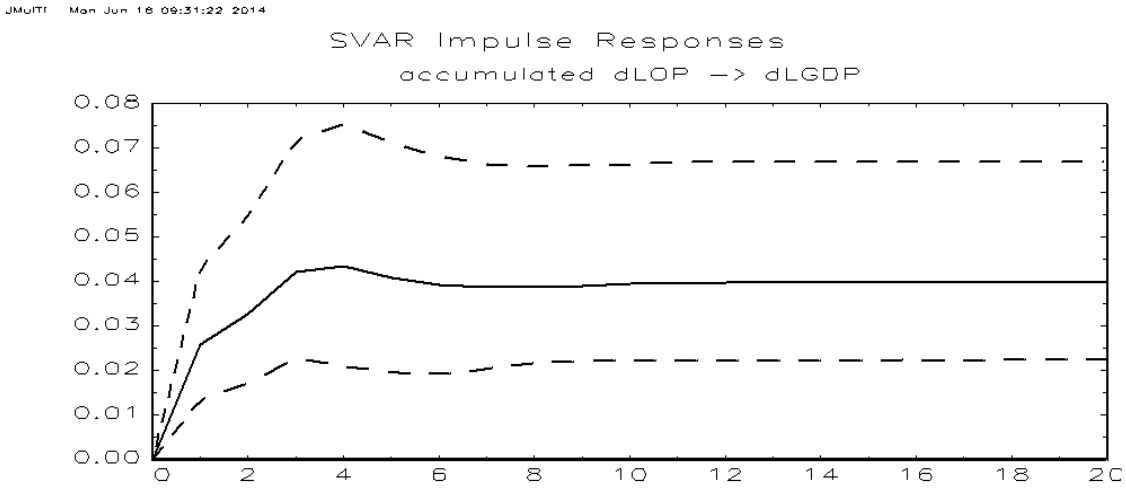
```
PORTMANTEAU TEST (H0:Rh=(r1,...,rh)=0)
Reference: Lütkepohl (1993), Introduction to Multiple Time
Series Analysis, 2ed, p. 150.
tested order:              16
test statistic:            188.9648
 p-value:                  0.9927
adjusted test statistic:   215.2967
 p-value:                  0.8625
degrees of freedom:        239.0000
```

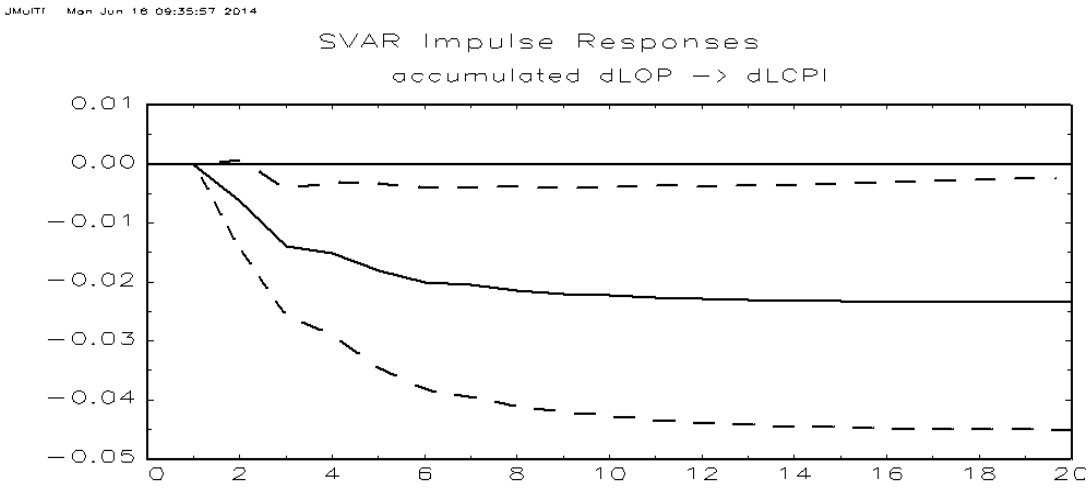
```
LM-TYPE TEST FOR AUTOCORRELATION with 5 lags

Reference: Doornik (1996), LM test and LMF test (with F-
approximation)
LM statistic:              63.6392
 p-value:                  0.9099
 df:                       80.0000
```

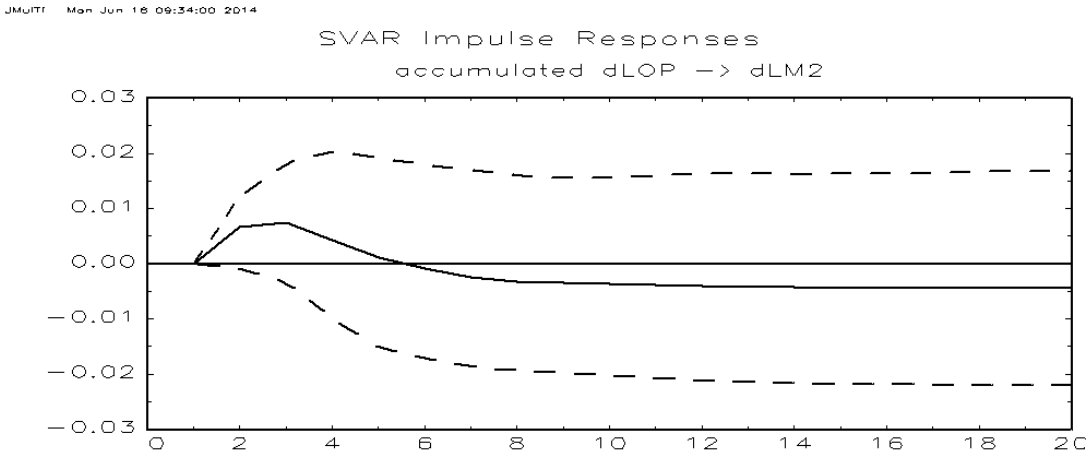
```
LMF statistic not computed for subset model.
*** Mon, 16 Jun 2014 00:44:31 ***
*** Mon, 16 Jun 2014 00:44:31 ***
ARCH-LM TEST with 16 lags

variable        teststat   p-Value(Chi^2)  F stat     p-
Value(F)
u1              2.2435     1.0000          0.1457     0.9999
u2              25.3092    0.0646          2.7359     0.0044
u3              15.9707    0.4550          1.3602     0.2073
u4              8.0857     0.9463          0.5841     0.8784
```

```
MULTIVARIATE ARCH-LM TEST with 5 lags

VARCHLM test statistic:   543.1935
 p-value(chi^2):          0.0886
 degrees of freedom:      500.0000

*** Mon, 16 Jun 2014 01:45:56 ***
PORTMANTEAU TEST (H0:Rh=(r1,...,rh)=0)
Reference: Lütkepohl (1993), Introduction to Multiple Time
Series Analysis, 2ed, p. 150.
tested order:             16
test statistic:           192.6774
 p-value:                 0.9859
adjusted test statistic:  219.1530
 p-value:                 0.8043
degrees of freedom:       238.0000

*** Mon, 16 Jun 2014 01:45:56 ***
LM-TYPE TEST FOR AUTOCORRELATION with 5 lags
Reference: Doornik (1996), LM test and LMF test (with F-
approximation)
LM statistic:             92.6316
 p-value:                 0.1581
 df:                      80.0000
LMF statistic not computed for subset model.
*** Mon, 16 Jun 2014 01:45:56 ***



ARCH-LM TEST with 16 lags

variable        teststat   p-Value(Chi^2)  F stat     p-
Value(F)
u1              5.0477     0.9955          0.3445     0.9881
u2              23.8845    0.0921          2.4800     0.0091
u3              11.8711    0.7528          0.9249     0.5485
u4              6.4484     0.9825          0.4516     0.9568

*** Mon, 16 Jun 2014 01:45:56 ***
MULTIVARIATE ARCH-LM TEST with 5 lags

VARCHLM test statistic:   542.6509
 p-value(chi^2):          0.0912
 degrees of freedom:      500.0000
```

The impulse responses obtained by alternating the order of the money supply and inflation variables, named as Model 3






JMulTi Mon Jun 16 09:34:00 2014
SVAR Impulse Responses
accumulated dLOP -> dLM2
0.03
0.02
0.01
0.00
−0.01
−0.02
−0.03
0
2
4
6
8
10
12
14
16
18
20