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THE MACROECONOMIC EFFECTS OF OIL SECTOR CRISIS IN LIBYA

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ABSTRACT

This paper analyses and investigates the impact of the oil sector crisis on the Libyan economy from 2012 Q4 to 2022 Q3, using the Bai-Perron model and a structural vector autoregressive model (SVAR). The findings demonstrate that the multiple structural breaks test statistics approved that nearly all of the study's variables had a structural break at years around political division and political agreement. In contrast to inflation, the results of the impulse response functions (IRFs) indicate that the shock to oil revenue had a considerable negative impact on the money supply and exchange rate. Furthermore, the study reveals that, with the exception of claims on the government with the central bank, shocks to oil revenue are the major contributors to variance decomposition for all variables. The results reveal that oil revenue, in particular, accounts for roughly 16%, 13%, and 16% of the variance decomposition of the money supply, exchange rate, and inflation rate, respectively. As a result, the oil sector crisis is a controlling factor in the explanation of variations in these variables. The study concluded that oil sector revenues have a sensitive impact on the Libyan economy and that the latter has a strong tide with a secure environment and political stability.

Keywords: *Oil Sector Crisis; Multiple Breakpoints; Structural VAR; Libya.*

1. Introduction

The Libyan economy has recently experienced structural shocks as a result of tribal, political, and military crises. These conflicts caused the closure of oil ports for three years, from 2013 to 2016. The intermittent closures in 2020 and the first quarter of 2022 caused the structural shocks in the oil sector to recur for a variety of reasons, including demands for an equitable distribution of oil wealth and others related to the National Oil Corporation (NOC), such as requests to hire some protesters or complaints about the performance of the NOC board chair in particular. In addition, the oil sector in Libya encountered other shocks because of the outbreak of wars between Libyan cities and the occurrence of a division in state institutions. This division led to the emergence of two governments, one in the east and the other in the west.

The fluctuating price of crude oil has also had other shocks for the Libyan oil sector. Oil prices witnessed a significant decline, falling to less than $30 per barrel in the first quarter of 2020 due to the blockade on economic activity during the COVID-19 pandemic, and then quickly rising to about $85 per barrel in the fourth quarter of 2021. This sudden increase was due to the distribution of anti-epidemic vaccines, which raised hopes for oil demand.

The oil industry in Libya is the "lifeblood" of the country's economy because it accounts for more than 60% of GDP, nearly 93% of all exports, and the majority of government revenue (an average of about 80% of total government revenue during the study period). The exposure of the Libyan oil sector to production and price shocks over the years led to a decline in oil revenues, which represent more than 90% of the real income flows to the Libyan economy. Although changes in the price of crude oil had an impact on Libya's oil exports during the study period, the shocks to oil revenues were more the result of oil production due to the frequent closure of oil fields and ports than of changes in oil prices.

The study's main objective is to use quarterly data from 2012 to 2022 to examine the effects of oil sector crises (shocks in oil revenue) on the Libyan economy. By using the Bai and Perron (1998; 2003) methodology, this study is regarded as an empirical investigation. In order to identify all abrupt structural changes in the time series and demonstrate the breakpoints using quantitative identification rather than descriptive reports the study used 40 observations for five significant macroeconomic variables. The study also applied the AB-SVAR model of Amisano and Giannini (1997) to differentiate between the effects of various structural shocks on macroeconomic variables. The relative contributions of each shock to the variability of the Libyan economy are then ascertained using the variance decomposition.

This study contributes to the literature in a different way of detecting structural breaks in time series data and identifying the long- and short-run macroeconomic impacts of oil revenue shocks in Libya for the first time, while most previous studies assumed the breaks from economic reports and used dummy variables to dominate the effect of time series breaks. The rest of the paper is organised as follows: Section 2 is the literature review; empirical methodology is in Section 3, and results analysis and discussion are presented in Section 4, while Section 5 is for the conclusion.

2. Literature review

Several studies were conducted on the impact of crude oil price volatility on main macroeconomic variables both in developed and developing economies (Agren, 2006; Park and Ratti, 2008; Aliyu, 2009; Ramos and Veiga, 2013; Moshiri, 2015; Abdlaziz, 2019; BenMabrouk and Hadj Mohamed, 2022). However, some of these studies concentrated on these volatilities as shocks to oil incomes and others as shocks to oil costs. This is because the shocks of oil prices bring about different results on the macroeconomic performance and stability of oil-exporting and oil-importing countries (Kilian *et al.*, 2009; Le, 2013; Rafiq *et al.*, 2016). For example, the impact of a rise in oil prices on oil-importing countries may differ from that of oil-exporting countries. The increases in oil prices may benefit countries exporting oil, while oil-importing countries tend to be in an economic downturn from these increases (Sek, 2017).This section will focus on previous studies that explore the impact of fluctuations in oil prices on economic activity in oil exporting and developing economies. Some of these studies are hereby presented because this study is concerned with determining the impact of the oil sector crisis on oil revenues and then on the macroeconomic variables in Libya.

Based on the impulse response functions (IRFs) and the forecast error variance decomposition (FEVD) analysis in a system, Mehrara and Mohaghegh (2011) used a Panel VAR approach including economic output, money supply, price index, and oil price for developing net oil exporters. The study found that oil shocks are not necessarily inflationary. However, the shocks significantly affect economic output and the money supply. In the case of Iran, Farzanegan (2011) examined the dynamic effects of oil shocks on different chapters of government expenditures from 1959 to 2007. The study found that oil revenue shocks strongly and positively impact military and security expenditures, while the social spending chapter does not show a significant response to such shocks. Ahmad and Masan (2015) employed the VAR model and examined the relationship analysis between oil revenue, economic growth, and government expenditure in Oman during 1980–2013. They found that the three variables that are very important to the short-run dynamics of the Omani economy and government expenditure are generally derived from oil revenue shocks.

In recent studies for a hydrocarbon economy, Al-Shammari *et al.* (2020) used the VAR model to examine the effects of oil price and oil revenue on major macroeconomic variables for the Iraqi economy during 1990–2018. The results found that oil price and oil revenue were slightly sources of GDP changes. Abdlaziz (2022) used broader data from 1968 to 2019 to examine the symmetric and asymmetric oil price shocks impact on economic activities. He confirmed that the Iraqi economy has been directly impacted by oil sector revenues due to the strong tide of world oil price changes. Samargandi and Sohag (2022) employed the TVP-VAR approach to measure the dynamic response of foreign assets and liabilities of the banking system to the oil revenue shocks in Saudi Arabia during 1993–2021 (weekly data). The results indicated that, in the last period of the study, particularly during the COVID-19 pandemic, the Saudi economy experienced negative net foreign assets, which occurred mainly as a significant pandemic of world oil prices.

A number of studies investigated the macroeconomic effects of oil price fluctuations using the SVAR model specification; for example, Ogunsakin and Oloruntuyi (2017) analysed the impact of oil price fluctuations on macroeconomic performance in Angola and Nigeria (the two largest oil exporters in Africa). The findings illustrated that oil price fluctuations have a minor impact on the economic growth of these countries. However, the impulse response function and variance decomposition illustrated that the exchange rate is affected greatly by fluctuations in oil prices, and this impact is considered to have the greatest impact on the economies of both countries. Benameur *et al*. (2020) used quarterly data covering the period 1999–2019 to evaluate the response of national account aggregates to oil price shocks. The study's findings showed a significant impact of world oil price volatility on the growth rate of GDP, oil revenues, and government expenditure. Additionally, Nasir *et al.* (2019) examine the effect of oil price shocks on the macroeconomic performance of Bahrain, Kuwait, the KSA, Oman, Qatar, and the UAE (Gulf Cooperation Council member countries) for the period 1980–2016. They found the significant direct effects of oil price shocks on the growth rate of GDP, inflation, and trade balance of all countries.

Although the world oil price volatility had an impact on oil revenues in Libya, Libyan economies passed through different kinds of conflicts and wars during the period of the study. Aside from the effects of oil price shocks, there was an internal crisis that occurred in the oil sector, which led to shocks in oil exports and consequently, in oil revenues. A large base of theoretical literature places cross-country using both the impulse response functions and the variance decomposition from the SVAR model to examine the macroeconomic impact of economic crises, namely financial crises and health crises (Bolaño-Bolaños, 2014; Babecký *et al.*, 2014; Benlagha and Charfeddine, 2021; Bobeica and Hartwig, 2021; Chellai, 2021; Alexandra, 2022; Roberto *et al.*, 2022). That means the present study tries to display the impact of oil sector crises (oil revenues shocks) on the Libyan economy, whether the cause of the shocks is a result of the fluctuation of international oil prices or an internal crisis that stops oil production and exports, using the Bai-Perron model and an AB-SVAR model in order to identify multiple structural breaks in the time series and analyse the impact and contribution of oil revenues shocks to the variability of the Libyan economy.

3. Research methodology

3.1. Data Description

To examine the economic effect of the oil sector crisis on the macro-economy in Libya, the study used quarterly macroeconomic data from 2012 Q4 to 2022 Q3 (T = 40), which is a time series as accessed from various bulletins of the Central Bank of Libya on its website, (www.cbl.gov.ly) except for parallel market exchange rate data obtained from quarterly paper reports published by the Faculty of Economics at the University of Al-Marqab. Note that the parallel market exchange rates used in this study instead of the official rates because the latter bears little resemblance to the actual market conditions. Other variables should be included in the study, i.e., economic growth and government spending; however, quarterly data are not available for these variables. The timeframe is crucial to the study following the shocks to which the oil revenues in Libya were exposed because of the repeated closures of oil production facilities and to the significant changes in world oil prices.

The oil export shocks significantly affect the macroeconomic variables of Libya, as seen in table (1). The effects of these shocks caused the Central Bank of Libya (CBL) to lose foreign currency, which fell from 155.8 billion LYD ($112.2 billion) in 2012 to 102.7 billion LYD ($49.99 billion) in 2020; this resulted in the emergence of a public finances deficit. Due to the ineffectiveness of fiscal policy, the Central Bank only used monetary policy to increase the money supply in order to cover the public budget deficit. This caused the money supply balance to rise from 59.214 billion LYD in 2012 to its highest level of 122.95 billion LYD in 2020, before falling to 102.653 billion LYD in the third quarter of 2022.

Additionally, there was a sharp growth in the Claims on Government (COG) balance with the Central Bank, which went from 1.8 billion LYD in 2012 to 88.6 billion LYD in the third quarter of 2022. The fact that both governments (in the east and west) adopted an expansionary expenditure policy in spite of the fall in public revenue flows is what causes the large balance of claims against the government (Libyan Audit Bureau, 2021). The lack of liquidity in the banking system, the drop in the value of the Libyan dinar, which exceeded its official rate from

1.40 to 8.85 dinars for one US dollar in the parallel market, and the rise in the general level of prices were all clear indications of the inadequacy and incapacity of economic policies to deal with the oil sector crisis.

Table (1): Libyan macroeconomic variables

Year	Foreign Currencies (FORC)	MS1	Claim Gov (COG)	Exch (1 LYD vs. $)	CPI
2012	155,782	59,214	1,816	1.25	159.6
2013	154,905	64,299	2,171	1.30	164.4
2014	130,721	66,740	24,235	1.80	175.3
2015	115,111	76,783	43,378	3.00	191.6
2016	107,151	94,609	47,852	6.60	238.7
2017	109,637	109,089	59,142	8.85	258.8
2018	119,395	109,559	64,039	4.66	265.1
2019	119,063	105,376	59,982	3.90	263.5
2020	102,726	122,950	83,905	5.45	269.1
2021	105,449	97,335	87,659	5.08	280.1
2022*	104,909	102,653	88,659	5.10	289.2

Source: Central Bank of Libya Bulletin 2022 Q3.
(*) 2022 Q3 except for oil export data 31/12/2022.

3.2. Multiple Structural Changes Test

To test the hypothesis, a long-term series of macro-variables in Libya should experience some breakpoints due to fluctuations in oil revenue or the results of crises in the oil sector. The Bay-Pyron method is possibly the best one for figuring out breakpoints. The Bay-Pyron method is possibly the most suitable for figuring out breakpoints. Within this framework, the model developed by Bai and Perron (2003) to test multiple structural breakpoints at unknown dates can be structured coherently. A multiple linear regression with m breaks (m + 1 regime) was suggested by the model, as in:

$$x_t = z_t\alpha + j_t\beta_k + u_t\,, \qquad t = T_{k-1} + 1,\ldots\ldots\ldots,T_k \qquad (1a)$$

Where x_t is the observed dependent variable at time *t*, while z_t $(p \times 1)$ and j_t $(q \times 1)$ are vectors of covariates and α and β_k: $(k = 1,\ldots.., m + 1)$ are the corresponding vectors of coefficients. u_t is disturbance term at time *t*. The breakpoints $(T_1 \ldots T_m)$ are explicitly treated as unknown.

This test uses least squares specification to obtain an estimate of the unknown parameters and the break-dates when the number of observations on the dependent and the vectors of covariates are available. The observations are made quarterly on each variable. The variables included foreign currency balance, claims on government with CBL, money supply (narrow), Libyan dinar exchange rate in parallel market, and consumer price index (CPI).

The estimation procedure for the multiple breakpoints test applies a simple equation for each of the five mentioned variables under the OLS specification in linear regression; each estimated regression coefficient shows the relationship between the constant as one independent variable and each variable as a dependent variable. The quadratic spectral kernel specification was based on heteroscedasticity and autocorrelation consistent (HAC) covariance estimation employing pre-whitened residuals to allow for error terms in a time series transfer from one period to another in the model (serial correlation), whereby the kernel bandwidth is determined using the Andrews AR(1) method. Thus, the model for each variable can be given as follows:

$$x_t = constant + \varepsilon_t \quad (2a)$$

Bai (1997) and Bai and Perron (1998) applied the default method for investigating multiple unknown breakpoints, which is called sequential testing $L + 1$ vs. l breaks. This study applied two methods to investigate the assumption that the behaviour of the variables is instable or has significant structural breaks over the 10-year test period.

At the first stage, the global Bai and Perron (2003) break method was used to test the null of no structural changes against the alternative hypothesis of globally optimised breaks, along with the corresponding UD_{max} and WD_{max} tests. At the second stage, the method of global information criteria was applied, where the method obtained the parameters of each m-partition of the sample estimates by minimising the sum of squared residuals from Eq. (2a).

As a pre-requirement for the first method, allow error distributions to differ across breaks in order to allow for error heterogeneity, while the second does not need computing coefficient covariance. The selection criterion for the optimum number of breakpoints will be discussed later on in Results and Discussion Section 4.

3.3. Structural VAR Model (SVAR)

The structural vector autoregressive model (SVAR) allows identifying and disintegrating oil sector crisis shocks into foreign currency revenue shocks, public finance shocks, money supply shocks, exchange rate shocks, and general price shocks. The study then included the volatility of quarterly data for these variables to capture their sensitivity to these constructed oil sector shocks.

The econometric approach proposed in the analysis is the impulse response functions (IRFs) and the forecast error variance decomposition (FEVD) of the SVAR model. The SVAR model imposes restrictions on the error terms in order to identify orthogonal innovations. (Amisano and Giannini, 1997; Breitung *et al.*, 2004 and Kilian, 2009). In this section, the AB-SVAR model was used, which consists of estimating the SVAR in the following steps:

Step (1): Identifying the reduced form of the $AB{-}SVAR$ model, which is given by Amisano and Giannini (1997):

$$AZ_t = A_1 Z_{t-1} + A_2 Z_{t-2} + \dots + A_p Z_{t-p} + Bu_t \quad (1b)$$

Where Z_t; represents the [5x1] vector of endogenous variables, including the following: foreign currency balance as a proxy of oil sector shocks; claims on government balance as a proxy of public budget deficit; money supply as a proxy of monetary policy; the LYD exchange rate in the parallel market as a proxy of exchange rate; and changes in consumer price index as a proxy of inflation. All variables are in log except for inflation[1].

$A_{\boldsymbol{i}}$ for $\boldsymbol{i}= 1\dots p$ is the expression for [5 ×5] autoregressive coefficient matrix, where the optimal lag p is of the estimated VAR model, which was indentified based on the information criteria.

[1] Note that the equation is a semi-log model since the variable inflation is decimal. In the case of a decimal variable, taking the log of the variable may change the nature of the data (it will give negative values).

A is the [5 ×5] contemporaneous matrix of endogenous variables and B is the [5 ×5] instantaneous matrix of the structural shocks, which are crucial components of IRFs. All economic restrictions will be imposed in two matrices (A and B). u_t represents [5 ×1] vector with structural innovations assuming no serial correlation with $E(u_t) = 0$ and $E(u_t u'_t)$ = (5X5) identity matrix = I_n.

The equation (1b) must be multiplied at first with the inverse of the matrix (A^{-1}) on both sides in order to reduce the form of the structural VAR model and obtain the following expression:

$$Z_t = A^*_1 Z_{t-1} + A^*_2 Z_{t-2} + \ldots + A^*_p Z_{t-p} + \boldsymbol{\varepsilon}_t \qquad (2b)$$

Where $\boldsymbol{A_i}^*= A^{-1}A_i$ for i=1,…,p, and $\boldsymbol{\varepsilon}_t = A^{-1}Bu_t$, $\boldsymbol{\varepsilon}_t$ represents the innovations of the reduced form and assumed to be white noise, possibly correlated with each other due to contemporaneous effects, are related to the structural errors (shocks)$_t$ by,

$$A\boldsymbol{\varepsilon}_t = Bu_t \qquad (3b)$$

Step (2): Short-run constraints should be imposed on the contemporaneous effects among variables.

One of the important features of the AB-SVAR model is ordering the variables in the vector of endogenous variables because the relationship structure of innovations will be implicitly changed by converting the order of variables. As the 5x5 matrix of endogenous variables has more than 100 different orders, the issue of choosing the optimal order arises. Therefore, in equation (3b), the recursive Cholesky factorization approach is performed on the SVAR, and matrix B is not assumed to be an identity matrix, in order to reduce the restrictions in the SVAR model and make it more flexible. (Amisano and Giannini, 1997; Kilian, 2009). While matrix A is a lower triangular matrix, which assumes that A^{-1} is a Cholesky factor of Σ_ε, the variance-covariancee matrix ($\Sigma_\varepsilon = A^{-1}\Sigma_u A^{-1\prime}$, Σ_u= I, got $\Sigma_\varepsilon = (A^{-1}A^{-1\prime})$ (Lütkepoh, 2005). The variables are ordered according to their degree of indigeneity based on the economic relationship in Cholesky factorization, which can be expressed in equation (4b):

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ NA & 1 & 0 & 0 & 0 \\ NA & NA & 1 & 0 & 0 \\ NA & NA & NA & 1 & 0 \\ NA & NA & NA & NA & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_t^{oil} \\ \varepsilon_t^{cog} \\ \varepsilon_t^{ms} \\ \varepsilon_t^{xch} \\ \varepsilon_t^{inf} \end{bmatrix} = \begin{bmatrix} NA & 0 & 0 & 0 & 0 \\ 0 & NA & 0 & 0 & 0 \\ 0 & 0 & NA & 0 & 0 \\ 0 & 0 & 0 & NA & 0 \\ 0 & 0 & 0 & 0 & NA \end{bmatrix} \begin{bmatrix} u_t^{oil} \\ u_t^{cog} \\ u_t^{ms} \\ u_t^{xch} \\ u_t^{inf} \end{bmatrix} \qquad (4b)$$

The elements zero in the matrices indicate that certain variables do not contemporaneously respond at all to specific shocks, and elements NA indicate that there are no particular expectations for the contemporaneous effects. In A and B matrices, 35 constraints should be taken in total to make the system in the SVAR model just identified: $2n^2 - n(n + 1)/2$ (n is the number of endogenous variables). The B matrix has 20 coefficients that are equal to zero, and the main diagonal of matrix A provides another 5 restrictions. The remaining constraints applied to the system are based on the theory of economics, and the respective responses of variables to oil shocks are taken from Ben-Taher (2021) as follows:

A rise in oil prices and production leads to an increase in foreign currency revenues, as foreign currency income is almost entirely dependent on oil exports. Libya, as a country, does not have the power to influence international oil prices. In addition, the shocks to which the oil sector was exposed and led to declines in oil production and exports for various periods resulted from the repeated closures of oil ports and fields as a result of tribal conflicts and political disputes, not because of economic variables that could be influenced. Therefore, oil revenues are completely exogenous and give four additional restrictions. Simultaneously, the oil revenues affect the government debt, money supply, exchange rate, and inflation variables, but not vice versa, as mentioned above. These assumptions are valid due to the fact that the oil revenue variable does not react to domestic variables' shocks.

The second row of equation (4b) assumes that oil revenue has a contemporary influence on the public budget deficit (COG), and the same influence is not true of the inverse. However, the restrictions assume that the public budget deficit (COG) affects other variables (money supply, exchange rate, and inflation) and has no inverse impact on any one of those variables. This assumption gives three more restrictions and is valid due to the fact that the shocks that happened to the oil sector led to declines in oil revenues, which represent more than 90% of government revenue, and an appearance of a public budget deficit. In order to finance the public budget deficit (COG), the central bank has increased the money supply (MS). Row 3 of Eq. (4b) assumes that oil income and the public budget deficit, as previously mentioned, have an immediate impact on the money supply variable, adding two further restrictions.

The restrictions in row four assume that the decline in foreign currency flows and the rise in financing the public budget deficit with the money supply resulted in a decrease in the exchange rate of the Libyan dinar on the foreign exchange market because the majority of goods and services on the Libyan market are imported from abroad. As a result, the fundamental determinant of the general price index (CPI) is the exchange rate of the Libyan dinar on the foreign currency market (the main determinant of import costs). It is assumed that the exchange rate variable is affected by all variables except for inflation, which provides one more restriction, and inflation responds to innovations in all other variables in the period (t) but does not immediately affect them (there are no restrictions on inflation).

4. Results and discussion

4.1. Introductory analysis

Table (2) summarizes the statistical results for the macroeconomic variables used in estimating the impact of the oil sector crisis on Libya's economy, and all data employed for this investigation are over the study's period. The statistics summarized in rows one and four are meant to confirm that the means and standard deviations of the five series appear to have a normal distribution; the means and medians are fairly close to each other. Moreover, all variables are fairly symmetrical; the skewness is between -0.5 and 0.5, except for the oil revenues, which are moderately skewed, while the kurtosis of the data is closer to 3 than too far from it. In addition, the Jarque-Bera statistics indicate that the null hypothesis of normality is rejected at the 5% significance level for all the series, except for FORC, where the normality assumption is rejected at the level of %10, but we fail to reject it at the level of %5.

Table (2): Descriptive statistics and tests of the macroeconomic variables

	FORC	COG	M1	Exch (1 $ vs. LYD)	CPI
Mean	75771.15	50176.95	91907.36	4.30	8.49
Median	69133.00	58669.50	99859.05	4.70	3.85
Maximum	121845.0	88660.00	12295.30	8.85	30.30

Minimum	49865.00	0.00	59049.40	1.25	-5.60
Std. Dev.	18907.34	29456.56	2039.25	2.21	10.25
Skewness	1.0	-0.4	-0.3	0.2	-0.3
Kurtosis	3.3	1.9	1.6	2.3	1.3
Jarque-Bera	8.08	2.75	3.96	1.08	5.18
Probability	(0.02)	(0.25)	(0.14)	(0.58)	(0.08)
ADF – level	-2.001	-1.046	-1.553	-2.413	-0.806
PP – level	-2.005	-1.028	-1.553	-1.650	--0.815
ADF – deferent (1)	-5.778***	-4.807***	-5.029***	-2.288	-7.157***
PP - deferent (1)	-5.814***	-4.708***	-5.029***	-5.076***	-7.162***

Source: Author's own calculation using EViews10

The base of using a SVAR is that all variables should be stationary. The Augmented Dickey-Fuller (ADF) test and the Phillips Perron (PP) test were used to test the stationarity of the data series. As shown in the table below, the results of the unit root for ADF and PPP tests illustrate the failure to reject the null hypothesis of a unit root at the 5% significance level for all variables, thus the data series are non-stationary in the level. These results mean that all variables are stationary in the first differencing of time series data.

4.2. The structural breakpoint test results analysis

Table 3 reports the results for each variable from three-month observations, in which model specification details and multiple structural breakpoint tests are given. According to Bai and Perron (2003), the procedure starts with the estimation of equation (2a) using least squares with simply a constant as a regressor (constant, jt = [1]) and accounting for possible serial correlation via non-parametric adjustment. Three test results were found, respectively, for five variables. By the Bai-Perron model, the tests allowed up to five breaks and used a trimming = 0.15; hence, each segment has at least six observations. The results of the breakpoint coefficient and the standard errors for each partition are presented in panel (2) of the table.

The test of *l* globally optimised breaks versus the null of no structural breaks, along with the corresponding UD_{max} and WD_{max} tests are reported underneath the model specifications. These tests are employed to identify the number of breaks in dates across the variables, as an alternative hypothesis of a certain number of breaks can be decided by the significance of operator supremum Wald type statistic tests FT(k) and reject the null hypothesis of no break (Bai and Perron, 2003). The double maximum tests (UDmax and WDmax) are employed to test the null hypothesis of no structural break versus an unknown number of changes. The significance of all double max statistics (pointed by star *) indicates that there are one or more structural breaks in the time series.

The results of the global information criteria are shown in Panel (2). The upper panel shows the results of two break-selection criteria that are employed to determine the optimum number of breaks. According to Bai and Perron (2003), the selection of the optimum number of breaks was obtained from a modified Schwarz Criterion (LWZ), whereby the minimum information values for all variables were chosen. The actual breaks identified by the LWZ test are reported as shaded letters. For example, in the case of oil revenues (FORC), three breaks are identified, which are in 2014 (q2), 2015 (q4), and 2021 (q1).

Going back to the reported events that took place during the study period, the breakpoint in 2014 was caused by protesters demanding federal rule closing the major oil ports; the breakpoint in 2015 was caused by the continued partial closure of some oil fields and ports due to political division, which started to emerge with the rejection of some of the parties to the political agreement signed in 2015; the breakpoint in early 2021 was the date of implementation of the new political agreement; and neutralising the oil sector for military conflict and political division (Ben-Taher 2021).

It is important to recall that during the study period, the volatility of the global oil price had an impact on oil revenues; however, the shocks to these revenues were more caused by changes in production and export quantities as a result of the frequent closure of oil fields and ports than by changes in the price of oil. Furthermore, when the security conditions of the oil sector improve, oil exports have a high ability to achieve large surpluses of financial revenues, and this is a comparative advantage for the ability of the Libyan economy to achieve a rapid accumulation of financial balances of foreign exchange.

Similar interpretations of breakpoints can be applied to claims on government (COG) and money supply (M1). Given that the decline in oil revenues has a direct impact on the public budget deficit, which can only be covered by borrowing from the Central Bank (CBL), the two important breakdowns are related to early 2017 and 2021. In 2017 due to addressing the legislative problem of funding the public budget by borrowing from CBL (called financial arrangements stipulated in the Skhirat Political Agreement), which led to an expansion of money supply to finance public expenditures, while 2021 due to the end of the political division by uniting the government based on the Geneva Political Agreement, which gave the government the legitimacy to cover the budget deficit by borrowing from the Central Bank (Ben-Taher and Hamoda, 2022).

The expansion of COG through the expansion of MS and printing new paper currency to provide cash liquidity to banks along with the decline in foreign currency flows prompted CBL to impose some quantitative restrictions on foreign currency exchange. These restrictions had two breakpoints in the exchange rate of the Libyan dinar (Exch): 2014 (q4) and 2015 (q4), while the breakpoint of 2018 (q3) was due to CBL lifting restrictions on importing all products after imposing 138% of the official exchange rate as a fee on foreign exchange sales. The general level of price experienced four breakpoints because of the CPI-related changes in the exchange rate, considering the majority of products supplied in the domestic markets are imported from outside the country, except for 2021, where the impact on the general price was due to the global economic disruption caused by the COVID-19 pandemic.

Table (3): Multiple Breakpoint Test: Macroeconomics Variables (Quarterly Data)

Panel (1)	Model specification						
j_t = [1]	p = 0	q =1	trim = 15%	max breaks = 5		sig- level = 0.05	
Global L breaks VS. none –test							
	Sup-Weigh F(T₁)	*Sup-Weigh F(T₂)*	*Sup-Weigh F(T₃)*	*Sup-Weigh F(T₄)*	*Sup-Weigh F(T₅)*	UD_{max}	WD_{max}
FORC	1.191	6.943	5.558	33.333*	29.977*	19.386*	33.333*
COG	0.799	13.309*	80.871*	620.126*	616.538*	360.656*	620.126*
M1	6.768	67.483*	15.386*	171.356*	157.220*	99.658*	171.356*
Exch	7.430	15.287*	42.546*	42.231*	38.293*	29.554*	42.546*
CPI	2.482	23.91*	14.696*	13.105*	20.588*	23.916*	45.179*

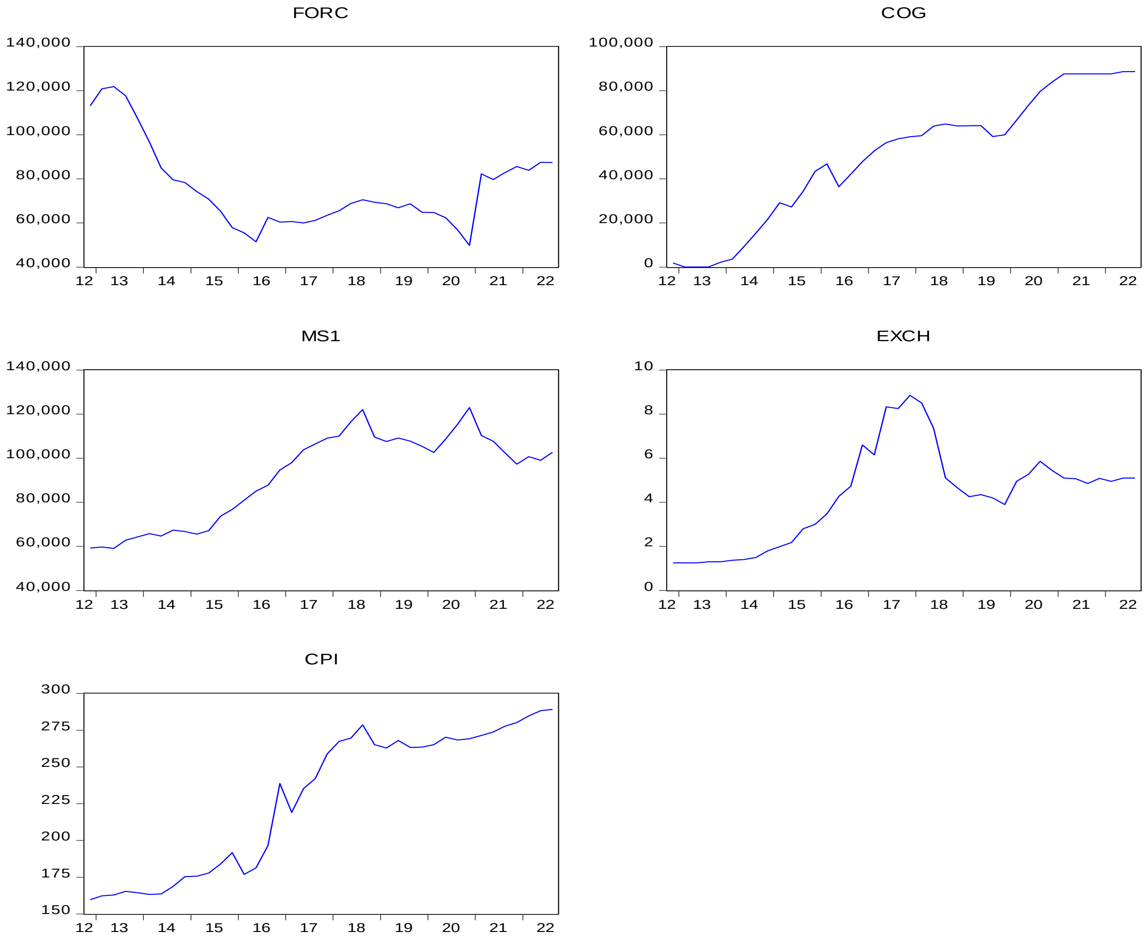
Panel (2)	Number of selected breaks				
	FORC	COG	M1	Exch	CPI
LWZ criterion:	3	4	3	3	4
Schwarz criterion:	3	4	3	3	4

	Coefficient and Standard Deviation of Segments					Estimated Break Dates				
	β_1	β_2	β_3	β_4	β_5	T_1	T_2	T_3	T_4	T_5
FORC	112934.5 (9579.12)	75542.67 (6939.88)	62418.19 (5780.02)	84171.57 (2855.81)	NA	2014Q2	2015Q4	2021Q1	--	--
COG	1267.75 (1512.61)	22867.9 (9333.61)	44880.57 (5552.23)	62598.12 (4517.61)	86573.86 (2954.15)	2014Q2	2015Q4	2017Q2	2020Q3	--
M1	63845.53 (3195.85)	83146.02 (7618.33)	107613.8 (6828.35)	NA	NA	2015Q3	2017Q1	2021Q2	--	--
Exch	1.44 (0.26)	3.4 (0.95)	7.72 (1.03)	4.89 (0.49)	NA	2015Q2	2016Q4	2018Q3	--	--
CPI	3.50 (3.78)	22.7 (5.55)	1.6 (2.7)		NA	2015Q4	2016Q4	2018Q3	2021Q2	--

Source: Author's own calculation using EViews10

The breakpoint tests were only applied to quarterly data to identify the accuracy of the test results. If a note is made about the small data series used in the analysis of breakpoint tests, the graphs in this regard would obviously be determined as an annual breakdown. The similar interpretations of breakpoints for five macroeconomic variables can be confirmed from Figure (1). Note that in the breakpoints test, the particular observations at which the break appears are determined by quarterly dates across the variables in which the break started, whereas in a graph, it is identified when the break ended.

Figure (1): Multiple Structural change Macroeconomics Variables (Annual Data)



4.3. AB-SVAR results analysis

4.3.1. Standard VAR model diagnostic

The base of using a SVAR model is that the heteroskedasticity and autocorrelation in the Standard VAR model are absent. The VAR model is examined by applying the Langrage Multiplier (LM) test and the White Heteroskedasticity test to confirm that there is no serial correlation or heteroskedasticity. The results of the tests reported in Table (4) illustrate that there is no serial correlation among the residual terms, and the specification of the VAR model is also sound.

Table (4): Diagnostic Test Results

Breusch-Godfrey Serial Correlation LM Test			Wh- Hetero Test	
Lags*	LM-Stat	Prob.	Chi-sq	267.571
1	21.5206	0.6731	Df	300
2	18.7458	0.8157	Prob.	0.9111

Source: Author's own calculation using EViews10

(*) The selection of lag length 2 was obtained from AIC criteria.

4.3.2. Impulse response functions

The impulse response function (IRF) measures the behaviour or effect of one variable after one-unit change in another over certain periods. The impulse response functions in figure (2) show the effect of a one-positive standard deviation shock on oil revenues on the endogenous variables of the model (government debt by the central bank, money supply, exchange rate, and inflation). Where a positive or negative shock does not matter, a negative shock (decrease in oil revenues) would just have the mirrored effect. The positive shocks in a structural VAR model are symmetric, so in order to obtain the negative shocks, the sign of the IRFs will be changed when interpreting the figures (2).

The likelihood ratio statistical test (LRT) was applied to compare the specifications of models by testing the significance of restrictions on the models. The results of impulse responses are statistically significant for the entire period of the four variables at a 95 percent confidence interval (the middle lines and the red dashed lines in the graphs present impulse responses and confidence interval bands, respectively). The interpretation for the IRFs is split into 10 periods to effectively trace the effect of shocks in the Libyan oil sector to variables; it uses periods 4 and 10 to represent the short- and long-run periods, respectively.

Figure (2a) reveals that the effect of a positive oil revenue shock on government claims, which is used as a proxy variable for government debt, has a negative impact in the short and long term. The mentioned effect dies as the impact returns to almost zero in period 10, and throughout the entire period, the effect is in the performance range between 1 and -2 units of measurement of the variable. The results are significant statistically only for period 4, which is reported in Table (5). Directions and significance of effects are in line with the theoretical relationship; a negative shock to oil revenues is expected to create a public budget deficit and thus result in the government expanding lending to CBL to meet budgetary funding requirements. The government can conceivably contract for loans from the central bank to cover the public revenue deficit that appears at the end of the year.

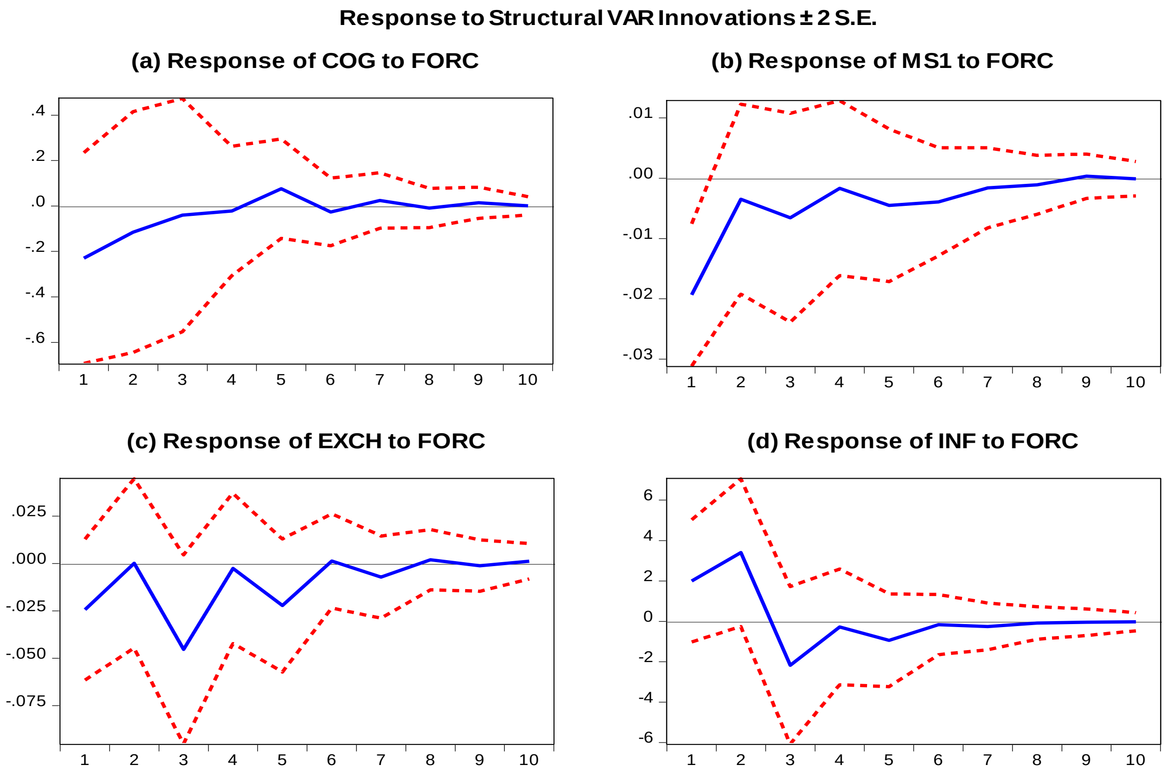
The oil revenue shock has a minimal effect on the money supply (within -0.02 units of measurement of the variable). The oil revenue shock effect on money supply is a significant negative effect that prevails until the eighth quarter (see Figure 2b and Table 5). The main motive behind the central bank’s expansion in the money supply is to cover the oil revenue deficit, and the increase or decrease in the monetary base results from the change in the balance of the claims on the government with the CBL. This conclusion is consistent with Ben-Taher (2021).

As noted above, the oil revenue decline shock has a short and long run positive impact on money supply, which is apparent until two year. The effect of an oil revenue shock on money supply, after the initial volatility, disappears 9 and 10 quarter. This effect is in line with the growing government debt, because if public revenues are not sufficiently funding the government expenditure, the needed funds will be debt-financed by CBL by increasing money supply.

Figure (2c) reveals that a positive shock to the exchange rate appreciates gradually for the entire period of 2 years and vice versa. This implies that a negative shock to oil revenue will result in a gradual depreciation of the Libyan dinar against the US dollar in the short and long run. This result is anticipated, given that, from an economic perspective, the decline in oil revenue prompted the CBL to impose some administrative and quantitative restrictions on foreign currency exchange, which had a negative impact on the exchange rate of the Libyan dinar in the parallel market.

Figure (2d) reveals that the response of inflation to the shock in oil revenues has an immediate positive effect in the first two periods and a sharply negative effect in the third quarter. The value subsequently fluctuates under the zero lines and quickly dies as the impact returns to almost zero in the sixth period. Table (5) indicates that oil revenue shocks have a significant impact on exchange rate fluctuation, while no such relationship is found for inflation.

Figure 2: IRF of the Libyan claim on government with CBL, money supply, exchange rate and inflation to structural 1 standard deviation shock on the oil revenues



Source: Author's own calculation using EViews10

Table (5) Response to Structural One S.D. Innovation on the oil revenues

Period	COG	MS1	EXCH	INF
1	-0.2292	-0.0193***	-0.0243	1.9977
2	-0.1149	-0.0035***	0.0001**	3.4009
3	-0.0396	-0.0066***	-0.0453**	-2.1705
4	-0.02192*	-0.0017***	-0.0026**	-0.2774
5	0.0756*	-0.0045***	-0.0222**	-0.9392
6	-0.0264*	-0.0039***	0.0013**	-0.1620
7	0.0242*	-0.0016***	-0.0072***	-0.2542
8	-0.0090**	-0.0011***	0.0020***	-0.0812
9	0.0139**	0.0003***	-0.0011***	-0.0465
10	0.0006**	-0.0001***	0.0012***	-0.0207

Cholesky ordering: FORC COG MS1 EXCH INF
Source: Author's own calculation using EViews10

4.3.3. Forecast errors variance decomposition

The analysis continues with an examination of the variance decomposition for the basic SVAR model for a period of one quarter to three years of government debt with CBL, money supply, exchange rate, and inflation. The results are reported in Figure (3).

Figure (3a) shows that the shock to oil revenues plays the primary role in understanding the volatility in oil revenues, and that this role persisted until the end of the third year, declining from 100% in the first quarter to 78% by the end of year 2. This outcome is in line with the theoretical argument that Libya's oil revenue is an exogenous variable that is largely determined by factors unrelated to the Libyan economy.

The results of the variance decomposition for government banking debt (COG), as shown in Figure (3b), reported that after two quarters, the variable itself explained more than 90% of the variance of its forecasting errors. Thus, no variable in the model explains the fluctuation of the claims on the government with the central bank, and oil revenues shock play no significant role in explaining the volatility in the variable in the contemporary. This unexpected influence of COG on oil revenues may be due to: the government reduces public expenditure to minimum limits when oil revenues decline before resorting to borrowing from the central bank; and also, there are unpaid amounts on the government that were to total almost 2.89 billion LYD at the end of 2021, according to the Libyan Audit Bureau (2021).

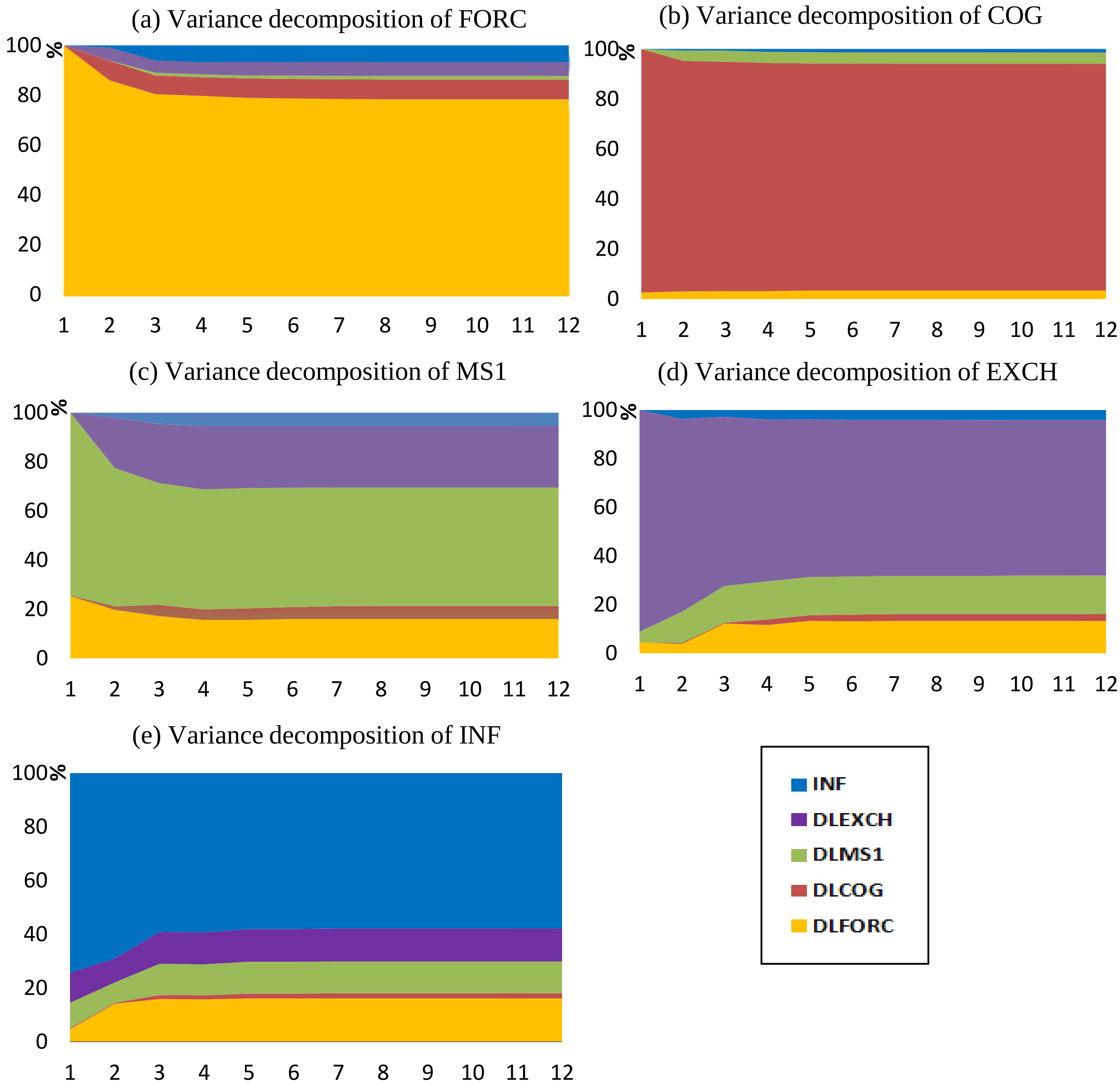
Figure(3c) shows the variance decomposition for money supply, which reveals that in the first quarter, much of the variation is caused by shocks to money supply itself and oil revenues (74% and 25%, respectively), thus the oil revenues help to explain the fluctuations in the money supply shock but not vice versa. However, as the period expands, the shock to the exchange rate from the second quarter until the end of the third year explains almost 25% of the fluctuation in the money supply, while inflation takes a negligible percentage of the fluctuation even at 3 years, and government banking debt shocks play no significant role in explaining the fluctuations in the money supply in contemporary times.

For the exchange rate, the results (see figure 3d) show that oil revenues and money supply have power in explaining the forecast variance error decompositions of the exchange rate. For example, from Q1 to Q4 (until the end of the third year), the power of explanation for the variance decomposition of the oil revenues and money supply has increased rapidly from 4% for both variables to 13% and 15%, respectively.

Figure (3e) reveals the forecast variance error decompositions of inflation. In the initial period, approximately 74% of the variation is from shocks to the inflation rate itself, and most of the remaining 11% and 9.5% are from the money supply and exchange rate, respectively. The contribution of oil revenues to the variation in the inflation rate changes rapidly over the first year and eventually seems to converge at around 16%. The contribution of money supply and exchange rate to variations in inflation rises more slowly than that of oil revenues and levels off at roughly 12%. The system has become stable since the second year.

A possible explanation of the low contribution of COG to variance decomposition (5% or less) for money supply, exchange rate, and inflation is that the government reduced public expenditure to the minimum limit, and any bridge financing arrangement between the government and the central bank can only be minimum and temporary. This policy was adopted in the financial arrangement stipulated in the political agreement. Thus, the purpose of lending to the government by the Central Bank was not to stimulate public expenditure but rather to cover the minimum level of public expenditure.

Figure 3: Variance decomposition analysis of the claim on government with CBL, money supply, exchange rate and inflation



4.4. Theoretical Contributions

This paper contributes to the literature in a different way by detecting structural breaks in time series data and identifying the long- and short-run macroeconomic impacts of oil revenue shocks in Libya. From a methodological point of view, the paper contains two innovative features. First, to the best of the researcher's knowledge, no empirical study has been conducted on the effects of the oil sector crisis on the main macroeconomic variables in Libya. However, most researchers used descriptive analysis methods to investigate the economic effects resulting from the decline in oil revenues. Second, this paper is considered an econometric research paper that employs formal models to precisely locate breaks, particularly in time series data, in order to pre-test data on oil revenues as a step before analysis. These breaks help in the detection of potential structural changes in the relationship between oil revenues and macroeconomic variables. While most researchers who have studied the Libyan case used news reports to identify breaks, this method is not formal and likely introduced estimation errors in research. Moreover, the special Libyan case is studied in this paper, which can be viewed as a contribution to the existing literature. This paper investigated the impact of oil revenue shocks on macroeconomic variables in relation to the frequent closure of oil ports and fields as well as the cessation of oil production and export, rather than just the fluctuation of the global oil price, which was the concern of most previous studies.

4.5. Implications for Policy

The intense reaction of volatility to oil revenue requires policymakers to put too much emphasis on the impact of oil revenue shocks. They should also be more cautious regarding the structure of the national economy and the high degree of dependence on the oil sector. The study’s findings have two most important policy implications. First, because oil sector shocks have a critical direct impact on Libya's economy, proper coordination of fiscal and monetary policy is needed to reduce risks from government debt, the exchange rate, and inflation. The inability of the economy in the short term to diversify the sources of income deserves immense attention by policymakers. Policy instruments such as public finance management, the exchange rate, foreign exchange management, cash liquidity management, and money supply are available to policymakers to maintain the value of the national currency, achieve stability in the general level of prices, and raise employment levels for all factors of production as well. Second, the study has shown that when the security conditions of the oil sector improve, oil exports have a high ability to achieve large surpluses of financial revenues, and this is a comparative advantage for the ability of the national economy to achieve a rapid accumulation of financial balances of foreign exchange. Hence, this implies that policymakers can play an important role in employing the surpluses of financial revenues in direct and indirect investments such as participation in holding companies or financing the Libyan sovereign fund companies, which will generate more financial revenues for the Libyan state and create a sort of economic diversification instead of keeping them in the form of huge balances under the name of foreign currency cash reserves.

4.6 Limitations and Future Research Directions

The study was conducted to investigate the impact of the oil sector crisis on a set of macroeconomic variables in Libya during the period after 2012, when the crisis led to the closure of oil ports and fields and the drop in oil income started to appear. The annual data for the study variables is considered insufficient to obtain the number of observations necessary to apply the empirical study. Therefore, the study desegregated data from annual frequency to quarterly frequency to run a large period covering 2012–2022 for all of the study's variables. The lack of quarterly data restricted the inclusion of other important endogenous variables in the study. Moreover, it might be challenging to identify the study's model (the AB-SVAR model) via Cholesky decomposition because the model is typically limited to only including a small number of endogenous variables. Other approaches to cointegration could be introduced, such as the autoregressive distributed lag (ARDL) bounds testing method. It would be possible to use different lag years with this methodology, whereas the vertical autoregressive techniques do not allow for this, and it might make for further research to re-estimate the short- and long-run effects of oil shocks with other variables such as black market premium (BMP), government spending, and economic growth.

5. Conclusions

This study examines the impact of the oil sector crisis (oil revenue shocks) on the volatility of a set of macroeconomic variables in Libya. The investigation is performed in two steps. First, the study used the Bai-Perron model to investigate multiple structural changes present in the time series data; second, the pulse response analysis and forecast error variance decomposition based on the AB-SVAR model, respectively, were also used to investigate the contribution of each shock to the variability of the Libyan economy. The results can be summarised with three statements. First, the multiple structural breaks test statistics would have us believe that almost all macroeconomic variables, namely oil revenue, government banking debt, money supply, exchange rate, and inflation, experienced a structural break at dates around political division and political agreements. Second, the IRFs reveal that a shock to oil revenues has a significant negative effect on the money supply and exchange rate, while no such relationship is concluded for inflation. A possible explanation of this unconventional direction influence of inflation may be the predominant effect of the policy of subsidising the prices of several commodities by the Prices Stabilisation Fund (PSF). An additional influence is a decline in aggregate demand as a result of the decline in public expenditure and also the lack of liquidity in the banking system. Third, the variance decomposition analysis shows that shock to oil revenues plays the dominant role in explaining the fluctuations in oil revenues.

This result is consistent with the theoretical discussion that oil revenue is an exogenous variable. The analysis also shows that oil revenue is the main contributor to variance decomposition for all variables except for claims on government with CBL. In particular, the result found that the oil revenue explains approximately 16%, 13%, and 16% of the variance decomposition of the money supply, exchange rate, and inflation rate, respectively; thus, the oil revenue shock helps to explain the fluctuations in these variables. However, a possible explanation for the unexpected influence of claims on the government with CBL on oil revenues shock may be that a large amount of the public budget deficit has not been funded but added to the balance of the outstanding debts. Based on these findings, the study draws the conclusion that oil sector revenues, particularly given Libya's inability to diversify its revenue sources in the short term, directly affect Libya's economy.

The AB-SVAR model was used in the study in conjunction with readily accessible quarterly data. In practice, it might be difficult to identify the AB model via Cholesky decomposition because the model is typically restricted to only including a small number of endogenous variables. The lack of quarterly data and challenges facing obtaining proper identification for the study model are considered limitations to applying more endogenous variables; thus, future studies can consider more variables and fill this gap.

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