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THE EFFECTS OF OIL PRICE SHOCK AND EXCHANGE RATE ON GROSS DOMESTIC PRODUCT: EVIDENCE FROM LIBYA

Mahmoud Kraim
Sabratha University, Surman, Libya
Email: makkraim@sabu.edu.ly

Abstract
Many studies have investigated the relationship between oil price shock, exchange rate, and gross domestic product (GDP). This paper examines the effects of an oil price shock and the exchange rate on the GDP in the case of Libya. In this context, we applied the Johansen VAR-based cointegration technique to examine the sensitivity of GDP to the oil prices and exchange rate in the long run. In short-run relationships, we have used the vector error correction estimates (VECM) test through time-series data that included the period between 1990 and 2019. The main finding is that the oil price and exchange rate are important influences on the GDP of Libya. This study has proved that oil prices positively affected the Libyan economy, while we found that the exchange rate harms Libyan GDP.
Keywords: Oil price, Exchange rate, GDP, VAR, VECM

Abstrak
Banyak penelitian telah menyelidiki hubungan antara guncangan harga minyak, nilai tukar, dan produk domestik bruto (PDB). Makalah ini mengkaji dampak guncangan harga minyak dan nilai tukar terhadap PDB dalam kasus Libya. Dalam konteks ini, kami menerapkan teknik kointegrasi berbasis Johansen VAR untuk memeriksa sensitivitas PDB terhadap harga minyak dan nilai tukar dalam jangka panjang. Dalam hubungan jangka pendek, kami telah menggunakan uji estimasi koreksi kesalahan vektor (VECM) melalui data deret waktu yang mencakup periode antara tahun 1990 dan 2019. Temuan utamanya adalah bahwa harga minyak dan nilai tukar merupakan pengaruh penting terhadap PDB Libya. Penelitian ini telah membuktikan bahwa harga minyak berdampak positif terhadap ekonomi Libya, sementara kami menemukan bahwa nilai tukar berdampak negatif terhadap PDB Libya.

Kata kunci: *Harga minyak, Nilai tukar, PDB, VAR, VECM*

Introduction

The impact of the exchange rate and oil price on economic growth remains an issue of concern to emerging world economies. Since the discovery of crude oil in the 1800s, it has been considered one of the most important commodities in the world. In the case of an oil-exporting country like Libya, which is heavily dependent on crude oil exports, any shock in oil prices is a cause for concern. In general, an increase in oil prices suggests a positive impact on output and GDP growth for oil-producing countries, while the effect is negative for oil-importing countries. The Libyan economy has heavily depended on the oil sector since the early 1960s. As shown in Table 1, oil revenues highly contributed to the total government revenue, which accounted for almost 97% in 2021. A significant share of national income is derived from oil production, due to this over-oil dependency, the economic sectors of oil countries behave differently (Kraim et al., 2023).

The fluctuations in oil prices occurred more frequently by the mid-1980s than in the past. OPEC has been trying to allocate the production quotas to its member countries to influence oil prices to ensure its stability, but it has been unable to stabilize it, as OPEC's share of the world's oil production has fallen from 55 percent in 1976 to 42 percent today. On the other hand, such empirical studies found that depreciation of the exchange rate tends to increase exports and reduce imports. In contrast, the exchange rate appreciation would encourage imports and discourage exports. Thus, exchange rate depreciation results in income transfer from importing to exporting nations via trade shift, affecting both importing and exporting nations. As a result, the economic growth of both importation and exportation countries is affected in this case. (Berument et al., 2010; Musa et al., 2019; Wesseh & Lin, 2018). In this respect, the issue of the exchange rates regime attracts attention as one of the important problems for many developing countries. Mostly, the choice of fixed, flexible, and sustainable exchange rate regimes gives rise to this issue.

Libya has maintained a fixed exchange rate regime and demonstrated that such a policy could significantly contribute to achieving extremely high economic growth rates. Therefore, in this study, we analyze the effectiveness of such a policy, which may guide developing countries in modeling the exchange rate policy and economic development. Our main objective, therefore, is to apply the Johansen VAR-based cointegration technique and vector error correction model (VECM) to study the short-run dynamics and long-run effects of changes in crude oil price and exchange rate on the Libyan GDP.

Table: Total Revenues, Oil Revenues and Non-Oil Revenues in Millions of LYD

	2016	**2017**	**2018**	**2019**	**2020**	**2021**
TOTAL REVENUES	8,845.2	22,337.6	49,143.6	57,365.2	22,818.0	**105,620.0**
OIL REVENUES	6,665.5	19,209.0	33,475.8	31,394.7	5,280.0	**103,368.9**
NON-OIL REVENUES	**2,179.7**	**3,128.6**	**2,435.4**	**2,523.2**	**2,281.0**	**2,251.1**

Source: The Central Bank of Libya, Economic Bulletin, various issues.

Many studies have investigated the effects of oil price shocks and the exchange rate on oil-exporting countries. For example, Edwards & Levy Yeyati, (2005) Used panel estimations for more than 180 countries and confirmed that nations with more flexible exchange rates may grow faster. Moreover, Eichengreen & Leblang, (2003) Found a strong negative link between growth and exchange rate stability for 12 countries. The results of this paper concluded that the estimations are strongly dependent on the period and the sample studied. A study by Jiménez-Rodríguez & Sánchez, (2005), investigates the relationship between oil price shock and real GDP growth. As a result of this paper, the consequence of oil price fluctuations should vary among oil-exporting as well as oil-importing nations. Also, Lardic & Mignon, (2006) Showed evidence of co-integration between the oil price and GDP growth in the United States and other countries within Europe.

Furthermore, a recent study by Polbin et al., (2020) applied an SVARX approach to examine an oil price shock and nominal shock as well as two types of productivity shocks. As a result, this paper confirmed that oil price dynamics was the most influential source of real exchange rate and real GDP fluctuations. A similar finding by Dong et al., (2020) indicated that depreciation in international oil prices and the RMB are both conducive to economic growth. Further, an appreciation in international oil prices will widen the output gap between the poor and the rich regions.

On the other hand, Schnabl, (2008) Investigated the volatility of exchange rate and GDP growth in small open economies at the EMU Periphery. According to this analysis, even major, relatively closed economies such as the Eurozone and Japan are vulnerable to huge exchange rate fluctuations, particularly in appreciation. From the macroeconomic perspective, Schnabl, (2008) Also asserts that flexible exchange rates allow an easier adjustment in response to asymmetric country-specific real shocks. In a single-country analysis, Musa et al., (2019) Studied the influence of exchange rate and crude oil price on Nigeria's economic growth over the period 1982 to 2018. Utilizing "an autoregressive distributed lag" model, the findings of this study implied that crude oil price and exchange rate significantly affect economic growth in the long run as well as the short run.

Many other kinds of research have compared oil exporting and importing countries. For instance, Jin, (2008) Discovered that oil price increases exert an inverse impact on GDP growth in China and Japan and a positive impact on the GDP growth of Russia. Particularly, a 10% increase in oil prices leads to a 5.16% growth in Russian GDP and a 1.07% reduction in Japanese total GDP. On the one hand, an appreciation of the real exchange rate is associated with positive GDP growth in Russia and negative GDP growth in Japan and China. A further study by Berument et al., (2010), investigated the impact of oil prices on the output growth of certain MENA countries that are well-thought-out to be either exporters or importers of oil using the time-series technique. As a result, this study reported that an increase in the prices of oil has a statistically significant direct impact on the output of Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Syria, and the UAE. In contrast, oil prices do not appear to have a statistically significant impact on the output of Bahrain, Djibouti, Egypt, Israel, Jordan, Morocco, and Tunisia. A study by El Anshasy & Bradley, (2012), who applied a GMM estimation in a panel of 16 oil-exporting countries from 1957–2008, found that government expenditures rise relatively less proportionately in the short run than the oil revenue increase. However, this study argues that higher oil prices induce a larger government size in the long run. A recent study by Al-Nakib, (2017) Presented that the recent oil price slump is likely to slow growth and widen the fiscal deficit in the Saudi economy.

In the Libyan context, many studies examine the relationship between oil price, exchange rate, and GDP, such as Aimer, (2016). This study concludes that a 10% rise in oil prices leads to a 54% increase in the GDP of Libya. A further study by Aimer, (2017) investigated the impacts of oil price volatility on Libyan economic sectors using annual data spanning from 1968-2012. This study has a significant impact on the Libyan economy in the case of policy development on oil prices. Besides, Benlagha & Hemrit, (2018) argue that the volatility of oil prices results in large fluctuations, which increases the economy's reliance on the petroleum sector. On the other hand, Todorović & Mladenović, (2018) analyzed the linkages between exchange rate and economic growth. The work recommends coordinated action of monetary and fiscal policies as a measure through which exchange rate policy could stimulate economic growth while discouraging inflationary tendencies in the economy. Most of the previous studies have focused on developed countries, and some of them studied developing countries. Therefore, this paper explicitly investigates this issue in the case of Libya, which is considered one of the biggest oil-exporting countries over the period 1990 to 2019.

This period covers all importing events that affected Libya's economy, such as the Libyan revolution in 2011.

Research Method

In this section, we describe the data used in this paper. Further, we will discuss the empirical model and the methodology used to examine the relationship between the three variables for our analysis.

A. Data definition

To investigate the relationship between oil prices, exchange rates, and gross domestic product, we will use annual time-series data during the period from 1990 to 2017. The data about oil prices are collected from the "U.S. Energy Information Administration", while the data about the nominal exchange rate is obtained from the International Financial Statistics Database of the International Monetary Fund. The data regarding the gross domestic product (GDP) is obtained from the World Development Indicators provided by the World Bank. All variables were converted to real terms with the Consumer Price Index (CPI) 2013 as its base year, and all variables are expressed in logarithm terms.

B. Empirical model

This paper employed a simple model to analyze the effect of oil prices and the exchange rate on the GDP in the Libyan context. The model is expressed as follows:

$$LRGDP_t = a_0 + \beta_1 LWTC_t + \beta_2 LREXE_t + \varepsilon_t$$

Where $LRGDP_t$ Is the real rate of output, $LWTC_t$ Present the oil price, and $LREXE_t$ Is the real term of the exchange rate. ε_t are a stochastic error term assumed to have constant variance and a zero mean, a_0 is a constant term, and β_1 is the coefficient of oil price, $\beta_2$is the coefficient of the exchange rate.

C. Methodology

Several econometric steps will be applied before presenting the results from the empirical VAR model.

Stationarity test

The Augmented Dicky-Fuller (ADF) and Phillips and Perron tests were applied to examine the existence or otherwise of a unit root in the data set. The ADF test was used to test for stationarity in the time series and to confirm the integrational properties of the data series in their levels and first differences. Also, non-stationary time series data, when used in regression, would lead to inconsistent and efficient parameter estimates. Therefore, we test for the level of stationarity. However, the Phillips–Perron (PP) (1988) unit root test is applied to augment the ADF since, in an ADF test, there is a loss of observation. Hence, the PP (1988) unit root test was applied to augment the ADF because of its use of non-parametric methods to adjust for serial correlation and endogeneity of regressors. The model is specified as follows:

$$\Delta y_t = \alpha + \alpha_1 y_{t-1} + \sum_{p}^{t=1} \gamma_i \, \Delta y_{t-1} + \varepsilon_t$$

Where Δy_tindicates the data set from the individual variables, α represents the intercept term, while α_1 Is the coefficient for the unit root test, and γ is the parameter of the augmented lagged difference.

From equation (2), p-values are used to reject or not reject the hypothesis, and the decision rule is that if $\alpha_1 = 0$, then it means the test has failed to reject the null hypothesis implying that the data are non-stationary or have a unit root. Alternatively, if $\alpha_1 \neq 0$, that means the unit root does not exist in the data set, and the test accepts the alternative hypothesis. To determine the optimal lag length of the VAR model, most of the lag length is specified by using Akaike (AIC) and Schwarz Information Criteria.

Cointegration test

The Johansen test (Søren Johansen, (1988); Soren Johansen & Juselius, (1990) The test is considered in this study for the cointegration analysis. Johansen's cointegration technique is used as a starting point in the vector autoregression (VAR) model. The VAR model is given by:

$$\Delta y_t = \emptyset_0 + \sum_{i=1}^{p-1} \Gamma_i \, \Delta y_{t-i} + \Pi y_{t-1} + \varepsilon_t$$

Where y_tIs a (3×1) vector of the log of real GDP, the log of oil price, and the log of the exchange rate, $\emptyset_0$ is the (3×1) intercept vector and ε_t Is a vector white noise process. While $\Gamma_i$denotes a (3×3) matrix of coefficients and contains information regarding the short-run relationships among the variables. The matrix Π conveys the long-run information contained in the data.

The Johansen test makes use of two likelihood ratio (LR) statistics: the trace statistic (λ_{trace}) and the maximum eigenvalue statistic (λ_{max}), which are all based on the estimated eigenvalue $\hat{\lambda}$ Of Π.

The sequential test for the trace test relies on the hypothesis:

H_0 : r = r_0

H_1 : $r_0 \leq$ r $\leq$ K

with LR statistics given by

$$\lambda_{trace}(r) = -T \sum_{i=r_0+1}^{k} \text{In}(1 - \hat{\lambda}_i)$$

A similar test is applied for the maximum eigenvalue with the alternative hypothesis that the rank $r = r_0 + 1$. The LR statistic here is given as follows:

$$\hat{\lambda}_{max}(r_0 + 1) = -T \ \text{In}(1 - \hat{\lambda}_{r+1}).$$

For the cointegration test, both tests can be used. If the test statistic is greater than the critical value at the chosen significance level, the null hypothesis that exactly r_0He vectors are cointegrated is rejected. This is sequentially done until the null hypothesis cannot be rejected. Consequently, the $r$value at the null hypothesis becomes the accepted cointegration rank. If the Johansen test indicates co-integration relation(s) among the variables, applying the VECM model becomes the appropriate model to capture the long-term equilibrium relationship of the variables.

Result and Discussion

Unit Root Tests

Augmented Dickey-Fuller (1981) tests for unit roots and the Phillips & Perron (PP) tests were employed to examine the order of integration of the data. As shown in Table 2,3, the result of both tests shows that all variables were non-stationary at the level. However, after the first difference, all the variables were stationary.

Table: ADF Unit Root Test

VARIABLE	LEVEL	PROB	1ST DIFFERENCE	PROB
LRGDP	-0.623524	0.4378	-5.768698	**0.0000**
LRWTC	0.366505	0.7833	-4.730448	**0.0000**
LREXE	**-1.650575**	**0.0924**	**-2.787464**	**0.0072**

***Source*:** Researcher's computations.

Table: PP Unit Root Test

VARIABLE	LEVEL	PROB	1ST DIFFERENCE	PROB
LRGDP	-0.623524	0.4378	-5.768698	**0.0000**
LRWTC	0.395176	0.7908	-4.717465	**0.0000**
LREXE	**-1.462263**	**0.1313**	**-2.736761**	**0.0082**

***Source*:** Researcher's computations.

Selection of lag order

In this section, we will determine the optimal lag length of the VAR model using information criteria.

Table: VAR Lag Order Selection Criteria

LAG	LOGL	LR	FPE	AIC	SC	HQ
0	-46.74394	NA	0.012675	4.145328	4.292585	**4.184395**
1	7.729932	90.78978	0.000289	0.355839	0.944866*	**0.512108**
2	14.29376	9.298761	0.000370	0.558853	1.589650	**0.832324**
3	29.88238	18.18672*	0.000238*	0.009802*	1.482369	**0.400474***
4	**36.00843**	**5.615543**	**0.000380**	**0.249298**	**2.163635**	**0.757172**

Notes: * indicates lag order selected by the criterion, LR: sequential modified LR test statistic (each test at 5% level),

FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

***Source*:** Researcher's computations.

Table 4 shows the lag selection using different methods such as the information criteria viz, final prediction error (FPE), Schwartz information criterion (SC), Hannan–Quinn information criterion (HQIC), and Akaike information criterion (AIC). We selected a maximum lag length of 4. Most of the information criteria support an optimal lag of 3, except the result from the (SC) which indicates an optimal lag of 2. Therefore, the optimal lag selected in our study is lag 3.

Johansen Cointegration Test and Vector Error Correction Model

To examine the effect of oil price and exchange rate on the GDP, we applied Johansen's maximum likelihood method. The result is shown in Table 5. Using the trace statistics indicated the presence of one cointegrating equation at a 5% significance level. Furthermore, the maximum likelihood statistics indicated the presence of one cointegrating equation at a 5% significance level. As a result, both the trace statistics and the Max-eigenvalue test indicated a long-run relationship among the variables.

Table: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.600805	33.35166	29.79707	0.0187
At most 1	0.343852	11.31231	15.49471	0.1930
At most 2	0.048749	1.199453	3.841466	0.2734

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.600805	22.03935	21.13162	0.0372
At most 1	0.343852	10.11285	14.26460	0.2046
At most 2	0.048749	1.199453	3.841466	0.2734

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LRGDP	LRWTC	LREXE
0.729352	-6.394465	6.289510
2.939809	1.693131	-0.742571
3.552883	-3.944465	0.818070

Unrestricted Adjustment Coefficients (alpha):

D(LRGDP)	0.201581	-0.071461	0.008374
D(LRWTC)	0.101765	0.032527	0.029633
D(LREXE)	-0.057804	-0.030629	0.024607

1 Cointegrating Equation(s):	Log-likelihood	30.35227

Normalized cointegrating coefficients (standard error in parentheses)

LRGDP	LRWTC	LREXE
1.000000	-8.767327	8.623425
	(2.20717)	(1.94774)

Adjustment coefficients (standard error in parentheses)		
D(LRGDP)	0.147024	
	(0.04209)	
D(LRWTC)	0.074222	
	(0.03383)	
D(LREXE)	-0.042159	
	(0.02666)	

Table presents the normalized coefficients; All the coefficients were statistically significant. This result confirms that oil prices are positive and statistically significant at a significant level of 5%, with a coefficient of 0.074. This indicates that a one percent increase in oil prices increases the GDP of Libya by 7%. However, we found that the exchange rate negatively influences the GDP of Libya with a coefficient of -0.042 and a 5% significance level. The test results suggest studying the long-term relationship among the variables and the direction of causality that might run among the variables in the long term.

Based on Table 6, the VECM equation for the LRGDP is extracted, which in this case takes the form:

D(LRGDP) = C(1)*(LRGDP(-1) -8.76732749881*LRWTC(+8.62342461502*LREXE(-1) + 10.5729782301) + C(2)*D(LRGDP(-1)) + C(3)*D(LRGDP(-2))+C(4)*D(LRGDP(-3)) + C(5)*D(LRWTC(-1)) + C(6)*D(LRWTC(-2)) + C(7)*D(LRWTC(-3)) + C(8)*D(LREXE(-1)) + C(9)*D(LREXE(-2)) + C(10)*D(LREXE(-3)) + C(11).

From the equation above, C (1) is the coefficient of the error term. Since this coefficient of the error term in our regression output, as seen in Table 6, is positively significant, this indicates no long-run causality from oil price and exchange rate to GDP.

Table: **VECM equation regression output**

	Coefficient	**Std. Error**	**t-Statistic**	**. Prob**
C(1)	0.147024	0.042088	3.493269	0.0040
C(2)	-0.588780	0.291963	-2.016629	0.0649
C(3)	-0.454996	0.302955	-1.501860	0.1570
C(4)	-0.250095	0.244186	-1.024197	0.3244
C(5)	0.618159	0.442490	1.397003	0.1858
C(6)	0.619101	0.356077	1.738673	0.1057
C(7)	-0.614806	0.429805	-1.430431	0.1762
C(8)	-0.845768	0.445394	-1.898922	0.0800
C(9)	-0.906462	0.498494	-1.818403	0.0921
C(10)	-0.480041	0.504571	-0.951384	0.3588
C(11)	-0.000617	0.085826	-0.007194	0.9944
R-squared	0.663454	Mean dependent var		-0.034259
Adjusted R-squared	0.404573	S.D. dependent var		0.366361
S.E. of regression	0.282698	Akaike info criterion		0.614690

Sum squared resid	1.038939	Schwarz criterion	1.154631
Log-likelihood	3.623720	Hannan-Quinn criteria.	0.757937
F-statistic	2.562775	Durbin-Watson stat	2.219191
Prob(F-statistic)	0.057310		

To analyze the short-run causality running from the variables tested to the GDP of Libya, we apply the Wald causality test. We used the VECM equation to test the causality from oil price and exchange rate to our dependent variable, the gross domestic product (GDP). First, we test for oil price with the coefficient C(5) =C(6)=C(7). In this respect, the null hypothesis of no causality is C(5) =C(6)=C(7)=0. The result obtained from the Wald test, as seen in Table 7, indicates that oil prices cause GDP to change in the short run. Second, we test for short-run causality from the exchange rate to GDP. Therefore, we test the null hypothesis of no causality as C(8) =C(9)=C(10)=0. However, the result from Table 8 shows that there is no short-run causality from the exchange rate to the GDP of Libya. In other words, the short-run causality test indicates that GDP responds to short-term shocks in the oil price. However, the result also shows that the exchange rate does not influence the GDP, which can be explained by the fact that Libya has maintained a fixed exchange rate.

Table: Wald Test Result

Test Statistic	Value	df	Probability
F-statistic	3.937976	(3, 13)	0.0336
Chi-square	11.81393	3	0.0080

Null Hypothesis: C(5)=C(6)=C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(5)	0.618159	0.442490
C(6)	0.619101	0.356077
C(7)	-0.614806	0.429805

Table: Wald Test Result

Test Statistic	Value	df	Probability
F-statistic	2.070463	(3, 13)	0.1537
Chi-square	6.211390	3	0.1018

Null Hypothesis: C(8)=C(9)=C(10)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(8)	-0.845768	0.445394
C(9)	-0.906462	0.498494
C(10)	-0.480041	0.504571

Conclusion

The present study applied an empirical analysis to investigate the effect of oil prices and the exchange rate on Libyan GDP using a sample of observations from 1990 to 2019. Augmented Dickey-Fuller (ADF) and Phillips and Perron tests were employed to test for the stationarity of the series. Besides, the Johansen cointegration test has been used to develop a VECM for the three variables that have been chosen in this paper. This paper used VECM to gauge the influence of oil prices and the exchange rate on GDP. Finally, the Wald test was applied for short-run causality. Based on the results obtained, there is a cointegration relationship between GDP and both oil price and exchange rate. Furthermore, there is a positive relationship between oil price and GDP, one percent increase in oil price increases the GDP of Libya by 7%. On the other hand, we found that the exchange rate negatively correlated with GDP. At the same time, the result from the Wald test indicated that there is no short-run causality from the exchange rate to GDP while the same test confirmed a short-run causality from oil price to GDP. This implies that Libya should not depend on oil exports to achieve a higher GDP and make it less vulnerable to external shocks since we have confirmed the sensitivity of GDP to the oil price. Also, this paper proves that the fixed exchange rate policy can have a very beneficial effect on the Libyan GDP.

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