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Implications of Oil Price Shocks for the Macroeconomy of African Oil exporting Countries

Evidence from Angola and Nigeria

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DEDICATION

This master thesis is dedicated solely unto my Lord and Saviour Jesus Christ. Since I got Lisbon as an atheist, He revealed Himself to me and since then I have been learning to know and trust Him.

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ABSTRACT

Angola and Nigeria are the two largest oil production countries in Africa. Oil related activities represent a large proportion of their economic activity which make them vulnerable to oil price shocks.

A large body of research suggests that oil price fluctuations have considerable consequences on economic activity, however, the empirical literature on macroeconomics effects of oil price shocks is biased towards developed oil importing countries and lacks developing countries study cases (Bangara & Dunne, 2018).

Following existing literature (Jiménez-Rodríguez & Sánchez, 2004), a quarterly four variables SVAR from 2002Q1 to 2017Q4 is applied to investigate the implications of oil price shocks in the key macroeconomic variables of Angola and Nigeria.

The study finds that even though the two countries share similar dependence on oil exports, there is strong evidence that they react differently to crude oil price shocks. While in Angola oil prices granger-cause real GDP, real exchange rate and inflation, in Nigeria it only granger-cause real exchange rate.

Furthermore, whereas in Angola, a positive oil price shock, increases real GDP, contributes to an appreciation of the real exchange rate and a reduction in inflation. In Nigeria, real GDP doesn't seem to respond significantly to oil price shocks and at least in the short run neither inflation. These results suggest that Angola is more vulnerable to oil price shocks than Nigeria which maybe explained by the different structure of their domestic economies as well as the differences in the reserve buffers strategies to soften the magnitude of the external shock's impact.

Keywords: Oil price shocks, Granger-Cause, SVAR, Angola and Nigeria

Sumário Executivo

Título da Dissertação: Implicações das alterações no preço do petróleo para a macroeconomia dos países exportadores de petróleo em África.

Evidência de Angola e Nigéria.

Angola e Nigéria são os dois maiores produtores de petróleo em África. A maior parte da literatura empírica consultada sugere que flutuações do preço do petróleo têm um impacto considerável na atividade económica dos países. Entretanto, estes estudos analisam maioritariamente países desenvolvidos (importadores de petróleo). Sendo que existe uma carência de estudos de casos de países em desenvolvimento exportadores de petróleo (Bangara & Dunne, 2018).

Seguindo a literatura (Jiménez-Rodríguez & Sánchez, 2004), procuramos investigar as implicações dos choques petrolíferos em Angola e na Nigéria através da aplicação de um SVAR de 2002Q1 a 2017Q4.

O estudo constata que, embora os dois países sejam similarmente dependentes das exportações de petróleo, há fortes evidências de que eles reagem de maneira diferente aos choques petrolíferos. Em Angola os choques petrolíferos causam (no sentido de Granger) um aumento do PIB real, da taxa de câmbio real e da inflação. Mas, na Nigéria os choques petrolíferos causam apenas a taxa de câmbio real.

Além disso, enquanto em Angola, um aumento no preço do petróleo, aumenta o PIB real, contribui para uma apreciação da taxa de câmbio real e uma redução da inflação. Na Nigéria, o PIB real não parece responder de forma significativa aos choques petrolíferos e, pelo menos a curto prazo, nem à inflação. Os resultados sugerem que Angola é mais vulnerável aos choques petrolíferos do que a Nigéria e aponta como possível explicação a diferença na estrutura económica, e na existência de fundos de estabilização macroeconómica.

Palavras-chave: choque petrolífero, causalidade de granger, SVAR, Angola e Nigéria

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ADF	Augmented Dickey Fuller
BP	British Petroleum
BNA	Banco Nacional de Angola
CEIC-UCAN	Centro de Estudos e Investigação Científica da UNiversidade Católica de Angola
CPI	Consumer price Index
FEVD	Forecast Error Variance Decomposition
GDP	Gross Domestic Product
IMF	International Monetary Fund
SVAR	Structural Vector Autoregressive
USD	United States' Dollars
U.S. EIA	United States' Energy Information Administration
VAR	Vector Autoregressive
WEO	World Economic Outlook

1. INTRODUCTION

1.1 Motivation

In the fall of 2015 the IMF world outlook report projected the Angolan economy (real GDP) to grow 3.5% in 2016. The actual growth rate turned out to be -0,7% in 2016. In the same publication, the annual inflation rate was expected to be 10.3% in 2015 and 14.2% in 2016. For those years the annual inflation rates were 14,3% and 42%, respectively.

There is evidence that the crude oil price drop can be the reason for the failing of projections since crude oil price registered a great plummet of about 60% (from June 2014 to January 2015. According to Rocha, Paulo, Bonfim, & Santos, 2016, more than half of economic activity in Angola[1] is made of crude oil related activities, which represents more than 95% of its total exports and at least 75% of state budget revenues.

A large body of research suggests that oil price fluctuations have considerable consequences on economic activity (Grigoli, Herman, & Swiston, 2017; Sadeghi, 2017; Jiménez-Rodríguez & Sánchez, 2004). But, most of the empirical studies on macroeconomics effects of oil price fluctuations are on developed oil importing countries (Bangara & Dunne, 2018; Akpan,2009). Hence, in the scarce literature focused in developing countries we could not find any specific study about the Angolan economy[2]. For this reason, we apply a standard approach in this kind of literature (see Hamilton, 2005; Jones&Leby,2004) to assess the effects of oil prices shocks (i.e. a positive one standard deviation shock in oil prices) in the macroeconomy of the two largest oil exporting countries in Africa. Nigeria and Angola.

[1] Angola is the second largest oil production in Africa (cf. BP statistical review, June 2018).

[2] Using the standard approach in the literature of domestic macroeconomics effects of commodities price volatility. For this reason, Angola is the focus of the study.

1.2 Statement of the Problem

Angola and Nigeria are the two largest oil production countries in Africa. According to U.S. Energy Information Administration (2018) between 2002 and 2017, Nigeria produced in average 2.28 million barrels per day whilst Angola stood at 1.58 million barrels per day in the same period. Oil related activities represent more than 50% of Angolan's GDP, over 95% of export earnings and on average 75% of government revenue (Rocha et al 2016). In Nigeria, crude oil export revenues, represents about 90% of total export earnings and on average about 70 per cent of government revenues in annual budgets (Akpan, 2009) . These numbers can solely give us a rough idea of the importance of oil price fluctuations for these economies.

This dissertation investigates the implications of oil price shocks in the macroeconomic performance of Angola and Nigeria. Following existing literature (Bangara & Dunne, 2018; Ødegaard, 2012; Jiménez-Rodríguez & Sánchez, 2004), the study focused on four macroeconomic variables: real international oil prices, real gross domestic product, real exchange rate and consumer prices.

1.3 Research objectives

Our general objective is to investigate the relationship between oil price shocks and macroeconomic variables in Angola and Nigeria. Accordingly, the specific objectives are:

1. To assert the direction (causality) of the relationship between crude oil price shocks and key macroeconomic variables.
2. To estimate the effect of world crude oil price shocks on Angola and Nigeria's economic activity (real gross domestic product), real exchange rate and consumer prices.

1.4 Research Questions

To achieve the aforementioned objectives, we sought to answer the following questions:

1. Are the oil price shocks really causing the fluctuations on the macroeconomic variables?
2. What is the effect of international crude oil price shocks on economic activity (real GDP), real exchange rate and inflation?

1.5 Relevance

As already mentioned, the empirical literature on macroeconomics effects of oil price is biased towards developed oil importing countries, with a few studies focusing on developing economies (Bangara & Dunne, 2018; Akpan, 2009). The studies that focused on developing economies are based on cross country data sets (Choi, Furceri, Loungani, Mishra, & Poplawski-Ribeiro, 2017), with a small portion focusing on case studies of small open economies. Bangara & Dunne (2018) arguing in favour of small countries case studies, stated that cross country studies usually fail to address heterogeneity problems within and between countries because factors that affect the macroeconomic variables differ not only between developed and developing countries but also among different developing countries (Stiglitz, Ocampo, Spiegel, French Davis, & Deepak, 2006).

Therefore, this dissertation contributes to the existing empirical literature on the link between oil prices shocks and the macroeconomy in developing oil exporting countries, providing a comparative case study on the macroeconomics effects of oil price shocks in Angola and Nigeria.

There are a few studies on the subject for Nigeria (Akinleye & Ekpo, 2013; Akpan, 2009 and Olomola, 2006). However, most of them do not cover the two major oil crises of the last decades (2008/2009 and 2014/2015) and invariably start in the 1960/1970 decades. Since the literature points out a decrease in the relationship between oil price shocks and the macroeconomy in developed countries (Blanchard & Galí, 2007) we think that this dissertation will contribute to literature by providing an answer to this question posted to a developing country (Nigeria).

Nevertheless, this is not the case for Angola which completely lacks this kind of studies (using this specific standard methodology). For this reason, we are going to give greater significance to the results for the Angolan economy.

Angola is in a unique moment of its history with great politics, social and economics challenges ahead. The country is facing the highest challenges of its recent history because at the same time as it remains the second largest oil producer in Africa, oil production has levelled off and could decline in the medium term. Meanwhile, oil prices are expected to remain soft at US$50–55 per barrel over the medium term (IMF 2018)[3].

Since the economic diversification can only be attained in the long run crude oil price is still going to be a determinant variable to shape both the economic policy and future in Angola. For this reason, assessing the implications of crude oil price shocks on the macroeconomy is a highly important subject.

1.6 Scope of the Study

The study covers the period between the first quarter of 2002 to the last one of 2017 for the two countries. This period was chosen, firstly, because of data limitations availability. Secondly, for the case of Angola to isolate the war effect (which ended in April 2002). A robustness check starting in the first quarter of 2005 was conducted to see how the results are sensible to the immediate post-war effects[4].

The great challenge of this dissertation was to overcome the data limitations for Angola, that hasn't got consistent and reliable high frequency data on national income accounts, constraining substantially the methodological options available for this kind of empirical analysis.

[3] See IMF Angola selected issues 2018

[4] The results do not change significantly. However, the results of stationarity and stability tests improved their significance.

Like several other developing countries, data on Angola's national income accounts are officially only available at annual frequency. Non-availability of a high frequency data on national accounts is one of the big hurdles faced by the researchers working with time-series data (Lariau, Said, & Takebe, 2016). To cope with this issue, researchers suggest different econometric methods in order to convert low-frequency economic time-series data into high-frequency data (Rashid & Jehan, 2013). Thus, we have used the method of Denton (1970)[5] – a well-known econometric disaggregation technique – to convert Angola annual real GDP data into quarterly.

1.7 Organization

The rest of the dissertation follows with an economic overview of both countries in chapter two while chapter three reviews related empirical literature; in chapter four the methodology and the database that was adopted in order to meet the study objectives are presented and explained. Chapter five presents the results of the estimated models. Finally, chapter six presents the conclusions and the policy implications of the study, and chapter 7 the limitations and areas for further research.

5 As recommended in International Monetary Fund (IMF) publications, this method is "relatively simple, robust, and well-suited for large-scaled applications." (see (Ajao, Ayoola, & Iyaniwura, 2015))

2. COUNTRIES' ECONOMIC OVERVIEW

Crude oil related activities earnings play a key role in the economic structure of the oil exporting countries. In most of these countries, the crude oil revenues are an important source of financing the state and usually the government budget dependence on it is very high. In fact, the key hypothesis in the annual budgets both in Angola and in Nigeria is the oil price. Therefore, it is expected that oil price changes highly affect the aggregate demand in these economies, because the government budget constitutes a significant portion of aggregate demand (Abrishami, 2008).

In the next section the recent economic history of Angola and Nigeria is going to be presented giving relevance to the behaviour of key macroeconomic variables during periods of high fluctuations in the oil prices.

2.1. Angola

A country sharing Africa's southwestern coastline with the Atlantic Ocean, the Republic of Angola is a leading African country in terms of natural resources. It is the second major oil producer in Africa and the seventh diamond producer in the world. It is a former Portuguese colony since 1975. Nevertheless, it failed to find stability following independence and was thrown into several civil conflicts between two opposing factions (UNITA and MPLA) for the following 27 years (1975-2002). The conflicts, which cost up to 1.5 million lives and damaged most of the infrastructure, ended in 2002. Since then, Angola's economy, infrastructure and institutions have been growing and put in place very quickly.

The period between 2002 and 2008 has been termed as the mini golden age of Angolan growth (Rocha, 2012); because in this period, Angola experienced the highest period of real GDP growth performance and improvements in the standard of living of its history.

Nevertheless, in one hand the country failed to turn that rapid economic growth into a proportional improvement of current living conditions. In another hand, it is still relying largely on its oil production as the only source for state revenues and international reserves as well as the main engine of economic growth (Rocha, et al., 2014). This makes the country vulnerable to the erratic behaviour of the oil price in the international markets, as it can be seen in the table 1.

Table 1 Angola selected macroeconomic indicators

Date	GDP (Annual Growth)%	Inflation	Fiscal Balance	Exchange Rate	Oil Price
2002	13,7	105,6	- 3,1	41,7	24,2
2003	5,3	76,6	- 5,9	79,1	28,2
2004	10,9	31,0	1,4	83,4	36,9
2005	18,3	18,5	9,4	80,8	50,6
2006	20,7	12,2	11,8	80,3	61,4
2007	22,6	11,8	4,7	76,5	72,9
2008	13,8	13,2	- 4,5	75,2	93,7
2009	2,4	14,0	- 7,4	89,4	60,9
2010	3,4	15,3	3,5	92,6	76,5
2011	3,9	11,4	8,7	95,3	108,7
2012	5,2	9,0	4,6	95,8	110,9
2013	6,8	7,7	- 0,3	97,6	107,7
2014	4,8	7,5	- 6,6	102,9	96,9
2015	3,0	14,3	- 3,3	135,3	53,0
2016	- 0,7	42,0	- 5,0	143,8	53,0
2017	1,5	23,4	- 6,8	165,4	57,6

Source: IMF WEO database, U.S. Energy Information Administration (hereafter U.S.EIA)

As it can be seen in the table 1 the Angolan economic history of the last 16 years can be divided into three periods, all of them tightly related to the behaviour of the oil prices in the international markets.

The first period goes from 2002 to 2008 where the annual average rate of GDP growth was 15.1%. Throughout this period the oil price in the international market generally increased. The average oil price was $54.5 per barrel (U.S. EIA, 2018). It is noteworthy that in average the crude oil price in the early decades had never achieved the maximum of $20 per barrel. Therefore, those were times of unprecedented high prices in the oil markets (the peak was $96 per barrel in the end of the period).

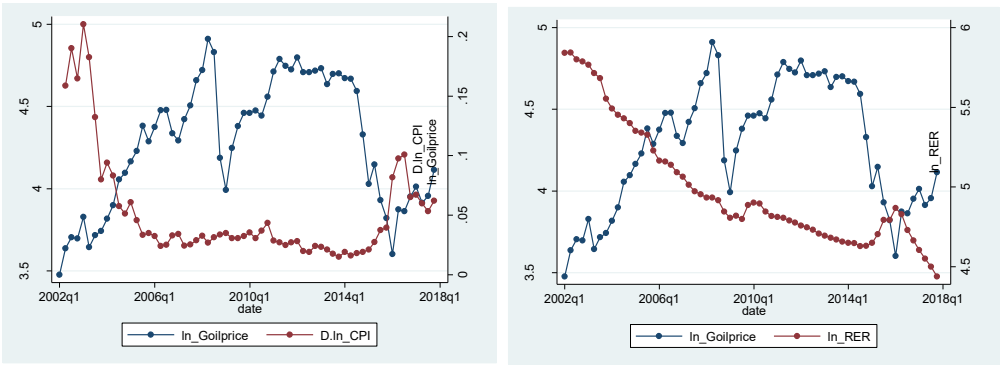
For the Angolan economy those prices were like a blessing. The end of the war associated with high oil prices created incentives for foreign investments which improved crude oil production from 910 thousand barrel per day in 2002 to 1.910 thousand in the end of 2008 (U.S. EIA, 2018). This highly improved state revenues, helping leverage public investments projects and stimulating private investments (Rocha, 2012) and consequently the overall economic growth. Oil-fuelled GDP increased ten-fold in this period.

The revenues from the oil sector also helped to stabilize the macroeconomic environment. For example, the annual rate of inflation reduced from 109.3% in 2002 to 12.5% in 2008. According to the Research Centre of the Catholic University in Angola (CEIC-UCAN,

2013) this reduction in inflation was achieved because increased oil revenues have helped to stabilize the nominal exchange rate (a fixed exchange rate regime during that period was in place) which was essential to bring inflation down because the country had at the time to import all, both intermediate and final goods, as well as equipment.

The second period goes from 2009 to 2013. The stunning economic performance of the mini golden age ended with the great international financial and economic crisis of 2008/2009, which has had a great impact in the international oil markets. A reduction in the oil prices from almost $140 per barrel in June 2008 to $30 per barrel in December was detrimental to the Angolan economy. In 2009 the GDP grew only 2.4% in a great contrast to the 13.8 and 22.6% rates in 2008 and 2007, respectively. The inflation rate stopped its reduction tendency and grew from 12% in 2007/2008 to almost 15% in 2010/2011. The exchange rate registered as well a big depreciation.

Figure 1 Angola: Global Oil Price (Brent crude, U.S. dollars per barrel) VS inflation and real exchange rate



Source: US EIA, BNA (Central Bank of Angola)

As can be seen in figure 1, after a sharp decline in 2008, oil prices went up to a relatively stable price range between $100 and $120 per barrel for about 3.5 years (January 2011-June 2014). Even though the GDP growth in Angola had not recovered its performance of the previous years, the inflation rate reacted very rapidly to the better oil market environment achieving for the first time in the Angolan history a single digit record. In 2012 the annual inflation rate was 9.02%. As can be seen in figure 01, the exchange rate remained relatively stable during this period until the last half of 2014 which is the beginning of the last period. In this last period (the third one) between June of 2014 and December of 2017 the exchange rate depreciated almost 100%.

In this last period, the oil price plummeted again from mid-2014 onwards and reached a minimum level of $ 26 per barrel in January 2016. This has been a catastrophe for the Angolan economy which was not completely recovered from the turmoil of 2008/2009. During this last period the annual average growth was 1.9% with a recession in 2016.
The average annual inflation went up from 7.5% in 2014 to 42.0% in 2016. And a clear degradation in the social conditions was observed (CEIC-UCAN, 2017).
Angola is in a unique moment of its history. The scars of the civil conflict are fading away and the physical infrastructure needed to support growth has been progressively rebuilt and expanded. A new political environment has been put in place after the ending of the long-lasting former presidency (38 years) – itself an important ingredient for sustainable growth – which can help to put the rule of law in place as well as the right institutions to attain sustainable growth.
However, economically speaking the country is facing the highest challenges of its recent history because at the same time as remains the second largest oil producer in Africa, oil production has levelled off and could decline in the medium term. Aging oil fields and years of under-investment due to lower oil prices could lead to a steady decline of oil production over the coming decades. Meanwhile, oil prices are expected to remain soft at US$50–55 per barrel over the medium term (IMF, 2018).
Since the economic diversification can only be attained in the long run still crude oil price is going to be a determinant variable to shape both the economic policy and future in Angola. For this reason, assessing the implications of crude oil price volatility on the macroeconomy is a highly important subject.

2.2. Nigeria

A key regional player in West Africa, with approximately 184 million inhabitants, Nigeria accounts for 47 percent of West Africa's population. With an abundance of resources, it is Africa's biggest oil exporter, and also has the largest natural gas reserves on the continent (World Bank, 2017a).

Nevertheless, just like in Angola, this abundance of resources is becoming a curse (Akinleye & Ekpo, 2013), making the country highly vulnerable to fluctuations in the international oil market, given the fragile nature of its economy and the heavy dependence on crude oil proceeds (Akinleye & Ekpo, 2013; Akpan, 2009).

In the period under study (2002-2017), Nigeria's economy grew by an annual average of 7%, primarily driven by the oil sector which accounted for more than 30% gross domestic product and 70% of all exports. This influence can be seen in a clearer way when that period is broken down into two subperiods, pre and post global financial crisis in 2008/2009.

The first subperiod is characterized by a global increase in oil prices, a stable macroeconomic environment and a high economic growth. The annual average growth rate was 9%. The annual inflation rate went down from 18% in 2005 to 5% in 2007. In this period the exports grew at an annual rate of 3% and the general government overall balance was in average positive (4.9% of GDP).

However, the global financial crisis in 2008/2009 led to a fall in global oil prices which caused Nigeria's government revenue to fall accordingly, in a way that in 2009 and 2010 the general budget recorded an average deficit of 4.2% of GDP. In this second period the annual average growth rate was only 5% and the inflation rate went up from 5% in 2007 to 14% in 2010.

Even though Nigeria's economy has performed much better in recent years than it did during previous boom-bust oil-price cycles, such as in the late 1970s or mid-1980s (World Bank, 2017a), oil prices continue to dominate both the country's growth pattern and the stability of the macroeconomic environment.

Table 2 Nigeria: selected macroeconomic indicators

Date	GDP (Annual Growth) %	inflation %	Fiscal Balance	Exchange Rate	Oil Price
2002	14,6	12,2	1,3	120,6	24,2
2003	9,5	23,8	- 2,2	129,2	28,2
2004	10,4	10,0	5,5	132,9	36,9
2005	7,0	11,6	4,9	131,3	50,6
2006	6,7	8,5	8,7	128,7	61,4
2007	7,3	6,6	- 1,1	125,8	72,9
2008	7,2	15,1	5,7	118,6	93,7
2009	8,4	13,9	- 5,4	148,9	60,9
2010	11,3	11,8	- 4,2	150,3	76,5
2011	4,9	10,3	0,4	153,9	108,7
2012	4,3	12,0	0,2	157,5	110,9
2013	5,4	8,0	- 2,3	157,3	107,7
2014	6,3	8,0	- 2,1	158,6	96,9
2015	2,7	9,6	- 3,4	192,4	53,0
2016	- 1,6	18,6	- 4,7	253,5	53,0
2017	0,8	16,0	- 5,0	305,8	57,6

Source: IMF WEO database, U.S. Energy Information Administration (hereafter U.S.EIA)

The recovery of the oil prices after 2009 helped the Nigerian to stabilize and recover rapidly the performance they had in the pre-crises period as can be seen in table 02. However, just like in Angola, the oil price plummet in mid-2014 onwards has been disastrous for the Nigerian economy.

As can be seen in the next section, the responses of the macroeconomic fundamentals to oil prices both in Angola and Nigeria are not strange to the literature. Fiscal policy in developing oil-exporting countries is usually pro-cyclical (Lopez-Murphy & Villafuerte, 2010; Ilzetzki & Vegh, 2008) and fiscal positions usually deteriorate during oil price booms (or improve when oil prices decline) owing to expansions (contractions) in government expenditure (Lopez-Murphy & Villafuerte, 2010).

For most of the developing oil-exporting countries, crude oil sells are the prime source of foreign exchange earnings and fiscal revenue, in addition to comprising a substantial portion of the real economic activity. Linkages to non-oil activity are also strong, as oil price fluctuations drive changes in national income, fuelling consumption and investment. Furthermore, in many oil-dominant economies there are strong linkages to the financial sector as oil companies account for a large share of lending portfolios, creating the

potential for oil price shocks to affect the health of financial firms, and thus overall credit growth (Ferreira & Oliveira, 2018; Grigoli, Herman, & Swiston, 2017).

Currently low oil prices, relative to the levels registered before 2008/2009, and the not-so-promising oil price outlook beg for a long-term plan, to preserve economic stability and protect growth in oil exporting countries.

In this context, it is critical for oil-exporting countries to understand how exogenous oil price shocks affect their economies and how they can use policy instruments to not only protect their economies from adverse shocks in the short run, but also create a diversified, private-sector driven, oil-independent economy in the long run.

The concerns about the effects of oil prices shocks in the economy get back on the global recessions in 1970s and 1980s caused by oil prices turmoil, which sparked a wave of studies on the relationship between oil prices and macroeconomy both theoretical and empirical. In the next section the literature review on the link between oil prices and macroeconomy is presented.

3. LITERATURE REVIEW

After decades of interest on the relationship between oil price shocks and macroeconomics, a considerable amount of empirical literature focusing on the economic implications of oil price shocks have been produced. Most of it is based on advanced oil importing countries (Bangara & Dunne, 2018; Hamilton, 2013; Jones, Leiby, & Paik, 2004), covering roughly 10 decades of study and using a great variety of methodologies and approaches (see Jones, Leiby, & Paik, 2004; Mork, Olsen, & Mysen, 1994). Regardless of the differences both in findings and methodology applied, most of the studies asserts that oil price shocks affect significantly the macroeconomic performance in developed oil importing economies and that its influence has been declining over the years (Cologni & Manera, 2008; Blanchard & Galí, 2007) due to more effective monetary policy responses to unanticipated shocks, less rigid labour markets and lower energy intensity of industries.

James Hamilton's (1983) seminal study shows that all but one U.S. recession since World War II were preceded by spikes in oil prices[6], finding a strong correlation between oil price changes and GNP growth for the U.S. data, with causality running from the former to the latter. Then, subsequent studies aimed to test the validity of those results over time for the US (Mork, Olsen & Mysen, 1994; Mork, 1989), adding features not taken into consideration in the Hamilton's initial study such as the asymmetric responses to oil price increase and decrease, as well as including others industrialized economies.

In a known study of the effects of an oil price shock in the main industrialised countries (individual G-7 countries[7], Norway and the euro area as a whole), Jimenez-Rodriguez and Sanchez (2004) found a non-linear effect of oil price on real economic activity and that the effect of oil price rise on output decline is higher than the effect of oil price fall on output increase. However, for the oil exporting countries in the sample, oil price increases were associated with higher economic growth and reduced unemployment rates. These results are in accordance with those of Lescaroux & Mignon, 2008.

[6] The key finding that established the case that oil shocks cause recessions was Hamilton's (1983) result that up to 1980, 'All but one of the U.S. recessions since World War II have been preceded, typically with a lag of around three-fourths of a year, by a dramatic increase in the price of crude petroleum' (p. 228)

[7] Canada, France, Italy, United Kingdom, Japan, Germany and the United States

Oil price fluctuations can be even more disruptive for oil exporting countries (see Sadeghi, 2017; Cashin, Mohaddes, Raissi, & Raissi, 2014; Berument, Ceylan, & Dogan, 2010). This is the case because in these countries the export of crude oil is the prime source of foreign exchange earnings and fiscal revenue, in addition to comprising a substantial portion of the real economy both directly via production, and through associated activities such as refining and distribution (Grigoli, Herman, & Swiston, 2017).

For example, Rautava (2004) found that the Russian economy is significantly influenced by fluctuations in oil prices through both long-run equilibrium conditions and short-run direct impacts. The author reports that a 10% permanent increase in the international price of oil is associated with a 2.2% growth in the level of Russian real GDP. Nevertheless, a higher oil price does not lead to a stronger real exchange rate in Russia, as the literature asseverates (see for example Korhonen & Mehrotra, 2009; Husain, Tazhibayeva, & Ter-Martirosyan, 2008; Brown & Yucel, 2002).

In the same line of research, Korhonen & Mehrotra (2009) studied the effects of oil price shocks on real exchange rates, and output in four large oil producing economies including Russia[8], finding that, even though oil price shocks are found to have a positive and statistically significant effect on domestic output, they play a relatively minor role in the movements in real GDP. This result is in accordance with those of (Husain, Tazhibayeva, & Ter-Martirosyan, 2008) which in a study of ten oil-producing countries found out that oil prices have no statistically significant effect on the countries' non-oil output, and the effect on GDP is realised only via pro-cyclical fiscal policy. Moreover, they concluded that a positive shock to real oil prices leads to an appreciation of the real exchange rate only in Iran and Venezuela.

Brown & Yucel (2002) argue that a rise in oil prices does not only affect the output and the prices, but it also affects the currency exchange rate of a country. When oil prices go up it occurs an immediate transfer of wealth from oil importers to oil exporters (positive income and wealth effects). However, as the oil importing trading partners suffer oil induced recession, they demand less export of traditional goods and services (usually commodities in the case of developing countries) from the oil exporting countries. Thus, the export sector of the oil exporting country will decrease and have a negative stimulus to the oil exporting countries economy.

[8] Iran, Kazakhstan, Venezuela and Russia

Those results are in accordance with the theory of exchange rate determination which states that an increase in the oil price causes the currency of an oil exporting country to appreciate as the demand for its domestic currency increases in the foreign exchange market.

When it comes to the reactions of domestic inflation to oil price shocks it is expected that an increase in oil prices might have an inflationary effect because, first of all, energy prices represent a portion (sometimes considerable) of production costs. Secondly, because it might lead to higher inflation expectations[9]. Thirdly, because it might lead workers to demand higher wages to compensate for the increase in energy prices (Blanchard & Galí, 2007). And finally, because it might mimic an adverse supply shock if real wages do not decrease sufficiently thus triggering an adjustment in employment (Bruno & Sachs, 1982). By contrast, an increase in oil prices might have a deflationary effect in the same fashion as an adverse demand shock because higher energy prices tend to reduce net-disposable income, and thus consumption and investments (Edelstein & Kilian, 2007). But these results are not accepted without controversy, for example, while Barsky & Kilian (2004) show that crude oil price increases generate high inflation, LeBlanc & Chinn, 2004 argue that oil prices have only a moderate impact on inflation (Lescaroux & Mignon, 2008).

Choi et al (2017) found out that a 10 percent increase in global oil prices increases on average domestic inflation by about 0.4 percentage point on impact, with the effect vanishing after two years and being similar in advanced and developing economies. They also find that the effect is asymmetric, with positive oil price shocks having a larger effect than negative ones. Conflitti & Luciani (2017) in a study covering only the U.S. and the Euro area estimated a small pass-through of oil price to core inflation statistically different from zero and long lasting.

As already mentioned, even though fluctuations of international oil prices can have more serious economic implications in developing economies than in developed (Stiglitz, Ocampo, Spiegel, French Davis, & Deepak, 2006) the empirical literature on macroeconomics effects of oil price shocks is biased towards developed oil importing countries. Perhaps not surprisingly, the American economy has been the recipient of most

[15]An oil price increase leads to a rise in the consumer price index (CPI), depending upon the share of oil products in the consumption basket. Due to the decline of their purchasing power, households may ask for increasing wages, leading to price-wage loops. Firms can pass the oil price increase on to selling prices. These effects tend to feed a wage-price spiral and to generate upward revisions of inflation expectations.

of the empirical studies on the subject. However, the dominant view among economists is that an increase in oil price, *ceteris paribus*, tends to have a positive effect on developing oil exporting countries at least in the short run. This is based on the evidence that a boost in oil price generates a change in terms of trade as income is transferred from importing to exporting nations, resulting in an increase in the national income (Jiménez-Rodríguez & Sánchez, 2004). However, following a price rise, the oil exporting countries potential gains are diminished because of the decreased demand for crude oil from importing economies (Akpan, 2009; Brown&Yucel,2002).

For example, Akpan (2009) found that in Nigeria, positive as well as negative oil price shocks significantly increase inflation and also directly increases real national income (slightly) through higher export earnings, though part of this gain is seen to be offset by losses from lower demand for exports generally due to the economic recession suffered by trading partners. Furthermore, the "Dutch Disease" syndrome is observed through significant real effective exchange rate appreciation after an increase in the oil prices. This result is in accordance with those of Olomola (2006). This last author, found evidence that oil price shocks may give rise to a wealth effect that appreciates the real exchange rate and may squeeze the tradable sector, giving rise to the "Dutch-Disease" just like Akpan (2009). However, different from Akpan (2009), Olomola (2006) reveals that oil price shocks do not affect output and inflation in Nigeria significantly.

However, others studies found different results for developing countries, for example, Berument, Ceylan, & Dogan (2010) showed that oil price shocks have a significantly positive effect on the outputs of OPEC countries. In another study, Monesa & Qazi (2013), found that increases in oil prices have a statistically significant negative impact on GDP growth of some countries (Algeria), a statistically significant positive impact of oil price shock on GDP growth of others (Venezuela). In those countries where positive oil price shocks helped to boost the economic growth the inflation rate responded negatively.

Even though a study on the macroeconomics effects of oil prices shocks following the methodology applied in this dissertation for Angola was not found, some studies considering the same variables and the relationship between them deserve to be mentioned.

Carvalho, Santos, & Massala, 2012, in a study of the determinants of inflation in Angola based on the quantitative theory of money, found that money supply and exchange rate are critical variables in explaining inflation in Angola. This result is in accordance with

those of Klein & Kyei (2009) suggesting that the inflation path has been largely affected by exchange rate movements and the excess liquidity, which is measured by positive deviations of M2 from its equilibrium level. They show as well that exchange rate stability is dependent on oil revenues and rapid growth. So, it is to be expected that in Angola oil price shocks affect the inflation rate through exchange rate channel.

Alves da Rocha (2012) points out that as it happened after the "financial crisis" in 2008/2009 when the price per barrel dropped from 138 USD in June to 35 USD in December, the 2014 turmoil in the oil markets has had serious consequences to the macroeconomic fundamentals in Angola, a great decreasing in the annual average GDP growth, a big depreciation in the national currency (as foreign exchange availability becomes limited) and a surge in the inflation rate, as noted above.

Based on this brief literature review, one might expect that a positive oil price shock has a direct and positive effect on GDP, a negative one in the inflation, in crude oil exporting countries, at least in the short run. However, the effect on the real exchange rate is not straightforward. Crude oil exporting countries may try to use the exchange rate as a policy instrument during oil booms, for example.

4. METHODOLOGY AND DATA

4.1.Data, Sources and Measurement of Variables

The standard approach in the literature is to employ a vector autoregressive to identify the shocks and analyse their impact through impulse response functions (Grigoli, Herman, & Swiston, 2017; Jiménez-Rodríguez & Sánchez, 2004; Stock & Watson, 2001).

A quarterly time series for the period 2002Q1 to 2017Q4 is employed. This period was chosen because of data availability issues.

Table 3 Variables definition, measurement and data sources

Variable	Definition	Measurement	Source
Real Oil Price	Oil price after adjusting for inflation effects	Ratio of the price of an internationally traded variety of crude (Brent Europe) in US dollars to the US Producer Price Index[10].	U.S. Energy Information Administration[11] and Federal Reserve Bank of St. Louis
Real GDP	Quarterly measure of total real economic output	Country's gross domestic product at 2010 constant prices in Billions of national currencies	IMF: World Economic Outlook Database
Real exchange rate[12]	nominal exchange rate deflated by the price level[13]	Nominal exchange rate (KZ and Naira/ USD) deflated by the price level (ratio of US price level and the domestic price level)	National Central Bank
CPI		The quarterly measure of each country consumer price indices (proxy for inflation).	National Bureau of Statistics

Source: Author´s computation

[10] See (Jiménez-Rodríguez & Sánchez, 2004)

[11] See https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=A

[12]Defined such that an increase means a real appreciation of the currency considered. An appreciation of the real exchange rate is expected to hurt the country's external competitiveness

[13] Defined as in Bangara & Dunne (2018), $\frac{NC}{US\$} * \frac{P^*}{P}$ where NC is the national currency, P^* is the US consumer price index price and P is the domestic price index

4.2.Discussing the choice of the variables

Oil Price (OPt,) following Jiménez-Rodríguez & Sánchez (2004) we define oil prices in real terms, taking the ratio of the price of an internationally traded variety of crude (Brent Europe) in US dollars to the US Producer Price Index. However, for robustness check other definitions of oil prices were used[14].

This is a key variable in the study because the general objective is to study the responses of domestic macroeconomics variables to international oil prices shocks - which is the only identified shock in the study.

The restrictions placed on oil prices considers that the variable is contemporaneously exogenous to any variable in the model and only responds contemporaneously to its own shocks allowing us to model a recursive SVAR where real oil price shocks are ordered first.

Even though, we are studying the two largest oil producers in Africa their combined production represents only 3,9%((BritishPetroleum, June 2018) of world production. So, it does make sense to consider international oil price as exogenous for each country. This amounts to say that both countries are price takers in the international oil price market.

Since both countries are heavily dependent on crude oil export proceeds, as already showed it is reasonable to assume that international oil prices cause great variability in their macroeconomic variables. Then, the inclusion of oil prices as an exogenous variable will assist in identifying and measuring the impact of oil price exogenous shocks in the domestic economies.

GDPt, defined as real GDP, is included in the model as a measure of real output. It is measured as each country's gross domestic product at 2010 constant prices in Billions of national currencies.

The main challenge in this dissertation was to overcome the data limitations for Angola that has not consistent and reliable high frequency data on national income accounts

[14] Others definitions included: Nominal oil price Brent Europe and both nominal and real Angolan crude Oil export price from central Bank of Angola. As well as for Nigeria (Oil Price - Bonny Light in US dollars per barrel). The results do not change considerably

which has been substantially constraining the methodological options available for this kind of empirical studies for Angola.

Like several other developing countries, data on national income accounts of Angola are officially available only at annual frequency. Non-availability of a high frequency data on national accounts is one of the big hurdles faced by the researchers working with time-series data (Choi et al, 2017; Lariau et al., 2016). To handle this issue, researchers suggest different econometric methods in order to convert low-frequency economic time-series data into high-frequency data (Rashid & Jehan, 2013)[15]. Thus, we have used the method of Denton (1970)[16] – a well-known econometric disaggregation technique- to convert Angola´s annual real GDP data into quarterly[17].

The Denton procedure computes the interpolation of a time series observed at low frequency by using a related high-frequency indicator time series, imposing the condition that the sum of the interpolated series within each year equals the annual sum of the underlying series for that particular year (Rashid & Jehan, 2013). In this last paper, a GDP series is interpolated using CPI and IPI (industrial production index) as the indicator variables. However, for this dissertation we couldn't use neither IPI because there is not data available nor CPI because we didn't want the GDP to follow the pattern of CPI to avoid multicollinearity issues in the estimation of the main model. So, for this reason we opt to use M2[18] deflated and seasonally adjusted as the indicator variable. Still, we have computed the quarterly GDP using CPI as the indicator variable (see appendix 10.4) as a mean of robustness check. Apart from the beginning and the end the series they behave fairly same fashion.

Exchange rate (EXt) measures the expression of the price of each country's currency in another country's currency. The US dollar exchange rate has been selected as the benchmark because it is the most traded on the foreign exchange market (Kim, Hammoudeh, Hyun, & Gupta, 2017). Both Angola and Nigeria have US dollar as main coin of imports and its exports are traded in US dollars, justifying the choice of this

[15] For an application of this method see for example (Bredin & O'Reilly, 2004)

16 As recommended in International Monetary Fund (IMF) publications, this method is "relatively simple, robust, and well-suited for large-scaled applications."

[17] Though, for robustness check other disaggregation technique- to convert annual real GDP data into quarterly was used.

[18] The choice of real M2 as the indicator variable can be justified by the quantity theory of money given by the identity MV=PY (where P is the aggregate prices, M total money supply, Y is real output and V is velocity of money). This identity simply says that the total stock of money used for transactions must be equal to the value of goods sold in the economy.

exchange rate measure. Following literature, we define the real exchange rate as each national nominal currency deflated by the price level (ratio of US price level and the domestic price level)[19].

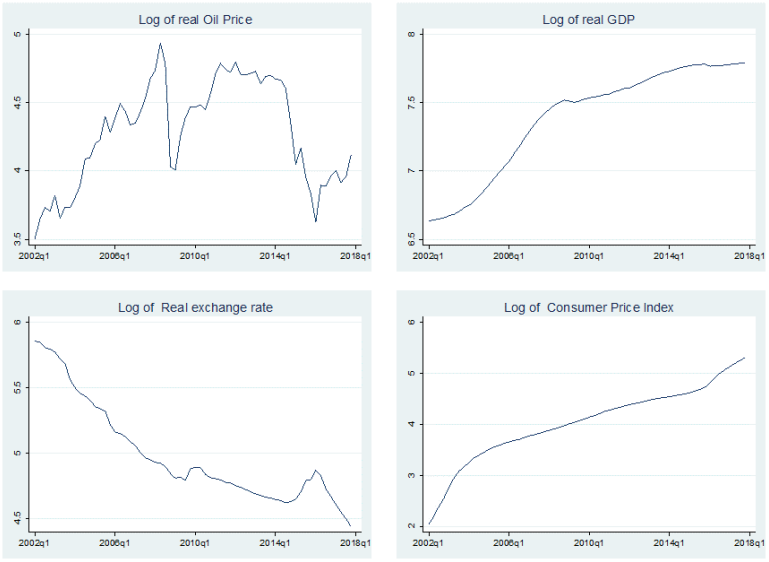
Consumer prices (CPt), is introduced as each countries all items national composite consumer price index with base year 2010. As noted by (Wang & Zhu, 2017) it functions as a key monetary policy responding to oil price shocks. It also serves as a control variable that has a link with monetary policy decisions, more specially with the interest rates through which economic stability is attained. But, for the means of this study it is going to help only to comprehend how the domestic consumer power is affected in the periods of oil prices changes.

[19] The nominal exchange rate against the US dollar was also used for the same analysis since firms make price decisions usually based on the nominal exchange rate. The results are broadly similar to the one in the base model.

4.3.Preliminary data inspection

Angola

Figure 2 Angola: Oil Price, real GDP, Real Exchange rate and CPI, in logarithms (2002-2017)



Source: IMF, INE and BNA (Central bank of Angola)

The graphs display that the three macroeconomic variables have a deterministic trend while real oil price has a stochastic trend with a break in 2008/2009. In the beginning of the series there is very high volatility in the four variables which is somehow associated with the end of civil war (already mentioned), and to the beginning of stabilization programs which aimed at reducing inflation through reduction of money in circulation and stabilization of exchange rate[20]. Noteworthy mentioning the big drop in oil prices in 2008/2009 and in 2014/2015. For this reason, a dummy variable (doil - takes the value 1 from 2008q03 and zero otherwise) was created to account for the period of very high crude oil price volatility from 2008-09 onwards.

[20] For this reason, a robustness check starting in first quarter 2005 was conducted to see how the results are sensible to the immediate post-war effects.

Table 4 Angola: summary statistics (2002Q1:2017Q4)

Variable	Obs	Mean	Std. Dev.	Min	Max
RealOilprice	64	77.58672	27.98403	33.2	139.59
GDP	64	1727.918	577.4344	761.1452	2418.485
RER	64	159.0636	70.37651	84.68	344.74
CPI	64	70.85755	45.43718	7.726667	202.6

Real Oil Price (UK Brent) in US dollars per barrel deflated by US Producer Price Index.

GDP at 2010 constant prices in Billions of Kwanzas.

RER - Real exchange rate – Nominal exchange rate (KZ/USD) deflated by the ratio of US price level and domestic price level.

CPI Consumer price index (Dez2010=100).

This preliminary assessment of the data for Nigeria is presented in Appendix 10.1. The features of the data are similar to those of the Angolan data.

4.3.1. Correlation between the variables

Table 5 Angola & Nigeria: Correlation between the variables

Angola				
	Oil Price	GDP	Exrate	CPI
Oil Price	1,0000			
GDP	0,4328	1,0000		
Exchange rate	-0,5236	-0,9678	1,0000	
CPI	-0,3716	-0,3148	0,3761	1,0000
Nigeria				
	Oil Price	GDP	Exrate	CPI
Oil Price	1,0000			
GDP	0,5188	1,0000		
Exchange rate	-0,0654	0,6975	1,0000	
CPI	-0,1167	-0,0079	0,1068	1,0000

All variables in real terms, log form and Deseasonalized (CPI in log differences)

Considering the correlation between oil price and the three variables in the model, Table 5 shows that oil price is positively correlated with GDP, implying that a positive shock to

oil price is likely to result in an increase in real output. Since a positive oil shock raises output as it works through the money market, money demand increases and this also raises the nominal exchange rate which subsequently decreases exchange rate (national currency becomes stronger), resulting in the appreciation of the real exchange rate (see Bangara & Dunne, 2018). This is evidenced by a negative correlation between oil price and the real exchange rate in Table 5. Since Angola is essentially an importing economy the appreciation in the exchange rate could lead to a reduction in the inflation rate (this may happen because the real cost of importing decreases). This is indicated by the negative correlation between oil prices and (first log differences) consumer prices in Table 05 (-0,3716). As pointed out above, this negative correlation between oil prices and the exchange rate can signalize the "dutch disease" effects in the Angolan economy. What have just been said for the Angolan economy holds also for the Nigerian as is seen in the table 05, even though with some differences in the degree of the correlation.

However, as any introductory econometrics book would point out correlation does not imply causation (Gujarati, 2004) and since this dissertation is striving to assert the direction (causality) of the relationship between crude oil price volatility and macroeconomic performance in African oil producing countries we ran a pairwise Granger causality tests (see section 5.1.4).

4.4.Time series properties

After that first inspection on data, where features such as trends, seasonality and structural breaks where taken care of, the stochastic properties of the series were analysed through order of integration tests using the standard unit root tests. And the existence of cointegrating vectors among the series were verified.

This last procedure is important because the existence of a cointegrating vector among the series (being them non-stationary) can make the estimation of a Vector Error Correction Model (VECM) instead of VAR in levels necessary.

4.4.1. Unit Root Tests

The foundation of time series analysis is stationarity. A time series process is stationary if the mean and the variance are constant over time (and both are finite) and if the autocorrelation between values of the process at two times periods, say t and s, depends only on the distance between these time points and not on the time period itself (Tsay, 2002)

Failing to meet this assumption, regression analysis yield not reliable results (spurious regression) and cannot be used to do inference. A non-stationary variable is then said to have a unit root, where the variable has to be differentiated d times before it becomes stationary. The series is now said to be integrated of order d, I(d).

The order of integration for each time series is determined through unit roots tests, The Augmented Dickey-Fuller (ADF) and the Philips Perron.

Augmented Dickey-Fuller test[21]

The Augmented Dickey-Fuller (ADF) test is the most frequently used unit root test. Dickey and Fuller (1979,1981), introduced a procedure to formally test for non-stationarity where this is equivalent to testing whether a unit root is present in the data.

21 The ADF can sometimes be biased and fail to determine the availability of unit root in a variable. Therefore, it is advised to further confirm the stationarity of the variable with an alternative test, this is the reason why the PP test is employed.

This test is based on the null hypothesis of non-stationarity against the (trend) stationary alternative. The test takes into account the autoregressive process, AR (1), of the form

$$\boldsymbol{Y_t = \rho Y_{t-1} + \varepsilon_t}$$

The Dickey and Fuller test is based on the assumption that the disturbance term, $\boldsymbol{\varepsilon_t}$, is a white noise process. As this assumption most likely does not hold, Dickey and Fuller extended their test procedure to a higher order process, AR(p), where the equation includes extra lagged terms of the dependent variable in order to eliminate the issue of autocorrelation. The following equation are estimated for each of the time series

$$\boldsymbol{\Delta Y_t = \propto_0 + \propto_t t + \beta_0 Y_{t-1} + \sum_{i=1}^{K} \beta_i \Delta Y_{t-i} + \varepsilon_t}$$

Where Y_t is the time series, $\boldsymbol{\Delta}$ denotes the first difference operator, t is the trend, k is the number of lags used, $\boldsymbol{\varepsilon_t}$ is the error term, and $\propto$ and $\boldsymbol{\beta}$ are parameters. In the ADF test is tested whether $\boldsymbol{\beta}$ =0. If this is true, the dependent variable does not depend on its previous values and hence the time series is non-stationary.

4.4.2. Cointegration

Granger (1981) presents cointegration as a concept for modelling equilibrium or long-run relations of economic variables. Assume $\boldsymbol{Y_t = \alpha + \beta X_t + \varepsilon_t}$ where $\boldsymbol{Y_t \sim I(1)}$, $\boldsymbol{X_t \sim I(1)}$ and $\boldsymbol{\varepsilon_t}$ is a white noise process. In general, a linear combination of non-stationary variables will itself be non-stationary, expressed as $\boldsymbol{Y_t - \beta X_t \sim I(1)}$. But in the case where $\boldsymbol{Y_t - \beta X_t \sim I(0)}$ the variables are said to be cointegrated. Meaning that there exists a ling-run relationship between them. More generally, if a linear combination of a set of no-stationary variables is stationary, then the variables are cointegrated.

In order to test the existence of a cointegrating vector between variables, Johansen´s approach (1988) might be used. The author proposes a maximum likelihood (ML) method for estimating long-run equilibrium relationships or cointegrating vectors and derives likelihood ratio tests for cointegration. Johansen (1988) constructed two likelihood ratio statistics: the maximum eigenvalue statistic and the trace statistic.

The maximum eigenvalue statistic for the null hypothesis of r cointegrated relation is computed as

$$\boldsymbol{\lambda_{max} = -Tln(1 - \lambda_{r+1}),} \qquad \textbf{r=0,1,2,…,n-1}$$

Where the alternative hypothesis is that there are r+1 cointegration relations. The trace statistic for the null hypothesis of r cointegrated relations is computed as

$$\boldsymbol{\lambda_{trace} = -T\sum_{i=r+1}^{n} ln(1-\lambda_i)} \qquad \textbf{r=0,1,2,…,n-1}$$

Where the alternative hypothesis is that there are more than r cointegration relations.

4.5. SVAR Framework

After Sims´ (1980) seminal paper, vector autoregression (VAR) have become an essential part of time-series toolkit (Becketti, 2013). As already noted above, VAR[22] is the leading approach employed in the analysis of dynamic interactions between commodities price shocks and the macroeconomy. However, what Sims posed as an advantage (theory-free method) it is been criticised leading to the birth of Structural VAR models. Models in which shocks identification is conducted by the imposition of constraints drawn from economic theory (Ben-Arfa, 2012). This methodology is going to be applied to both economies under study in order to identify the importance of oil price shocks to macroeconomic fluctuations.

Following the literature (Bangara and Dunne, 2018; Becketti, 2013; Ødegaard, (2012); (Jiménez-Rodríguez & Sánchez, 2004), a (recursive) SVAR is represented as follows

$$Y_t = A_t Y_{t-1} + \cdots + A_q Y_{t-q} + BZ_t + B_1 Z_{t-1} + \cdots + B_p Z_{t-p} + u_t \qquad (1)$$

where t=1,…,T; Y_t is an Mx1 vector of endogenous time series variables, containing an intercept, a time trend, and other deterministic terms; Z is a vector of exogenous variables; u_t is a vector of residuals; A_i and B_i are matrices of coefficients; and p and q are non-negative integers representing the number of lags included in the model.

The variance covariance matrix $\sum$ is given as $\sum = Eu_t u_t^{'}$. Estimates of A_i, B and $\sum$ are obtained using ordinary least squares. Once the estimates are obtained, one has to recover the parameters of the structural form model, as:

[22] Vector autoregression (VAR) is an econometric model used to capture the evolution and the interdependencies between multiple time series, generalizing the univariate AR models. All the variables in a VAR are treated symmetrically by including for each variable an equation explaining its evolution based on its own lags and the lags of all the other variables in the model. Based on this feature, Christopher Sims advocates the use of VAR models as a theory-free method to estimate economic relationships, thus being an alternative to the "incredible identification restrictions" in structural Vector models (Sims, 1980).

$$C_0 Y_t = C_1 Y_{t-1} + \cdots + C_q Y_{t-q} + DZ_t + \varepsilon_t \quad (2)$$

where C_i and D are matrices of parameters underlying the structure of the economy; ε_t is a vector of structural shocks; and the corresponding variance covariance matrix is $W = E\varepsilon_t \varepsilon_t^{'}$. The reduced and structural form parameters are related as:

$$A_i = C_0^{-1} C_i \; ; \varepsilon_t = C_0 u_t \quad (3)$$

The relationship between the variance covariance matrices of the reduced and structural form models are written as: $\sum = C_0^{-1} W (C_0^{-1})'$. The lack of information about the contemporaneous parameter matrix, C_0, results in identification problems often encountered in the SVAR literature.

This identification problem is associated with the fact that the number of estimated parameters in the reduced form model (1) is smaller than the number of parameters in the structural form model (2). This problem is resolved by imposing certain restrictions on the structural parameters, otherwise the structural form cannot be identified.

There are many approaches for identifying structural shocks in a VAR and restrictions can be imposed in a number of ways. The most common and generally used is the recursive factorisation based on Cholesky decomposition (Sims, 1980), where the matrix C_0 is assumed to be triangular.

Cholesky Decomposition

The Cholesky identification scheme is a recursive system where one chooses an ordering of the variables in the system that only allows for a contemporaneous correlation between certain series. The order of the variables is important as it implies that the variable ordered on top will only react to its "own shock" while the variable at the bottom will react to all shocks. Meaning that the first variable in the ordering is not contemporaneously affected by shocks to the remaining variables, but shocks to the first variable do affect the other variables in the system. Further, the second variable does not affect the first one

contemporaneously, but does affect the other ones. However, it is not contemporaneously affected by them, and so on. No equation in the system contains its own contemporaneous value, but the contemporaneous value of the variable that is above itself in the system. Such a system is called a recursive system (Ødegaard, 2012)

With the four variables SVAR in this dissertation, four structural shocks can be described and the following ordering is assumed: oil price shock ($\varepsilon_{oil,t}$) – the only identified shock in the study, real GDP shock ($\varepsilon_{gdp,t}$,), exchange rate shock ($\varepsilon_{ex,t}$) and inflation shock ($\varepsilon_{CP,t}$).

Ordering the vector structural shocks as ε_t= [$\varepsilon_{oil,t}$, $\varepsilon_{gdp,t}$, $\varepsilon_{ex,t}$, $\varepsilon_{CP,t}$], the recursive order between oil price shocks and the macroeconomic variables implies the following restrictions in the C_0 matrix.

$$\begin{bmatrix} Oilt \\ GDPt \\ EXRt \\ CPt \end{bmatrix} = \begin{bmatrix} g11 & 0 & 0 & 0 \\ g12 & g22 & 0 & 0 \\ g13 & g23 & g33 & 0 \\ g14 & g24 & g34 & g44 \end{bmatrix} \begin{bmatrix} \varepsilon_{oil,t} \\ \varepsilon_{gdp,t} \\ \varepsilon_{ex,t} \\ \varepsilon_{CP,t} \end{bmatrix}$$

Each member of X_t is assigned is own structural equation which ensure that the shocks can be given an economic interpretation.

In the ordering of the variables most of the existing literature treats oil price as an exogenous variable (Ødegaard, 2012; Kilian, 2008). This is the case because oil price developments are usually led by exogeneous shocks, such as global economic growth, energy intensity within industrialized economies, speculator operations in oil markets, the policy of key oil consumers/producers on strategic oil reserves, etc.

Hence, for the two countries under study, even though, they are key oil producers in Africa their combined production represents less than 4% of world oil production so, the countries are just small open economies having no significant influence in the international oil prices markets. Since oil price is regarded as exogenous for the economies under study, it is expected that significant shocks in oil markets affect contemporaneously the other macroeconomic variables in the system.

So, it is assumed that oil price shocks respond only to its own shocks. As in much of the related literature (Jiménez-Rodríguez & Sánchez, 2004) it is assumed that real GDP does

not react contemporaneously on shocks of other variables but oil prices and its own shocks. However, it is assumed that GDP shocks affects both Real Exchange rate and consumer price index.

Real exchange rate is assumed to be directly influenced by oil price and real GDP shocks. Ordering consumer prices index last (as the most endogenous) allows to analyse the exchange rate pass-through to domestic prices (Klein & Kyei, 2009). Furthermore, consumer price levels are assumed to react to structural shocks of oil price and real GDP.

For this reason, as a robustness check, we also report results on an alternative ordering, namely[23]: OilPrice GDP CPI Exrate.

4.6.Granger Causality

As postulated by Gujarati (2004) in a regression of Y on other variables (including its own past values) if we include past or lagged values of X and it significantly improves the prediction of Y, then we can say that X (Granger) causes Y. The test involves estimating the following pair of regressions.

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \cdots + \alpha_m Y_{t-m} + \beta_p X_{t-p} + \beta_q X_{t-q} + \varepsilon_{1t} \quad (1)$$

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \cdots + \alpha_m X_{t-m} + \beta_p Y_{t-p} + \beta_q Y_{t-q} + \varepsilon_{2t} \quad (2)$$

where α and β are the coefficients and it is assumed that the disturbances ε_{1t} and ε_{2t} are uncorrelated.

Equation (1) postulates that current Yt is related to past values of itself as well as that of X, and (2) postulates a similar behaviour for X. Then, we can say that there is:

1. Unidirectional causality from X to Y if the estimated coefficients on the lagged X in (1) are statistically different from zero as a group and the set of estimated coefficients on the lagged Y in (2) is not statistically different from zero.
2. Conversely, unidirectional causality from Y to X exists if the set of lagged X coefficients in (1) is not statistically different from zero and the set of the lagged GDP coefficients in (2) is statistically different from zero.

[23] The results were not affected.

3. Feedback, or bilateral causality, is suggested when the sets of X and Y coefficients are statistically significantly different from zero in both regressions.
4. Finally, independence is suggested when the sets of X and Y coefficients are not statistically significant in both the regressions.

5. ESTIMATION AND RESULTS

5.1.Data Analysis

5.1.1. Lag order selection results

The lag order of the VAR model may be determined using various information criteria which are selection criterions that balance model fit and its complexity. A criterion is said to be order consistent if the it is minimized at the true order with probability that approaches unity as the sample size increases (Gayawan & Ipinyomi, 2009). For this dissertation, the lag order is based on Schwarz's Bayesian information criterion (SBIC). Akaike (1978) showed that the SBIC may be more successful than AIC in estimating the order of an autoregressive model. Moreover, from the Table 06 that reports the lag order selection statistics we can see that others two (FPE e HQIC) indicates that six lags should be included in the estimation of SVAR.

Table 6 Angola: Lag order selection results

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	66.3268				1.1e-06	-2.39718	-2.33964	-2.24709
1	303.287	473.92	16	0.000	2.2e-10	-10.8957	-10.608	-10.1452
2	325.964	45.352	16	0.000	1.7e-10	-11.1524	-10.6346	-9.80158
3	350.686	49.444	16	0.000	1.3e-10	-11.4879	-10.7399	-9.53667
4	381.312	61.253	16	0.000	7.6e-11	-12.0505	-11.0722	-9.49885
5	440.506	118.39	16	0.000	1.6e-11	-13.7118	-12.5034	-10.5598
6	473.066	65.121	16	0.000	9.7e-12*	-14.3487	-12.9101*	-10.5963*
7	492.181	38.23	16	0.001	1.1e-11	-14.4685	-12.7998	-10.1157
8	512.794	41.225*	16	0.001	1.3e-11	-14.6459*	-12.747	-9.69276

* indicates lag order selected by the criterion

final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SBIC), and the Hannan and Quinn information criterion (HQIC) lag-order selection statistics for a series of vector autoregressions of order 1 A sequence of likelihood-ratio test

Regarding Nigerian case, even tough, SBIC and HQIC criteria proposes that only 1 lag should be included in the model (see appendix), based on the stability requirements of the VAR we decided to use four lags as proposed by FPE and AIC.

5.1.2. Stationarity tests results

All variables are expressed in logarithms. GDP, CPI and Exchange rate data were seasonally adjusted using holt-winters seasonal smoothing filter (multiplicative approach).

As can be shown in the table 07 the four variables are found to be non-stationary in levels but stationary after first difference. Thereby failing to reject the null of the presence of a unit root at 5% level. Both the ADF and PP methods provide similar results confirming the non-stationarity of the variables in levels and their stationarity after first difference, indicating that all variables are I(1).

Table 7 Angola and Nigeria: Unit root tests (P-values)

Angola				
Levels	Oil Price	GDP	Exrate	CPI
ADF	0,9718	0,4996	0,9271	0,8643
PP	0,8604	0,6723	0,9481	0,0816
FirstDifference				
ADF	0,0059*	0,0140*	0,0167*	0,0000*
PP	0,0000*	0,0000*	0,0000*	0,0000*
Nigeria				
Levels	Oil Price	GDP	Exrate	CPI
ADF	0,7174	0,9960	0,9967	0,0548
PP	0,6227	0,3613	0,9273	0,1235
FirstDifference				
ADF	0,0051*	0,0234*	0,1227	0,0042*
PP	0,0000*	0,0000*	0,0000*	0,0000*

Note: *indicates significance at 5% level

All variables in real terms and in logarithms. GDP, Exrate and CPI are deseasonalized.

5.1.3. Cointegration test results

Following the literature, the Johansen (1988) multivariate cointegration procedure was applied to test the existence of a cointegrating vector among the non-stationary series, because the series were determined to be integrated of order 1. A linear trend term was added to the test model due to the trending behaviour observed in all the series. The number of lagged differences was determined based on model selection criteria applied to the SVAR in levels. The results show (Table 8) that for the Angolan data there is not cointegrating vector at the 5 percent level between the variables. Which means that SVAR with short run restrictions based on the economic theory relationship expected for the variables is the most appropriate method to carry out the objectives of this dissertation (Bangara & Dunne, 2018; Jiménez-Rodríguez & Sánchez, 2004).

Table 8 Angola and Nigeria: Cointegration test results

Angola

Johansen tests for cointegration

Trend: trend — Number of obs = 58
Sample: 2003q3 - 2017q4 — Lags = 6

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	88	524.3729	.	122.2283	54.64
1	95	560.52963	0.71257	49.9148	34.55
2	100	572.65477	0.34171	25.6646	18.17
3	103	581.22586	0.25588	8.5224	3.74
4	104	585.48705	0.13665		

Nigeria

Johansen tests for cointegration

Trend: trend — Number of obs = 60
Sample: 2003q1 - 2017q4 — Lags = 4

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	56	409.77104	.	63.6894	54.64
1	63	427.90272	0.45359	27.4261*	34.55
2	68	435.67927	0.22835	11.8730	18.17
3	71	441.58485	0.17869	0.0618	3.74
4	72	441.61575	0.00103		

Source: Author´s computation (Stata 12.1)

However, for the Nigerian case the results point for the existence of a single cointegrating vector at the 5 percent level. As discussed in Bangara & Dunne (2018) even tough in such cases the estimation of the vector error correction model (VECM) with cointegration analysis would be recommendable, a strand in the literature argues that transforming data to stationary forms by difference or cointegration practices when it appears to be integrated is not necessary because hypotheses of interest can be tested without transforming the data. Following this this approach, the estimation of a SVAR in levels is adopted for Nigeria as well since the objectives proposed for this dissertation is effectively achievable through impulse response functions and variance decomposition analysis (Jiménez-Rodríguez & Sánchez, 2004).

5.1.4. Granger Causality tests results

As already mentioned, is fairly easy to deal with the Granger causality concept in the context of VAR models. A subsidiary command (Vargranger) on Stata (12.1) allow to easily perform pairwise Granger causality tests for SVAR estimates. The table 09 below present the results.

Table 9 Angola and Nigeria: Granger causality test results

Angola (a)

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
ln_Goilprice	sln_GDP	6.5312	6	0.366
ln_Goilprice	sln_RER	8.3737	6	0.212
ln_Goilprice	sln_CPI	5.9035	6	0.434
ln_Goilprice	ALL	25.785	18	0.105
sln_GDP	ln_Goilprice	25.828	6	0.000
sln_GDP	sln_RER	19.094	6	0.004
sln_GDP	sln_CPI	43.36	6	0.000
sln_GDP	ALL	106.8	18	0.000
sln_RER	ln_Goilprice	17.591	6	0.007
sln_RER	sln_GDP	14.69	6	0.023
sln_RER	sln_CPI	29.87	6	0.000
sln_RER	ALL	77.192	18	0.000
sln_CPI	ln_Goilprice	40.876	6	0.000
sln_CPI	sln_GDP	96.319	6	0.000
sln_CPI	sln_RER	147.2	6	0.000
sln_CPI	ALL	341.15	18	0.000

Nigeria (b)

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
ln_Goilprice	sln_GDP	2.9028	4	0.574
ln_Goilprice	sln_realexrate	5.7538	4	0.218
ln_Goilprice	sln_CPI	2.5846	4	0.630
ln_Goilprice	ALL	13.054	12	0.365
sln_GDP	ln_Goilprice	1.387	4	0.846
sln_GDP	sln_realexrate	8.1094	4	0.088
sln_GDP	sln_CPI	7.657	4	0.105
sln_GDP	ALL	20.755	12	0.054
sln_realexrate	ln_Goilprice	25.142	4	0.000
sln_realexrate	sln_GDP	14.413	4	0.006
sln_realexrate	sln_CPI	8.282	4	0.082
sln_realexrate	ALL	48.445	12	0.000
sln_CPI	ln_Goilprice	4.2485	4	0.373
sln_CPI	sln_GDP	16.197	4	0.003
sln_CPI	sln_realexrate	12.358	4	0.015
sln_CPI	ALL	32.65	12	0.001

equations of interest

From the results in the table 9 we can see that there is unidirectional causality from real oil prices to the three macroeconomic variables under study (real GDP, real exchange rate and consumer prices). Meaning that the null hypothesis of non-causality between any variables (real GDP, RER and CPI) and the real oil price cannot be rejected for any of the

Wald tests. These results indicate that none of domestic macroeconomic variables directly granger-cause oil prices. Which is in accordance with the assumption that both Angola and Nigeria are price takers in the international oil market, helping us to justify the use of a recursive (Cholesky) identification scheme in the SVAR model such that real oil price is the most exogenous variable. Henceforward, as expected, in Angola the real oil price variable Granger-causes the remaining variables of the system at the 5% significance level. On contrary, in Nigeria only real exchange rate is granger-caused by it.

5.1.5. Estimated baseline Structural VAR

We focus our attention only in the direction (which is our prime interest) of the correlation and not in the magnitude itself (which turned out to be relatively small) the table (see appendix 9.4.4) shows that a positive oil price shock tends to have a positive impact on output (real GDP) an appreciation of the real exchange rate and a reduction in the consumer prices, as expected.

The analysis of the results is going to proceed in the next section through impulse-response functions (IRFs) - measure the dynamic marginal effects of each shock on all of the variables over time and forecast error variance decompositions[24] which measures the extent to which each shock contributes to unexplained movements (forecast errors) in each variable over time.

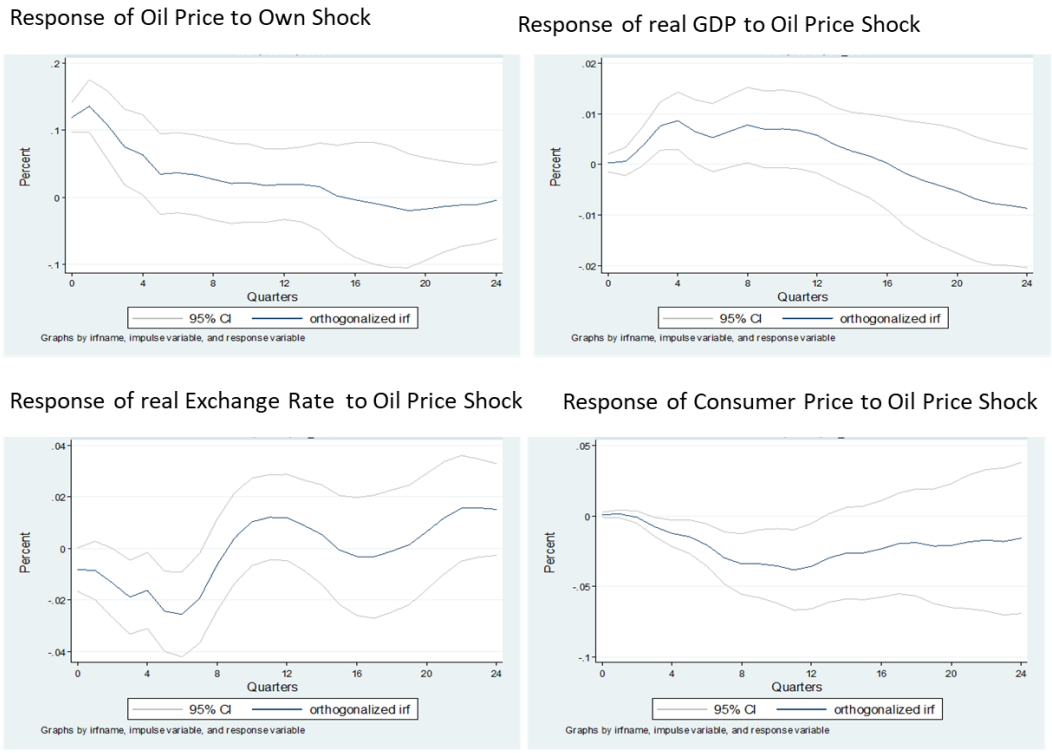
In figure 03 below, we have the IRFs for the Angolan economy. Each figure shows the impulse responses arising from a one-standard deviation shock to the oil price. The impulse responses are shown out to 24 quarters and the greys lines indicate two-standard error bands. For the variables in logs the numbers on the vertical axes may be interpreted as indicating the percentage deviation of each variable to the base case prior to the shock hitting the economy.

[24] See appendix 9.2

5.1.6. Dynamic responses to Oil Price Shocks (Impulse Response Functions and variance decompositions)

Angola

Figure 3 Angola: Impulse Response Functions of the macroeconomic variables to a one Standard deviation Shock to real oil price



The first figure (left) indicates the response of oil price to its own shock. Since we are analysing the orthogonalized IRFs the shock represents a one-standard deviation in current real oil prices. The shock tends to be quite persistent as can be seen in the figure since the impulse responses decay slowly to zero. A first conclusion from the figure is that oil price shocks and its effects tend to last many periods (i.e. the effect of the shock does not seem to die out even in the longer horizon).

Response of real GDP to oil price shocks

The second figure in the first line shows that GDP reacts positively (growing) to positive oil price shocks with a lag of almost 2 quarters. But, this statistically significant positive impact last only one year (4th quarter). Subsequently, real GDP shows a decreasing pattern in the next two quarters (5th and 6th) which is reverted in the 7th and 8th quarters. From

then on, real GDP continuously decreases until the end of period. This result is in accordance with the literature (Jiménez-Rodríguez & Sánchez, 2004)

Through forecast error variance decomposition (hereafter fevd) we can assess the extent to which oil prices shocks contributes to non-explained movements in GDP. From the table in appendix (10.2) we can see that in the two first quarters oil prices shocks are not relevant for the explanation of the volatility in the level of the economic activity. Real GDP registered almost 0,1% of its variation coming from oil price shock. However, it starts changing from the 3rd quarter onwards, when oil price shock becomes a very important explanation for the variations in real GDP. For example, this contribution is almost 40% in the 14th quarter. Accordingly, in the period under study, in average 30% of the variations in the real GDP emanated from variations in the crude oil prices.

This result can be justified by the high importance that oil related activities represent for the Angolan economic activity (both for public and private sector)[25]. And it is in accordance with literature[26], for example, (Collier & Goderis, 2007) found that in African countries higher oil prices are associated with higher GDP growth in the short run, but in the long run the correlation between the level of GDP and oil price is negative.

Thus, during the period under study, higher oil prices (accompanying higher revenues) stimulated economic growth in the short run in Angola but did not translate into sustained economic growth (long run).

Response of exchange rate to oil price shocks

From the first figure in the second line we can see that real exchange rate reacts negatively to a positive oil price shock, which is the expected effect. This appreciation is statistically significant and last roughly one year and half. From the 6th quarter the real exchange starts depreciating going back to the long run equilibrium value in the 8th quarter (after two years).

The fevd analyses (see appendix 9.2(a)) shows that a great part of the volatility in the real exchange rate is due to the volatility in oil prices. Even tough in the first quarter only 6% of the variations in the real exchange rate are explained by the oil prices movements, it

[25] According to Rocha et al (2016) more than half of GDP in Angola is made of crude oil related activities, which represents more than 95% of its total exports and at least 75% of state budget revenues.
[26] Cf. Chapter 3 Literature review

starts increasing very fast and in the end of the same year (4th quarter) of the shock it reaches 18% and after two years (8th quarter) it reaches 41,5%. in the period under study, in average, 40% of the volatility in the exchange rate are due to the volatility in the oil prices. This result can be justified by the fact that export of crude oil is the source of roughly 95% of the Angolan foreign reserves. So, when crude oil price rises foreign exchange availability increases and then demand for Kwanzas (domestic currency) in exchange for US dollars (stronger currency) rise putting a pressure on domestic currency to appreciate.

Response of domestic consumer prices to oil price shocks

In the last figure it is clear that consumer price falls (with a lag of roughly three quarters, after which it becomes statistically significant) in response to a positive oil price shock. Consumer price only reaches its lowest (trough) decline in the 12th quarter (after three years), and thereafter starts increasing until the end of the period. The lagged impact can be seen in the fevd (see appendix 9.2(a)) where the importance of oil price volatility in explaining the variability in the consumer prices is only 1% in the three first quarters. But it becomes more important from the second year (after the shock) onwards, reaching its maximum influence in 14th, almost 45%. So, we can say that in the short run (first year) there are other factors explaining the variability in the consumer prices in Angola, rather than variations in oil price.

According to Lariau, Said, & Takebe (2016), the exchange rate pass-through to inflation in Angola has been relatively high (given the country's not diversified economic structure and, therefore, heavy reliance on imports). So, one channel through which crude oil prices affects the inflation is the exchange rate depreciation. Then, the lagged response of CPI to oil price shocks in Angola in the short run could possibly be attributed to the fact that it takes a while to the exchange rate reacts to the increases in the foreign reserves sales (from the Central Bank). The other reason could be that the economic agents reacts with a lag to the changes in exchanges rates because they take a while to import the products and incorporate the changes in economic environment. As time passes however, the reduction in the cost of imports pass through prices of goods and services leading to a reduction in inflation.

Nigeria

Figure 4 Nigeria: Impulse Response Functions of the macroeconomic variables to a one Standard deviation Shock to real oil price

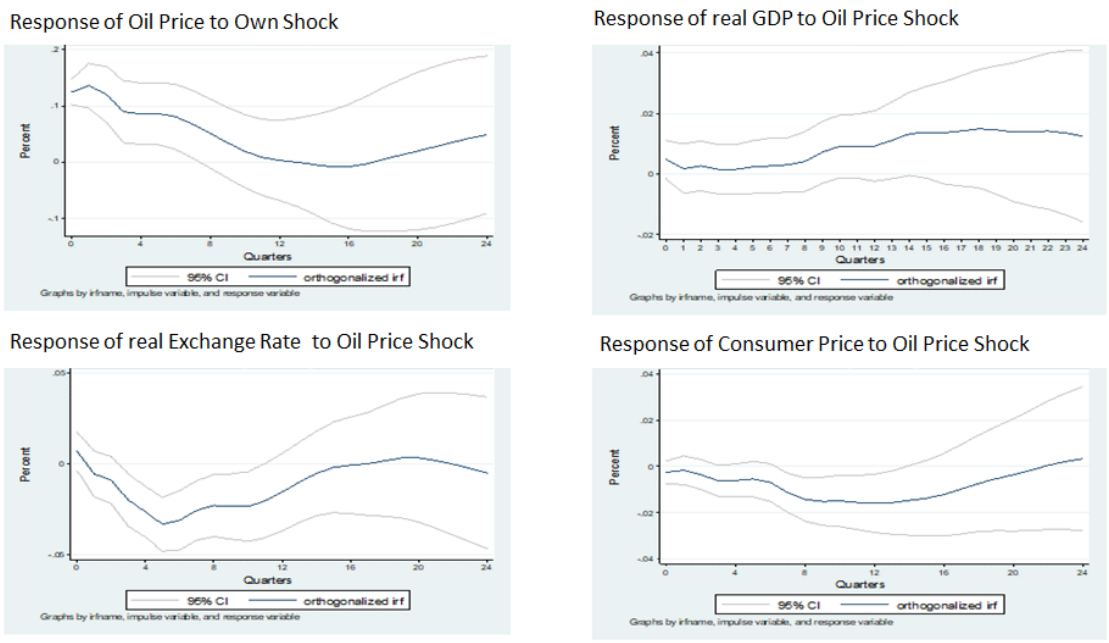


Figure 04 shows the response of the variables to a one standard deviation shock to oil price in Nigeria. The first figure indicates the response of oil price to its own shock while the others figures show the responses of GDP, exchange rate and inflation to a shock on oil price.

Response of real GDP to oil price shocks

The results suggest that the level of economic activity is more responsive to crude oil price shocks in Angola than in Nigeria. For example, in Nigeria real GDP takes roughly two years to react (rising) after an increase in crude oil prices. However, the impact is not statistically significant. Suggesting that the importance of oil for Nigeria should not be overemphasised, at least as an independent source of shocks driving economic activity (GDP).

This is also attested by the fevd analysis where the results suggest that in the 12th quarter only 9% of the fluctuations of real GDP are explained by the variability in the oil prices. But, from then on it increases fast such that in the end of period (24th) oil price shocks

can explain almost 38% of the variability in the domestic activity. Suggesting that oil prices shocks only affects GDP in the long run in Nigeria.

This result is in accordance with those of Akpan (2009), and Olomola (2006) that (for the period between 1970 and 2007) found that oil price shocks do not significantly affect industrial output in Nigeria. But it does not confirm the findings of Akinleye and Ekpo (2013) that found that shocks in real oil price significantly increased real GDP.

Response of exchange rate to oil price shocks

As in Angola the first figure in the second line suggest that real exchange rate reacts negatively on impact to a positive oil price shock.

The fevd analyses (see appendix 9.2.(b)) shows that like in Angola, in Nigeria more than the half of the volatility in the real exchange rate is due to the volatility in oil prices. For example, in the end of the first year after the shock, 14% of the variations in the real exchange rate are due oil prices variability. In the end of the second year (8^{th} quarter) it reaches 52,9% and it peaks at 58,7% after a bit more than three years (13^{th} quarter).

This result is in accordance of those of Akpan (2009) and Olomola (2006) which found that a high oil price may have given rise to wealth effects that appreciates the exchange rate the consequence being a squeeze in the tradable sector given rise to the effects of the "Dutch-disease" syndrome in Nigeria.

Response of domestic consumer prices to oil price shocks

In Nigeria, consumer prices react sluggishly and it only becomes statistically significant in the 6th quarter. From the fevd we can see that in the end of the first year (4th quarter) only 7% of consumer price volatility are explained by changes in oil prices. However, it eventually grows and in the end of second year (8th quarter) this number is 17%. But it becomes more important from the third year (after the shock) onwards, reaching its maximum influence in 16th, almost 44%. So, we can say that there are other factors explaining the variability in the consumer prices in Nigeria, rather than variations in oil price, at least in the short run. Akpan (2009) found the same result arguing that changes in industrial production are the core root of variability in consumer prices and not the variations in oil price. This may happen because in one hand food represents roughly a half of the CPI and in another hand most of the food is locally produced, being more responsive to local market supply and demand developments to foreign market developments (see Lariau et al.,2016). Since Angola is importing most of the final goods

it is reasonable to expect that oil price markets volatility to have more effects in Angola than in Nigeria, a more diversified economy.

6. CONCLUSION AND POLICY IMPLICATION

6.1.Conclusion

This dissertation sought to investigate the relationship between oil price shocks and macroeconomic variables in Angola and Nigeria. Consistent with the empirical literature we find that oil price changes significantly affect both countries. However, as Bangara & Dunne (2018) pointed out, cross country studies can fail to address heterogeneity problems within and between countries indeed our results reveals that even though the two countries share similar dependence on oil exports, they react differently to crude oil price shock.

After the study of stochastic properties of the series which were found to be integrated of the first order and the existence of cointegrating vectors among the series verified, the techniques of Granger causality test allowed us to determine the direction of the relationship between the variables.

The results show that for both countries none of their macroeconomic variables granger cause international real oil prices. Confirming, indeed, that although they are the two largest crude oil producing countries in Africa, they cannot alone affect the prices in the global crude oil market. However, while for the Angolan case real oil prices granger-cause the three domestic macroeconomic variables, in the Nigerian only real exchange rate is granger-caused by it.

In order to study the dynamic response of oil price shocks a quarterly four variables (recursive) SVAR from 2002Q1 to 2017Q4 was employed for both countries and impulse response functions and variance decompositions analysed.

The results show that a large proportion of the volatility in the macroeconomic variables in Angola is explained by the oil price shocks. Hence, a positive oil price shock, have a positive (increases) impact on the real GDP in the short run, however it lasts roughly 4 quarters after which starts decreasing until the end of the period. After an oil price shock, the exchange rate appreciates (declines) on the first six quarters after which depreciates until the 12^{th} quarter and then cycles without showing a tendency to die out. Consumer

price falls (with a lag of roughly three quarters) in response to a positive oil price shock. Consumer price only reaches its lowest (trough) decline in the 12th quarter (after three years), and thereafter starts increasing but it does not show a tendency to die out.

On contrary, Nigerian economic activity (real GDP) does not seem to respond significantly to oil price shocks and at least in the short run neither inflation. However, like in Angola, the results suggest that the Nigerian exchange rate appreciates right after the oil prices shocks hits and takes roughly four years to return to its equilibrium value.

Overall, these results lead to the conclusion that the Angolan economy is greatly more vulnerable to oil price volatility than the Nigerian economy which can be explained by the different structure of their domestic economies as well as the differences in the reserve buffers strategies to soften the magnitude of the shock's impact. In one hand Nigerians are producing locally most of the final goods they consume but Angola is essentially an importing economy (Lariau et al.,2016). In another hand, during the period under study Nigeria has made some progress towards counter cyclical fiscal policy by adopting several fiscal savings and stabilization mechanisms (World Bank, 2017b) which Angola has not accomplished yet.

6.2.Policy implications

Based on these findings, we think that economic policy in Angola should strive to:

- accelerate the pace of structural reforms in pursue of economic diversification in order to reduce the higher import dependence and diversify the sources of foreign exchange revenues helping to reduce the actual high exposure to international markets.
- reduce the procyclical nature of government expenditure through a 'stabilization' fund with a clear deposit and withdrawal rules, such those used in Norway, which would help to create a fiscal buffer.
- adopt a more flexible exchange rate regime. Because the literature argues that those countries with a flexible exchange rate regime can soften the impact of oil price volatility better than those with a fixed regime. Pointing to the role of the exchange rate in buffering the slowdown in the real economy by letting relative prices absorb, at least in part, the burden of the adjustment, or through providing fiscal space by raising revenue in terms of domestic currency (see Grigoli, Herman, & Swiston, 2017).

Even though in a lesser extent than Angola, Nigeria is also vulnerable to oil price shocks. The findings suggest that oil price may influence the Nigerian economy through exchange rate channel. Oil exports represent the overwhelming majority of Nigerian exports and a big source of foreign revenues (source). For this reason, we think that the adoption of an exchange regime that permits greater exchange rate flexibility would help to mitigate the impact of an external shock and reduce the burden on other policies.

7. LIMITATIONS AND AREAS FOR FURTHER RESEARCH

The main limitation to this dissertation is the size of sample due to lack of high frequency data for both countries. For Angola, the high volatility in the beginning of the series reflecting the end of civil war as well as the last two years (2016 and 2017) which are not definitive data (for real GDP) can limit the conclusions of our study.

Another great limitation has to be with the fact that we bound ourselves to the analysis of the effects of oil price shocks on four macroeconomic variables.

However, the results could be expanded and implications of crude oil prices in the domestic economies better understood if variables such as interest rate, unemployment rate, aggregate money, fiscal and current account balance would be included.

Starting from our findings, further research could be accomplished in three directions:

- The first one is to include variables such as the interest rate (and others monetary policy instrument) in the model which would help to understand how central banks in Angola and Nigeria react to external shocks and compare the effectiveness of both central bank in soften the adverse effect of oil price volatility.
- A second would be to include more African oil producing countries in the sample and assess how important it is the heterogeneity in the reactions to oil prices shocks in Africa.
- Finally, a useful line of research could be to compare the role of oil shocks on macroeconomic performance across oil exporting and importing African economies which could offer insights into the ways in which oil shocks shape economic performance in Africa.

8. REFERENCE LIST

Abrishami, H. M. (2008). The asymmetric relatoinship between oil prices and macroeconomy in OECD net oil importing countries . *Journal of Economic Research (Tahghighat-e-Eghtesadi), 43(2)*, 1-16.

Ajao, I. O., Ayoola, F. J., & Iyaniwura, J. O. (2015). On Comparison of Temporal Disaggregation Methods in Flow Variables of Economic Data. *The Pacific Journal of Science and Technology*, retrieved from: https://zapdoc.tips/queue/on-comparison-of-temporal-disaggregation-methods-in-flow-var.html.

Akinleye, S. O., & Ekpo, S. (2013). Oil Price Shocks and Macroeconomic Performance in Nigeria. *economía mexicana nueva época, vol. Cierre de Época (II)* .

Akpan, E. O. (2009). Oil Price Shocks and Nigeria's Macroeconomy. *paper presented at the Annual Conference of csae Conference, Economic Development in Africa, 22nd-24th March, Oxford. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.410.4739&rep=rep1&type=pdf*.

Bangara, B. C., & Dunne, J. P. (2018). Macroeconomic Effects of Commodity Price Shocks in a Low-income Economy: The Case of Tobacco in Malawi. *South African journal of Economics*, Pages 53-75. Retrieved from: https://onlinelibrary.wiley.com/doi/abs/10.1111/saje.12186

Barsky, R. B., & Kilian., L. (2004). Oil and the Macroeconomy since the 1970s. *Journal of Economic Perspectives*, 18(4): 115–34.

Becketti, S. (2013). Introduction to Time Series Using Stata. Texas: Stata Press.

Ben-Arfa, N. (2012). Sources of economic fluctuations in France: A structural VAR model. *European Journal of Government and Economics Volume 1, Number 1 (June 2012)*, ISSN: 2254-7088.

Berument, H., Ceylan, N., & Dogan, N. (2010). The Impact of Oil Price Shocks on the Economic Growth of Selected MENA1 Countries. *The Energy Journal, vol. Volume 31, issue Number 1,* , 149-176.

Blanchard, O., & Galí, J. (2007). The Macroeconomic effects of oil price shocks: Why are the 2000s So Different from the 1970s. *NBER Working Paper No. 13368*, DOI: 10.3386/w13368.

Bredin, D., & O'Reilly, G. (2004). An analysis of the transmission mechanism of monetary policy in Ireland. *Research Technical Papers 1/RT/01, Central Bank of Ireland*, DOI: 10.1080/0003684042000177198.

BritishPetroleum. (June 2018). *Statistical Review of World Energy.* Retrieved from: https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review/bp-stats-review-2018-full-report.pdf.

Brown, S., & Yucel, M. (2002). Energy prices and aggregate economic activity: an interpretative survey. *The Quarterly Review of Economics and Finance, 2002, vol. 42, issue 2,* , 193-208.

Bruno, M., & Sachs, J. (1982). Input Price Shocks and the Slowdown in Economic Growth: The Case of U.K. Manufacturing. *Review of Economic Studies , Vol. 51, No. 159*, 679-706.

Carvalho, J., Santos, M., & Massala, L. (2012). Determinantes da Inflação em Angola. *DEE, Banco Nacional de Angola* .

Cashin, P., Mohaddes, K., Raissi, M., & Raissi, M. (2014). The differential effects of oil demand and supply shocks on the global economy. *Energy Economics*.

CEIC-UCAN. (2013). *Relatório Económico de Angola 2013.* Luanda: Universidade Católica de Angola.

CEIC-UCAN. (2017). *Relatório Económico de Angola 2017.* Luanda: Universidade Católica de Angola.

Choi, S., Furceri, D., Loungani, P., Mishra, S., & Poplawski-Ribeiro, M. (2017). Oil Prices and Inflation Dynamics: Evidence from Advanced and Developing Economies. *IMF Working Paper WP/17/196*.

Collier, P., & Goderis, B. (2007). Commodity Prices, Growth, and the Natural Resource Curse:Reconciling a Conundrum. *University of Oxford , CSAE WPS/2007-15*.

Cologni, A., & Manera, M. (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries . *Energy Economics vol. 30, issue 3,* , 856-888.

Conflitti, C., & Luciani, M. (2017). Oil price pass-through into core inflation . *Finance and Economics Discussion Series 2017-085. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.085.*

Edelstein, P., & Kilian, L. (2007). The Response of Business Fixed Investment to Changes in Energy Prices: A Test of Some Hypotheses about the Transmission of Energy Price Shocks. *The B.E. Journal of Macroeconomics*, 1-41.

Eltejaei, E., & Afzali, M. A. (2012). Asymmetric impacts of oil prices and revenues fluctuations on selected macroeconomic variable in Iran. *Journal of Basic and Applied Scientific Research 2*.

Enders, W. (2004). *Applied Econometric Time Series, 4th Edition.* Alabama,: John Wiley & Sons,Inc .

Farzanegan, M. R., & Markwardt, G. (2009). The effects of oil price shocks on the Iranian economy. *Energy Economics, vol. 31, issue 1*, 134-151.

Ferreira, M. E., & Oliveira, R. S. (2018). The political economy of banking in Angola. *Oxford University Press, African Affairs, ady029*, https://doi.org/10.1093/afraf/ady029.

Gayawan, E., & Ipinyomi, R. A. (2009). A Comparison of Akaike, Schwarz and R Square Criteria for Model Selection Using Some Fertility Models. *Australian Journal of Basic and Applied Sciences*, 3(4): 3524-3530.

Grigoli, F., Herman, A., & Swiston, A. (2017). A Crude Shock: Explaining the Impact of the 2014-16 Oil Price Decline Across Exporters. *IMF working paper/WP/17/160*.

Gujarati, D. N. (2004). *Basic Econometrics.* 4th edition: The McGraw−Hill.

Hamilton, J. D. (1983). Oil and the Macroeconomy since World War II. *Journal of Political Economy*, 228-248.

Hamilton, J. D. (2005). Oil and the Macroeconomy. *Prepared for: Palgrave Dictionary of Economics.Retrieved from: https://econweb.ucsd.edu/~jhamilto/JDH_palgrave_oil.pdf*.

Haug, A. A., Karagedikli, Ö., & Ranchhod, S. (2005). Monetary policy transmission mechanisms and currency unions: A vector error correction approach to a Trans-Tasman currency unioin. *Journal of Policy Modeling 27(1)*, 55-74.

Husain, A., Tazhibayeva, K., & Ter-Martirosyan, A. (2008). Fiscal Policy and Economic Cycles in Oil-exporting Countries . *IMF Working Paper 08/253.*

Ilzetzki, E., & Vegh, C. A. (2008). Procyclical fiscal policy in developing countries: Truth of fiction? *National Bureau of Economic Research Working Paper 14191*, Retrieved from: https://www.nber.org/papers/w14191.pdf.

IMF. (2018). *Angola: Selected Issues.* Washington, D.C.: International Monetary Fund Country Report No. 18/157.

Jiménez-Rodríguez, R., & Sánchez, M. (2004). Oil price shocks and real GDP growth: empirical evidence for some OECD countries. *European Central Bank Working Paper No. 362.* .

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 231-254.

Jones, D. W., Leiby, P. N., & Paik, I. K. (2004). Oil prices shocks and the macroeconomy: What has been learned since 1996. *The Energy Journal*, 1-32.

Kim, W. J., Hammoudeh, S., Hyun, J. S., & Gupta, R. (2017). Oil price shocks and China's economy: Reactions of the monetary policy to oil price shocks. *Energy Economics, Elsevier, vol. 62(C),*, 61-69; DOI: 10.1016/j.eneco.2016.12.007.

Klein, N., & Kyei, A. (2009). Understanding Inflation Inertia in Angola. *IMF Working Paper No. 09/98*.

Korhonen, I., & Mehrotra, A. N. (2009). Real Exchange Rate, Output and Oil: Case of Four Large Energy Producers. *BOFIT Discussion Paper No. 6*.

Lariau, A., Said, M., & Takebe, M. (2016). An Assessment of the Exchange Rate Pass-Through in Angola and Nigeria. *IMF working paper WP/16/191*.

LeBlanc, M., & Chinn, M. D. (2004). Do High Oil Prices Presage Inflation? The Evidence from G-5 Countries. *UC Santa Cruz Economics Working Paper No. 561; SCCIE Working Paper No. 04-04*.

Lescaroux, F., & Mignon, V. (2008). On the Influence of Oil Prices on Economic Activity and Other Macroeconomic and Financial Variables. *Working Papers from CEPII research center*.

Lopez-Murphy, P., & Villafuerte, M. (2010). Fiscal Policy in Oil Producing Countries During the Recent Oil Price Cycle. *IMF Working Paper No. 10/28*.

Monesa, I., & Qazi, L. T. (2013). The Effects of Oil Price Shocks on Economic Growth of Oil Exporting Countries: A Case of Six OPEC Economies. *Business & Economic Review, Institute of Management Sciences, Peshawar, Pakistan, vol. 5(1)* , 65-87.

Mork, K. A. (1989). Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results . *Journal of Political Economy*, pp. 740-744.

Mork, K. A., Olsen, O., & Mysen, H. T. (1994). Macroeconomic Responses to Oil Price Increases and Decreases in Seven OECD Countries. *The Energy Journal, Volume15, issue Number 4*, 19-36.

Ødegaard, L. N. (2012). Oil price shock and monetary policy in the Nordic : a study of Denmark, Norway and Sweden. *FCEE - Dissertações de Mestrado / Master Dissertations.*

Olomola, P. (2006). Oil Price shock and aggregate Economic activity in Nigeria. *African Economic and Business Review Vol.4No.2*.

Rashid, A., & Jehan, Z. (2013). Derivation of Quarterly GDP, Investment. *MPRA Paper No. 46937*.

Rautava, J. (2004). The role of oil prices and the real exchange rate in Russia's economy - a cointegration approach. *Journal of Comparative Economics*, 315-327.

Rocha, A. (2012). Economic growth in Angola to 2017: The main challenges. *Bergen: Chr. Michelsen Institute (Angola Brief vol. 2 no. 4) 4 p.*, Retrieved from: https://www.cmi.no/publications/4669-economic-growth-in-angola-to-2017.

Rocha, A., Kolstad, I., Santos, R., Bonfim, L., Paulo, F., & & Wiig, A. (2014). Diversification of the Angolan economy. *CMI Insight, No. 6, September 2014*, Retrieved from: https://www.cmi.no/publications/5212-diversification-of-the-angolan-economy.

Rocha, A., Paulo, F., Bonfim, L., & Santos, R. (2016). *Estudos sobre a diversificação da economia angolana.* Luanda : Angola Catholic Universitiy press.

Sadeghi, A. (2017). Oil Price Shocks and Economic Growth in Oil-Exporting Countries: Does the Size of Government Matter? . *IMF working paper/ WP/17/287*.

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica, Vol. 48, No. 1*, 1-48.

Stiglitz, J. E., Ocampo, J., Spiegel, S., French Davis, R., & Deepak, N. (2006). Stability with Growth Macroeconomics, Liberalization and Development. *Oxford Univerty Press*.

Stock, J. H., & Watson, M. W. (2001). Vector Autoregressions. *Journal of Economic Perspectives*, 101-115.

Tsay, R. S. (2002). *Analysis of financial time series.* Wiley series in probability and statistics .

Wang, Y., & Zhu, Q. &. (2017). OIL PRICE SHOCKS, INFLATION, AND CHINESE MONETARY POLICY. *Macroeconomic Dynamics*, 1-28.

WorlBank. (2017). *Nigeria bi-annual economic update: A fragile reovery.* The world Bank.

WorldBank. (2017, May). *The World Bank in Nigeria*. Retrieved from The World Bank: https://www.worldbank.org/en/country/nigeria/overview

9. APPENDICES

9.1.Nigeria: Summary statistics (2002Q1:2017Q4)

Variable	Obs	Mean	Std. Dev.	Min	Max
Oilprice	64	70.65412	30.66688	21.29667	127.3467
GDP	64	12897.49	3533.658	6914.07	18563.5
RER	64	147.8167	35.68137	103.32	230.66
CPI	64	110.503	53.61737	40.16936	237.3472

Real Oil Price (UK Brent) in US dollars per barrel deflated by US Producer Price Index.

GDP at 2010 constant prices in Billions of Naira.

CPI Consumer price index (Dez2010=100).

RER - Real exchange rate.

9.2.Table of Forecast Error Variance Decomposition (FEDV)

Angola (a)

step	(1) fevd	(2) fevd	(3) fevd
0	0	0	0
1	.00191	.062153	.015524
2	.003499	.067321	.021595
3	.05497	.104729	.012143
4	.175796	.180326	.085256
5	.252857	.231783	.145177
6	.262323	.323071	.174546
7	.25886	.394068	.212683
8	.272668	.419454	.281911
9	.300468	.416441	.339282
10	.322234	.412705	.376255
11	.34418	.421466	.403073
12	.363319	.433777	.430837
13	.376301	.445203	.447121
14	.380942	.450781	.45045
15	.38131	.451998	.444832
16	.379253	.451544	.438804
17	.374826	.450807	.430379
18	.369988	.445848	.420218
19	.366638	.437406	.409367
20	.364765	.425828	.402923
21	.364536	.417612	.398617
22	.367851	.417042	.394998
23	.373709	.42686	.39141
24	.379588	.437994	.389968

Nigeria (b)

step	(1) fevd	(2) fevd	(3) fevd
0	0	0	0
1	.035839	.028581	.016661
2	.023656	.030722	.014456
3	.027869	.052213	.029029
4	.029309	.142585	.07327
5	.025263	.268598	.089178
6	.022905	.407256	.092872
7	.024671	.487526	.113207
8	.027767	.52865	.173139
9	.031666	.550871	.23855
10	.045999	.571869	.287063
11	.070985	.582435	.329878
12	.094495	.586161	.371548
13	.112311	.587356	.401495
14	.13399	.587074	.418172
15	.16799	.582593	.431337
16	.202167	.573586	.441702
17	.229279	.565166	.443487
18	.25298	.561057	.43718
19	.28044	.557745	.429898
20	.304719	.551537	.423363
21	.321968	.541986	.414885
22	.33559	.533105	.404487
23	.351509	.525555	.396092
24	.365674	.51826	.390595

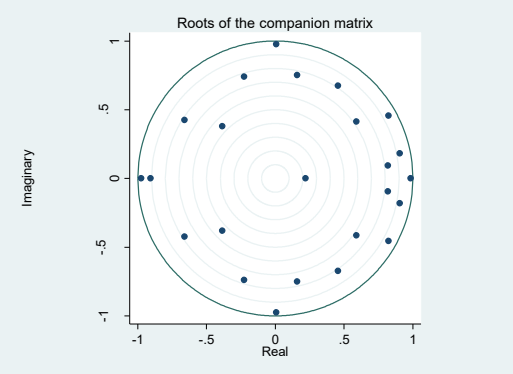
(1) irfname = test1, impulse = res4oil, and response = sln_GDP
(2) irfname = test1, impulse = res4oil, and response = sln_REER
(3) irfname = test1, impulse = res4oil, and response = sln_CPI

(1) Impulse: real Oil Price and response: real GDP
(2) Impulse: real Oil Price and response: real Exchange Rate
(3) Impulse: real Oil Price and response: Consumer prices

9.3.Assessing the validity of the results

9.3.1. **AR Roots Graph and Table**

Angola (a)

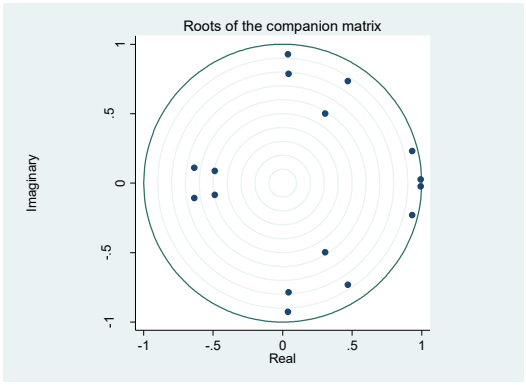


Eigenvalue stability condition

Eigenvalue	Modulus
.9838434	.983843
.00617024 + .9760168*i*	.976036
.00617024 - .9760168*i*	.976036
-.9748396	.97484
.8246399 + .4564747*i*	.94255
.8246399 - .4564747*i*	.94255
.9058928 + .1810733*i*	.923812
.9058928 - .1810733*i*	.923812
-.9066717	.906672
.8203661 + .09368*i*	.825698
.8203661 - .09368*i*	.825698
.4574342 + .6742028*i*	.814736
.4574342 - .6742028*i*	.814736
-.6609087 + .4239747*i*	.78521
-.6609087 - .4239747*i*	.78521
-.2257131 + .7403187*i*	.773963
-.2257131 - .7403187*i*	.773963
.1594029 + .7514668*i*	.768187
.1594029 - .7514668*i*	.768187
.5900277 + .4137118*i*	.720618
.5900277 - .4137118*i*	.720618
-.384267 + .380274*i*	.540619
-.384267 - .380274*i*	.540619
.2208415	.220842

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

Nigeria (b)



Eigenvalue stability condition

Eigenvalue	Modulus
.9929827 + .02521776*i*	.993303
.9929827 - .02521776*i*	.993303
.9329309 + .230822*i*	.961061
.9329309 - .230822*i*	.961061
.03823761 + .9273565*i*	.928145
.03823761 - .9273565*i*	.928145
.4708072 + .7327738*i*	.870986
.4708072 - .7327738*i*	.870986
.04384576 + .7863344*i*	.787556
.04384576 - .7863344*i*	.787556
-.6360214 + .1094795*i*	.645375
-.6360214 - .1094795*i*	.645375
.3069508 + .4996944*i*	.586441
.3069508 - .4996944*i*	.586441
-.4884789 + .08622033*i*	.49603
-.4884789 - .08622033*i*	.49603

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

9.3.2. Autocorrelation Test

Angola (a)

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	24.3674	16	0.08178
2	19.3908	16	0.24892
3	17.3164	16	0.36542
4	15.2786	16	0.50433
5	27.2537	16	0.03875
6	14.2885	16	0.57723
7	26.6217	16	0.04588
8	11.3471	16	0.78757
9	23.4293	16	0.10273
10	11.3725	16	0.78593
11	21.5003	16	0.16007
12	8.4296	16	0.93504

H0: no autocorrelation at lag order

Nigeria (b)

Lagrange-multiplier test

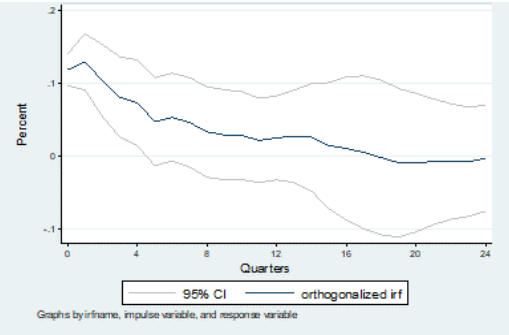
lag	chi2	df	Prob > chi2
1	13.9734	16	0.60070
2	9.4692	16	0.89284
3	16.0228	16	0.45137
4	12.5454	16	0.70566
5	34.0985	16	0.00527
6	19.0565	16	0.26574
7	9.5416	16	0.88945
8	13.0677	16	0.66780
9	20.2492	16	0.20921
10	14.8969	16	0.53220
11	12.1874	16	0.73098
12	20.9176	16	0.18170

H0: no autocorrelation at lag order

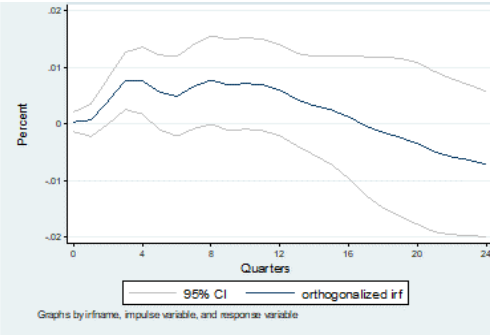
9.4.Robustness checks

9.4.1. SVAR in levels: different variables ordering

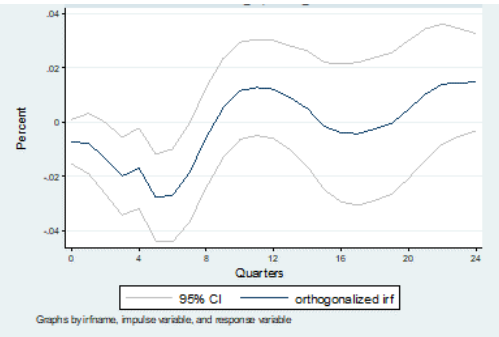
Response of Oil Price to Own Shock



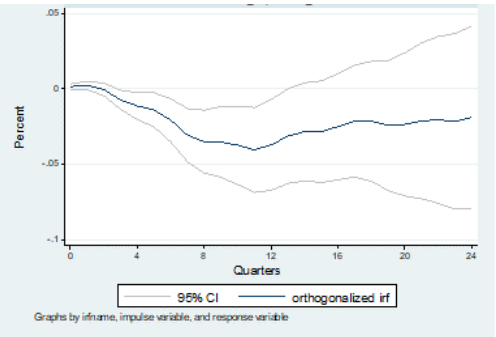
Response of real GDP to Oil Price Shock



Response of real Exchange Rate to Oil Price Shock

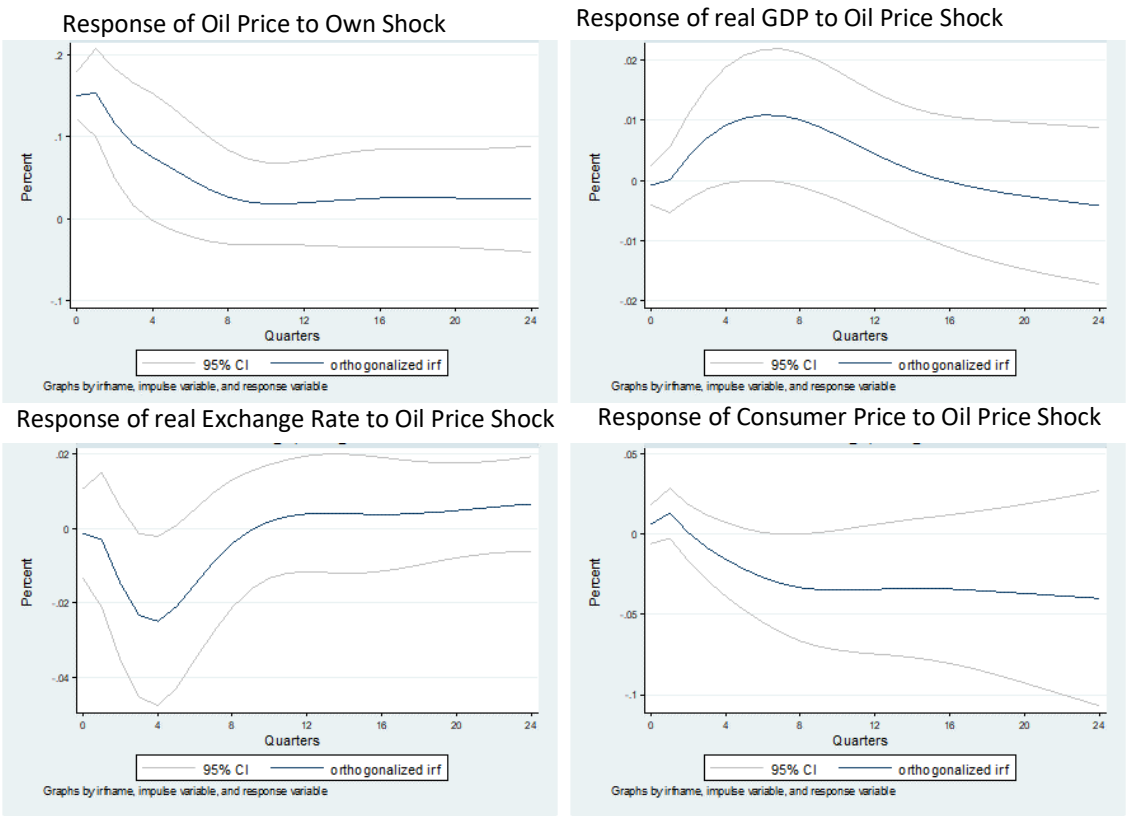


Response of Consumer Price to Oil Price Shock

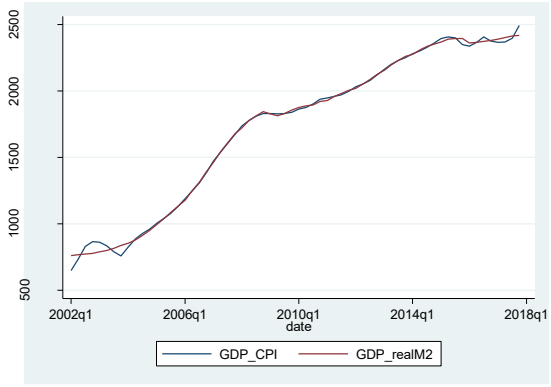


In line with literature, the stability of the results was confirmed by changing the Cholesky ordering of the variables. The ordering of the domestic macroeconomic variables was adjusted while maintaining oil price as the first variable. The rationale of not changing the position of oil price was to maintain the exogeneity of oil prices to the domestic economies in the estimation process. The contemporaneous coefficients results obtained after the reordering were almost similar to the initial results while a new set of results were produced when the exogeneity status of crude oil price was violated. This implies that the estimates are robust to the ordering of the domestic variables in the SVAR model.

9.4.2. SVAR in levels starting date (2005q1)



9.4.3. Denton: Indicator variables (CPI vs real M2)



9.4.4. Estimated contemporaneous structural parameters.

SVAR model parameters

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0{,}04 & 1 & 0 & 0 \\ 0{,}06 & -0{,}02 & 1 & 0 \\ -0{,}00 & -0{,}06 & -0{,}05 & 1 \end{bmatrix} \begin{bmatrix} Oil_t \\ GDP_t \\ EXR_t \\ CP_t \end{bmatrix} = \begin{bmatrix} 0{,}12 & 0 & 0 & 0 \\ 0 & 0{,}05 & 0 & 0 \\ 0 & 0 & 0{,}03 & 0 \\ 0 & 0 & 0 & 0{,}0 \end{bmatrix} \begin{bmatrix} Oil_{t-1} \\ GDP_{t-1} \\ EXR_{t-1} \\ CP_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{oil} \\ \varepsilon_{gdp} \\ \varepsilon_{ex} \\ \varepsilon_{CP} \end{bmatrix}$$

Where $\varepsilon_{oil}, \varepsilon_{gdp}, \varepsilon_{ex}; \varepsilon_{cp}$ are structural disturbances oil prices, GDP, exchange rate and of consumer prices, respectively.