The Effects of Asymmetric Shocks in Oil Prices on the Performance of the Libyan Economy

Haytem Troug and Matt Murray

University of Exeter

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THE EFFECTS OF ASYMMETRIC SHOCKS IN OIL PRICES ON THE PERFORMANCE OF THE LIBYAN ECONOMY

Matthew W. Murray[1]

Haytem A. Troug[2]

Abstract:

This essay examines the presence of asymmetry in the response of the Libyan economy to fluctuations in oil prices, subsequent to the discovery of oil in the country. Three Vector Autoregressive (VAR) models are illustrated and estimated along with a multivariate rolling VAR approach. All of the examined sectors of the economy are found to react asymmetrically to shocks in oil prices over the 1962-2012 period. The magnitude of the adverse effect of the negative oil shocks on the manufacturing and agriculture sector appears to outweigh the positive effect of the positive oil shocks. The services sector, on the other hand, is able to overcome the shocks of the oil prices, due to absence of external competition. In addition, the results of the Multivariate rolling VAR highlight the existence of structural changes in the relationship between the sectors of the Libyan economy and oil prices. The essay promotes implementing reform to the fiscal policy to de-link the real sector from fluctuations in oil prices. It also advises on enabling the financial sector in order for it to contribute in the diversification process of the economy.

Key words: Asymmetric Oil Shocks; Fiscal Policy; Rolling-VARs; OPEC.

[1] Department of Economics, University of Exeter.
[2] University of Exeter, Department of Economics. Central Bank of Libya.

1. Introduction

Libya's economy presents all characteristics of an oil-rich developing country—with a large hydrocarbon sector supporting a weak and vulnerable non-hydrocarbon sector. The country both affects the international oil market and is broadly affected by it. Libya's economy relies substantially on crude oil export revenues, representing 97% of total export earnings and, on average, 91% of government revenue in annual budgets (Central Bank of Libya, 2013). The share of oil value added in the GDP of Libya averaged 47% between 1962 and 2012. Therefore, any particular shock in oil prices can have a significant effect on government revenue and the economy.

The large amounts of oil revenues which overwhelmed the country during the 1970's, similar to other oil-rich countries, encouraged officials to undertake ambitious development projects to meet the social and economic needs of the country. There is little evidence that those projects were conducted on the basis of feasible project-planning schemes. The intention was to make the country self-dependent in every possible industry, as mentioned in each development plans in our sample period[3]. When oil prices crashed in the 1980's, the country took severe austerity measures that affected development spending the most. These measures resulted in cutting expenditure on projects that were half-completed "White-elephant Projects" (Collier, 2010), which also affected most non-hydrocarbon sector components.

Current government expenditures, on the other hand, are inflexible and sticky downward. Whenever oil revenues increase, current expenditures also go up due to pressure from civil servants to raise wages, and that in turn increases the subsidies bill. When oil prices go down, however, the government is not able to reduce the size of its activities immediately, leading to a significant budget deficit. These types of annual budget deficits in Libya are financed through withdrawals from Government reserves at the central Bank of Libya. This is identical to spending directly from the windfalls of oil revenue, and it has

[3] 6 medium-term development plans took place in Libya during our sample period. They are as follows; i) 1963-1968, ii) 1969-1971, iii) 1972-1976, iv) 1977-1981, v) 1982-1985 & vi) 2008-2012.

an inflationary effect through increasing money supply without an increase in productivity. Considering the high rigidity of recurrent expenditures in Libya, any noteworthy negative oil price shocks will worsen the budget deficit of the government and create inflationary pressures for the whole economy. Thus, this will negatively affect the competitiveness and growth of the non-hydrocarbon economy.

The effects of the volatility and the large windfalls of natural resources on developing countries have been widely discussed in the literature, and cross-country analysis showed that those mentioned economies were homogenous in various categories (Arezki & Brückner, 2009). For instance, Arezki & Van der Pleog (2007) found that there is a significant negative direct effect of natural resources on the growth of income per capita. This conclusion was reached earlier by Gylfason (2002), but the former went further to investigate additional trends in those economies, the most significant of which was the negative effect of natural resources on institutions in those countries. Consequently, the resemblance in the economic structure of natural resource-rich countries will provide scholars a credible guide whenever attempting to analyse a certain phenomenon in a natural resource-rich country.

This paper aims to evaluate the consequences of the practice that was followed by the Libyan government in managing the country's hydrocarbon wealth in the presence of fluctuating oil prices. Most importantly, we intend to detect which sectors in the economy, and which development-expenditure items were most affected by the fluctuations in oil prices. In addition, this paper will test whether the relationship between oil prices and economic output changed over time or if it stayed stable over the sample period. Finally, it is useful in assessing whether, when and how to reformulate the fiscal and monetary and exchange rate frameworks.

The remainder of the paper is organized as follows. We begin by reviewing some of the relevant developments in the Libyan economy that took place during our sample period in section (2). We review the relevant literature in section (3). A detailed exposition of the methodology and a description of the data in our model is presented in section (4). In section (5) we perform our empirical analysis on the model. Section (6) offers concluding remarks.

2. Background

Libya is blessed with large oil reserves, estimated at 48.5 billion barrels of crude oil and 1.5 billion cm of natural gas (OPEC 2013). Nevertheless, the country struggled to obtain a sustainable level of development since the discovery of oil in 1959. Before this, Libya was ranked amongst the poorest countries in the world (Monitor Group, 2006). Two years later, after the receipts of the oil exports started flowing in the national deposits, the policy makers started taking ambitious development planning measures; to improve the living standards of Libyan citizens.

The first medium-term development plan was that of 1963-1968. Total development spending during that period was 551 million Libyan dinars (LYD), around 1/6 of total GDP. This might appear a humble figure for development, but the main objective of this development plan was to improve the infrastructure of the Libyan economy to pave the way for sustainable economic diversification (Ministry of Planning).

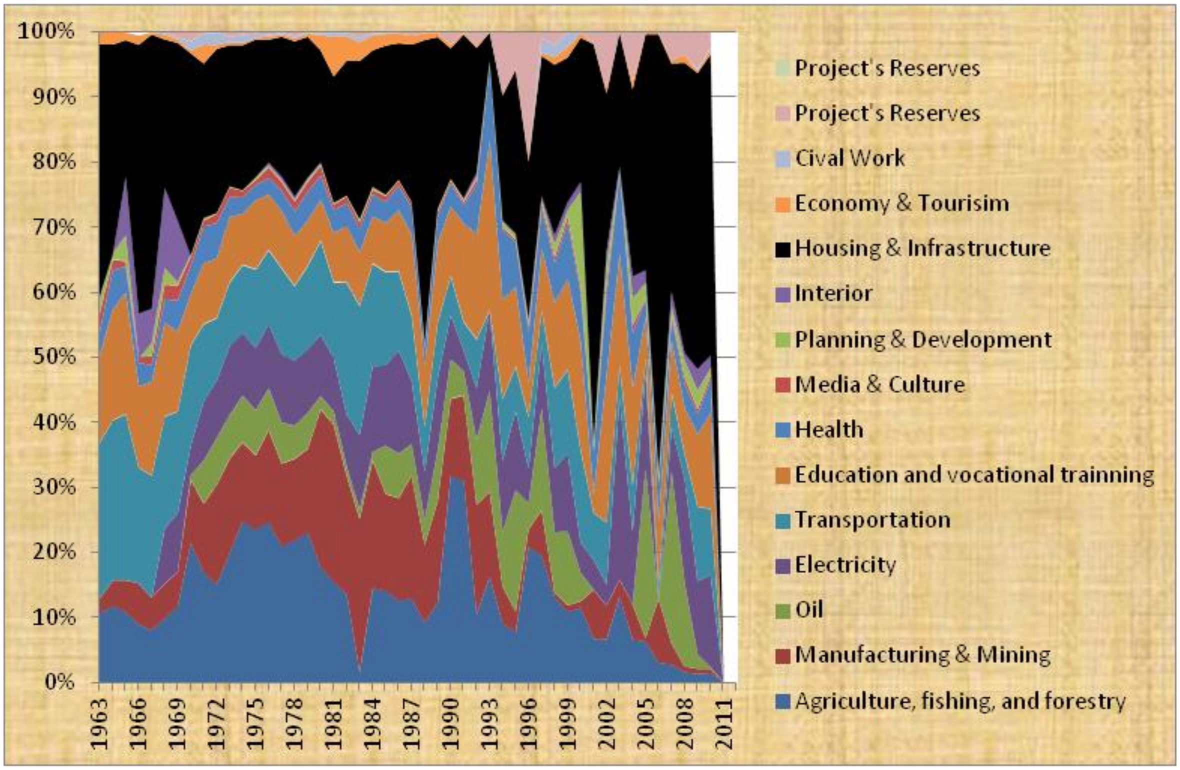
The development plans of the 1970's followed a regime change in the country, which brought an evident change in the structure of the government. Since 1969, the country took a hostile position against cooperation with western companies, and directed its development spending towards achieving self-dependency by all means possible. The increasing oil prices of that period offered the government more fiscal space to manoeuvre and to undertake ambitious development projects. Development spending averaged over 25% of GDP during this period, raising questions about the quality of spending and its limitations in generating sustainable growth. Additionally, Libyan policy makers disregarded the reversing trend in oil prices. This behaviour of spending continued in the 1982-1985 development budget, and the results of spending in that period were clearly reflected in double-digit growth rates of GDP per capita until it reached a peak of around 13,000 US Dollars (USD) in 1981 (Masood, 2014), as illustrated in figure 1.

After oil prices plummeted to 12.5 USD per barrel in 1986, the Libyan government halted its medium term development planning scheme, and started executing a year-by-year development budget. The government also issued bonds to state owned banks in 1986 to fulfil spending commitments that were made during the periods of high prices. This resulted in a large set of incomplete projects known as "Cement Mountains" that were left unfinished until the mid-2000’s when oil prices started to climb again. Although most oil-exporting countries were affected by the sharp decline in oil prices, the effects were more severe in Libya due to the political instability, whilst wars with neighbouring countries exhausted Libya’s finances. Resulting international sanctions also contributed to a decline in Libyan GDP per capita to 5,600 USD

Rising oil prices in the early 2000’s and the lifting of international sanctions led GDP per capita to grow, reaching 16,000 USD. The fiscal stance of the Libyan government was procyclical, pursuing expansionary policy during economic booms and implementing contractionary policy during economic slumps. This behaviour is typical among oil producing countries (Barnett and Ossowski 2002). From 2000-2008, the Libyan Ministry of Finance developed estimates of oil revenue based on production capacity, market developments and OPEC quotas. After this, the development requests of each Ministry are negotiated based on permitted aggregate expenditure.

In 2005, the government implemented fiscal controls to limit current expenditures to 30% of estimated oil revenues. This was circumvented however, after the 2008 financial crisis, which caused development spending to fall, with further deteriorations up to 2012.

Figure 1: The Relative Share of Each Sector in the Development Budget 1963 - 2011

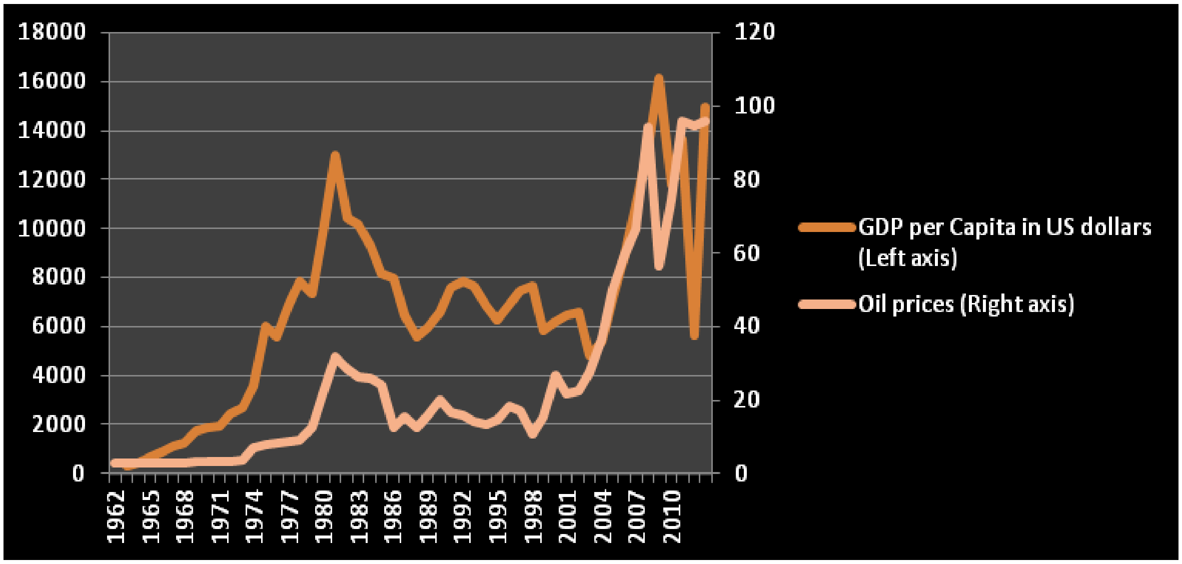


Source: Author's calculation based on data provided by the ministry of planning.

Figure (1) depicts the share of each sector in the Libyan development budget from 1963 to 2011. Notably, spending on housing and infrastructure has always dominated the development budget, which is intuitive given the positive impact on social cohesion and the lack of infrastructure required for development. This is complemented by development spending on electricity which of course, only began in 1968 after a large segment of the first development spending was completed.

Spending on agriculture and manufacturing were fundamental to each development budget, aimed at job creation and protection from oil price fluctuations. Nevertheless, we see their share in total development spending affected by these fluctuations and this spending reduced significantly in the final 10 years shown. The same is true for development spending on transportation. In the oil sector, the data demonstrates that development spending only began in 1970. This was a result of the nationalization of the majority of oil companies operating in the country after a political power shift in 1969. The effect on oil production has been felt ever since and we attempt to capture this effect by introducing oil revenues and oil prices into our model. The above analysis of the share of each sector in the development budget also reflects the opportunity cost of not allocating the available exhausting resources of oil revenues into other investments (Sanz and Velazquez, 2002).

Figure 2: The Evolution of GDP per Capita and Oil Prices



Source: Ministry of planning, Central Bank of Libya, IEA.
Note: Oil prices in USD were downloaded from the IEA's database, and the GDP series was converted to USD via the official average exchange rate published by the CBL.

Figure 2 shows that Libyan GDP per capita is highly correlated with oil price movements, with the exception of 2011 when oil production was halted due to violent conflict in the country. The figure also signals a sounding alarm regarding the incapability of policy makers to detach the real sector from fluctuating oil prices. This issue will be investigated with more detail once we construct our model. Further analysis might also reveal whether even the positive changes in the price of oil also had a negative impact on certain sectors of the economy. This can also help us in detecting the syndromes of the "Dutch Disease". Finally, that period witnessed a large increase in the non-hydrocarbon fiscal deficit (AFDB, 2009), which is a strong indicator of increasing oil-dependence.

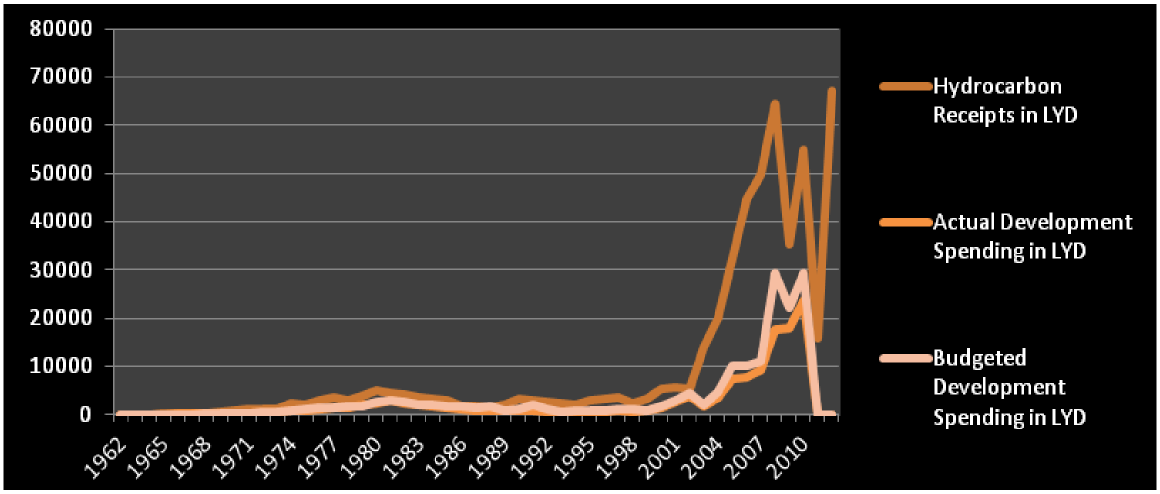
As indicated previously, Libyan economic growth was state-led and heavily affected by financing from oil revenues.. These distortionary policies led to a crowding-out of the private sector, with an exception in small- and medium-scale enterprises and the agricultural sector. The contribution of the oil sector in the country's total output immediately leaped from 25%in 1962 to average over 50% of total output for the rest of the decade. This contribution fluctuated around that average during our sample period (1962-2012), experiencing a positive relationship with oil prices.

The economy suffered from the distortionary fiscal policy that was funded by oil revenues. Wells (2014) argues that the lack of solid policies prevented the country from being transformed to a wealthy, stable and more diversified state. Wells also measures the quality of investment in Libya and finds that every USD invested by the government generates 0.56 USD. When we tried to calculate the quality of investment in our sample our index was even lower at 0.496. The larger length of the data set that we are using in this paper can explain this. Also, estimates by Dabla-Norris et al., (2012) and Gupta et al., (2011) about the quality of government investment in developing economies were around 0.5, which is consistent with both calculations. Kumah & Matovu (2005) explain that this behavior of non-judicious expenditure normally takes place in oil-rich countries during times of high oil prices without considering the cost of reversing them.

Libya's business environment also undermined efforts to transform to a more diversified, resilient economy as authorities did not make efforts to engage the private sector. The WEF 2013 report ranks Libya 113th globally in terms of global competitiveness principally due to the lack of market efficiency, relatively weak human capital, and lack of financial sector development. Widespread corruption also contributed to lacking development during the periods when oil prices were increasing. This observation is also consistent with the study by Arezki & Brückner (2009), which concluded that an increase in oil rents significantly increases corruption in a poll of oil producing countries. The World Bank (2012) also ranked Libya amongst the bottom 5% in terms of government effectiveness.

Additionlally. Before the Libyan Investment Authority (LIA) was established in 2007, the country never had a well-governed Sovereign Wealth Fund (SWF), which obstructed efforts to sustain investment over longer periods by delinking the economy from fluctuating oil prices. SWFs could also be used as parking funds; a place to hold excess money until the country's investment capacity improves (Barnnet and Osswaski 2002). This is required because there are normally bottlenecks in the skilled workers and capital that is needed for investment: *it takes teachers to teach new teachers, and roads to connect to other roads* (Van der Ploeg & Venables, 2012).

Figure 3: The Evolution of Fiscal Components



Source: Ministry of planning.
Note: the y-axis represents the values in LYD millions

In figure 3 we easily notice the period in which the surpluses were transferred to LIA. During the boom periods of oil prices the government had difficulty in executing the planned spending. This is clearly noticeable in the last decade and back to the time when the government stopped implementing any medium term planning. This also raises the question about the institutional and 'absorptive capacity' of the economy. This burden prevented the ability to absorb any additional spending efficiently and transform those resources into services and infrastructure. The absorptive capacity also meant that the private sector could easily react to increasing demand by the government via increasing the production capacity through employing more people and using new capital instead of just raising the prices which is the case in Libya. This will also lead to the ability of the labour market to react to the demand generated by the government.

Oil will still be a major source of finance for the Libyan authorities in the foreseeable future. The country also still has a large infrastructure gap. A feasible solution to the above mentioned bottlenecks is essential to make the required transformation possible. In our model below, we identify which sectors of the economy were affected the most by the fluctuations in oil prices. We will also investigate if the past rapid investment adversely affected any particular sector.

3. Literature Review

Researchers in the past concentrated on analysing the effects of crude oil price shocks mostly within developed, net oil-importing economies. However, explicit research on net oil-exporters has been rare so far. In a general context, oil price shocks might have a different impact depending on a country's sectoral compositions, their institutional structures and their economic development. As shown below, the literature is far from reaching agreement. We will divide our review on some selected studies into Developed and developing economies:

3.3.1 Developed Economies:

After Darby (1982) failed to prove the relationship between oil prices and the macroeconomy, Hamilton (1983) employed a VAR also to study the relationship between oil and some key macroeconomic variables in the U.S after World War II. Using the Impulse Response Function (IRF) he was the first to prove that oil prices had a negative effect on macroeconomic variables.

In an extension to Hamilton's paper, Mork (1989) was the first to try to distinguish between negative and positive shocks. He also employed a VAR model and used the IRF technique to investigate the presence of asymmetry in shocks in oil prices. Mork allowed for asymmetric response of selected U.S macroeconomic variables to changes in oil prices by specifying positive and negative changes in separate variables. Although he was not able to prove the significance of the negative changes in oil prices, the paper provided crucial guidance to papers that followed: (Mork et al., (1994), Lee, Ni & Ratti, (1995), and Hamilton (1996, 2003)). We will discuss some of those methodologies in more detail later.

More recently, Jimenez-Rodriguez & Sanchez (2005) examined the effect of oil price fluctuations on key macroeconomic variables in seven developed OECD countries, Norway, and the Eurozone area economy. They employed multivariate VAR analysis to model both symmetric and asymmetric effects of oil prices. They concluded that positive oil prices have a larger impact on the economy than negative changes in oil prices. They also distinguished between oil exporting countries and oil importing countries. In this matter, they concluded that the effect of an increase in oil prices has a negative effect on selected macroeconomic variables in oil importing countries, while the effect on oil exporting countries was ambiguous.

Also, Park and Ratti (2008) empirically analysed the effect of oil prices on stock market returns in 14 developed economies. They employed multivariate VAR model analysis on a dataset spanning 1986 to 2005 with monthly frequency, using both symmetric and asymmetric models. They concluded that positive oil price shocks have a negative effect on stock returns, except for the U.S. Norway, as a net exporting country, had a positive response in stock returns to increasing oil prices.

The choice of dependent variables in industrial countries also attracted wide debate in the literature (Bernanke & Mihov, 1998), but eventually reached a consensus on choosing industrial output per capita to analyze the effect of oil prices fluctuations on the economy, given the high frequency and availability of the data as illustrated by Kim & Roubini (2000) and Papapetrou (2001).

In a different approach, Blanchard & Gali (2007) investigated whether or not the effects of fluctuating oil prices on inflation and output in a pool of selected developed economies changed over time. They employed a Structural VAR to take into account the lag effect of changes in oil prices on output, also taking into account country specific characteristics. After implementing the IRF, they conducted the bivariate rolling VAR procedure to capture the changing effect of fluctuating oil prices. They concluded that the effects of oil price movements have weakened after 1984 due to a number of structural changes in those economies. They argue that the main reasons for this change in the effect are the use of less energy intense production methods, a more flexible labour market, and more credibility in monetary policy.

3.3.2 Developing Economies:

Analysing the issue of the effect of fluctuating oil prices in developing economies comes with a different approach than the one regarding developed economies. The economies of developing oil exporting countries suffer from shallow financial markets that rarely help in absorbing external shocks, a large government sector that usually crowds out the private sector, and a large informal sector that operates outside the supervision of the authority (Bauer, 2008). Also, oil revenue represents a large segment of the sovereign revenues, and all development plans highly depend on those large windfalls. Additionally, those large windfalls created social pressure on governments of those countries to distribute the wealth among the population by all means possible. As a result, governments of those countries provided generous subsidies that were reflected in cheap energy prices (Charap et al., 2013), which also presented a burden for those oil-rich countries when the oil prices increased.

In spite of the focus of research towards developed economies, some recent papers investigated the effects of oil price changes on macroeconomic variables in developing economies. The first two studies we investigate are those of Al-Mutawa (1991) and Al-Mutawa & Cuddington (1994). These two papers tried to measure the effect of oil shocks (in quantity and prices) on the UAE's economy, concluding that an increase in quantities benefits the economy more than a price increase. They also concluded that a drop in the quantity or prices of oil had a negative effect on economic activities in the UAE.

Eltony & Al-Awadi (2001) conducted a study on the effect of oil on the Kuwaiti economy and government expenditure. They employed a (VECM) on a set of quarterly data covering 1984 to 1998. They concluded that oil price shocks are vital in explaining deviations that occur in the Kuwaiti economy, and on government spending which is a significant determinant for the economic activity in Kuwait. In more details on the last part, the recurrent government expenditure was rarely affected but with the oil price fluctuations, it was the development expenditure that suffered the most from those oil shocks. In the literature we also note that Chun (2010) conducted a study to measure the relationship between oil revenues and military expenditure in five oil-rich countries (Iran, Kuwait, Venezuela, KSA, and Nigeria). Using annual data from 1997 to 2007, and employing a VAR model, Chun found that those countries show inelastic demand for military expenditure.

Mehrara (2008) investigated the presence of nonlinearity in the relationship between oil prices and output in 13 oil-exporting countries during the period 1965-2004. He finds the presence of nonlinearity, and concludes that the negative oil shocks adversely affect output. Positive oil shocks, conversely, have a minimum effect on output. Mehrara states that the reason behind these results is that those countries lack institutional capabilities to de-link government expenditure from fluctuating oil prices. He concluded by recommending establishing a stabilization fund, and concentrating on diversifying the economy.

In a similar approach, Berument et al., (2010) investigated the effect of oil shocks on output and inflation in 16 MENA countries. Using a VAR model and employing an IRF on annual data from 1952 to 2004, they found that oil price increases have a positive effect on output in hydrocarbon-exporting countries. Libya was included in that study, but the analysis was conducted on the aggregate level. Our analysis is detailed and uses more accurate data. In a more detailed study, Farzanegan & Markwardt (2009) employed a VAR model and conducted an IRF and VDC analysis on six macroeconomic variables in the Iranian economy, finding that fluctuating oil prices had a positive effect on inflation. They also find the industrial production is positively correlated with oil prices, and that aggregate government expenditure is merely affected by oil prices. Esfahani et al., (2013) conducted research on the effect of oil exports on the Iranian economy. Using a VARX model and employing the Generalized IRF, which is not affected by the ordering of the variables, they concluded that the Iranian economy rapidly responds to shocks in oil prices. They link these results to underdevelopment of the money and capital markets, and these results come aligned with our analysis above.

Aliyu (2011) conducted a study to prove non-linearity in the relationship between oil prices and the Nigerian macroeconomy. He employed a multivariate VAR model and a Granger causality test to prove the presence of symmetric and asymmetric relationships between real GDP and oil prices. In his asymmetric analysis, Aliyu shows that the positive shock has a positive effect on GDP with a larger magnitude than the effect of the negative shocks. In a study on the effect of oil prices on the Russian economy, Rautava (2004) employed a VECM to capture the long term and short-term relationship between oil prices and key macroeconomic variables. He concluded that the fluctuations in oil prices significantly affect the Russian economy both in the short-term and the long-term. In addition, Rautava also concludes that the effect of oil prices started to diminish in recent years. Grownwald et al., (2009) also employ a VAR model to estimate the effect of oil prices on the Kazakh economy, concluding that all of the macroeconomic variables in their model have a positive relationship with oil prices.

4. Methodology and Data Description

4.1 Methodology

4.1.1 VAR model:

Traditional models fail to take into account multiple sources of shocks and endogeneity that are based on economic theory. Sims (1980) criticized the "incredible identification restrictions" that are inherent in those models. In a VAR model, the time path of one of the variables is regressed on a constant (and a time-trend, if required), and on the past realizations of the other variables and its own past realizations of order "P" as well. In other words, VAR models analyse joint behavior of the endogenous variables (Bernanke, 1986). The residuals of the model are considered to be uncorrelated and time-invariant (i.e. white-noise). In addition, VAR models do not make any use of theoretical considerations about how the variables of the model are expected to be correlated. Hence, the reduced form models cannot be used to evaluate and interpret the data in terms of economic theory (Blanchard & Watson, 1986). VAR models and structural models play a complementary role (Clements & Mizon, 1991).

A VAR with stable parameters, given it is statistically specified, forms a legitimate foundation for examining hypotheses of dynamic specification, a prior structure, and exogeneity. Thus they help in the evaluation of the model as well as recommending a possible decent model development plan (Sims, 1980). The other significant feature of the VAR model is that it can be further extended to other models such as VECM and VARMA models, if required.

In addition to the well-known AR representation, there is also the Moving Average (MA) representation, where each variable is regressed on current and past representations of the innovations of all the endogenous variables of the model. This form might seem different from the AR representation, but it represents the same system. VAR models have also proved their dominance when it comes to their forecasting power (Stock & Watson, 1989).

The identification that is being used in the reduced form VAR model is the Cholesky decomposition, which empirically imposes a lower triangular structure on the matrix. This procedure ensures that the number of restrictions meets exact identification. As a result, the ordering of the variables in the model is the only determinant of the structure of the innovations, and this comes as a significant drawback of the approach (Bauer, 2008). The prominent feature of the VAR model with respect to the innovations occurs not because shocks to policy are essentially vital, nevertheless since tracing the dynamic reaction of macroeconomic variables to a commodity innovation gives an insight on the effect of a policy change under the smallest possible identifying assumptions (Bernanke and Mihov, 1998).

$$\mathrm{Yt} = \sum_{t=1}^{Pi} \mathrm{Ai}\,\mathrm{Yt} - \mathrm{i} + \mathrm{B}'\mathrm{Xt} + \mathrm{error} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Y is a vector of the endogenous variables of the model, A(L) is an n x n matrix polynomial in the lag operator, B(L) is an n x k matrix polynomial in the lag operator, Xt is a k x 1 vector of exogenous variables, and the error term is also an n x 1 vector of disturbance terms (Kakes 1999, Sims 1980, Spanos et al., 1997). Under the general condition, the OLS estimation of Ai is consistent and asymptotically normally distributed. Sims et al., (1990) argue that this structure is valid for both stationary and non-stationary but possibly co-integrated variables in the VAR model. The coefficients of the current period on the RHS of the equation are set to the power of zero, while the coefficients of the first lag are set to the power of one, and the coefficients at lag p are set to the power of p.

In our VAR model above, the innovations of the current period are unanticipated but become part of the information set in the next period (Hamilton, 1994). While the coefficients of the lag polynomials in the system are considered as the anticipated part of the models. This is an outstanding feature of the VAR system, where traditional models used to only deal with the anticipated part of the model (Stock & Watson, 1989). The innovations also represent the aggregate effect of a number of variables that each have an insignificant effect on the endogenous variables of the model. In a well specified model, they should be of a minimum size. Therefore, if the error terms in the system are unusually large, this will make the dependent variables unusually large as well. This also means that the dependent variables of the system are correlated with the innovations, and that, in return, will prevent us from estimating the model with the OLS approach (Enders, 2010).

Once we estimate the VAR, we aim to trace out the dynamic response of the variables of the model to a shock in the innovation of oil prices. We employ the IRF method to accomplish this procedure. In addition, we analyse the relative importance of a variable in causing variations in its own value and the values of the other variables using the Forecast Error Variance Decomposition (VDC) procedure (Farzanegan & Markwardt, 2009). The first variable in the Cholesky ordering is normally the most exogenous variable in the VAR system. A debatable point in VAR analysis is the ordering of variables in the system. In order to check the stability of our results, we will re-estimate IRFs and VDC with alternative orderings based on VAR Granger causality tests.

In practice, theory may not offer a comprehensible framework to classify variables as exogenous or endogenous. Such ambiguity leaves researchers with an immense deal of discretion in classifying variables (Brooks & Tsolacos, 2010). In Sim's (1980) presentation of the VAR model, he argued that the use of some variables as exogenous is continuously done on an arbitrary basis in large macroeconomic models, rather than doing so based on some theoretical background. In this matter, we will discuss the issue of exogeneity in our model later on and explain the theoretical background that our assumptions are based on.

The VAR approach lacks any theoretical substance (Cooly & LeRoy, 1985; Leamer, 1985), where it assumes, by using the Cholesky ordering, contemporaneous effect. In other words, the classification of the shocks in the traditional VAR model is based on their order not their source. The Cholesky ordering is considered as an implicit identification assumption, and "It evades, rather than confronts, the issue of identification" (Blanchard & Gali, 2007). By implementing the ordering, the last variable in the order will not have any effect on the rest of the variables of the model when the shock is implemented at period T. The residual ordering assumes that all the variables have a recursive effect on each other. In addition, impulse responses in traditional VAR models do not accord with economists' priors, but this might also be considered as strength of the VAR methodology (Walsh 2000). Thus, we will check different orders for robustness.

4.1.2 Asymmetric Shocks

Following the discussion of Hicks (1991) that developing countries do not distribute the burden of a fiscal austerity measures among different spending items, and the supporting argument of Gylfason (2002) around how oil producing countries reallocate spending whenever oil prices change, we aim to test the presence of an asymmetric response in output to changes in oil prices. Although Hicks also states that the level of democracy is a key factor in how spending is allocated, we cannot *per se* predict the behavior of the Libyan government in allocating oil funds to different categories of spending. This is a matter of empirical investigation, which we carry out in the following sections. Distinguishing between the negative and positive should enable very rich analysis on the response of the Libyan governments to fluctuating oil prices. It will enable us to measure whether the government misused the large oil windfalls when the oil prices increased and overheated the economy. It will also enable us to test if the government was able to protect the economy from the negative oil prices.

A large set of different measures are available for testing for nonlinearity in the relationship between oil shocks and macroeconomic variables. After Loungani (1986) first discovered nonlinearity of this relationship, Mork (1989) constructed separate coefficients for both deviations of oil prices. The basic idea behind Mork's approach was to separate the original oil price series into two series: containing the negative and positive growth rate observations respectively (Hamilton, 2005), as illustrated in equations 4.a and 4.b:

$$roilp_t + = \max(0, (roilp_t - roilp_{t-1})) \qquad (4.a)$$

$$roilp_t - = \min(0, (roilp_t - roilp_{t-1})) \qquad (4.b)$$

After Mork's (1989) measure, Lee, Ni & Ratt, (1995) and Hamilton (1996) developed the Scaled Oil Prices measure. Their argument against Mork's measure is that an increase from one period to another might only be a result of price corrections to previous developments in the prices, and might not have significant effect on the economy. Therefore, they suggest a calculation that captures the periods when prices change after periods of stability, as shown in equations 5.a and 5.b:

$$roilp_t + = \max(0, (roilp_t - \max((roilp_{t-1}).........,(roilp_{t-4})) \qquad (5.a)$$

$$roilp_t - = \min(0, (roilp_t - \min((roilp_{t-1}).........,(roilp_{t-4})) \qquad (5.b)$$

Since our set of data is only available in annual frequency, we will employ Mork's procedure for the sake of relevance. We define the negative and positive representation of oil prices O_t following the below definitions in equation 6a and 6b:

$$O_t^+ = \begin{cases} Ot & \text{if } Ot > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (6a)$$

$$O_t^- = \begin{cases} Ot & \text{if } Ot < 0 \\ 0 & \text{otherwise} \end{cases} \qquad (6b)$$

4.2 Data Description

In our analysis, we make use of nine macroeconomic variables including four components of development government expenditures, as government expenditures are major determinants of the level of economic activity in Libya as previously mentioned. The sample comprises of annual observations from 1962 to 2012. Furthermore, we take the effects of the UN sanctions (1992-1999), and the Arab spring turmoil (2011) into account by using two dummy exogenous variables. Additional dummy variables are introduced as necessary. Most of this data is sourced from official Libyan institutions (CBL, Ministry of Finance and Planning, Ministry of Oil) with the exception of oil prices which are collected from the EIA's database.

We also use the logarithmic form of the data along with the values at the level to reduce variability of the data. The logarithmic form is also beneficial when trying to estimate the possibility of long-term relationships (Eltony & Al-Awadi, 2001). We note that we have excluded current government expenditure from the analysis because it is a component that is inflexible and sticky downward. The components of the current expenditure item in the Libyan budget are wages, subsidies, and administrative expenditure. As we mentioned above, financing for development projects is only allocated after the financing needs of the current expenditure are met. We also excluded development expenditure on military equipment due to the unavailability of the data that are recorded in the off-budget expenditure.

Our analysis will be on the nominal values of our macroeconomic variable. We base this analysis on the founding of Hamilton (2005) that using nominal or real prices doesn't make a difference in analysing the size of any given shock in a VAR model.

Table 1.

Data Summary*

		Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Observations
OIL**	Level	23.30	15.56	95.73	2.86	20.28	1.89	2.56	51
	Log	1.15	1.19	1.98	0.46	0.46	(0.04)	(0.83)	
OIL_REV	Level	9,702.56	2,922.31	67,100.09	1.03	17,189.70	2.30	4.26	51
	Log	3.39	3.47	4.83	0.01	0.89	(1.23)	3.50	
EXP_IHC	Level	1,997.75	487.80	20,513.03	9.50	4,445.98	3.38	10.92	51
	Log	2.70	2.69	4.31	0.98	0.74	(0.07)	0.43	
HCE	Level	2,736.77	1,039.60	16,123.70	40.60	4,016.77	2.00	3.26	51
	Log	3.00	3.02	4.21	1.61	0.67	(0.16)	(0.37)	
D_AGR	Level	179.79	158.99	917.69	1.10	171.54	1.88	5.90	51
	Log	1.94	2.20	2.96	0.04	0.69	(1.24)	0.99	
AGR	Level	673.79	411.20	2,543.60	14.90	695.15	1.03	0.20	51
	Log	2.46	2.61	3.41	1.17	0.69	(0.45)	(1.15)	
D_MANU	Level	113.25	54.88	583.20	-	145.79	1.74	2.56	51
	Log	1.52	1.74	2.77	(1.00)	0.91	(0.97)	0.71	
MANU	Level	993.12	397.20	5,809.50	9.00	1,493.92	2.01	3.13	51
	Log	2.44	2.60	3.76	0.95	0.82	(0.30)	(0.92)	
SER	Level	4,620.26	2,382.20	26,087.69	52.40	5,584.05	1.96	4.02	51
	Log	3.29	3.38	4.42	1.72	0.69	(0.64)	(0.38)	

* Date in () represent negative values.

** All values in level are in millions of Libyan Dinars, with an exeption to the Oil variable which is measured in dollars per barrel.

5. Empirical Analysis

5.1 Unit Root Test

In the first step of our empirical analysis we start by investigating the presence of a unit root in all of the series of the model. In our analysis we employ the methods of Dickey &

Fuller (1979), and Phillips & Perron (1988). The first is an extension of the DF test which adds lags of the first difference, while the second makes correction for serial correlation in the error terms with a non-parametrical approach "Newey–West modification" (Davidson, 2000). Thus if the series does not suffer from serial correlation the PP test will transform to a standard ADF test. The null hypothesis in each test is that the series suffers from a unit root when H_0=1. We will also employ a third test (KPSS) whenever the DF and ADF tests provide conflicting results. We expect the results of the KPSS test to be in line with those of the PP test, because the two tests employ the Newey-West adjustment for serial correlation in the series.

When we test for the stationarity in a series, we can apply three possible structures. Without a constant or trend, with a constant but without a trend, and with both a constant and trend. The first is rarely used in testing time series variables. While the third structure is widely used in the literature by assuming that the series is stationary around a deterministic trend, we aim to use the second procedure of a constant and no trend as recommended by Dickey & Fuller (1979).

Table 2 :Unit Root Tests

	Level		First Difference			
Variable	ADF Test Statistic	PP Test Statistic	ADF Test Statistic	PP Test Statistic	ADF/PP C.V	
Oil $	0.307	1.174	-8.775***	-8.829***	-3.568	-3.571
Oil+	2.312	-5.311***	-13.114***	-18.340***	-3.606	-3.578
Oil-	-7.263***	-7.272***	-6.549***	-48.720***	-3.571	-3.581
Oil_Rev	2.124	-0.432	2.519	-13.154***	-3.595	-3.596
Exp_IHC	-0.666	-3.143**	-7.687***	-9.82***	-3.585	-3.571
HCE	1.677	-1.411	-1.324	-9.438***	-3.606	-3.610
D_Agr	-3.512**	-3.426**	-7.422***	-11.630***	-3.568	-3.578
Agr	-4.317***	-1.484	-4.857***	-7.037***	-3.606	-3.578
D_Manu	-2.195	-2.218	-8.090***	-8.119***	-3.571	-3.568
Manu	2.616	-1.610	-4.846***	-10.065***	-3.601	-3.571
Ser	0.645	8.146***	4.845***	3.730***	-3.592	-3.568

*, **, ***, indicate a 10%, 5%, 1% significance level, respectively.

Notes: - The lag length was base one the Schwarz Information Criteria which imposes more penalties on additional coefficient. It is given by SIC=-2 $\frac{log\ k}{T} + \frac{k}{T}\log(T)$. Where T is the number of observations and k is the number of parameters.

- The probabilities in the ADF and PP tests are calculated by the Mackinnon one sided p-values which are based on the DF critical value.

Table 2 gives us mixed results at the I(0) stationarity level, while the above results clearly indicate that all of the variables are stationary at I(1). The two tests showed conflicting results regarding the stationarity of some for the variables:

a) The first contradiction was concerning the stationarity of the Oil+ variable. While the ADF test showed that the variable was not stationary at the I(0) level, the PP test opposed that result and showed that the variable was stationary at I(0). When we conducted the KPSS, it showed that the variable was stationary at I(0). This is also the same situation for the Exp_IHC variable.

b) As for the HCE variable, the ADF test concludes that the variable is not stationary at both the level and first difference vales. The PP test contradicts these results for the first difference case, where it shows that the variable is stationary at the I(1) level. The results of the latter are supported by the KPSS test.

c) Concerning the Agr variable, both tests agree that the variable is stationary at the I(1) level, but they contradict on the stationarity of the variable at the I(0) level. The ADF test shows that the variable is stationary at the I(0) level, while the PP test shows that it is not. The KPSS test surprisingly supports the results of the ADF test that the variable is stationary at the I(0) level.

Although our results indicate that we should proceed our analysis with the first differences of the variables, we will follow recommendations by Doan et al., (1984) to conduct VAR analysis with the level values of the variables. Fuller (2009) also showed that differencing variables in a VAR model does not produce any gains when it comes to asymptotic efficiency and that differencing variables in a VAR model throws away valuable information which could be valuable for analysing comovements in the data. Sims (1980), Hamilton (1994), and Sims et al., (1990) approved Fuller's recommendations and advised against differencing variables, even if they are not stationary. They argue that the goal of a VAR model is to capture the inter-correlation between the variables of the model rather than determine the parameter estimates. These recommendations were strictly followed in subsequent studies which employed a VAR model in their analysis including Eltony & Al-Awadi (2001).

5.2 Johansen Cointegration Test

To investigate for the existence of a long-term relationship among the variables of model, we employ the VAR-based multivariate Johansen cointegration test. Here, we will run three tests using various oil price definitions: Oil prices, negative changes of oil prices, and the positive changes in oil prices.

Table 3

Johansen Cointegration Test

	With Oil Prices			With Negative changes in Oil prices			With Positive changes in Oil prices		
Trace Test									
No. of Cointegrations	Trace Statistic	Critical Value	Prob.**	Trace Statistic	Critical Value	Prob.**	Trace Statistic	Critical Value	Prob.**
None *	828.7519	197.3709	0.0001	818.9158	197.3709	0.0001	668.1514	197.3709	0.0001
At most 1 *	568.9417	159.5297	0.0000	588.7204	159.5297	0.0000	411.7758	159.5297	0.0000
At most 2 *	381.6660	125.6154	0.0000	391.9303	125.6154	0.0000	254.5785	125.6154	0.0000
At most 3 *	242.6399	95.75366	0.0000	257.3780	95.75366	0.0000	189.2955	95.75366	0.0000
At most 4 *	158.1785	69.81889	0.0000	170.1434	69.81889	0.0000	137.1103	69.81889	0.0000
At most 5 *	97.53584	47.85613	0.0000	87.74351	47.85613	0.0000	87.89238	47.85613	0.0000
At most 6 *	49.56987	29.79707	0.0001	45.16144	29.79707	0.0004	49.63275	29.79707	0.0001
At most 7 *	22.02390	15.49471	0.0045	20.10423	15.49471	0.0094	20.08668	15.49471	0.0094
At most 8 *	6.664251	3.841466	0.0098	2.411147	3.841466	0.1205	8.357032	3.841466	0.0038
Maximum Eigenvalue Test									
None *	259.8102	58.43354	0.0000	230.1953	58.43354	0.0000	256.3756	58.43354	0.0000
At most 1 *	187.2757	52.36261	0.0001	196.7901	52.36261	0.0001	157.1973	52.36261	0.0000
At most 2 *	139.0261	46.23142	0.0000	134.5524	46.23142	0.0000	65.28300	46.23142	0.0002
At most 3 *	84.46136	40.07757	0.0000	87.23452	40.07757	0.0000	52.18515	40.07757	0.0014
At most 4 *	60.64265	33.87687	0.0000	82.39993	33.87687	0.0000	49.21794	33.87687	0.0004
At most 5 *	47.96597	27.58434	0.0000	42.58207	27.58434	0.0003	38.25963	27.58434	0.0015
At most 6 *	27.54597	21.13162	0.0055	25.05721	21.13162	0.0133	29.54608	21.13162	0.0026
At most 7 *	15.35965	14.26460	0.0334	17.69308	14.26460	0.0138	11.72965	14.26460	0.1212
At most 8 *	6.664251	3.841466	0.0098	2.411147	3.841466	0.1205	8.357032	3.841466	0.0038

Both tests for the Oil Prices variable indicate 9 cointegrating equations at the 0.05 level. While the tests for the negative oil changes variable indicate 8 cointegarting equations at the 0.05 level. Also, the trace test for the positive changes in oil prices indicates 9 cointegrating equations,andthe max-eigenvalue test indicates 7 cointegrating equations.

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 3 indicates that there exists a long term relationship between the variables of the model in all of the three forms tested. We also note that, despite indication above that there is more than one cointegration equlibria for each combanition that we tested, it is counterintuative when we try to link these results to economic theory. Nevertheless, this is only a mechanical procedure to test for the presence of cointegrations between the variables of our model given the sample in hand (Troug & Sbia, 2015). Thus, the Johansen cointegration test is a procedure that tests for numerous possible cointegrations depending on the number of variables in our model.

5.3 Granger Causality Test

The last test we conduct before estimating our model is the Granger Causality test. Here we say that a variable does not Granger cause another variable if all of the lags of the first have insignificant parameters (Enders, 2010). In practice, the test is employed in VAR models to get an indication on the appropriate ordering to be used in the IRF and VDC.

The results of our test show that all of our endogenous variables are Granger caused by the different representations of oil prices with an exception of D_Manu and Ser[4]. While the first is not Granger caused by all of the variables that proxy the oil variable, it is however, highly affected by the oil revenues variables, which is our second exogenous variable in order. As for our first variable, although the oil revenues variable Granger causes all of the other endogenous variables of the model, it does not Granger cause D_Manu. This might be a result of the privatization actions which were first initiated in 2005, whereas our results also show that D_Manu does not Granger cause the manufacturing sector as well. Therefore, we will employ an exogenous dummy variable for that year and beyond to capture that effect.

As for Exp_IHC, our results show that it Granger causes all of the subsequent variables in our model with an exception of D_Manu, which is consistent with our previous results. This result also comes in line with our assumption and previous literature that investment in infrastructure and human capital has a widespread effect on all of the sectors of the economy, and incentivises more public investment in those sectors.

The results from the Granger Causality test also show that in some cases there is a recursive effect between some of the variables. This comes as counterintuitive, but as

[4] Results are available upon request.

explained in the methodology section, the VAR has a virtue of pinning down the relationship in a sequential order from the most exogenous variable to the most endogenous one. Also, since annual changes in oil prices seem to linger in one direction for a number of consecutive periods, the procyclicality of fiscal policy might give a wrong indication that fiscal policy has a lag effect on oil prices.

5.4 The models

Given the results obtained above, we will estimate three VAR models for our analysis: a 5-variable model for the effect of oil prices on agricultural output, a 5-variable model for the effect of oil prices on manufacturing output, and a 4- variable model for the effect of oil prices on the service sector[5]. All models have three variables in common {Oil^{+} or Oil^{-}, Oil_Rev, and Exp_IHC}, and our sectoral variables of interest will follow along with the development expenditure allocated for that sector as well.

Following Wells (2014), we assume that oil prices are exogenous. In each model we will alternate between the positive changes in oil prices and the negative ones. This means that we will run each model twice: once with the positive oil changes, and the other time with the negative oil changes.

As for the lag selection for our models, we employed three selection criteria (Akaike, Schwartz and Hannan-Quinn information criterion) to identify the optimal lag length for each model. After allowing for a maximum lag length of four, the criterions unanimously indicated that the fourth lag is the most fitting for all of the three models. The length of our models in this case represents the length of a business cycle in a developing country. This is consistent with results from Rand and Trap (2002) who concluded that the length of a business cycle in developing countries should not exceed six years.

[5] We excluded the output of the housing and construction variable (HCE) after learning from experts in the National Accounts department that only the government's contribution in this sector was accurately accounted, based on data collected from the development budget allocated to this sector. As for the contribution of the private sector, the lack of regular surveys on the sector prevented data compilers from making any accurate estimates.

Model (I): In our first model we concentrated on the effect of fluctuations in oil prices on the agricultural sector. This model contains the following variables: {Oil^+ or Oil^-, Oil_Rev, Exp_IHC, D_Agr, and AGR}. This will also be the order which we will follow in our analysis, and it is supported by the results obtained from the Granger causality test[6].

Model (II): In our second model we turn our focus to the effects of fluctuations in oil prices on the manufacturing sector in Libya. This model also contains five variables: {Oil^+ or Oil^-, Oil_Rev, Exp_IHC, D_Manu, and Manu}. Given the results obtained from the Granger causality test, we introduced a dummy variable for the period when privatization was introduced to the economy as an exogenous variable in the model. Nevertheless the coefficient of this variable was insignificant[4].

Model (III): In our last model we concentrated on the effect of fluctuations in oil prices on the services sector. This model contains the following variables: {Oil^+ or Oil^-, Oil_Rev, Exp_IHC, and SER}. This will also be the order that we will follow in our analysis, and it is supported by the results obtained from the Granger causality test[4]..

Following recommendations from Stock & Watson (1989), we will concentrate our work on the IRF and VDC analysis, along with the Granger Causality test, which are more informative than the coefficients and the R^2. This also comes in line with our comments regarding differencing the variables of interest.

5.5 Impulse Response Function

Our simulations are conducted by considering a one standard deviation shock to oil prices, and its impact on the subsequent variables in the model over 10 years after the shock. The simulation used in this VAR model is similar to the one used by Dalsgaard & de Serres (1999) who used a Monte Carlo simulation. According to Runkle (1987), reporting IRF without confidence bands is like reporting coefficients without T-statistics. The Monte Carol simulation assumes that the response is symmetrically distributed through time. Thus, the responses that we will illustrate in this paper are the median responses derived

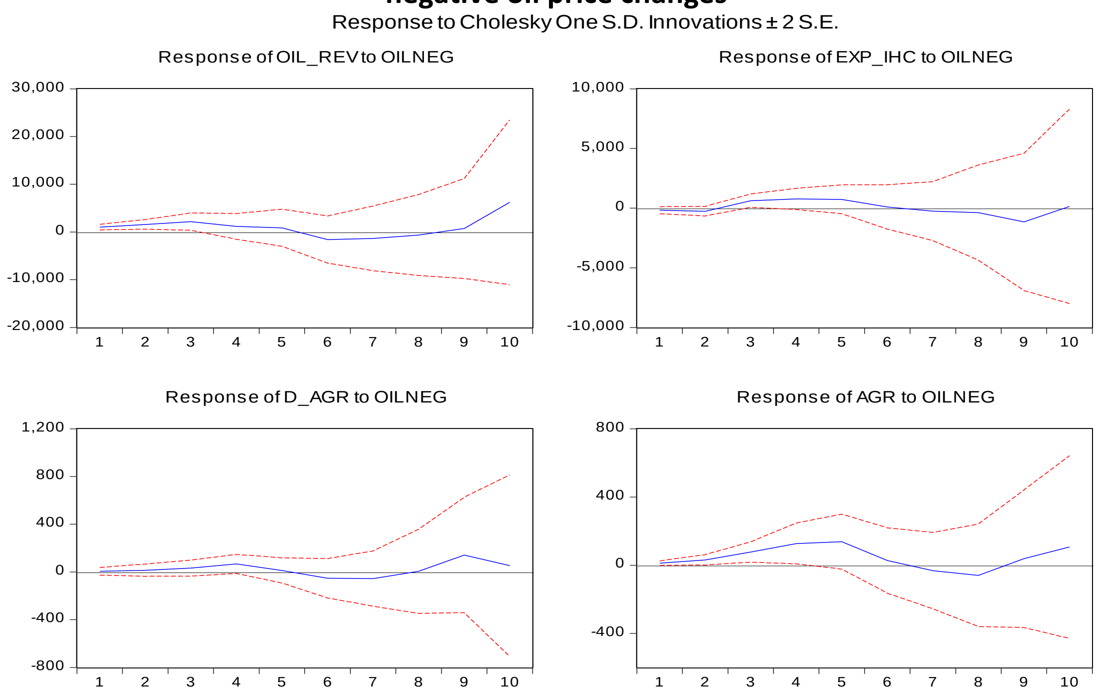
[6] Results are available upon request.

from 2000 replications. Nevertheless, given the strict assumption of the Monte Carlo simulation, the confidence bands created should only be considered as an indicator for uncertainty rather than being considered as confidence intervals.

Model (I):

- **Negative Oil Shocks:**

Figure 4 : The impulse response of the variables of model (I) to a one S.D shock in negative oil price changes



Source: Author's calculations.

Note: The graphs display impulse responses of the variables of the model to a one s.d. shock in negative changes in oil prices. The dotted red lines represent ±2 s.d.. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

The results shown in Figure 4 indicate that a one s.d. shock in the negative oil prices will lead to a slight increase in the oil revenues. Here, we must take into account that since we are using a censored variable (OILNEG), a shock in the variable means that the value of this variable will be an even bigger negative value. Also, given that we are estimating a reduced form VAR, the sudden increase in the negative value (decrease) will be followed by a lesser negative value and thus, this will result in an increase in the oil revenue of the current period as shown in the upper left plot in Figure 4. After five periods ahead, oil revenue starts declining for four periods ahead, before it goes back up again. This case will apply to the same two variables in some of the IRF functions that we will encounter below.

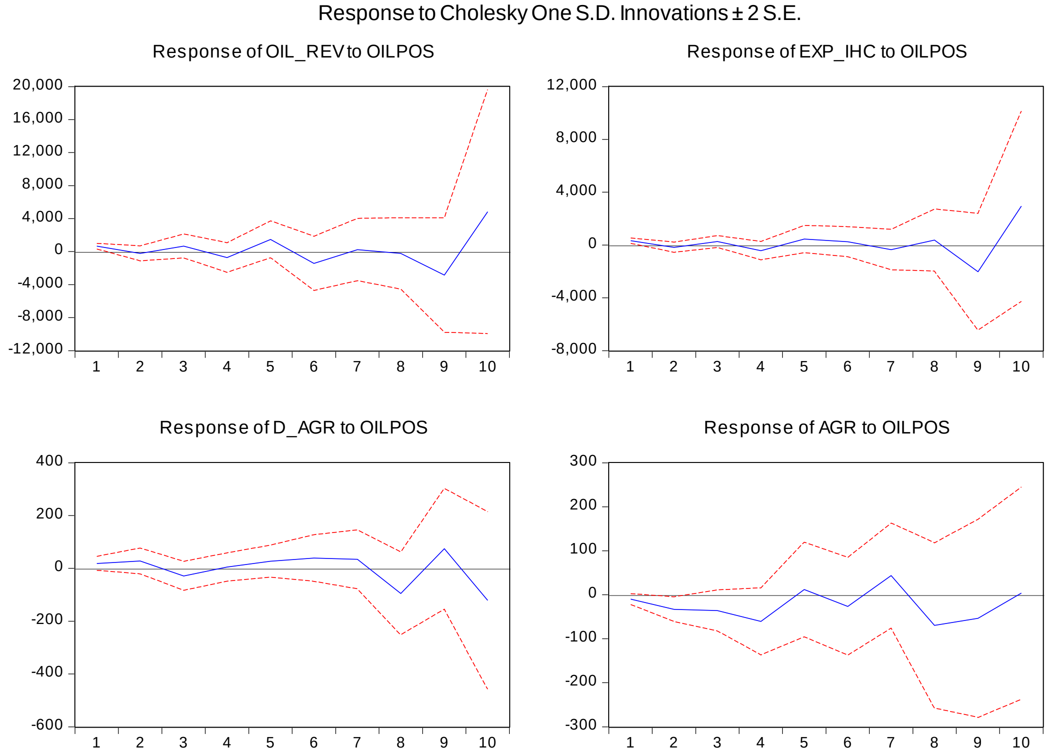
As for the investment in infrastructure variable, it goes to negative territory for the first two periods after oil prices drop, reflecting a normal behavior of oil producer to put on hold some of the investments once a drop in oil prices occurs. Afterwards, as oil revenue starts increasing, development spending starts to increase from the third period up to the sixth period. The development spending on infrastructure dips to negative territories in the seventh period before going back to its pre-shock level in the last period.

Development spending on agriculture and the output of the agricultural sector start increasing for six years after the occurrence of the shock, reflecting the positive increase in oil revenue during that period. Both variables start decreasing for the following three years, and go back up to positive increases afterwards.

Our above analysis clearly shows that a one-time shock in the negative oil prices causes the variables of the model to fluctuate over time, and they never decay to their original values. This reflects the uncertainty that oil prices introduce to the Libyan economy.

Positive Oil shocks:

Figure 5 : The impulse response of the variables of model (I) to a one S.D shock in positive oil price changes

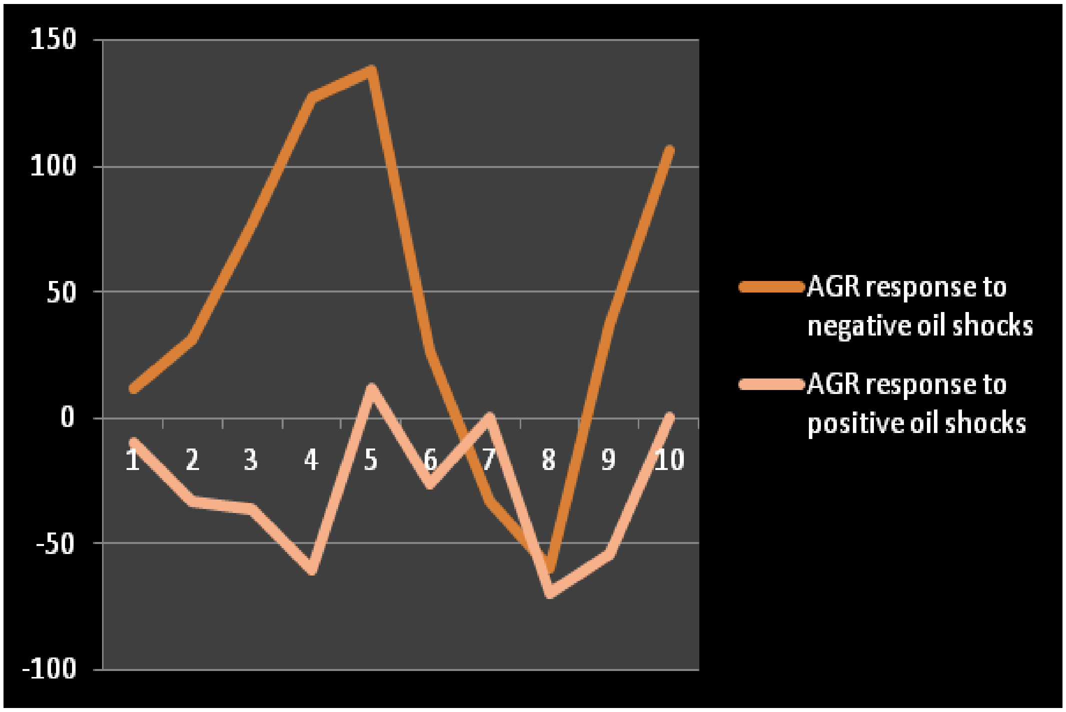


Source: Author's calculations.

Note: The graphs display impulse responses of the variables of the model to a one s.d. shock in negative changes in oil prices. The dotted red lines represent ±2 s.d.. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

The positive shock in positive changes in oil prices also causes instability to the variables of the model, as shown in Figure 5. Nevertheless, the effect of a positive shock affects the variables of the model with a lesser magnitude than the effect of the negative oil shocks. Also, we notice that the positive oil shocks cause more harm to the agriculture sector than the negative oil shocks, reflecting the reallocation effect of the "Dutch Disease" symptoms.

Figure 6: The effect of shocks in oil prices on the agricultural sector



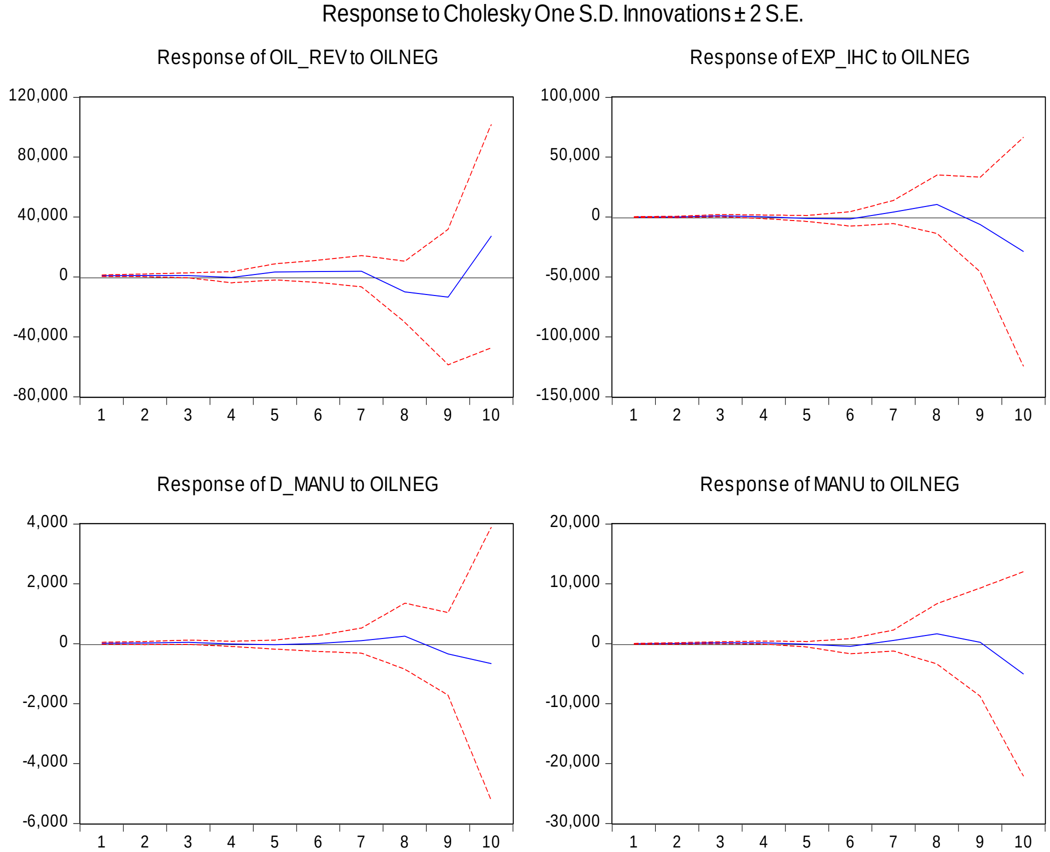
Source: Author's calculations.

Figure 6 clearly depicts not only that the shocks are asymmetric, but also that the positive changes in oil prices harmed the agriculture sector more than the negative shocks. These results reflect how the policy makers' procyclical policies harmed the diversity of the economy and damaged its structure. The positive effect of negative oil prices reflects how domestic demand reverts to domestic supply when oil prices decrease to avoid causing a larger current account deficit in the balance of payments.

Model (II):

- **Negative oil shocks:**

Figure 7: The impulse response of the variables of model (II) to a one S.D shock in negative oil price changes



Source: Author's calculations.

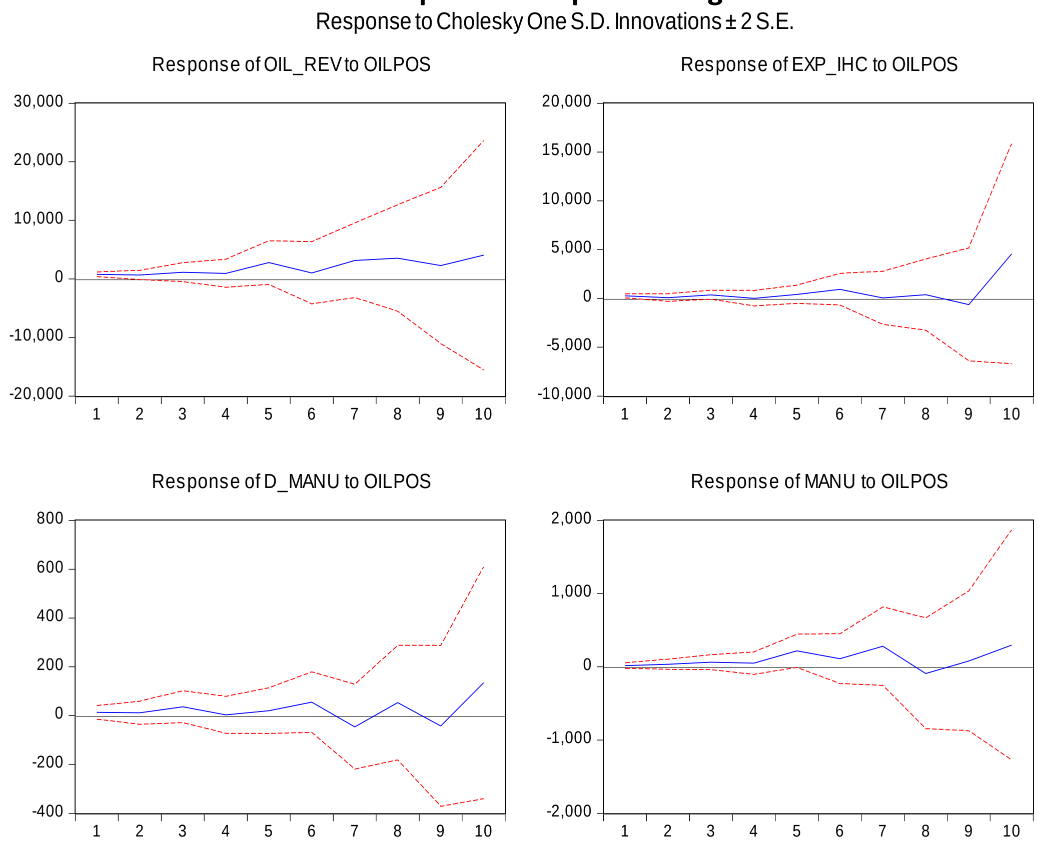
Note: The graphs display impulse responses of the variables of model (II) to a one s.d. shock in negative changes in oil prices. The dotted red lines represent ±2 s.d. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

We notice that the results shown in Figure 7 indicate that the effect of a negative shock in oil prices has a similar effect on oil revenue as in the first model, but with a smaller magnitude. This is a result of the new two manufacturing variables that we introduced to the model instead of the agricultural variables in the first model. A shock in the negative values of the oil prices causes the variables of the model to fluctuate along the horizon of the following 10 years. Although in this case, after the eighth period, the last three variables of the model start taking an explosive downward trend well into the negative territories.

Manufacturing output, our variable of interest, is barely affected by the shock in the first six periods. This is attributed to the privatization plan, which took place in 2005. Also, the domestic inputs of this sector are heavily subsidized in Libya. The latter creates a shield to domestic industries against fluctuating international markets. Nevertheless, at the end of shock period, manufacturing output plummets into negative territories.

- **Positive Oil shocks:**

Figure 8: The impulse response of the variables of model (II) to a one S.D shock in positive oil price changes

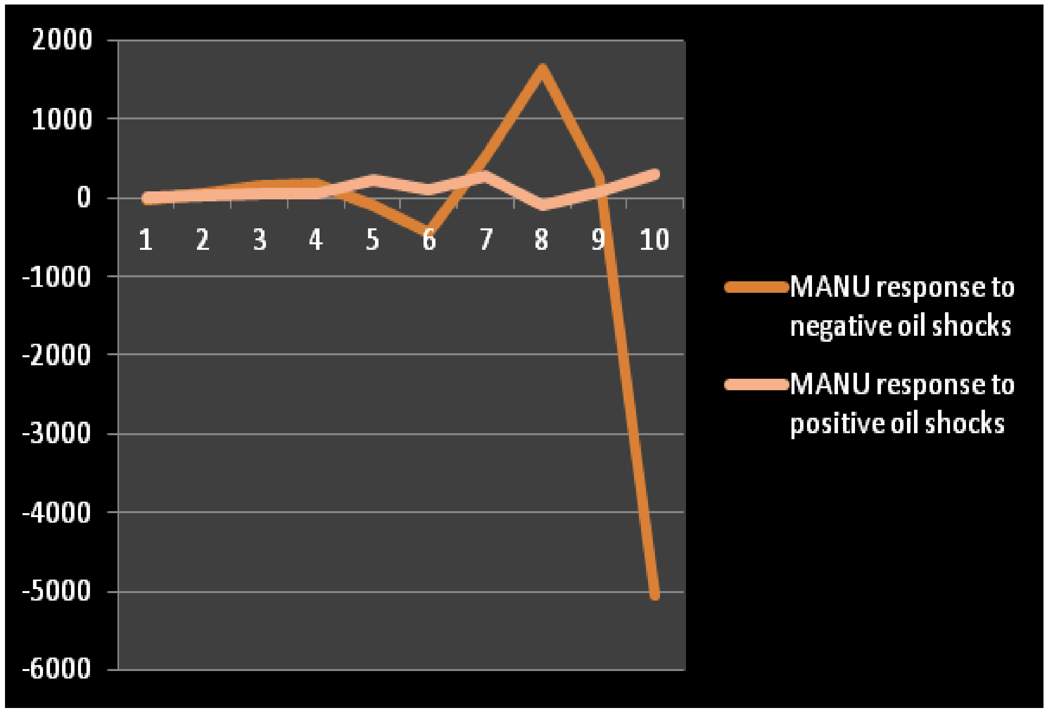


Source: Author's calculations.

Note: The graphs display impulse responses of the variables of model (II) to a one s.d. shock in positive changes in oil prices. The dotted red lines represent ±2 s.d. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

A shock in the positive values of oil prices also causes the variables of model fluctuate during the 10 years following the shock. Nevertheless, these fluctuations are mostly in the positive area of Figure 8. All of the variables of the model divert to a permanent increase from their initial values. The permanent increase in the manufacturing sector's output reflects the increase of domestic demand, which does not accompany an increase in inputs due to the heavy subsidy regime implemented by the Libyan government.

Figure 9: The effect of oil prices shocks on the manufacturing sector



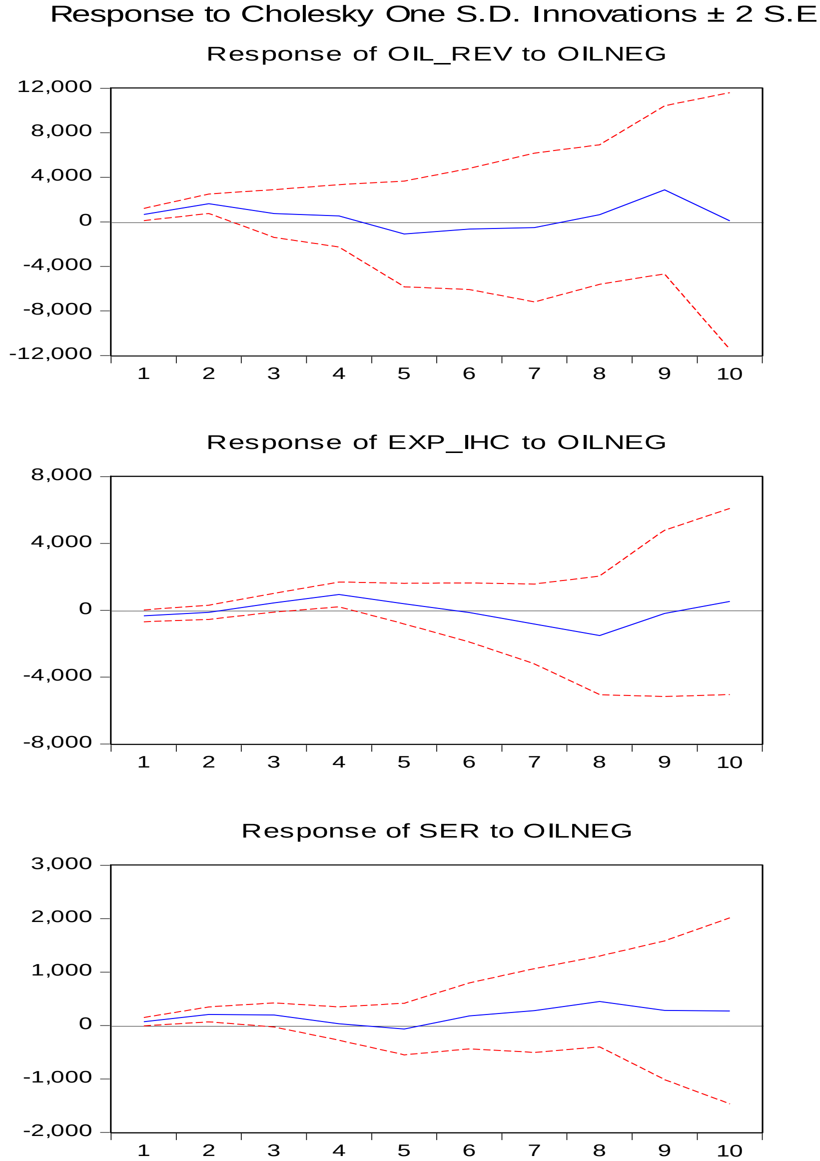
Source: Author's calculations.

We notice from Figure 9 that the manufacturing sector does not respond symmetrically to shocks in oil prices. While the sector is barley affected by the shocks during the first five years, the negative shocks causes instability in the sector and leads to a permanent drop in output. The permanent drop in the output of manufacturing is related to the fact of its inability to compete with foreign competition when the input prices go down equally for foreign and domestic manufacturers. Thus, we conclude that the manufacturing sector was damaged more by the negative oil changes than it gained from the positive oil changes.

Model (III):

- **Negative oil shocks:**

Figure 10: The impulse response of the variables of model (III) to a one S.D shock in negative oil price changes



Source: Author's calculations.

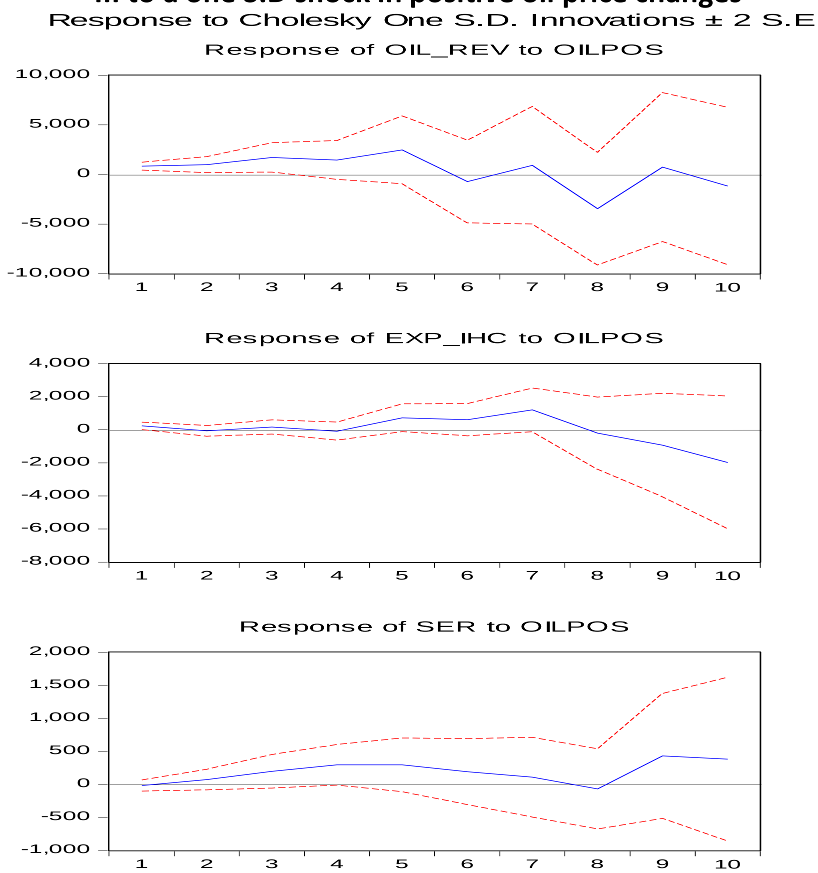
Note: The graphs display impulse responses of the variables of model III to a one s.d. shock in negative changes in oil prices. The dotted red lines represent ±2 s.d. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

In the analysis of the response of macroeconomic variables to fluctuations in oil prices, we turn our attention to our last model. The response of oil revenue to negative oil shocks in this model is quite similar to the response of the same variable in model I, and this is also attributed to the reasons stated earlier. The same applies for the investment in infrastructure and human capital variable, as shown in Figure 10.

The services sector starts to increase for the first three years after the occurrence of the shock, reflecting the positive increase in oil revenue during that period. It dips to the negative territory during the 4th and 5th periods, and it goes back to the positive increases afterwards. In this model we also highlight the fact that the negative shocks in oil prices also cause permanent instability to the variables of the model.

- **Positive Oil shocks:**

Figure 11 : The impulse response of the variables of model III to a one S.D shock in positive oil price changes

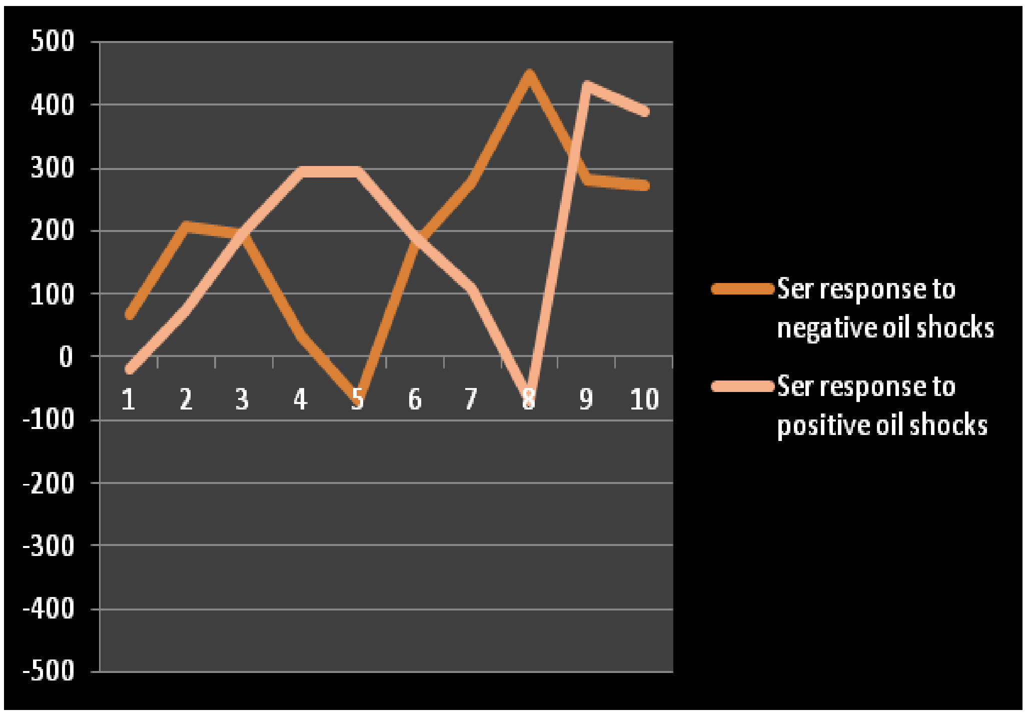


Source: Author's calculations.

Note: The figures display impulse responses of the variables of model III to a one s.d. shocks in positive changes in oil prices. The dotted red lines represent ±2 s.d.. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses.

A shock in the positive values of oil prices (Figure 11) also causes the variables of model fluctuate during the 10 years following the shock. Nevertheless, these fluctuations are mostly in the positive area for the services sector. Although the shock of the positive changes in oil prices seem to negatively affect revenue and development investment on infrastructure during the last five years, the services sector was not affected by this decline in spending. The only period that the services sector plummeted to negative territories was the 8th period.

Figure 12: The effect of oil prices shocks on the services sector



Source: Author's calculations.

Figure 15 depicts that the services sector was the only sector that was able to immune itself from shocks in oil prices. The effect is also asymmetric, despite the quasi-counter movement in the positive territories. This result is also another symptom of the "Dutch Disease" phenomenon. Where the services sector has the advantage of facing no international competition, unlike the agricultural and manufacturing sectors.

5.6 Variance Decomposition Forecasting Error (VDC)

The VDC forecasting error is another prominent tool in the VAR models which helps in discovering the interrelationship between the variables of the model. If a residual of a certain variable does not explain any variance of the other variables along the time horizon, we consider the first as an exogenous variable. Thus, the VDC tells us the contribution of each variable in the model to the unexpected variations in all the other variables of the model. We will employ this test to compare between the contribution of the negative and positive shocks in oil prices in explaining the variations in three economic sectors of the models. For the sake of brevity, we will only focus on the contribution of oil prices to the unexpected variance in our three variables of interest.

Table 4 :VDC Analysis

	Agricultural		Manufacturing		Services	
	OILNEG	OILPOS	OILNEG	OILPOS	OILNEG	OILPOS
1	8.276992	5.472022	0.126142	1.855443	10.23323	0.445929
2	12.44285	17.57848	2.184159	4.222255	8.100290	2.735800
3	23.91520	14.10332	16.82663	7.320704	7.823356	9.155379
4	24.47448	11.41209	18.32159	7.048982	4.156029	19.58761
5	31.55622	7.204126	10.66417	20.36370	15.68111	21.19436
6	29.62514	6.829454	4.811052	12.97623	17.38058	18.71981
7	21.78525	5.710567	6.930186	8.603492	21.59791	12.22827
8	20.88614	6.645013	12.27040	7.791767	8.389786	11.93044
9	16.74919	6.631889	4.207960	5.226837	5.739101	12.74092
10	16.69588	6.098865	14.09502	7.192786	9.285790	9.552190

Source: Author's calculations.

In Table 4 we notice that the contribution of the negative changes in oil prices far exceeds the contribution of the positive oil changes to variation in Agriculture. In the 5th period ahead, the negative changes contributed four times the contribution of the positive changes. The second period was the only period where the contribution of the positive changes was more than the contribution of the negative changes in oil prices. The dominants of the contribution of the negative oil changes continues throughout the 10 periods ahead to end up in contributing more than two times than the contribution of the positive oil changes.

As for the manufacturing sector, the negative changes in oil prices also contributed more than the positive change, but with a smaller magnitude, and fewer periods. This result is also consistent with the results we obtained from the IRF. The deviation of the contribution of both variables ends at the 10th period with the negative changes in oil prices contributing double the contribution of the positive changes in oil prices. The contribution of oil prices to variations in the manufacturing sector was in general less than that regarding the agricultural sector.

On the other hand, we notice that the contribution of those two variables in explaining the variations in the services sector are almost equal in most periods, and they alternate whenever they are not. Where the negative changes dominated during the first two periods, and the positive changes did the same during the following four periods, they finish equal in the last period. These results are also consistent with the results obtained from the IRF in the preceding section.

5.7 Robustness Analysis and Considerations to Approach

5.7.1 The Generalized Impulse Response

To evaluate and compare our results from the IRF above, we now conduct the Generalized Impulse Response (GIR). The GIR was first introduced by Pesaran & Shin (1998) as an alternative to the structural innovations and the traditional IRF which follows the Cholesky ordering. The GIR takes into account historical patterns of correlation amongst the shocks of the variable, and constructs orthogonal innovations that are not correlated. By doing so, the GIR neglects the ordering of the variables.

The results obtained from the GIR approach (Appendix I) show estimates that are consistent with the ones we obtained from our original ordering. These results prove that the reasoning of our ordering was based on proper institutional behavior, and it was able to capture the inter-correlation amongst the variables of our models.

5.7.2 Multivariate Rolling VAR

Given that our sample period spans more than five decades, this raises concerns regarding the existence of a number of structural breaks in the sample period. Therefore, we employ a multivariate rolling VAR model to detect the presence of a structural break in our model. The bivariate rolling VAR model was first introduced by Blanchard & Gali (2007) as an alternative to the traditional structural break tests. This approach allows for a gradual change in the estimated coefficients without imposing a certain distinct period as the one used by Chow (1960).

Our approach differs from the one implemented by Blanchard and Gali (2007) and Farzanegan and Markwardt (2009), where both studies apply a moving window to capture the presence of a structural break. In addition, they only estimate the bivariate VAR between the oil prices and the variables of interest. Instead, we keep the other variables of each model to control for the behavior of fiscal policy. Also, we start estimating the first model and simulate the IRF for the sample period (1962-1982). We then iterate the procedure by adding an observation for each new model until we reach our full sample (1962-2012) to reach a total number of 31 IRFs for each variable.

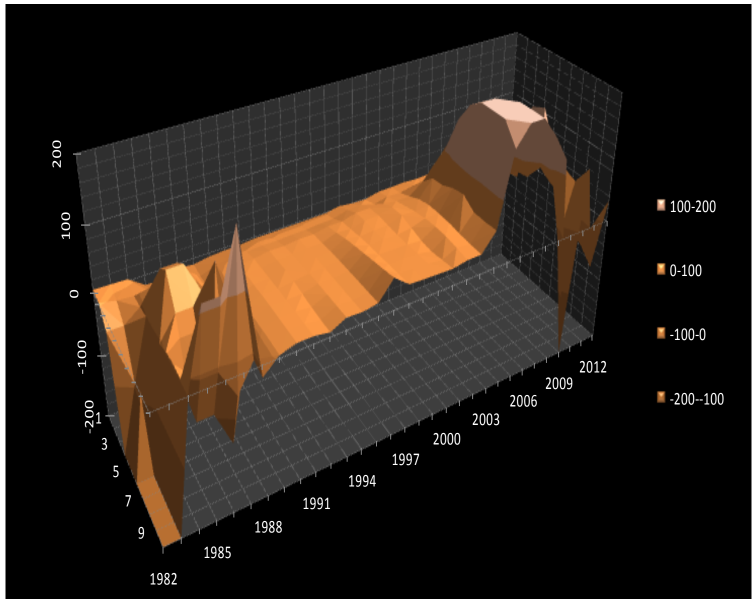
We focus our analysis on the main variables of interest in our models (agriculture, manufacturing, services). Figure 13 displays the rolling IRF for the agriculture sector to negative and positive oil prices. The results show that the negative changes in oil prices cause the agriculture sector to fluctuate more than effect of the positive oil changes. Also, the response of the agriculture sector to the negative shocks varies from one sample to another. In the samples that end with the first years of the 1980's we notice that after a negative first year after the shock, the sector picks up and gains from the reverse of domestic demand towards domestic supply for agricultural products. This was the same for the samples ending with years from 1986 to 2000, but with a lesser magnitude. While the effect for the years of the last decade were all positive, reflecting the effect of revaluation of LYD and the rapid increase in oil prices. Once we add the last two years of the sample (2011, 2012), on the other hand, the sample reverses its course and decreases severely by the negative oil changes reflecting the effect of the violence that took place in Libya during those years.

The reaction of the positive oil prices was unremarkable for almost all of the first samples. But we notice the positive effect of the high oil prices during (2006-2008), and the negative effect of the so-called "Arab Spring".

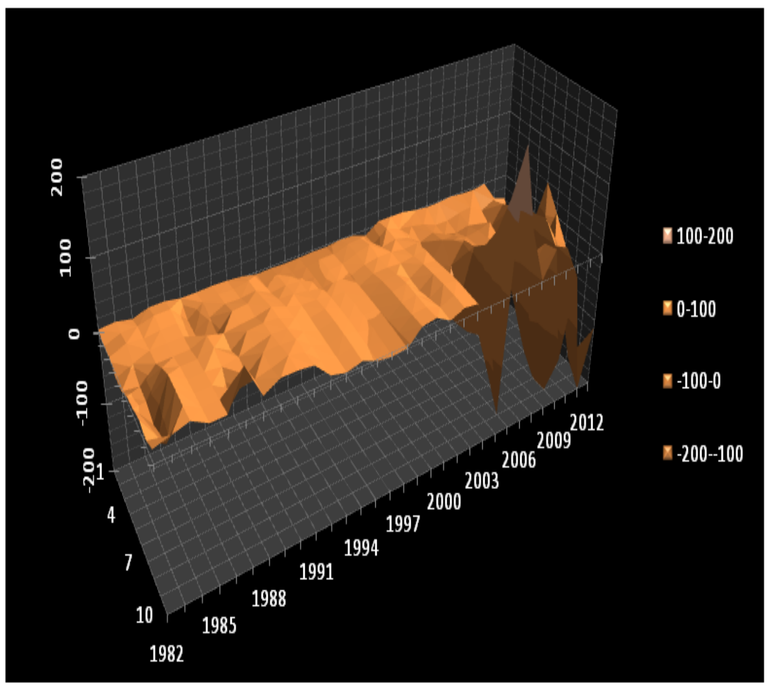
Figure 14 depicts the IRFs for the reaction of the manufacturing sector to the negative and positive shocks in oil prices. The results show that in the first years of the sample, the sector did not benefit from the positive increases as it was adversely affected by the negative oil prices. The effect flattened during the periods of low oil prices (1988-2004). After the introduction of the privatization law, the manufacturing sector started to gain from the positive shocks and the negative oil shocks for the same reasons we discussed above for the agriculture sector, but it was still reacting asymmetrically to those shocks.

Figure 15 verifies our previous results, which indicate that the services sector was the only sector in the economy that was able to protect itself from fluctuations in oil prices. The IRFs in Figure 15 also show that the reactions, although all positive, are asymmetric. These results also support the Dutch Disease hypothesis, where the advantage of the services is sector is that it faces no foreign competition unlike the other sectors of the economy.

Figure 13: The rolling IRF for the Agriculture sector.



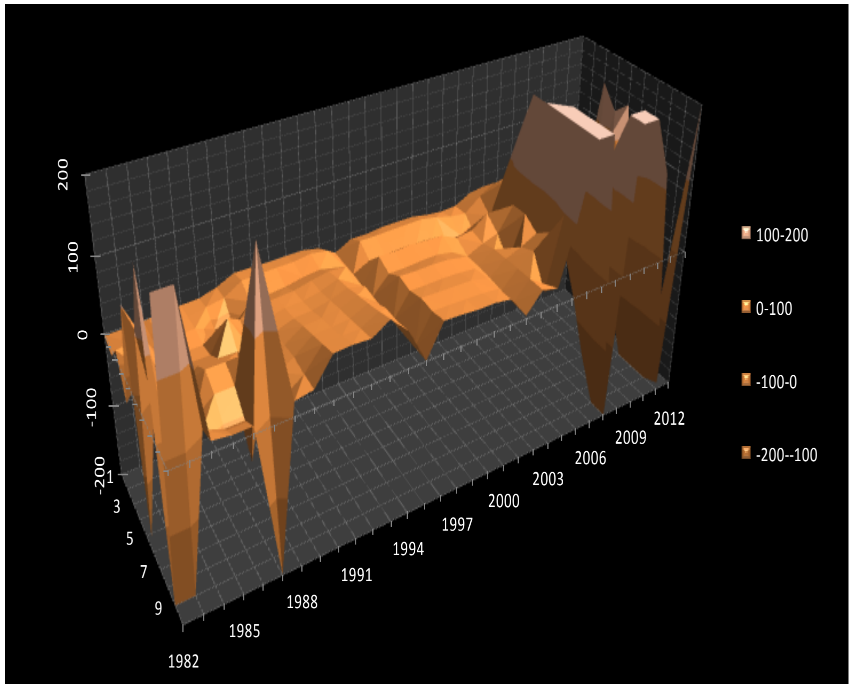
OIL^{-}



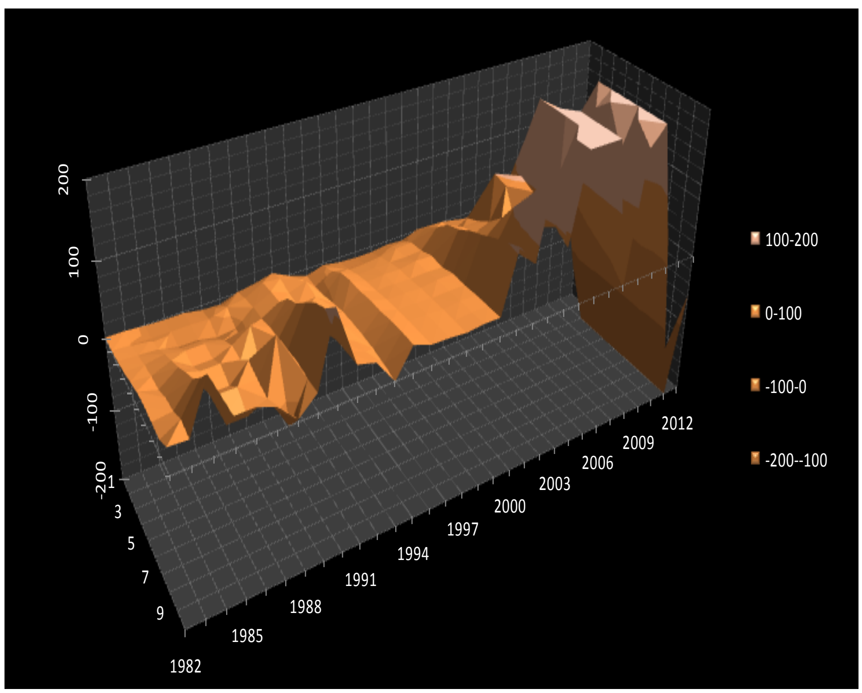
OIL^{+}

Source: Author's calculations.
Note: The z-axis represents the reaction of the variable to the shock, and the shocks are calculated in LYD millions. The y-axis shows the 10 years following the shock. The x-axis show the last year of the sample tested for the IRF. Also, the values of the reactions were capped between (-200, 200) for relevance.

Figure 14: The rolling IRF for the Manufacturing sector.



MANU-

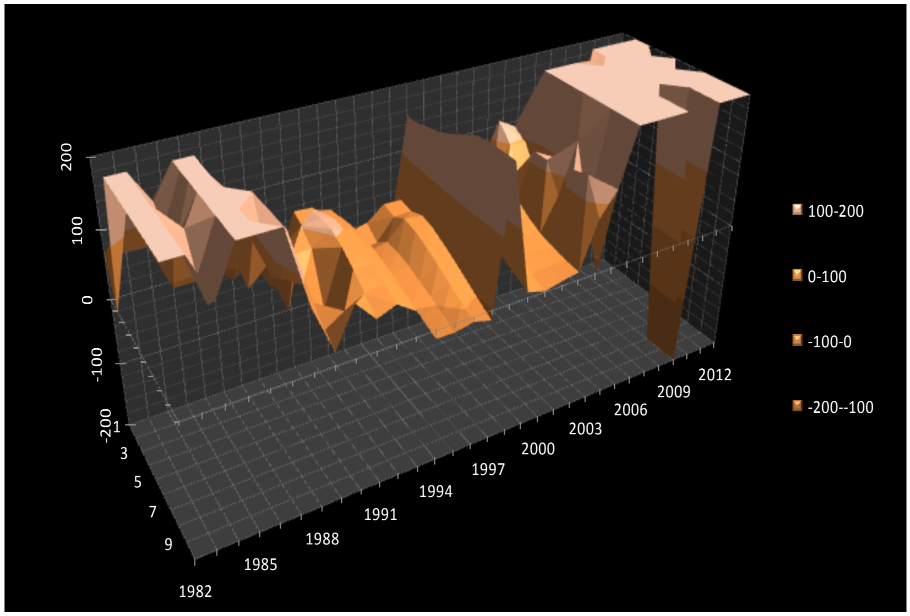


MANU+

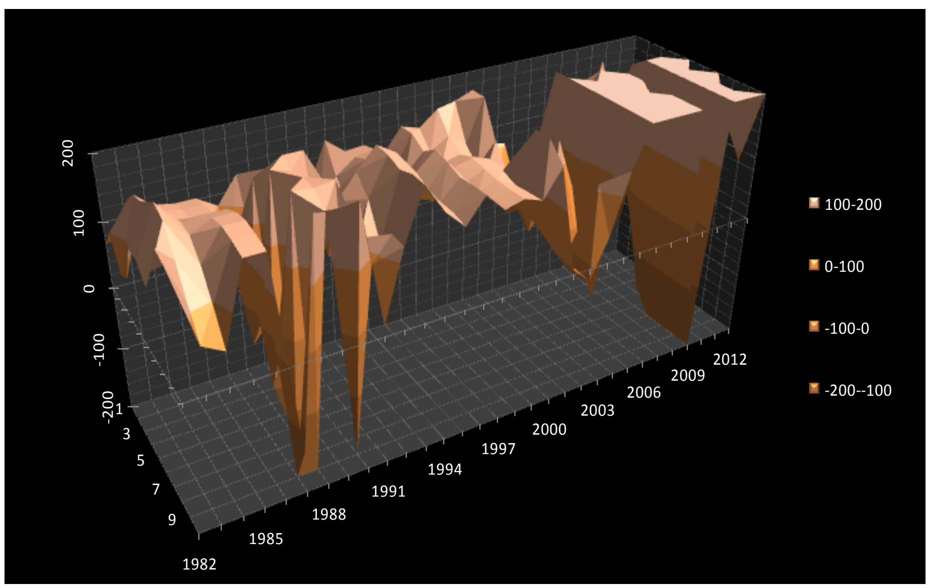
Source: Author's calculations.

Note: The z-axis represents the reaction of the variable to the shock, and the shocks are calculated in LYD millions. The y-axis shows the 10 years following the shock. The x-axis show the last year of the sample tested for the IRF. Also, the values of the reactions were capped between (-200, 200) for relevance.

Figure 15: The rolling IRF for the Services sector.



SER-



SER+

Source: Author's calculations.
Note: The z-axis represents the reaction of the variable to the shock, and the shocks are calculated in LYD millions. The y-axis shows the 10 years following the shock. The x-axis show the last year of the sample tested for the IRF. Also, the values of the reactions were capped between (-200, 200) for relevance.

6. Conclusions

The main results obtained from this paper suggest that, due to the lack of a proper institutional framework to delink the economy from fluctuations in oil prices, the Libyan economy was asymmetrically affected by shocks in oil prices. The results show that while the tradable sector (manufacturing, agriculture) was adversely affected by the negative oil shocks, it did not gain as much from the positive oil shocks. Conversely, the services sector was able to immune itself from those fluctuations due to the absence of competition in that sector. These results highlight the presence of "Dutch Disease" syndromes.

The fiscal policy adapted by policy makers in Libya caused a major threat for macroeconomic stability, and it also caused fiscal stress during periods of low oil prices. The negative effect of increasing oil prices clearly reflects overheating of the economy without any considerations regarding the absorptive capacity of the economy. In this regard, prudential medium term fiscal planning can rationalize annual spending behavior. Implementing a fiscal rule could also help to prevent adapting procyclical fiscal policy. This rule should also take into account the infrastructure needs of the Libyan economy.

The procyclicality behavior of fiscal policy in Libya also had an upward effect on current expenditure. The government has always provided jobs to unemployed people through direct employment in the public sector. The continuation of this behavior over the years limited the amount of financing available for development spending. Facilitating the role of the private sector in employment could help in controlling the spread of employment in the public sector. Thr government could help by investing more in education and vocational training, to limit the gap between demand and supply in the labour market.

The findings have practical implications for policy makers to revive the role of the sovereign wealth fund in Libya, and emerge it under a macro-fiscal framework. Doing so would help to minimize the damage caused by fluctuations in oil prices. The fund could also ensure a stable flow of financing and would shield the economy from fluctuations in oil prices, if it were managed transparently by international standards. The money should be parked outside of the economy during periods of high oil receipts, to avoid overheating the economy. This would also provide the needed financing during periods of low oil receipts.

Another approach for the policy maker to decrease the asymmetry of the oil shocks is to promote and facilitate financing for the different agents of the economy. For instance, excess liquidity in the banking sector was estimated to be around 35.4 billion USD (CBL, 2013). This liquidity could be directed to provide financing to the manufacturing and agricultural sectors to de-link them from fluctuating oil prices. Also, reviving the role of the Libyan stock market could help in the allocation of financial resources among the different agents of the economy.

Lastly, In order to present the results as conclusive, data with higher frequency would be required. This would enable us to capture more correlations amongst the variables, seasonal patterns which occur in particular periods of the year, and would have provided more observations in the model instead of the 51 annual observations that were employed in this research. As a result, the unavailability of any production index prevented us from applying interpolation to our existing data.

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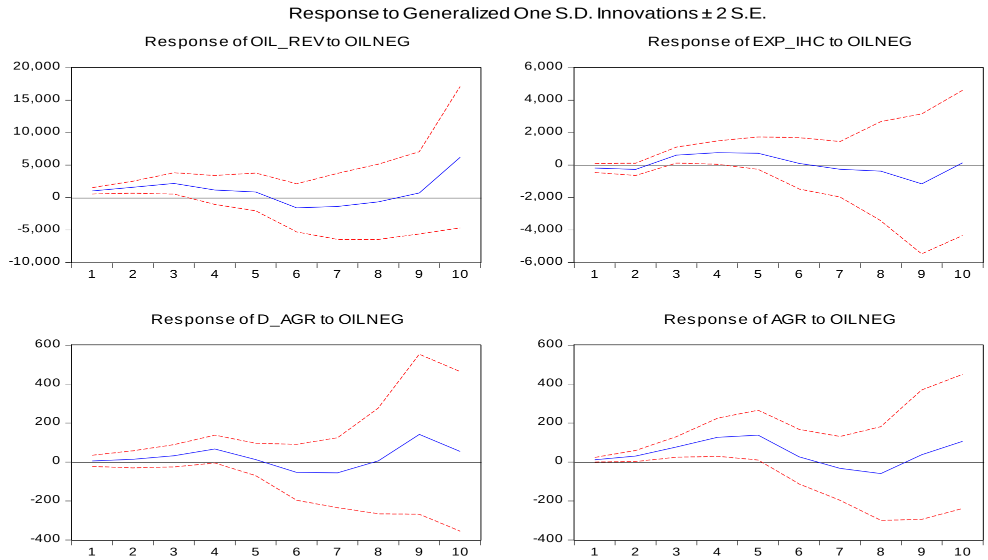
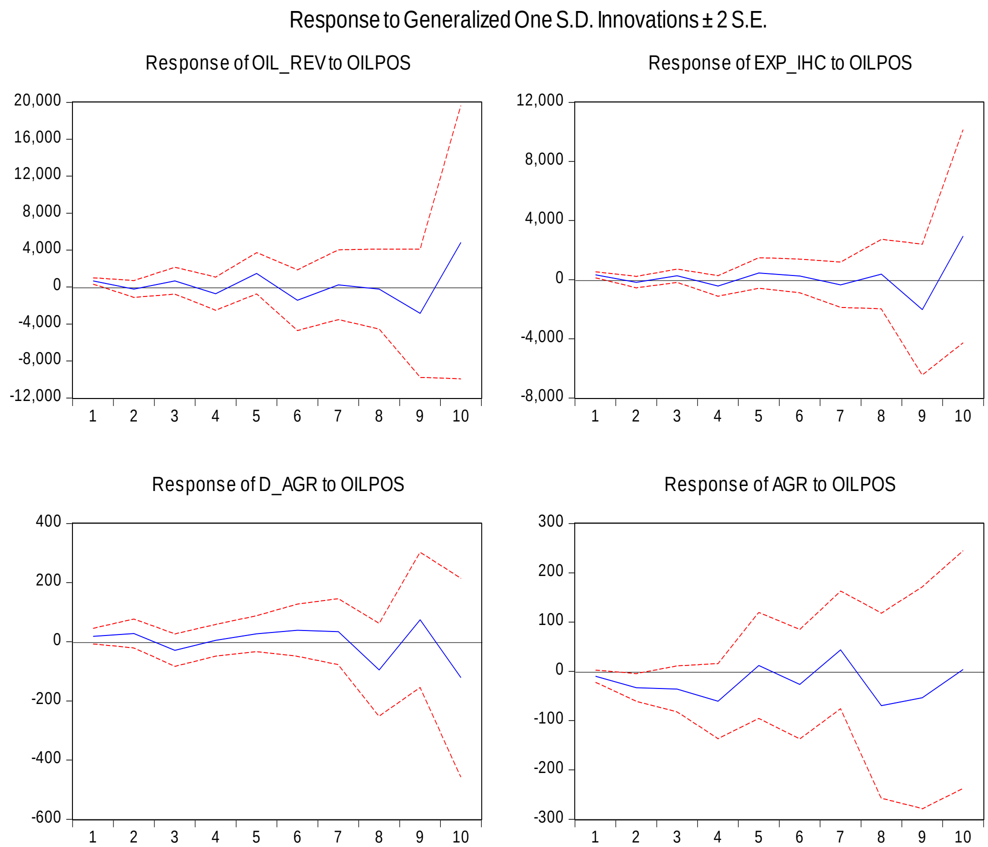
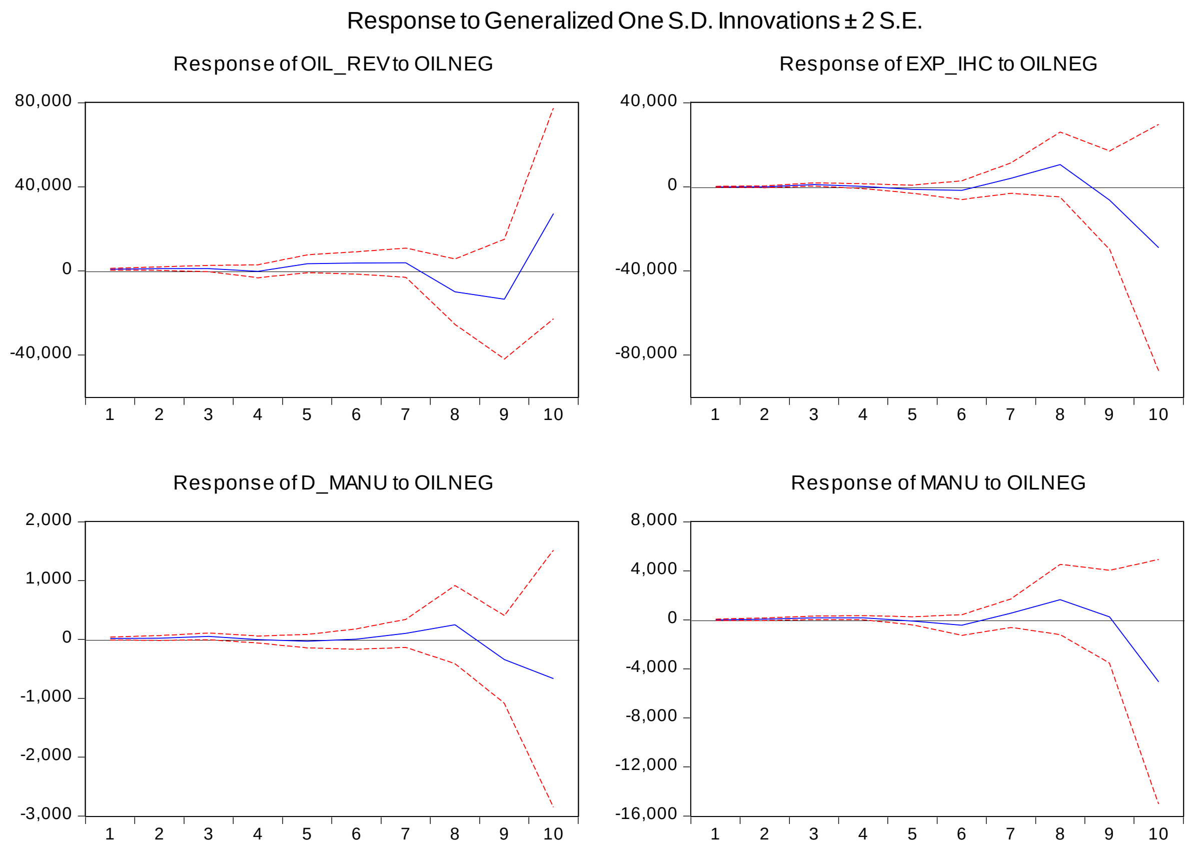
Appendices

Appendix I:



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Response of D_MANU to OILNEG
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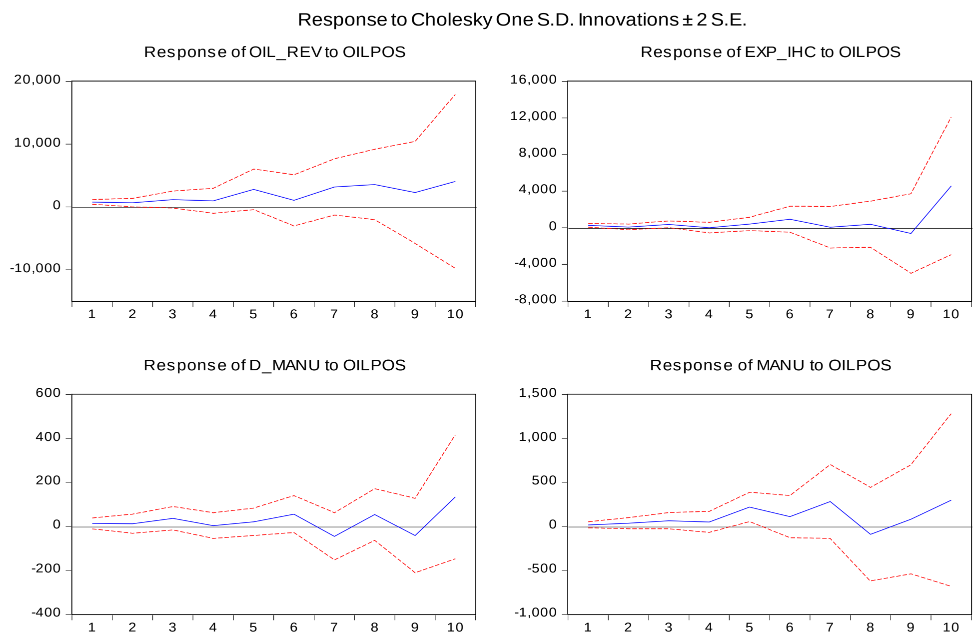
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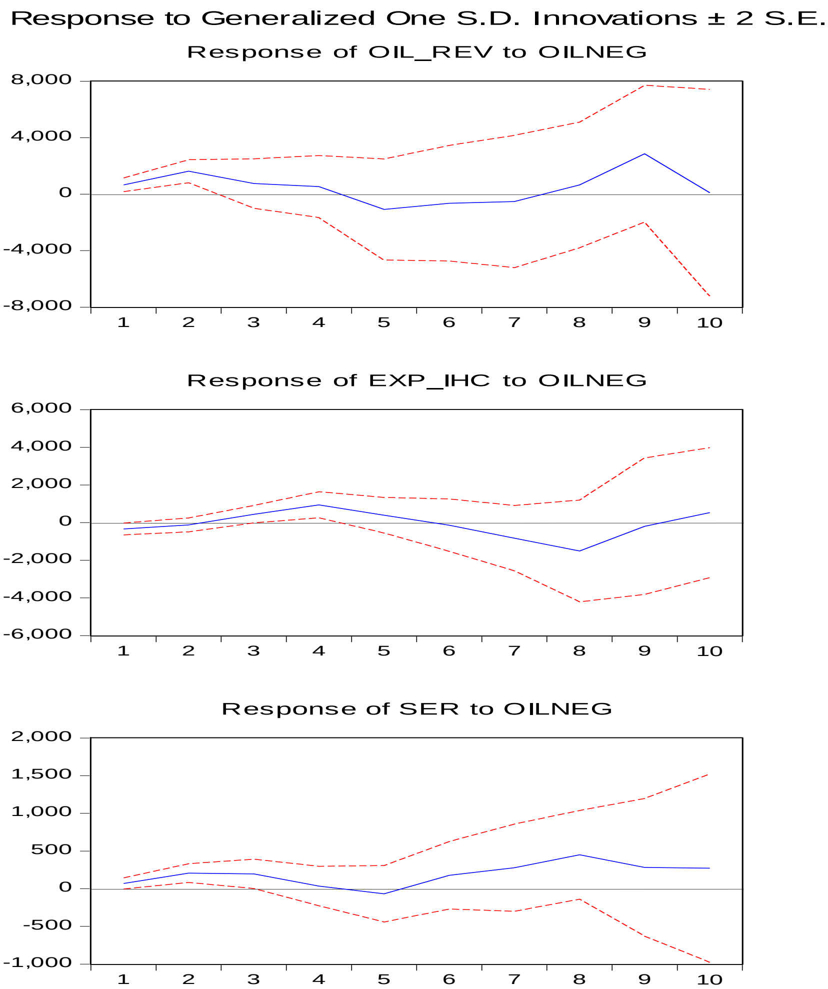
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Response of EXP_IHC to OILNEG
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4,000
2,000
0
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-4,000
-6,000
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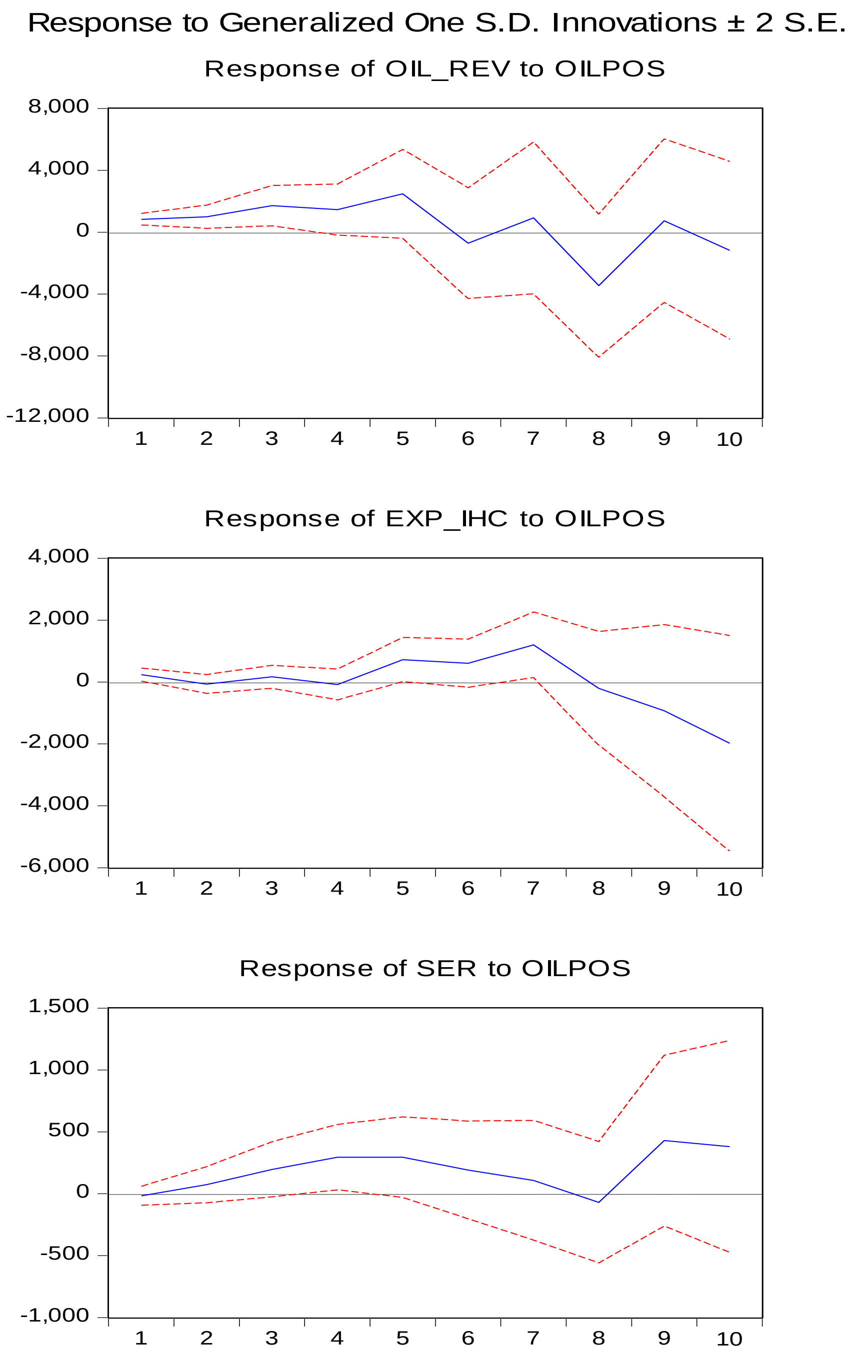
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-8,000
-12,000
1 2 3 4 5 6 7 8 9 10
Response of EXP_IHC to OILPOS
4,000
2,000
0
-2,000
-4,000
-6,000
1 2 3 4 5 6 7 8 9 10
Response of SER to OILPOS
1,500
1,000
500
0
-500
-1,000
1 2 3 4 5 6 7 8 9 10