The Asymmetric Effects of Fluctuations in Oil Prices on the Performance of the Libyan Economy: A VAR Approach

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ABSTRACT

This paper examines the presence of asymmetry in the response of the Libyan economy to fluctuations in oil prices, subsequent to discovery of oil in the country. Three Vector Autoregressive (VAR) models are illustrated and estimated along with a multivariate rolling VAR approach. All sectors 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 sectors of the Libyan economy and oil prices. The essay recommends implementing fiscal policy reform to de-link the real sector from fluctuations in oil prices. It also advises promoting the development of the financial sector in order for it to contribute in the diversification of the economy.

Keywords: Asymmetric Shocks, Oil Prices, Fiscal Policy, Management of Natural Resources
**JEL Classification:** E62, O13, H54

1. INTRODUCTION

The effects of the volatility and the massive 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 and Markus, 2011). For instance, Arezki and 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 and Zoega (2006). Still, 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 with a credible guide whenever attempting to analyse a certain phenomenon in a natural resource-rich country.

Figure 1 shows how GDP per capita in Libya is highly correlated with the movement in oil prices. The only period where the two trends deviated was in 2011, and this can be explained by the halt of oil production during the conflict that took place in the country. Figures 1 and 2 signal a sounding alarm regarding the inability 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, which is a strong indicator of increasing oil-dependence.

As for development spending in the oil sector, the data clearly demonstrates that spending on this sector only started to take place in 1970. This is a result of the nationalisation that took place

Figure 1: The Evolution of GDP per capita and oil prices
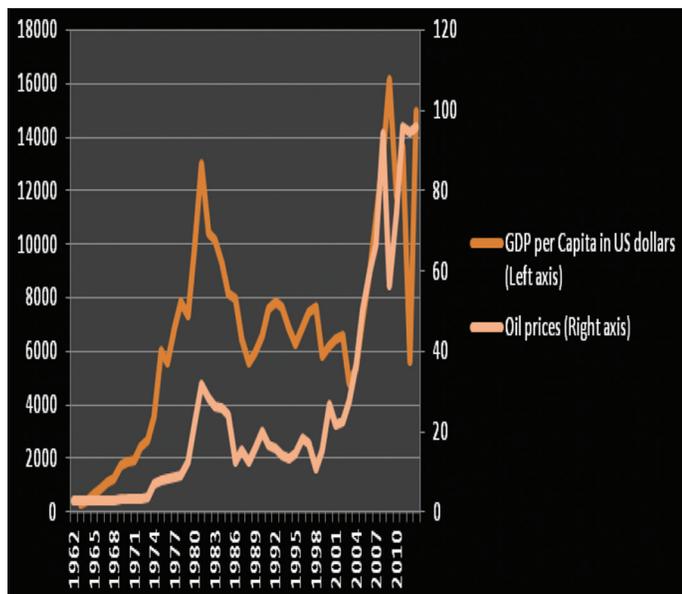
Source: Ministry of planning, Central Bank of Libya, IEA. Oil prices in USD were downloaded from the IEA's database, and the GDP series was converted to USD via the official average exchange rate published by the CBL

Figure 2: The evolution of fiscal components
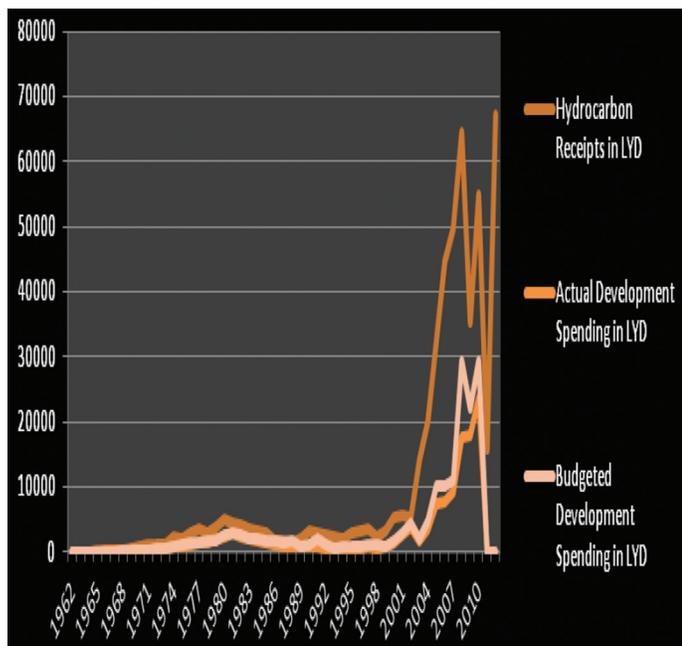
Source: Ministry of planning. The y-axis represents the values in LYD millions

on the majority of oil companies operating in the country by the regime that took power in 1969. This also had an effect on the produced quantities of oil ever since. We will try to capture this effect by introducing the oil revenue variable to our model along with oil prices. 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).

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 and Matovu (2005) explain that this behaviour of non-judicious expenditure normally takes place in oil-rich countries during times of high oil prices without considering the cost of reversing them.

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. Also, it is useful in assessing whether, when and how to reformulate the fiscal and monetary and exchange rate frameworks.

This paper relates to the literature that investigates the effect of oil shocks on developing countries. Analysing the issue of the impact 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 possible means. 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.

The main results obtained from this paper suggest that, due to the lack of a proper institutional framework to de-link 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 adverse 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 findings have practical implications for policymakers to revive the role of the sovereign wealth fund in Libya and emerge it under

a macro-fiscal framework. Doing so would help to minimise 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.

The remainder of the paper is organised as follows: (1) A detailed exposition of the methodology and a description of the data in our model is presented in section (2). In section (3) we perform our empirical analysis on the model. Section (4) offers concluding remarks.

2. METHODOLOGY AND DATA DESCRIPTION

2.1. Methodology
This paper employs a Vector Autoregressive model in the following form:

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

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, and 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 and 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 in the system, and that will prevent us from estimating the model with the OLS approach (Enders, 2010).

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 characteristic of the VAR model on 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).

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 and 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.

Moreover, following the discussion of Hicks (1991) that developing countries do not distribute the burden of fiscal austerity measures among different spending items, and the supporting argument of Gylfason and Zoega (2006) 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 behaviour 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 negative oil prices.

Since our set of data is only available in annual frequency, we will employ Mork's (1989) procedure for the sake of relevance. We define the negative and positive representation of oil prices O_t following the below definitions in equation 2a and 2b:

$$O_t^+ = \begin{cases} Ot & \text{if } Ot > 0 \\ 0 & \text{otherwise} \end{cases} \qquad (2a)$$

$$O_t^- = \begin{cases} Ot & \text{if } Ot < 0 \\ 0 & \text{otherwise} \end{cases} \qquad (2b)$$

2.2. Data Description

In our analysis, we make use of nine macroeconomic variables, including four components of development government expenditures. 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 when the necessity occurs. Most of this data is sourced from official Libyan institutions (CBL, Ministry of Finance and Planning, Ministry of Oil) apart from 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 (Table 1). The logarithmic form is also beneficial when trying to estimate the possibility of long-term relationships (Eltony and 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. We also excluded development expenditure on military equipment due to data limitations that are recorded as 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.

3. EMPIRICAL ANALYSIS

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[1]. Although our results indicate that we should proceed our analysis with the first differences of the variables, we follow recommendations by Doan et al., (1984) to conduct VAR analysis with the level values of the variables[2]. 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.

The results of our Granger causality test (Appendix 1) 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. 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 privatisation actions which were first initiated in 2005, whereas our results also show that D_Manu does not Granger cause the manufacturing sector

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1 In our analysis we employ the methods of Dickey and Fuller (1979), and Phillips and Perron (1988).
2 Results are available upon request.

Table 1: Data summary*

Variable	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	2,922.31	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	993.20	397.2	5,809.50	9.00	1,493.92	2.01	3.13	51
Log	2.44	2.60	3.76	0.95	0.82	(0.3)	(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)	

*Dara in () represents negative values. **All level values are in millions of Libyan dinars. The exception is OIL, which is measured in dollars per barrel

as well. Therefore, we will employ an exogenous dummy variable for that year and beyond to capture that effect.

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[3]. All models have three variables in common $\{Oil^+ \text{ or } Oil^-, Oil\_Rev, \text{ and } Exp\_IHC\}$, 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 6 years.

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: $\{Oil^+ \text{ or } Oil^-, Oil\_Rev, Exp\_IHC, D\_Agr, \text{ and } AGR\}$. 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 (Appendix 1).

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: $\{Oil^+ \text{ or } Oil^-, Oil\_Rev, Exp\_IHC, D\_Manu, \text{ and } Manu\}$. Given the results obtained from the Granger causality test, we introduced a dummy variable for the period when privatisation was introduced to the economy as an exogenous variable in the model. Nevertheless, the coefficient of this variable insignificant.

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: $\{Oil^+ \text{ or } Oil^-, Oil\_Rev, Exp\_IHC, \text{ and } SER\}$. 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 (Appendix 1).

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3   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.

Following recommendations from Stock and 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.

3.1. Impulse Response Function

Model (I): The results shown in Figure 3 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. 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 behaviour 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.

Figure 3: The effect of shocks in oil prices on the agricultural sector
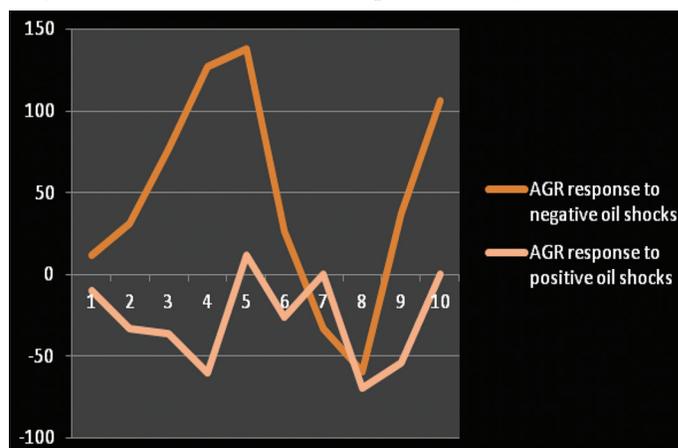
Source: Author's calculations

The positive shock in positive changes in oil prices also causes instability to the variables of the model, as shown in above. 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.

The figure 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): The results in Figure 4 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 privatisation plan, which took place in 2005. Also, domestic inputs of this sector are heavily subsidised 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.

A shock in the positive values of oil prices, on the other hand, also causes the variables of model fluctuate during the 10 years following the shock. Nevertheless, these fluctuations are mostly in the positive area of the above figure. All 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.

We notice from the figure 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): 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 the figure.

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.

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 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 5 illustrates 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.

3.2. 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

Figure 4: The effect of oil prices shocks on the manufacturing sector

Source: Author's calculations

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.

In Table 2 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.

Figure 5: The effect of oil prices shocks on the services sector

Source: Author's calculations

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.

3.3. Robustness Analysis
3.3.1. The generalised impulse response
To evaluate and compare our results from the IRF above, we now conduct the Generalised Impulse Response (GIR) introduced by Pesaran and Shin (1998). 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 2) 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 behaviour, and it was able to capture the inter-correlation amongst the variables of our models.
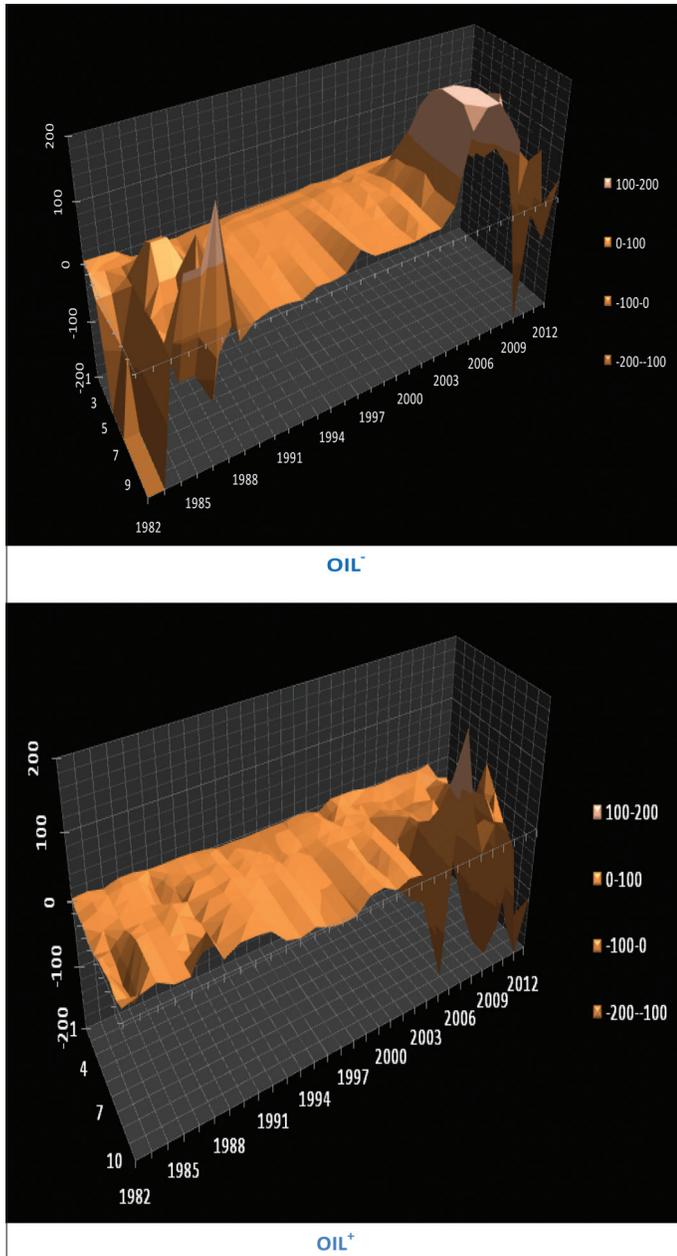
3.4. Multivariate Rolling VAR
Given that our sample period spans more than five decades, this raises concerns regarding the existence of a number of structural breaks in the sample period. Therefore, we employ a multivariate rolling VAR model to detect the presence of a structural break in our model. The bivariate rolling VAR model was first introduced by Blanchard and 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 behaviour 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

Table 2: VDC analysis

S. No.	Agriculture		Manufacturing		Services	
	OILNEG	OILPOS	OILNEG	OILPOS	OILNEG	OILPOS
1	8.28	5.47	0.13	1.86	10.23	0.45
2	12.44	17.58	2.18	4.22	8.1	2.74
3	23.92	14.1	16.83	7.32	7.82	9.16
4	24.47	11.41	18.32	7.05	4.16	29.59
5	31.56	7.2	10.66	20.36	15.68	21.19
6	29.63	6.83	4.81	12.98	17.38	18.72
7	21.79	5.71	6.93	8.6	21.6	21.23
8	20.89	6.65	12.27	7.79	8.39	11.93
9	16.75	6.63	4.21	5.23	5.74	12.74
10	16.7	6.1	14.1	7.19	9.29	9.55

Source: Author's calculations. VDC: Variance decomposition

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 6 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 1st years of the 1980's we notice that after a negative 1st 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 6: The rolling IRF for the agriculture sector

Figure 7: The rolling IRF for the manufacturing sector
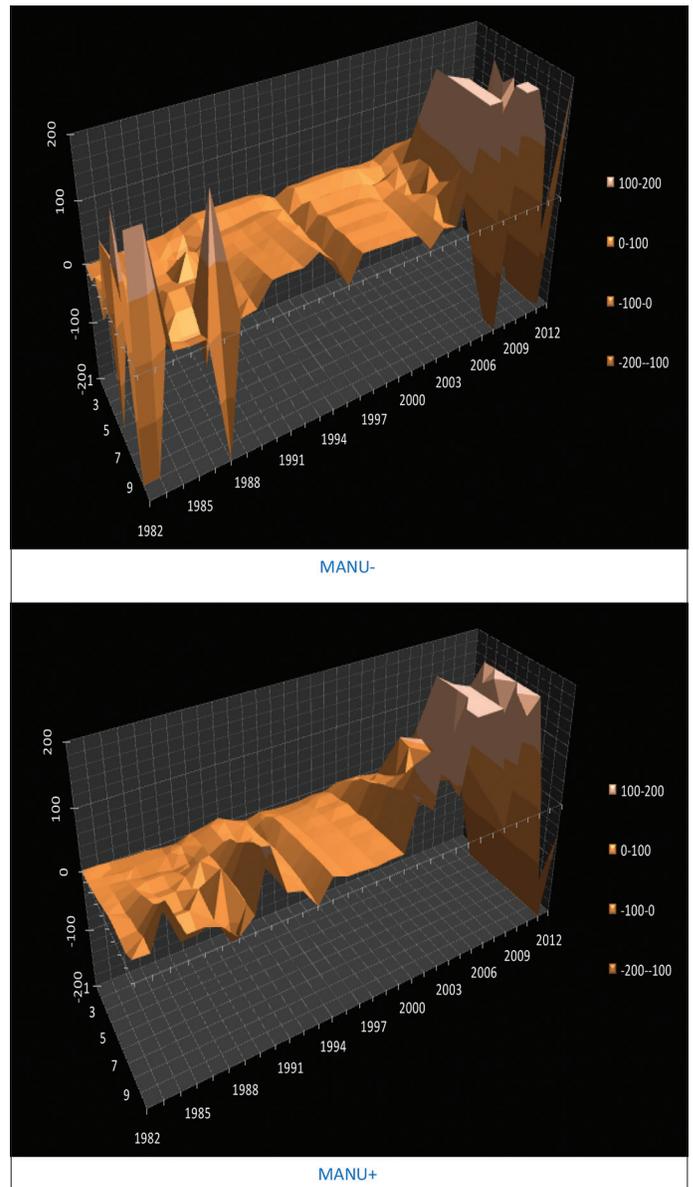
Source: Author's calculations. The z-axis represents the reaction of the variable to the shock, and the shocks are calculated in LYD millions. The y-axis shows the 10 years following the shock. The x-axis show the last year of the sample tested for the IRF. Also, the values of the reactions were capped between (−200, 200) for relevance

Source: Author's calculations. 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 8: The rolling IRF for the services sector
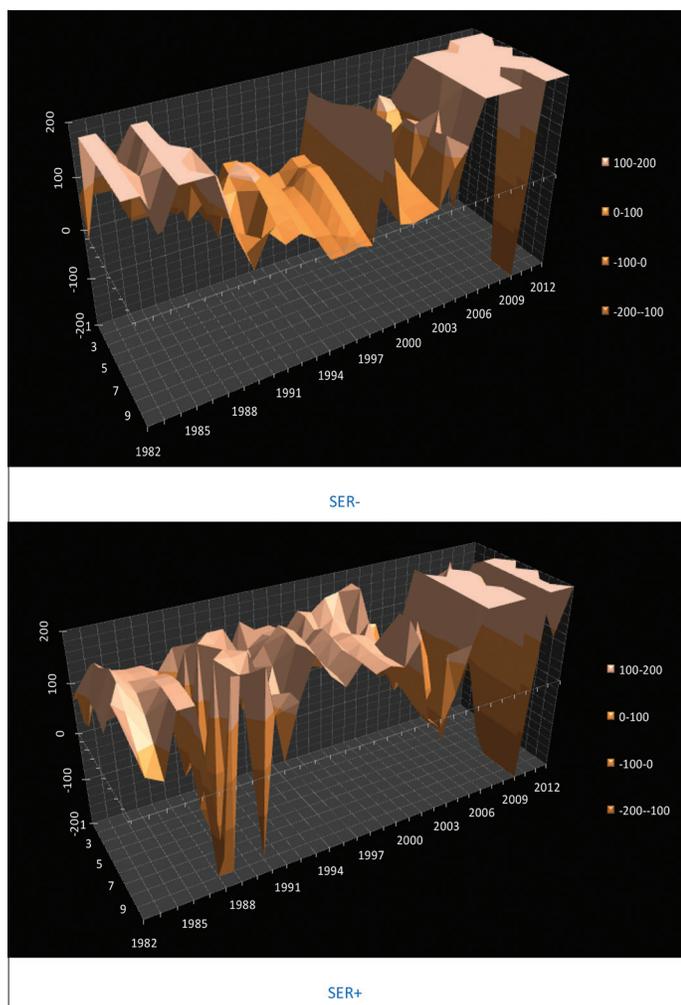
Source: Author's calculations. The z-axis represents the reaction of the variable to the shock, and the shocks are calculated in LYD millions. The y-axis shows the 10 years following the shock. The x-axis show the last year of the sample tested for the IRF. Also, the values of the reactions were capped between (−200, 200) for relevance

Figure 7 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 privatisation 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 8 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 8 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.

4. CONCLUSIONS

The main results obtained from this paper suggest that, due to the lack of a proper institutional framework to de-link 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 policymakers 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 rationalise annual spending behaviour. 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 behaviour 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 behaviour 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. The 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 minimise 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.

REFERENCES

Arezki, R., Markus, B. (2011), Oil rents, corruption, and state stability: Evidence from panel data regressions. European Economic Review,

55(7), 955-963.

Arezki, R., Van der Ploeg, R. (2007), Can the Natural Resource Curse be turned into a Blessing? The Role of Trade Policies and Institutions. IMF Working Papers. p1-34.

Bauer, A. (2008), An Analysis of the Monetary Transmission Mechanism in Tanzania: Evidence from a VAR Model. Oxford, United Kingdom: University of Oxford.

Bernanke, B.S., Mihov, I. (1998), The Liquidity Effect and Long-run Neutrality. Carnegie-Rochester Conference Series on Public Policy, 49, 149-194.

Blanchard, O.J., Gali, J. (2007), The Macroeconomic Effects of Oil Shocks: Why are the 2000s so Different from the 1970s? (No. w13368). Cambridge, Massachusetts: National Bureau of Economic Research.

Central Bank of Libya. (2013), Annual Report 2013. Libya: Central Bank of Libya.

Charap, J., Arthur, R.S., Pedro, C.R. (2013), Energy Subsidies and Energy Consumption; A Cross-Country Analysis, No 13/112, IMF Working Papers. Washington, DC: International Monetary Fund.

Chow, G.C. (1960), Tests of equality between sets of coefficients in two linear regressions. Econometrica: Journal of the Econometric Society, 1989, 591-605.

Dabla-Norris, E., Brumby, J., Kyobe, A., Mills, Z., Papageorgiou, C. (2012), Investing in public investment: An index of public investment efficiency. Journal of Economic Growth, 17(3), 235-266.

Dickey, D.A., Fuller, W.A. (1979), Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association, 74(366a), 427-431.

Doan, T., Litterman, R., Sims, C. (1984), Forecasting and conditional projection using realistic prior distributions. Econometric Reviews, 3(1), 1-100.

Eltony, M.N., Al-Awadi, M. (2001), Oil price fluctuations and their impact on the macroeconomic variables of Kuwait: A case study using a VAR model. International Journal of Energy Research, 25(11), 939-959.

Enders, W. (2010), Applied Econometric Time Series. 3rd ed. United Kingdom: Wiley, John and Sons, Incorporated.

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

Fuller, W.A. (2009), Introduction to Statistical Time Series. Vol. 428. Hoboken, New Jersey: John Wiley and Sons.

Gupta, S., Kangur, A., Papageorgiou C., Wane, A. (2011), Efficiency-Adjusted Public Capital and Growth, Working Paper 11/217. Washington, DC: International Monetary Fund.

Gylfason, T., Zoega, G. (2006), Natural resources and economic growth: The role of investment. The World Economy, 29(8), 1091-1115.

Hamilton, J.D. (1994), Time Series Analysis. Vol. 2. Princeton: Princeton University Press.

Hamilton, J.D. (2005), Oil and the Macroeconomy. In: The New Palgrave Dictionary of Economics. London: Palgrave Macmillan. p201-228. Available from: http://www.dictionaryofeconomics.com/dictionary.

Hicks, N.L. (1991), Expenditure reduction in developing countries revisited. Journal of International Development, 3, 29-37.

Kakes, J. (1999), Monetary Transmission: The Credit View. Ridderkirk: Labyrint Publication.

Kumah, F.Y., Matovu, M.J. (2005), Commodity Price Shocks and the Oddson Fiscal Performance (No. 5-171). Washington, DC: International Monetary Fund.

Mork, K.A. (1989), Oil and the macroeconomy when prices go up and down: An extension of Hamilton's results. Journal of Political Economy, 97, 740-744.

Pesaran, H.H., Shin, Y. (1998), Generalised impulse response analysis in linear multivariate models. Economics Letters, 58(1), 17-29.

Phillips, P.C., Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Rand, J., Tarp, F. (2002), Business cycles in developing countries: Are they different? World Development, 30(12), 2071-2088.

Sanz, I., Velazquez, F.J. (2002), Determinants of the Composition of Government Expenditure by Functions. Universidad Complutense de Madrid. Europea: Grupo de Economía Europea. p1-27.

Sims, C.A. (1980), Macroeconomics and reality. Econometrica: Journal of the Econometric Society, 1, 1-48.

Sims, C.A., Stock, J.H., Watson, M.W. (1990), Inference in linear time series models with some unit roots. Econometrica: Journal of the Econometric Society, 1, 113-144.

Spanos, A., Andreou, E., Syrichas, G. (1997), A VAR Model for the Monetary Sector of the Cyprus Economy. Nicosia, Cyprus: Central Bank of Cyprus.

Stock, J.H., Watson, M.W. (1989), Interpreting the evidence on money-income causality. Journal of Econometrics, 40(1), 161-181.

Wells, S. (2014), Managing Libya's Oil Wealth. Washington, DC: OxCarre Policy Paper and World Bank Country Economic Memorandum, Unpublished.

APPENDICES

Appendix 1: Granger causality

| Lags: 2			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
D_AGR does not granger cause AGR	49	12.9859	4.E-05
AGR does not granger cause D_AGR		0.41396	0.6636
D_MANU does not granger cause AGR	49	0.86584	0.4277
AGR does not granger cause D_MANU		0.35300	0.7045
EXP_IHC does not granger cause AGR	49	7.04910	0.0022
AGR does not granger cause EXP_IHC		5.24438	0.0091
HCE does not granger cause AGR	49	1.86240	0.1673
AGR does not granger cause HCE		2.66752	0.0806
MANU does not granger cause AGR	49	1.20457	0.3095
AGR does not granger cause MANU		1.89566	0.1623
OIL_REV does not granger cause AGR	49	4.27709	0.0201
AGR does not granger cause OIL_REV		2.52450	0.0916
SER does not granger cause AGR	49	5.22367	0.0092
AGR does not granger cause SER		71.2119	2.E-14
OILNEG does not granger cause AGR	48	101.612	5.E-17
AGR does not granger cause OILNEG		4.86495	0.0125
OIL does not granger cause AGR	49	1.24223	0.2987
AGR does not granger cause OIL		1.92761	0.1576
OILPOS does not granger cause AGR	48	6.98659	0.0024
AGR does not granger cause OILPOS		15.0681	1.E-05
D_MANU does not granger cause D_AGR	49	1.91848	0.1589
D_AGR does not granger cause D_MANU		1.85793	0.1680
EXP_IHC does not granger cause D_AGR	49	3.47472	0.0397
D_AGR does not granger cause EXP_IHC		14.5396	1.E-05
HCE does not granger cause D_AGR	49	0.69931	0.5024
D_AGR does not granger cause HCE		13.2361	3.E-05
MANU does not granger cause D_AGR	49	0.52761	0.5937
D_AGR does not granger cause MANU		12.7738	4.E-05
OIL_REV does not granger cause D_AGR	49	3.34532	0.0444
D_AGR does not granger cause OIL_REV		1.32112	0.2772
SER does not granger cause D_AGR	49	0.69486	0.5045
D_AGR does not granger cause SER		7.69964	0.0014
OILNEG does not granger cause D_AGR	48	5.47079	0.0076
D_AGR does not granger cause OILNEG		0.78984	0.4604
OIL does not granger cause D_AGR	49	8.34353	0.0008
D_AGR does not granger cause OIL		1.89350	0.1626
OILPOS does not granger cause D_AGR	48	7.11455	0.0021
D_AGR does not granger cause OILPOS		1.48295	0.2383
EXP_IHC does not granger cause D_MANU	49	0.17715	0.8382
D_MANU does not granger cause EXP_IHC		0.17277	0.8419
HCE does not granger cause D_MANU	49	0.50467	0.6072
D_MANU does not granger cause HCE		0.62615	0.5393
MANU does not granger cause D_MANU	49	0.45980	0.6344
D_MANU does not granger cause MANU		0.61392	0.5458
OIL_REV does not granger cause D_MANU	49	0.41327	0.6640
D_MANU does not granger cause OIL_REV		1.05258	0.3577
SER does not granger cause D_MANU	49	0.37866	0.6870
D_MANU does not granger cause SER		0.22069	0.8028
OILNEG does not granger cause D_MANU	48	2.48178	0.0955
D_MANU does not granger cause OILNEG		0.15530	0.8566
OIL does not granger cause D_MANU	49	0.70309	0.5005
D_MANU does not granger cause OIL		1.63962	0.2057
OILPOS does not granger cause D_MANU	48	1.22353	0.3042
D_MANU does not granger cause OILPOS		0.57061	0.5694
HCE does not granger cause EXP_IHC	49	8.51478	0.0007
EXP_IHC does not granger cause HCE		5.10617	0.0101
MANU does not granger cause EXP_IHC	49	9.61661	0.0003
EXP_IHC does not granger cause MANU		9.22840	0.0004
OIL_REV does not granger cause EXP_IHC	49	68.8384	3.E-14
EXP_IHC does not granger cause OIL_REV		76.6666	5.E-15
SER does not granger cause EXP_IHC	49	8.03470	0.0011
EXP_IHC does not granger cause SER		28.9897	9.E-09

(Contd...)

Appendix 1: (*Continued*)

Lags: 2			
Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
OILNEG does not granger cause EXP_IHC	48	28.3848	1.E-08
EXP_IHC does not granger cause OILNEG		26.5759	3.E-08
OIL does not granger cause EXP_IHC	49	17.9385	2.E-06
EXP_IHC does not granger cause OIL		2.12640	0.1314
OILPOS does not granger cause EXP_IHC	48	19.8121	8.E-07
EXP_IHC does not granger cause OILPOS		6.00933	0.0050
MANU does not granger cause HCE	49	0.71350	0.4955
HCE does not granger cause MANU		0.00549	0.9945
OIL_REV does not granger cause HCE	49	10.1038	0.0002
HCE does not granger cause OIL_REV		1.96281	0.1526
SER does not granger cause HCE	49	7.81234	0.0012
HCE does not granger cause SER		78.0487	3.E-15
OILNEG does not granger cause HCE	48	81.8879	2.E-15
HCE does not granger cause OILNEG		5.28049	0.0089
OIL does not granger cause HCE	49	5.95643	0.0051
HCE does not granger cause OIL		8.89335	0.0006
OILPOS does not granger cause HCE	48	24.4759	8.E-08
HCE does not granger cause OILPOS		27.2713	2.E-08
OIL_REV does not granger cause MANU	49	9.55914	0.0004
MANU does not granger cause OIL_REV		0.87649	0.4234
SER does not granger cause MANU	49	9.45004	0.0004
MANU does not granger cause SER		70.4498	2.E-14
OILNEG does not granger cause MANU	48	90.4556	4.E-16
MANU does not granger cause OILNEG		6.07679	0.0047
OIL does not granger cause MANU	49	5.05341	0.0106
MANU does not granger cause OIL		7.96931	0.0011
OILPOS does not granger cause MANU	48	18.2455	2.E-06
MANU does not granger cause OILPOS		39.2690	2.E-10
SER does not granger cause OIL_REV	49	19.6526	8.E-07
OIL_REV does not granger cause SER		8.23479	0.0009
OILNEG does not granger cause OIL_REV	48	10.5966	0.0002
OIL_REV does not granger cause OILNEG		8.58701	0.0007
OIL does not granger cause OIL_REV	49	1.06916	0.3520
OIL_REV does not granger cause OIL		1.39667	0.2582
OILPOS does not granger cause OIL_REV	48	3.98456	0.0259
OIL_REV does not granger cause OILPOS		17.3638	3.E-06
OILNEG does not granger cause SER	48	3.20682	0.0503
SER does not granger cause OILNEG		6.89494	0.0025
OIL does not granger cause SER	49	2.00373	0.1469
SER does not granger cause OIL		9.47412	0.0004
OILPOS does not granger cause SER	48	1.93654	0.1566
SER does not granger cause OILPOS		21.5643	3.E-07

Appendix 2: Generalized impulse response functions

(Contd...)
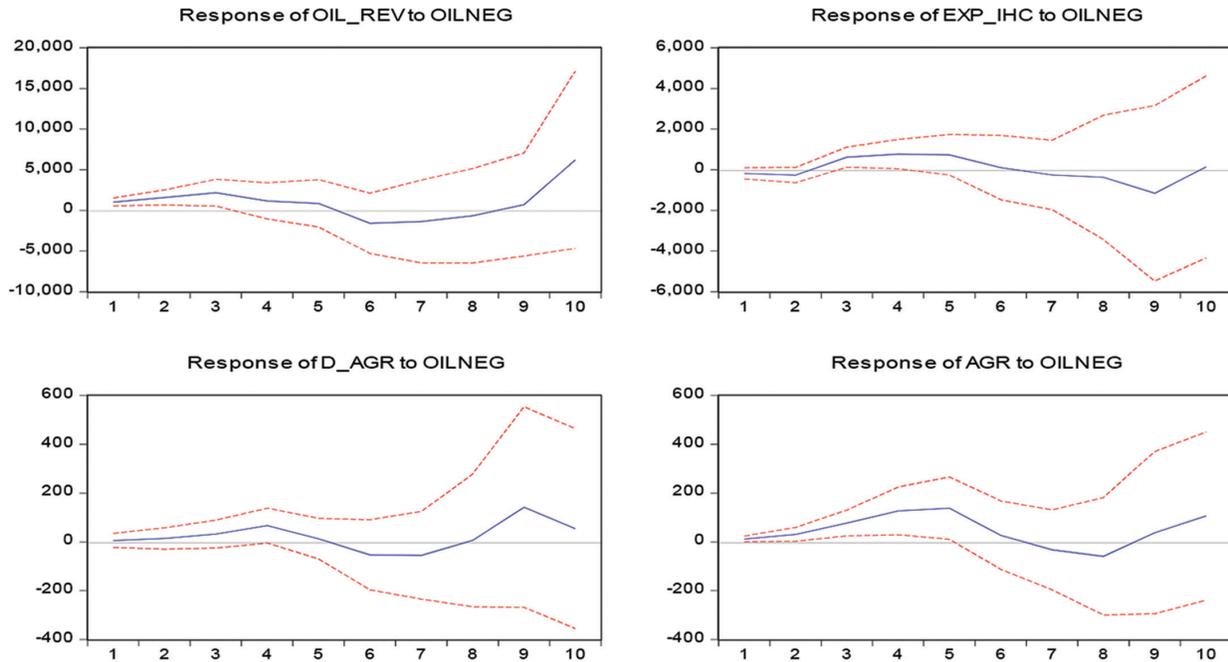
Appendix 2: Generalized impulse response functions (*Continued*)
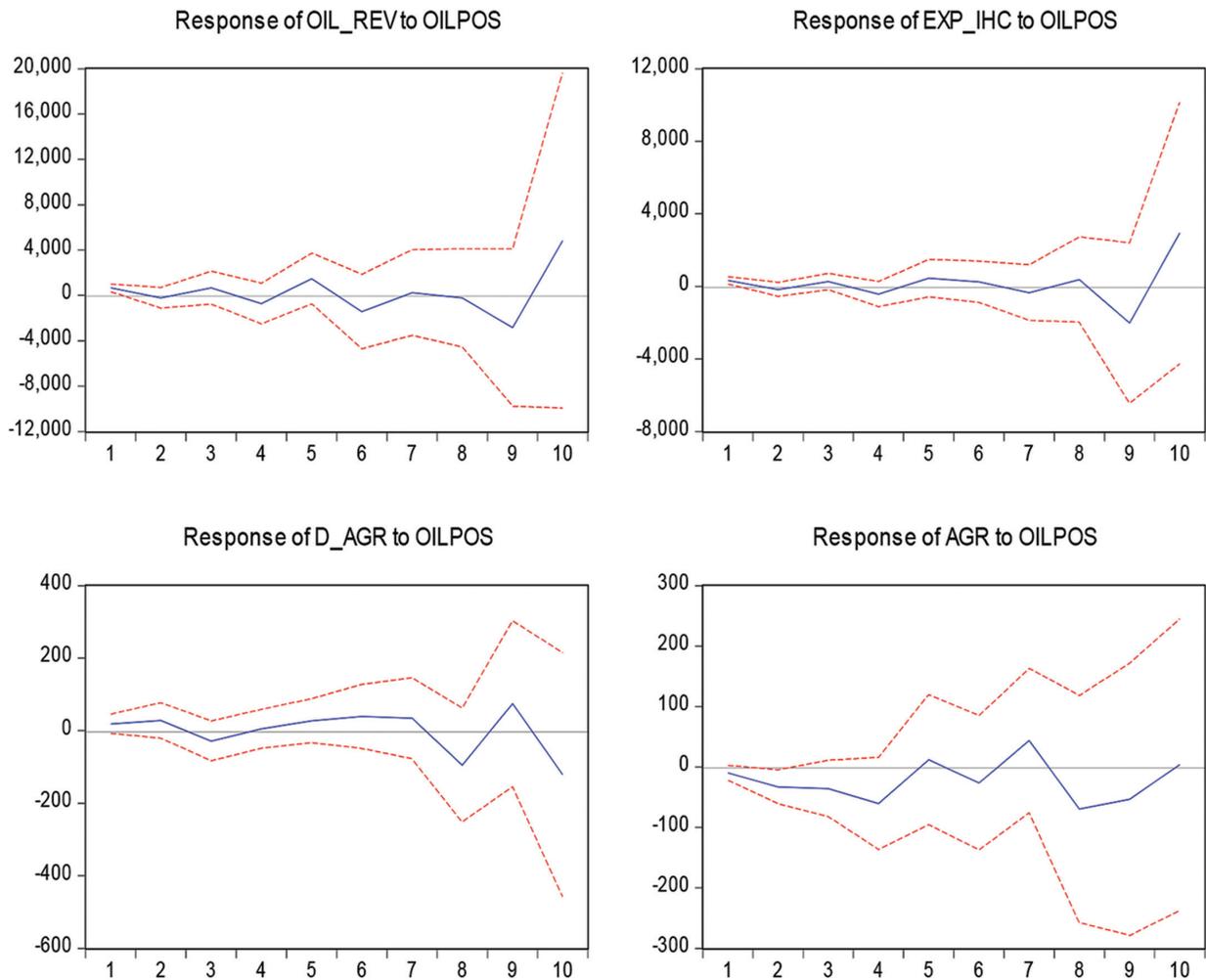
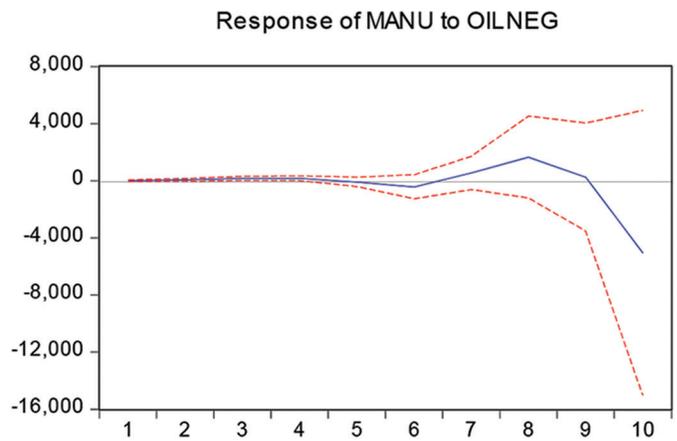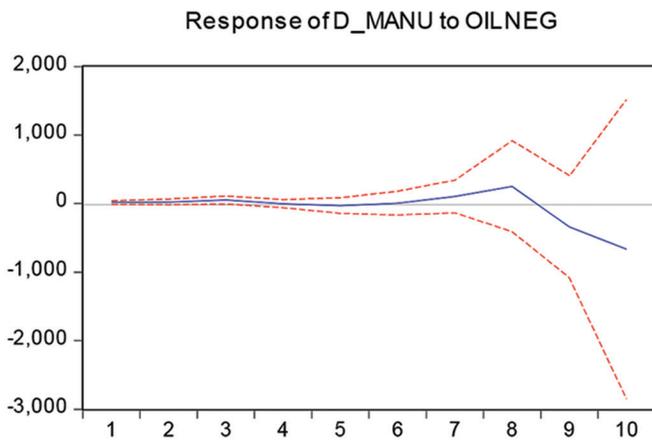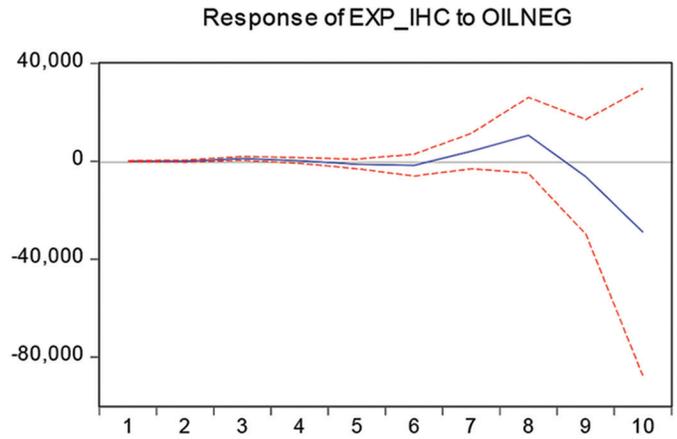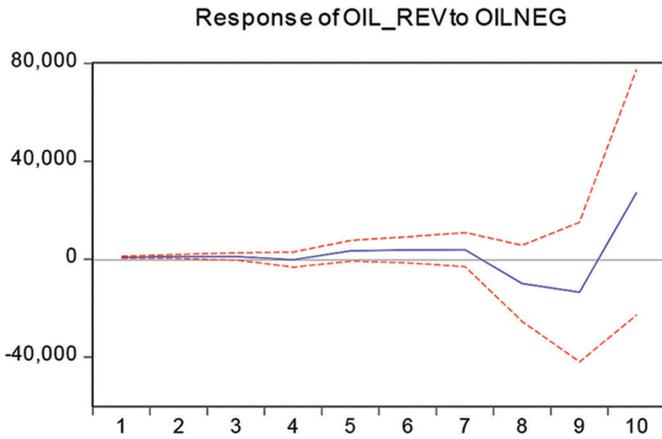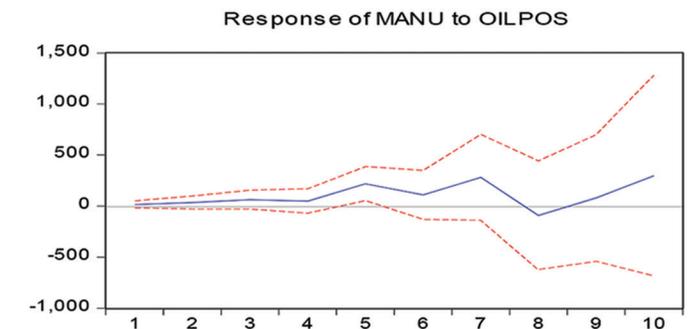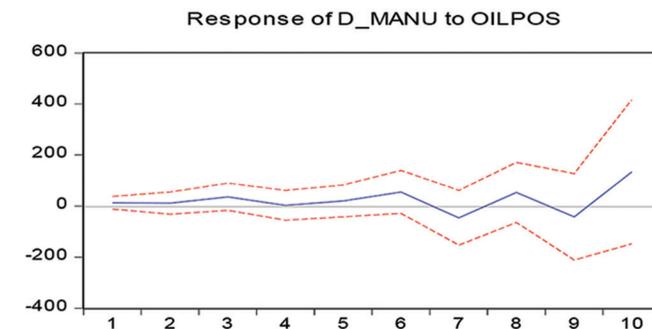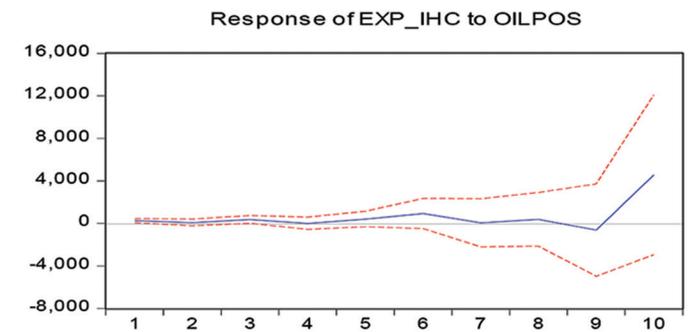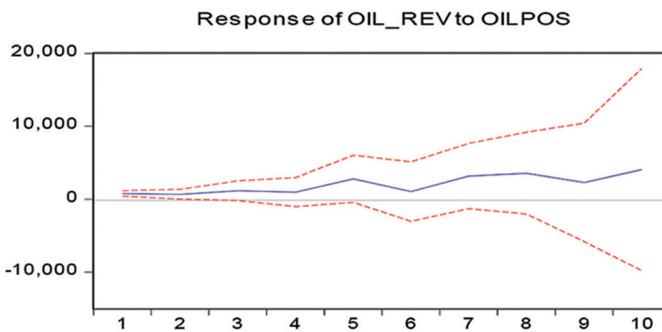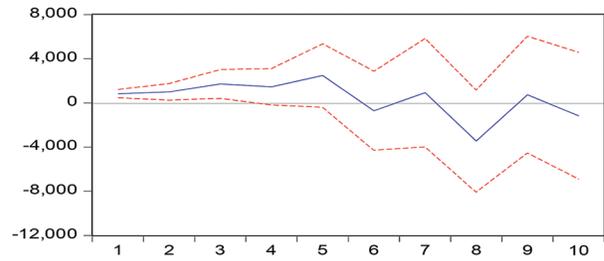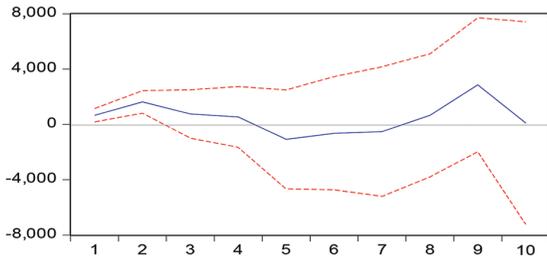(*Contd...*)

Appendix 2: Generalized impulse response functions (*Continued*)

Response to Generalized One S.D. Innovations ± 2 S.E.

Response of OIL_REV to OILNEG

Response of EXP_IHC to OILNEG
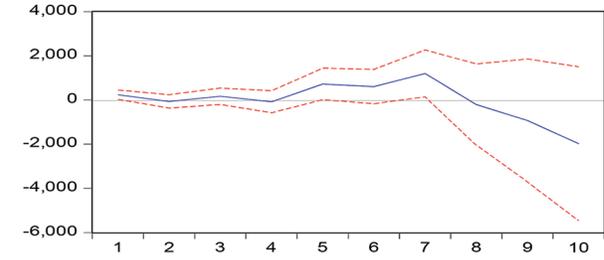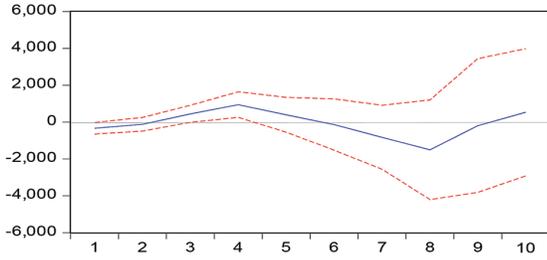
Response of SER to OILNEG

Response to Generalized One S.D. Innovations ± 2 S.E.

Response of OIL_REV to OILPOS

Response of EXP_IHC to OILPOS

Response of SER to OILPOS