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Article

Asymmetric Impacts of Oil Price on Inflation: An Empirical Study of African OPEC Member Countries

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Abstract: This study investigates the asymmetric impacts of oil price changes on inflation in Algeria, Angola, Libya and Nigeria. Three different oil price data were applied in this study; the actual spot oil price of individual countries, the OPEC reference basket oil price and an average of the Brent, WTI and Dubai oil price. The dynamic panels ARDL were used to estimate the short and the long-run impacts. Also, this study partitioned the oil price into positive and negative changes to capture asymmetric impacts and found both positive and negative oil price changes positively influenced inflation. However, the impact was found to be more significant when oil prices dropped. The results from the study also found that money supply, the exchange rate and GDP are positively related to inflation while food production is negatively related to inflation. Accordingly, policymakers should be cautious in formulating policies between the positive and negative changes in oil prices as it was shown that inflation increased when the oil price dropped. Additionally, the use of contractionary monetary policy would help to reduce the inflation rate, and lastly, it is proposed that the government should encourage domestic food production both in quantity and quality to reduce inflation.

Keywords: oil price; food production; inflation; asymmetric; Algeria; Angola; Libya; Nigeria

1. Introduction

During the 1970's, world economies experienced increasing inflation rates followed by the rapid rise in international crude oil prices. While, in contrast, the significant decrease in inflation experienced in the 1980's and 1990's was associated with falling oil prices in global markets [1]. However, despite the higher price for crude oil during the 2000s, the observation, in this case, suggests that inflation was lower in many countries compared with rising oil prices and inflation experienced in the 1970s [2]. Notwithstanding, the rise and decline in crude oil prices during the periods of inflation in 1970 and 1980 were quickly adjusted. However, more recently, little evidence has shown that changes in crude oil price influence inflation. This may be because many past studies employed linear time series methods suggesting that fluctuations or changes in oil prices may have a non-linear impact on inflation [3].

Notwithstanding, falling oil prices also weakened the overall foreign earnings of the African oil producing countries resulting in rising inflation rates given the demand for foreign offshore products; specifically for food items which did not fall. Interestingly, African countries are globally classified as food insecure countries [4]. In this instance, the price of goods and services continued to rise as oil prices fell whereas during periods of high oil prices, the price of goods and services did not fall, indicating non-linearity behavior of oil price changes on domestic prices. In 2016, the inflation rate in Angola, Libya and Nigerian hit double-digits. Notably, the inflation rate is usually volatile as it changes according to various reasons.

The oil boom during the mid-1970s was a case in point where the inflation rate was positively affected. Also, it is evidenced that positive and negative changes in oil prices in the same proportion

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will impact inflation differently. For example, in 2008, when oil prices increased, the inflation showed a more substantial response compared to when the oil price decreased in 2006 while during the middle of 2014, the oil price fell from US$115 per barrel to $52 per barrel, and inflation rose. Interestingly, this did not follow the previous pattern in the oil price hike as in the period between 2006 and 2008. The impact of oil price changes on inflation are ambiguous in oil exporting countries as increases in oil prices will increase the revenue in the economy and create inflation. Interestingly, in those economies, oil price decreases still cause the inflation rate to increase. Therefore, this study aims to examine the non-linear impact of oil price changes on inflation in African OPEC member countries.

Figure 1 displays the global crude oil price from 1975 to 2015. It can be seen that between 1975 and 1979 the price of crude oil was reasonably steady, and only fluctuating about US$12 to $14 per barrel during the period. Then, during the Iran-Iraq war and the Iranian revolution, from 1979 to 1980, crude oil production was cut by 10 percent, which in turn, influenced the price of crude oil to increase from US$14 to $35 per barrel [5]. Indeed, increasing oil prices have led towards the leading firms and major players in the industry to broaden the search for oil exploration and increase the production of oil by non-OPEC members.

Although in early 1982 to 1985 OPEC made an effort to stabilize the price of crude oil through production quotas, the global economic meltdown and illegal quotas produced by OPEC member countries contributed further to the drop of crude oil prices until reaching US$10 per barrel. In the mid-1980s, the fluctuation in the price of oil, however, rose more frequently than previously. In 1976, OPEC's contribution to the world's oil supply decreased from 55 percent to 42 percent in 2014 which shows that OPEC has slightly lost the means to control global oil prices. In June 2014, the oil price level reached a maximum price of US$115 per barrel, and around January 2016, the price dropped to less than US$30 per barrel due to increasing supply mostly by non-OPEC countries. Since then, the price of oil has been one of the most important global economic issues. Notwithstanding, the global economic crisis of 2008 to 2009 also contributed towards affecting oil prices. Although, the continuous fallen of oil prices has been significantly steeper compared to other non-oil prices such as metals and food prices [6].

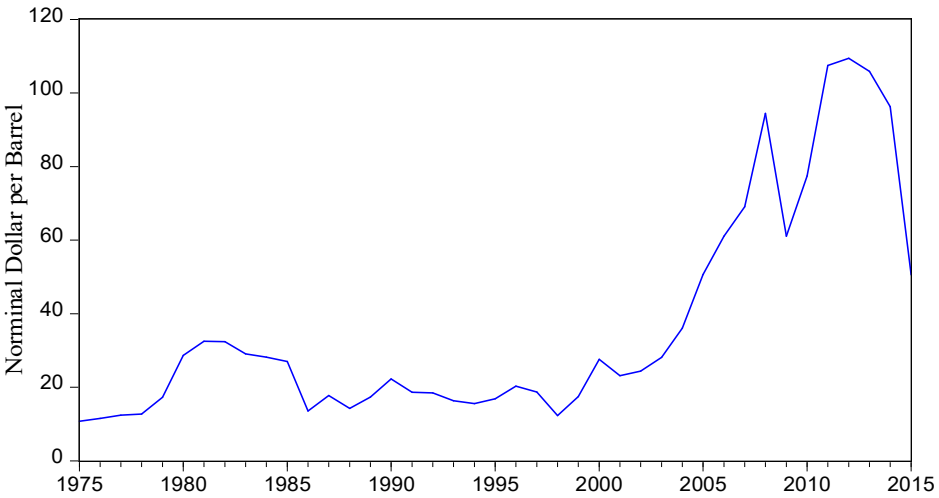

Figure 1. World Crude Oil Price Movements based on the OPEC reference price
Source: OPEC Annual Statistical Report [7]

Monetary policy is a highly effective measure for normalizing an economic condition which is affected by undesired shock and is also anticipated to promote price stability and long-term economic growth [8]. The common monetary policy tools that are frequently employed by central banks include; money supply (circulation of money), interest rates and exchange rates. Table 1 shows various monetary policy tools for four African oil producers that will be used in this study. Also, from the period of study, the African countries such as Algeria, Angola, Libya and Nigerian

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experienced depreciated exchange rates. In 1995, the official exchange rate of Algeria was 47.66/USD, Angola 0.001/USD, Libya 0.42/USD and Nigeria 21.90/USD whereas, in 2014 Algeria was 80.58/USD, Angola 98.30/USD, Libya 1.29/USD and Nigeria 158.55/USD. Notably, all of these countries mentioned experienced depreciation in exchange rates. Table 1, displays the money supply of the African OPEC Members from 1995 to 2014. In 1995, Libya had the highest exchange rate regarding money supply of 79.62, followed by Angola 40.10, Algeria 37.16 and Nigeria 15.87. While the money supply in Algeria, Angola and Nigeria increased gradually, the money supply of Libya increased 3-fold from 2010 to 2014. The leading causes of the money supply changes in Libya resulted from civil war and political instability that affected crude oil production.

Table 1. African OPEC Member Countries Monetary Policy Instruments

Years	1995	2000	2005	2010	2014
Exchange Rate/$)					
Algeria	47.66	75.26	73.28	74.39	80.58
Angola	0.0027	10.04	87.16	91.91	98.30
Libya	0.42	0.51	1.31	1.27	1.29
Nigeria	21.90	101.70	131.27	150.30	158.55
Money Supply(M2)					
Algeria	37.17	37.83	53.83	69.05	79.42
Angola	40.10	17.28	15.90	35.33	41.00
Libya	79.62	48.51	26.56	47.64	127.47
Nigeria	15.87	21.96	17.73	21.03	20.16

Source: OPEC Annual Statistical Report [7].

Figure 2 shows the relationship between the oil price and the inflation rate in oil exporting countries in a nonlinearity scatter plot. The graph reveals that in the initial stage, the relationship was positive with low oil price however when the oil price increased to a certain point the relationship became negative. Therefore, this shows that there is the possibility of a nonlinear relationship between the increase and decrease of oil prices and also has a different impact on inflation.

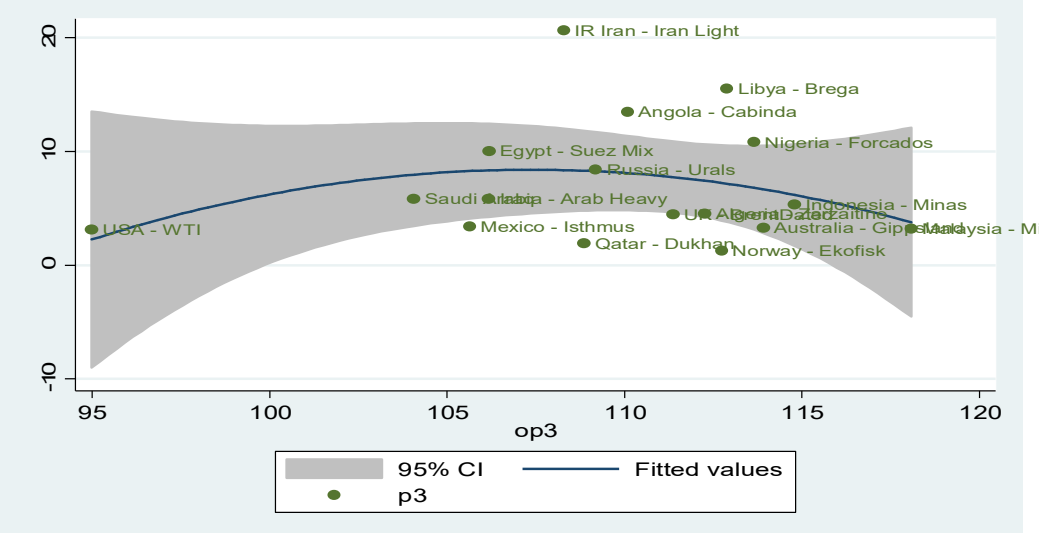

Figure 2. Oil Price and Inflation Rate in Oil Exporting Countries

Note: The oil exporting countries included in the graph and their respective oil prices are USA (WTI), IR Iran (Iran Light), Libya (Brega), Angola (Cabinda), Egypt (Suez Mix), Nigeria (Forcados), Russia (Urais), Saudi (Arab Light), Dubai (Arab Heavy), Indonesia (Minas), Mexico (Isthmus), UK (Brent), Angola (Girassol), Malaysia (Miri), Australia (Gipp), Qatar (Dukhan) and Norway (Ekofisk).

This paper is significant, as it extends the existing literature in four directions. First, this research is the earliest study contributing towards assessing the short-run and the long-run differential

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changes in the price of oil with regards to inflation in African OPEC members using the country's actual crude oil price. In contrary to the previous researches which used the general world's crude oil price, for example, the Brent price, West Texas Intermediate (WTI), or Dubai Brent, this study used the actual oil prices from the respective countries', namely; Algeria (Zarzaitine), Angola (Cabinda), Libya (Brega) and Nigeria (Bonny Light). Indeed, this is important because each type of crude oil will have a different price.

Secondly, this study will provide insight to respective monetary authorities or central banks which instrument monetary policy tools to stabilize the economic activities brought about by external shocks in oil price changes. Third, there is limited research considering the impact of oil price changes on the consumer price index (CPI) considering domestic food production and its role. This study included domestic food production in the model because the oil exporting countries like Algeria, Angola, Libya and Nigeria are food scarce countries. Fourth, as compared to the majority of previous literature that has investigated oil prices in African OPEC member countries employing the linear time-series model, this study provides recent empirical research that contributes to whether there is a non-linear impact from positive and negative oil price changes, towards inflation in African oil OPEC member countries.

2. Literature Review

Most studies exploring the impact of oil prices on inflation rates employed the linear time-series model. [9] applied the SVAR model with a view towards examining the impact of oil price on China's economy. The results revealed that increases in oil price have a positive impact on inflation, even though there is price control over domestic oil consumption and other commodities in domestic markets. In another study in China by [10] attempted to study China and the rest of the world by applying dynamic stochastic general equilibrium (DSGE). They found that the response of the total CPI is mostly driven by substantial price increases brought about by energy-intensive products. Moreover, oil supply shocks influenced China's CPI in the short-run due to uncertainty in price fluctuations and the nature of the energy markets. Especially towards the unexpected oil price changes thereby, creating an ambiguous effect in the general price level of oil [11]. By applying SVAR to examine the vulnerability of domestic prices against oil price shocks in ASEAN-4 countries, [12] found that a positive shock to oil price could reduce the CPI in Indonesia, but would increase the CPI in the Philippines and Thailand, while in Malaysia, there was no significant effect on the CPI.

[13] applied the Bayesian VAR model to examine the impact of oil price and inflation in USA quarterly data from 1948:1 to 2011:2. They found that oil price fluctuations do not necessarily spread and result in changes to overall inflation but rather are time specific. Some of the subsequent researchers attempted to investigate further the argument that oil price can affect CPI but not economic activities. [14] applied the USA monthly data ranging from 1974:1 to 2014:7 and disaggregated the consumer price into five different components and compared the impact of oil price separately. The results revealed that oil price shock has significant positive effects on the energy-intensive CPI. While [15] used the Autoregressive Distributed Lags (ARDL) method to study the pass-through effect of oil prices in Malaysia's consumer prices. The results indicated that oil prices and inflation have a positive relationship. On the contrary, [16] found that since 1980, oil price pass-through has become negligible. In a recent study by [17] the authors found that a fluctuation in oil price is absorbed and disappeared within the first five to six quarters after the shocks occurred. Notably, the shocks do not have any significant impact in the long-run, especially when the oil price is converted to domestic currency.

With the advancement of statistical tools, some studies applied nonlinear methods to examine the relationship between oil prices and inflation. [18] estimated monthly data from January 1981 to May 2011 and applied a nonlinear error-correction model revealing that oil price has long-run pass-through effects on producer price in Taiwan. Moreover, the adjustment of error-correction will be faster when the deviation of price from the equilibrium is more substantial. Similar findings were reported by [19] where they investigated the asymmetric response in the price of gasoline in France. In this study, they applied autoregressive distributed lags (ARDL), finding asymmetric relations

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when oil price changes and gasoline prices gradually adjusted to a long-equilibrium position. In this case, the adjustment was found to be faster when the crude oil price increases rather than decreases. In a separate study, [20] found that Iran is hugely exposed to oil price changes with asymmetric impacts to the economy. The study revealed that positive and negative oil price shocks significantly increase inflation, but the magnitude depends on the size of the shock. [21] showed that inflation is profoundly affected by oil price shock and to some extent, the impact is asymmetric where negative oil price shock confirmed the impact compared to the positive shock noted in India. [22] applied a multivariate two-regime threshold VAR model to assess the impact of oil prices in Turkey and found that oil price changes have a significant effect on inflation when the changes exceed the optimal threshold point and have the ability to influence macroeconomic variables adversely.

[23] investigated the relationship between food price and oil price on Malaysian annual data ranging between 1971 and 2012 applying non-linear ARDL to estimate the asymmetric impacts of oil price. The study found that there is an asymmetric relation and that long-run positive oil prices significantly influence food price while negative oil prices would not affect food prices. In the study of [24], the authors examined both internal and external factors influencing Ghana's inflation, finding that in Ghana and the Ivory-Coast there is a significant intra-continental transfer of inflation. The study also found a negative correlation between the food production index and inflation which indicates that an increase in food supply reduces the inflation rate. Furthermore, after considering the uncertainty of oil price fluctuations, they suggested that to reduce the inflation rate the government should place more effort into securing foodstuff. In recent [25] examined the long run impact of oil export and food production on inflation in African OPEC member countries. Found that oil exports has positive and significant impact connected to inflation meanwhile increases in food production has negative impact related to inflation.

The above discussion offers further insight, contrast and understanding of how oil price shocks have been investigated in other studies. Many different methods have been applied in previous research studies to explore how variable economic indicators are affected by oil price shock. Among these arguments - and especially the impact of oil price shock - symmetry or asymmetry are still debated as to what extent oil prices are endogenous. Also, all the above studies use the global world's crude oil price as the proxy for oil price. In fact, there are many types of crude oil as mentioned earlier as each country produces a different type of crude oil which also differs in price. Hence, this study intends to fill the gap in the literature by considering the actual crude oil price of the respective countries. Furthermore, this study also explores how the possibility of domestic food production increases will reduce the rate of inflation and whether persistent increases in food prices result from shortages in food production.

3. Econometrics Framework

Figure 3 is partially extracted from the theoretical framework of the oil price transmission channel. From the work of [26, 9, 12], oil price has a direct effect on inflation in an economy, as it implies that an increase in oil price and money supply will lead to an increase in the general price level.

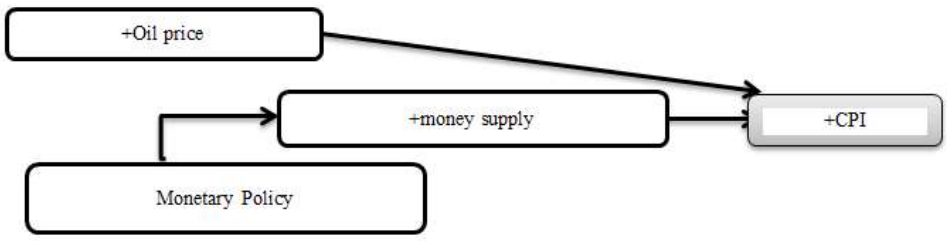

Figure 3. Oil Price Transmission Channel into CPI

3.1. Panel ARDL Models Specification

The extracted theoretical framework of oil price and the inflation channel can be written as:

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$$cpi = f\ (op, m) \tag{1}$$

Where cpi is the consumer price index as a proxy for inflation, op is the spot oil price, and m is the money supply. In addition, this study will include the food production index (FPI) in the model of oil price and inflation because these four African OPEC members (Algeria, Angola, Libya and Nigeria) are food scarce countries as mentioned earlier. As noted by [27] domestic food prices are affected by global crude oil price shock, especially in countries with high levels of subsistence food production. Therefore Equation (1) can be extended as follows:

$$cpi = f\ (op, m, fpi) \tag{2}$$

Next, the impact of oil price changes on inflation in four African OPEC members will be examined with the dynamic approach in a linear and nonlinear specification. We re-write the equation (2) with econometrics linear ARDL format in Equation (3). While in equation (4) the nonlinear specification model was used to detect the possibility of asymmetric relationship between oil price and inflation in accordance with the panel NARDL setup in Equation (4).

3.1.1. Linear Model Specification

$$lcpi_{it} = \alpha_0 + \beta_1 lop_{it} + \beta_2 lm_{it} + \beta_3 lfpi_{it} + \beta_4 lX_{it} + \mu_{it} \tag{3}$$

3.1.2. Nonlinear Model Specification

$$lcpi_{it} = \alpha_0 + \beta_1 lop_{it}^{+} + \beta_2 lop_{it}^{-} + \beta_3 lm_{it} + \beta_4 lfpi_{it} + \beta_5 lX_{it} + \mu_{it} \tag{4}$$

Where: $lcpi_t$ is the log of consumer price index, $lop_t^{+}\ and\ lop_t^{-}$ are positive and negative oil price changes, lm_t is a log of money supply as monetary policy instruments, $lfpi_t$ is the log of food production index and lX_{it} is other control variable (Exchange rate and GDP). The inclusion of these control variables was motivated by the role of monetary policy in sharpening the economy during oil price shocks. If the monetary authorities act to hold the growth of nominal GDP constant, the inflation rate will accelerate at the same rate at which the real GDP growth slows. If the monetary authorities hold the nominal exchange rate constant, the inflation rate will reduce and the pressure on foreign currency will increase (see, Brown and Yucel 2002). All those symbols $(\beta_{1,}, \beta_2, \beta_3, \beta_4)$ are the coefficients vectors of long-run parameters to be estimated.

From the linear model (Equation 3), it is expected that $\beta_{1,}, \beta_2$, to be positive while β_3 to be negative on inflation. The model represents all four African OPEC members (Algeria, Angola, Libya and Nigeria). Based on the nonlinear model (Equation 4), the formation of the long-run impacts of oil price increases on inflation is β_1 in Equation (5), which is expected to be positive. Meanwhile, β_2 in Equation (6) captures the long-run relations between the reductions in oil price on inflation. It is expected to move in the same direction, so β_2 is expected to be positive. In addition, the reduction in oil price has a greater impact on rising inflation compared to increases in oil price with the same magnitude, i.e. $\beta 2 > \beta 1$.

$$\beta_1 op_{it}^{+} = \sum_{j=1}^{t} \Delta op_j^{+} = \sum_{j=1}^{t} \max\left(\Delta op_j, 0\right) \tag{5}$$

$$\beta_2 op_{it}^{-} = \sum_{j=1}^{t} \Delta op_j^{-} = \sum_{j=1}^{t} \min(\Delta op_j, 0) \tag{6}$$

As shown in [29] framed a NARDL setting along with the extension techniques as [30], [31] expressed in ARDL as:

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$$\Delta lcpi_{it} = \alpha_0 + \beta_1 lcpi_{it-1} + \beta_2 lop_{it}^{+} + \beta_3 lop_{it}^{-} + \beta_4 lm_{it} + \beta_5 lfpi_{it} + \beta_5 lX_{it} + \sum_{i=1}^{p} \pi_i \Delta\, lcpi_{it-i} + \sum_{i=1}^{p} \emptyset_i \Delta\, lcpi_{it-i} + \sum_{i=0}^{q} p_i \Delta\, lm_{it-i} + \sum_{i=0}^{q} p_i \Delta\, lfpi_{it-i} + \sum_{i=0}^{q} p_i \Delta\, lX_{it-i} + \sum_{i=0}^{q} (\propto_i^{+} \Delta lop_{it-i}^{+} + \propto_i^{-} \Delta lop_{it-i}^{-}) + \mu_{it} \quad (7)$$

Where, the variables as defined above, p and q are lag orders and $\beta_2 = -\beta_2/\alpha_0$, $\beta_3 = -\beta_3/\alpha_0$, the aforementioned long-run impacts of respectively oil price increase and oil price reduction on the inflation. $\sum_{i=0}^{q} \propto_i^{+}$ is the measure of short-run influences in oil price increases on inflation while $\sum_{i=0}^{q} \propto_i^{-}$ is the short-run influences in an oil price reduction on inflation. Hence, in this setting, in addition to the asymmetric long-run relation, the asymmetric short-run influences of oil price changes on inflation are also captured. The analysis procedures are as follows. Firstly, the preliminary tests are used to examine the nature of the data of each variable and its structure.

Four different panel unit-root tests were used to examine the data namely, Levin, Lin, Chu [32], Im, Pesaran, Shin [33], Fisher-ADF and Fisher PP were suggested by [34]. Secondly, this study employed the Pedroni residual test, which is based on the panel cointegration procedure. The PMG and MG estimators have been used in detecting the short-run and the long-run coefficient including error correction term. Furthermore, this study examined the impacts of oil price changes in the nonlinear specification, using the same PMG and MG estimators. Three different proxy of oil price were used; the specific country oil price, OPEC reference oil price and average Brent, WTI and Dubai oil price.

4. Data and Descriptive Statistics

This study applied strongly balanced panel data, comprising of the oil price, CPI, money supply (M2), food production index (FPI) exchange rate (E) and gross domestic product (GDP). This study used annual data from the period of 1995 to 2014. The data were chosen based on the availability. The sample countries; Algeria, Angola, Libya and Nigeria have been selected given that they are in the same cartel OPEC and sharing the same continent. The oil price data used were the OPEC reference oil price, an average oil price of Brent, WTI and Dubai and the individual oil price from the respective country. For example; the Saharan Blend oil price for Algeria, the Girassol oil price for Angola, the Ess Sider oil price for Libya and the Bonny Light oil price for Nigeria. The inflation was a proxy with average consumer price index (CPI), and money supply was a proxy with M2 in USD. Food production was a proxy with FPI, the exchange rate was a proxy with the average official exchange rate against USD, and economic growth was a proxy with GDP constant USD. The data were converted to natural log.

The descriptive statistics and correlation matrix for the oil price and inflation results, presenting the features of the variables in Table 2, show the data mean, standard deviation, maximum and the minimum value of each variable both overall, between and within. The overall mean of annual CPI of African OPEC members is 74.98, oil price (54.83), food production (100.51), money supply (40.79), exchange rate (59.29), and gross domestic products (95,851). The correlation matrix displays the sign and magnitude of each variable which depends on the other variables in Table 3a, Table 3b and Table 3c where there is a positive correlation between the dependent variable (CPI) and all the independent variables. Among the independent variables, oil price is positively related to food price, money supply, exchange rate and GDP. Food production is positively related to money supply, exchange rate and GDP. Money supply is positively related to food production, which is negatively related to exchange rate and GDP and the exchange rate is positively related to GDP.

Table 2. Descriptive Analysis

Variable		Mean	Std. dev.	Min	Max
CPI	Overall	74.9837	38.0718	0.0006	146.0394
	Between		19.4111	53.4242	96.8450

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	Within		34.1070	21.5602	167.5989
OPC	Overall	54.8368	35.6944	12.2800	114.1500
	Between		0.8666	53.9565	55.8295
	Within		35.6864	11.7773	113.1574
OPEC	Overall	52.8825	34.32606	12.28	109.45
	Between		0	52.8825	52.8825
	Within		34.32606	12.28	109.45
OP	Overall	53.3972	33.58019	13.07667	105.0125
	Between		0	53.39722	53.39722
	Within		33.58019	13.07667	105.0125
FPI	Overall	100.5181	32.0088	46.0700	213.3900
	Between		7.4388	91.6992	109.5935
	Within		31.3454	36.9945	204.3146
E	Overall	59.2915	50.3602	0.0027	158.5526
	Between		45.2360	0.9945	110.3545
	Within		31.3369	-29.1785	107.4897
M2	Overall	40.7900	23.9209	13.2307	131.7197
	Between		19.2011	22.1446	57.8042
	Within		17.0938	8.9813	114.7056
GDP	Overall	95851.01	110624	4670	561600
	Between		62940.88	46625.75	178607
	Within		96067.12	-50229.99	478844

Notes: CPI = consumer price index, OPC = specific oil price for the countries, OPEC = OPEC reference oil price, OP = average oil price of Brent, WTI and Dubai, FPI = food production index, E = exchange rate, M2 = money supply, GDP = GDP per capita current. n = 4, T = 20 and N = 80.

Table 1a. Correlation Matrix for OPC Oil Price and Inflation

	CPI	**OPC**	**FPI**	**E**	**M2**	**GDP**
CPI	1.0000					
OPC	0.7396	1.0000				
FPI	0.7385	0.7294	1.0000			
E	0.2259	0.3751	0.3012	1.0000		
M2	0.5308	0.2911	0.2412	-0.2966	1.0000	
GDP	0.5616	0.6451	0.3439	0.6625	-0.0398	1.0000

Table 3b. Correlation Matrix for OPEC Oil Price and Inflation

	CPI	**OPEC**	**FPI**	**E**	**M2**	**GDP**
CPI	1.0000					
OPEC	0.7394	1.0000				
FPI	0.7385	0.7352	1.0000			
E	0.5308	0.2942	0.2412	1.0000		
M2	0.2259	0.3605	0.3012	-0.2966	1.0000	
GDP	0.5616	0.6332	0.3439	-0.0398	0.6625	1.0000

Table 3c. Correlation Matrix for OP Oil Price and Inflation

	CPI	**OP**	**FPI**	**E**	**M2**	**GDP**
CPI	1.0000					
OP	0.7354	1.0000				
FPI	0.7385	0.7344	1.0000			
E	0.5308	0.2854	0.2412	1.0000		
M2	0.2259	0.3647	0.3012	-0.2966	1.0000	
GDP	0.5616	0.6293	0.3439	-0.0398	0.6625	1.0000

3. Results and Discussion

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3.1. Panel Unit-root Test

It is recommended that before conducting the panel cointegration test, the level of stationarity of the variables need to be identified. As earlier stated there are four different approaches of unit-root test applied confirm the stationarity of each variable, LLC, IPS, Fisher-ADF and Fisher PP. The Fisher ADP and Fisher PP are reasonably straightforward and nonparametric unit-root test. The test was conducted in two different modes; initially, the test was carried out with an intercept and with an intercept and linear trend in all methods.

Table 4 presents the panel unit-root data test, revealing that the null hypothesis cannot be rejected at the level form for the CPI, FPI and GDP variables. The other variables OPC, OPEC, OP, E and M2, are stationary at the level form. The OPC, OPEC and OP are stationary when the trend is used in LLC and IPS while without the trend, they are rejected. E is stationary only when not using the trend in LLC while M2 is stationary only when the trend is used in LLC. Moreover, all the variables are stationary after being converted into the first difference. In summary, the stationarity results from the four different techniques confirm the fact that all the variables are free from the unit-root in the second difference. The next step is to conduct the panel cointegration test.

Table 4. Panel Unit-root Results

		LLC	IPS	Fisher-ADF	Fisher PP	LLC	IPS	Fisher-ADF	Fisher PP
		Level				First Difference			
CPI	No trend	7.11	7.17	0.50	0.16	-2.41***	-1.82**	16.70***	14.61
		(1.00)	(1.00)	(0.99)	(1.00)	(0.00)	(0.03)	(0.03)	(0.06)
	Trend	-0.29	1.84	4.99	3.17	-2.03**	-1.87**	15.74**	32.48***
		(0.38)	(0.96)	(0.75)	(0.92)	(0.02)	(0.03)	(0.04)	(0.00)
OPC	No trend	-0.86	1.73	1.58	1.08	-5.48***	-5.28***	40.41***	73.05***
		(0.19)	(0.95)	(0.99)	(0.99)	(0.00)	(0.00)	(0.00)	(0.00)
	Trend	-4.00***	-1.66**	13.58	11.53	-4.04***	-3.79***	27.91***	70.78***
		(0.00)	(0.04)	(0.09)	(0.17)	(0.00)	(0.00)	(0.00)	(0.00)
OPEC	No trend	-0.78	1.80	1.49	1.02	-5.35***	-5.25***	40.17***	63.32***
		(0.21)	(0.96)	(0.99)	(0.99)	(0.00)	(0.00)	(0.00)	(0.00)
	Trend	-3.98***	-1.63	13.43	11.49	-4.10***	-3.79***	27.92***	73.68***
		(0.00)	(0.05)	(0.09)	(0.17)	(0.00)	(0.00)	(0.00)	(0.00)
OP	No trend	-0.86	1.76	1.55	1.02	-5.72***	-5.07***	38.77***	73.68***
		(0.19)	(0.96)	(0.99)	(0.99)	(0.00)	(0.00)	(0.00)	(0.00)
	Trend	-0.42***	-1.89**	14.84	13.19	-7.93***	-6.32***	43.26***	66.82***
		(0.00)	(0.02)	(0.06)	(0.10)	(0.00)	(0.00)	(0.00)	(0.00)
M2	No trend	-0.38	-0.52	9.21	6.40	-5.90***	-4.20***	32.76***	56.21***
		(0.35)	(0.29)	(0.32)	(0.60)	(0.00)	(0.00)	(0.00)	(0.00)
	Trend	-1.90**	-0.08	8.62	8.79	-6.11***	-5.29***	36.79***	48.22***
		(0.02)	(0.46)	(0.37)	(0.36)	(0.00)	(0.00)	(0.00)	(0.00)
FPI	No trend	2.84	3.23	2.30	2.49	0.20	-4.25***	33.71***	75.84***
		(0.99)	(0.99)	(0.97)	(0.96)	(0.58)	(0.00)	(0.00)	(0.00)
	Trend	0.25	-0.61	10.76	13.64	1.05	-5.88***	41.43***	63.05***
		(0.60)	(0.27)	(0.21)	(0.09)	(0.85)	(0.00)	(0.00)	(0.00)
E	No trend	-1.74**	-0.29	6.80	7.81	-5.28***	-4.17***	31.11***	28.61***
		(0.04)	(0.38)	(0.55)	(0.45)	(0.00)	(0.00)	(0.00)	(0.00)
	Trend	-0.89	-0.31	9.15	2.98	-4.81***	-3.21***	23.05***	21.74**
		(0.19)	(0.37)	(0.32)	(0.93)	(0.00)	(0.00)	(0.00)	(0.02
GDP	No trend	3.16	4.32	3.45	3.33	-6.94***	-6.07***	45.56***	49.80***
		(0.99)	(1.00)	(0.90)	(0.91)	(0.00)	(0.00)	(0.00)	(0.00)
	Trend	-1.41	0.51	5.78	5.93	-7.67***	-6.46***	45.52***	63.41***
		(0.07)	(0.69)	(0.67)	(0.65)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: Figures in parentheses are probability values. ** and *** denote rejection of the null of non-stationary at the 5 and 1 percent levels of significance. The maximum numbers of lags length are selected based on Akaike information criterion (AIC).

3.2. Panel Cointegration Results

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Based on the unit-root test results indicate that the variables are stationary. Therefore, the study moves further to determine the long-run relation among the variables in the models. The panel cointegration test proposed by [35] was used. The panel cointegration test which has heterogeneous features also allows for cross-sectional interdependence with different individual effects. Pedroni provides seven different sets of residual-based tests, which are divided into two groups. Four out of seven are within dimension tests, namely; panel v-statistic, panel rho-statistic, panel PP-statistic and panel ADP-statistic. While the remaining three are between dimension tests, namely; group rho-statistic, group PP-statistic and group ADF-statistic.

The within dimension regression is based on pooling estimators in the autoregressive coefficient across individual countries on the residuals, while the between dimension is based on averaging individual coefficients estimators of each country. The panel cointegration results between oil price and inflation were conducted in two different specifications, namely; linear and nonlinear. The result of the panel cointegration based on the linear specification is presented in Table A1 of the Appendix. The cointegration results reveal that three to four out of seven null hypotheses of no cointegration have been rejected at the 1 % and 5 % level of significance. Therefore, the models are cointegrated in both within the dimension and between dimensions. Table 5 presents the result of the panel cointegration based on the nonlinear specification. For each specification, three models are estimated. Furthermore, where three different indicators of oil price, namely specific spot oil price of individual countries, OPEC reference oil price and an average of UK Brent, U.S WTI and Dubai oil price are used interchangeably, for each model, the first columns are estimated without trend while the second columns include the trend accordingly.

In the nonlinear specification process, this study employed the robust model from the linear specification and partitioned the oil price into positive and negative changes. Further, this study partitioned three different proxy of country-specific oil price (OPC), namely; OPEC reference basket oil price (OPEC) and an average of UK Brent, US WTI and Dubai oil price (OP) into positive and negative changes. The cointegration results in Table 5 reveal that four out of seven null hypotheses in the three models had been rejected at the 1 % and 5 % level of significance. Therefore, there is evidence of a long-run nonlinear relationship between oil price and inflation in African OPEC members in both within the dimension and between dimensions.

Table 5. Nonlinear Panel Cointegration Results

	Model 1		**Model 2**		**Model 3**	
Equations	$CPI = f(OP^+, OP^-, M2, E, FP, GDP)$		$CPI = f(OPEC^+, OPEC^-, M2, E, FP, GDP)$		$CPI = f(OPC^+, OPC^-, M2, E, FP, GDP)$	
	Model w/o trend	Model with trend	Model w/o trend	Model with trend	Model w/o trend	Model with trend
Panel v-statistic	-0.1030 (0.54)	-0.3197 (0.62)	-0.1388 (0.55)	-0.4456 (0.67)	-0.1593 (0.56)	-0.4650 (0.67)
Panel rho-statistic	1.0994 (0.86)	1.7611 (0.96)	1.1786 (0.88)	1.8051 (0.96)	1.1760 (0.88)	1.8150 (0.96)
Panel PP-statistic	-5.4535*** (0.00)	-5.1350*** (0.00)	-5.6242*** (0.00)	-5.2748*** (0.00)	-5.4877*** (0.00)	-5.1856*** (0.00)
Panel ADF-statistic	-7.5297*** (0.00)	-6.7085*** (0.00)	-8.3785*** (0.00)	-7.2733*** (0.00)	-8.2525*** (0.00)	-7.2418*** (0.00)
Group rho-statistic	2.2824 (0.98)	2.5763 (0.99)	2.3969 (0.99)	2.7397 (0.99)	2.3887 (0.99)	2.7185 (0.99)
Group PP-statistic	-2.0298** (0.02)	-1.8908** (0.02)	-1.9966** (0.02)	-1.8098** (0.03)	-1.9178** (0.02)	-1.8415** (0.03)
Group ADF -statistic	-3.8141*** (0.00)	-2.9324*** (0.00)	-4.4643*** (0.00)	-3.1794*** (0.00)	-4.4129*** (0.00)	-3.2274*** (0.00)

Notes: the figures in parentheses are the probabilities values. *, ** and *** denote the level of significance at 10, 5 and 1 percent respectively. Number of countries (N) = 4 and periods (T) = 20. The maximum lags are automatically selected by Akaike information criterion (AIC).

3.3. PMG and MG Results

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Since the evidence of long-run relationship was found from various oil price changes and inflation models, the pooled mean group (PMG) and mean group (MG) estimators are used to estimate the short-run and long-run dynamic relationship with the presence of the error correction term. After the two methodologies were estimated, the Hausman test was used to detect and recommend which estimator is most suitable for the model. The results of linear PMG and MG are presented in Table A2 of the Appendix. The Hausman test indicates that PMG is the appropriate model. The PMG results were found in accordance with the study's expectation.

Table 6 provides the results from the nonlinear specification for the PMG and MG results with three different proxies of oil prices, namely; OP, OPEC and OPC. The impacts of oil prices on inflation are separated into two parts (positive and negative changes). Next, the study applied the Hausman test to determine the best estimator between the PMG and MG, and it was found that PMG is better. The outcome of the PMG model reveals that both positive and negative oil price changes positively influence inflation in an asymmetric way. The results from the three models of oil prices OPC, OPEC and OP reveal that 1 percent increases in oil price are related to 0.005, 0.002 and 0.002 percent increases in inflation respectively. While a 1 percent reduction in oil price is related to 0.007, 0.004 and 0.004 percent increases in inflation respectively.

Notwithstanding, the nonlinear impact of oil price on inflation is higher when the oil price dropped. Therefore, the results indicate that the impact of a specific country's oil price is higher in causing inflation. However, this study observed that it is better to use an individual country-specific oil price since every country has a different oil price. In models 2 and 3 when the world's oil price was used, the impacts are the same as using the OPEC reference and OP since there is no difference between the countries. The results also revealed that food production affected inflation negatively as an increase in domestic food production reduces the rate of inflation in all models.

Furthermore, it is shown that a 1 percent increase in food production is associated with a 0.78, 1.17 and 1.17 percent reduction respectively in inflation in the long-run with the three proxies of oil prices. From the results, when other proxies of oil price were used OPEC and OP, the impact of food production becomes high. The results also revealed that exchange rate depreciation increases inflation. This observation is in line with the actual situation occurring in African OPEC members. Moreover, all the control variables in the nonlinear models maintained the same sign as in the linear models. Money supply, exchange rate and gross domestic products have a positive sign while food production has a negative sign. The coefficients of error correction term from the three models are negative, less than one and are a significant indication that there is evidence of convergence toward the long-run equilibrium.

Table 6. Oil Price Nonlinear PMG and MG Results

	Model 1		**Model 2**		**Model 3**	
Long-run	**P**MG	MG	**P**MG	MG	**P**MG	MG
OPC+	0.005***	0.002	-	-	-	-
	(4.08)	(1.32)				
OPC-	0.007**	0.002	-	-	-	-
	(2.18)	(0.90)				
OPEC+	-	-	0.02***	0.007	-	-
			(3.79)	(1.12)		
OPEC-	-	-	0.04**	0.017	-	-
			(2.18)	(0.84)		
OP+	-	-	-	-	0.02***	0.007
					(3.79)	(1.12)
OP-	-	-	-	-	0.04**	0.017
					(2.18)	(0.84)
LM2	0.50***	0.36**	0.54***	0.34***	0.54***	0.34
	(6.39)	(2.55)	(6.30)	(2.71)	(6.30)	(2.71)***
LE	0.34***	0.46***	0.39***	0.47**	0.39***	0.47**
	(7.59)	(2.69)	(7.60)	(2.46)	(7.60)	(2.46)
LFPI	-0.78**	-0.81	-1.17***	-0.80	-1.17***	-0.80

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	(-2.10)	(-1.18)	(-2.76)	(-1.12)	(-2.76)	(-1.12)
LGDP	0.48***	0.42***	0.51***	0.38***	0.51***	0.38***
	(9.14)	(4.56)	(8.84)	(4.26)	(8.84)	(4.26)
ECT	-0.23***	-0.007	-0.21***	0.02	-0.21***	0.02
	(-3.22)	(0.001)	(-2.65)	(0.05)	(-2.65)	(0.05)
Short-run						
OP+	0.001***	0.004	0.01**	-0.001	0.01**	-0.001
	(2.63)	(0.65)	(2.48)	(-0.30)	(2.48)	(-0.30)
OP-	-0.004	0.009	-0.02	0.001	-0.02	0.001 (0.16)
	(-0.85)	(1.07)	(-0.89)	(0.16)	(-0.89)	
LM2	0.01	0.01	0.02	0.02	0.02	0.02
	(0.25)	(0.29)	(0.33)	(0.42)	(0.33)	(0.42)
LE	-0.03	0.17	0.003	0.18	0.003	0.18
	(-0.33)	(1.61)	(0.04)	(1.64)	(0.04)	(1.64)
LFPI	-0.03	-0.01	-0.01	-0.01	-0.01	-0.01
	(-1.33)	(-0.59)	(-0.64)	(-0.48)	(-0.64)	(-0.48)
LGDP	0.13	0.02	0.13	0.02	0.13	0.02
	(1.47)	(0.30)	(1.56)	(0.40)	(1.56)	(0.40)
Cons	0.02	2.26	0.28*	2.26	0.28*	2.26
	(0.19)	(1.27)	(1.78)	(1.35)	(1.78)	(1.35)
Hausman Test		(0.50)		(0.96)		(0.96)
Size (N x T)	320	320	320	320	320	320

Notes: Figures in parentheses are t-statistics values. *, ** and denote the level of significance at 10, 5 and 1 percent respectively.

5. Conclusions

This study aimed to examine the impact of oil price changes on inflation in African OPEC members. Accordingly, the study used annual panel data of four African OPEC members namely Algeria, Angola, Libya and Nigeria ranging from 1995 to 2014. Further, this study used specific countries spot oil price Algeria (Saharan Brend), Angola (Girassol), Libya (Ess Sider) and Nigeria (Bonny Light). The Pedroni cointegration test was employed to establish the cointegration relationship between the variables of interest and the dynamic panel ARDL (PMG and MG models) were used to examine the short and the long-run impact of oil price changes on inflation. In the linear models, it was found that the long-run coefficient of oil price, money supply, exchange rate and GDP positively affected inflation while food production adversely influenced inflation.

Furthermore, the linear specification has low power to detect the asymmetric behaviour of oil price and this study further estimated the model using nonlinear specification by decomposing oil price into positive and negative changes. In the nonlinear model, it was found that the positive and negative changes in oil price encourage inflation but the impact on inflation is more significant when the oil price dropped. Also, the positive and negative changes in oil price encourage inflation, but the impact is more prominent when the oil price dropped. This showed that the policymakers could maintain the targeted inflation rate when the oil price is high rather than when it is low. Also, the policymakers can use the monetary policy tools, such as money supply to tackle the targeted inflation rate. This study concluded that efficient food production had reduced the rate of inflation in African OPEC member countries.

The findings of this paper will serve as an essential contribution to the considerations of policymakers in steering the policy outline for African OPEC members. First and foremost, the findings that are drawn from the non-linear relationship between oil price change and inflation indicates 1 percent increases and decreases in oil price are related to 0.005 percent rises in inflation and 0.007 percent rises in inflation. Accordingly, policymakers should use different policy between

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positive and negative oil price changes as it is shown that inflation is high when oil prices decrease. Further, policymakers can use the contractionary monetary policy to reduce the inflation rate.

Likewise, the government should encourage domestic food production both in quantity and quality to reduce inflation. The results show that efficient food production is also an anti-inflationary, as a 1 percent increase in food production will reduce the inflation rate by about 0.78 percent. Notably, the agricultural administrators of African countries need to have effective programs available and introduced on food production to benefit their economies. The advanced technique of farming through the use of mechanised farming machines will also help to improve food production. The result further shows that a more food secured state is also anti-inflationary and therefore, the government should support the agricultural sector to improve domestic food production.

Appendix A

Table A1. Linear Panel Cointegration Results

Models	**Model 1**		**Model 2**		**Model 3**	
	$CPI = f(OPC, M2, E, FPI, GDP)$		$CPI = f(OPEC, M2, E, FPI, GDP)$		$CPI = f(OP, M2, E, FPI, GDP)$	
	w/o trend	with trend	w/o trend	with trend	w/o trend	with trend
Panel v-statistic	-0.307	0.290	-0.315	0.540	-0.415	0.290
	(0.62)	(0.38)	(0.62)	(0.29)	(0.66)	(0.38)
Panel rho-statistic	1.075	1.966	1.068	2.113	0.998	1.966
	(0.85)	(0.97)	(0.85)	(0.98)	(0.84)	(0.97)
Panel PP-statistic	-3.41***	-4.251***	-3.36***	-2.971***	-4.180***	-4.251***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Panel ADF-statistic	-1.763**	-4.390***	-3.37***	-3.793***	-2.119**	-4.390***
	(0.03)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Group rho-statistic	1.927	2.082	2.0714	2.187***	1.851	2.082
	(0.97)	(0.98)	(0.98)	(0.98)	(0.96)	(0.98)
Group PP-statistic	-3.19***	-4.340***	-2.76***	-3.101***	-3.726***	-4.340***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Group ADF-statistic	-1.508*	-3.107***	-2.093**	-2.507***	-1.854**	-3.107***
	(0.06)	(0.00)	(0.01)	(0.00)	(0.03)	(0.00)

Notes: the figures in parentheses are the probabilities values. *, ** and *** denote the level of significance at 10, 5 and 1 percent respectively. Number of countries (N) = 4 and periods (T) = 20. The maximum lags are automatically selected by Akaike information criterion (AIC).

Table A2. Linear PMG and MG Results

Models	**Model 1**		**Model 2**		**Model 3**	
Long-run	**PMG**	**MG**	**PMG**	**MG**	**PMG**	**MG**
OPC	0.34**	0.41				
	(2.39)	(0.89)	-	-	-	-
OPEC			0.39**	0.50		
	-	-	(2.44)	(1.03)	-	-
OP					0.37***	0.37
	-	-	-	-	(2.70)	(0.75)
LM2	0.21***	0.43*	0.20***	0.48*	0.20***	0.37*
	(2.74)	(1.92)	(2.61)	(1.85)	(2.91)	(1.69)
LE	0.22***	-0.10	0.21***	-0.17	0.21***	-.0.01
	(5.08)	(-0.25)	(5.03)	(-0.38)	(5.63)	(-0.03)
LFPI	-1.55***	-4.19	-.1.57***	-4.75	-1.57***	-4.27
	(-3.18)	(-1.00)	(-3.17)	(-0.99)	(-3.47)	(-1.04)
LGDP	0.38***	0.58**	0.35***	0.56	0.39***	0.70***

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	(6.40)	(1.78)	(5.08)	(1.24)	(7.32)	(2.84)
ECT	-0.18**	0.05	-0.18**	0.05	-0.18**	0.02
	(-2.17)	(0.18)	(-2.14)	(0.20)	(-2.05)	(0.09)
Short-run						
OPC	0.22	0.07	-	-	-	-
	(1.15)	(0.89)				
OPEC	-	-	0.22	0.07	-	-
			(1.15)	(0.93)		
OP	-	-	-	-	0.21	0.09
					(1.15)	(1.08)
LM2	-0.05*	-0.07**	-0.05*	-0.07**	-0.06*	-0.07**
	(-1.83)	(-2.33)	(-1.85)	(-2.64)	(-1.81)	(-2.24)
LE	-0.06	0.06	-0.06	0.06	-0.06	0.04
	(-0.84)	(0.68)	(-0.81)	(0.73)	(-0.79)	(0.50)
LFPI	-0.04**	0.02	-0.04**	0.04	-0.05**	0.04
	(-2.45)	(0.47)	(-2.43)	(0.55)	(-2.45)	(0.55)
LGDP	-0.14	0.01	-0.15	0.02	-0.12	-0.005
	(-0.81)	(0.37)	(-0.80)	(0.51)	(-0.77)	(-0.12)
Cons	0.82***	3.55**	0.86**	3.63**	0.85**	3.51**
	(2.65)	(2.19)	(2.58)	(2.38)	(2.50)	(2.02)
Hausman	-	(0.62)	-	(N)	-	(N)
Size (NxT)	320	320	320	320	320	320

Notes: Figures in parentheses are t-statistics values N is not supported by the data. *, ** and *** denote the level of significance at 10, 5 and 1 percent respectively.

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References

1. Leblanc, M.; Chinn, M.D. Do high oil prices presage inflation? The Evidence from G-5 countries. *Department of Economics, UCSC UC Santa Cruz,* **2004**.
2. De-Gregorio, J.; Landerretche, O.; Neilson, C. Another pass-through bites the dust? Oil prices and inflation. *Economía*. **2007**, *7*, 155-196. doi:10.1353/eco.2007.0014.
3. Lu, W.; Liu, T.; Tseng, C. Volatility transmissions between shocks to the oil price and inflation : evidence from a bivariate GARCH approach. *J Inf Optim Sci*. **2010**, *31*, 927-939. doi:10.1080/02522667.2010.10700003.
4. Akpan, E.O. Oil resource management and food insecurity in Nigeria. In: *European Report on Development (ERD) Conference in Accra, Ghana*. ; **2009**, 21-23.
5. Rafiq, S.; Salim, R.; Bloch, H. Impact of crude oil price volatility on economic activities: An empirical investigation in the Thai economy. *Resour Policy*. **2009**, *34*, 121-132. doi:10.1016/j.resourpol.2008.09.001.
6. Baffes, J.; Kose, M.A.; Ohnsorge, F; Stocker, M. The great plunge in oil prices: Causes, consequences, and policy responses. *World Bank Gr*. **2015**, 1-51.
7. OPEC Annual Statistical Bulletin. **2015**, Vienna, Au:108. www.opec.org.
8. Masson, P.R; Savastano, M.A.; Sharma, S. The scope for inflation targeting in developing countries. **1997**, IMF Working.
9. Tang, W.; Wu, L.; Zhang, Z. Oil price shocks and their short- and long-term effects on the

Chinese economy. *Energy Econ*. **2010**, *32*, 3–14. doi:10.1016/j.eneco.2010.01.002.

10. Zhao, L.; Zhang, X.; Wang, S.; Xu, S. The effects of oil price shocks on output and inflation in China. *Energy Econ*. **2014**. doi:10.1016/j.eneco.2014.11.017.
11. Shaari, M.S.; Hussain, N.E.; Abdullah, H. The effects of oil price shocks and exchange rate volatility on inflation: evidence from Malaysia. *Int Bus Res*. **2012**, 5, 106.
12. Razmi, F.; Azali, M.; Chin, L.; Shah, H.M. The role of monetary transmission channels in transmitting oil price shocks to prices in ASEAN-4 countries during pre- and post-global financial crisis. *Energy*. **2016,** *101*, 581-591. doi:10.1016/j.energy.2016.02.036.
13. Valcarcel, V.J.; Wohar, M.E. Changes in the oil price-inflation pass-through. *J Econ Bus*. **2013**, *68*, 24-42. doi:10.1016/j.jeconbus.2013.03.001.
14. Gao, L.; Kim, H.; Saba, R. How do oil price shocks affect consumer prices? *Energy Econ*. **2014**, *45*, 313-323. doi:10.1016/j.eneco.2014.08.001.
15. Xuan, P.P.; Chin, L. Pass-through effect of oil price into consumer price : An Empirical study. *Int J Econ Manag*. **2015**, *9*, 143-161.
16. Hooker, M. Are oil shocks inflationary? Asymmetric and nonlinear specifications versus changes in regime. *J Money, Credit Bank*. **2002**, *34*, 540-561. doi:10.1353/mcb.2002.0041.
17. Basnet, H.C.; Upadhyaya, K.P. Impact of oil price shocks on output, inflation and the real exchange rate: evidence from selected ASEAN countries. *Appl Econ*. **2015,** *47*, 3078-3091. doi:10.1080/00036846.2015.1011322.
18. Chou, K-W.; Lin, P-C. Oil price shocks and producer prices in Taiwan: an application of non-linear error-correction models. *J Chinese Econ Bus Stud*. **2013**, *11*, 59-72. doi:10.1080/14765284.2012.755302.
19. Lamotte, O.; Porcher, T.; Schalck, C.; Silvestre, S. Asymmetric gasoline price responses in France. *Appl Econ Lett*. **2013**, *20*, 457-461. doi:10.1080/13504851.2012.714063.
20. Farzanegan, M.R.; Markwardt, G. The effects of oil price shocks on the Iranian economy. *Energy Econ*. **2009**, *31*, 134-151. doi:10.1016/j.eneco.2008.09.003.
21. Ghosh, S.; Kanjilal, K. Oil price shocks on Indian economy: Evidence from Toda Yamamoto and Markov regime-switching VAR. *Macroecon Financ Emerg Mark Econ*. **2013**, *7*, 122-139. doi:10.1080/17520843.2013.856333.
22. Çat, A.N.; Önder A.Ö. An asymmetric analysis of the relationship between oil prices and output: The case of Turkey. *Econ Model*. **2013**, *33*, 884-892. doi:10.1016/j.econmod.2013.06.004.
23. Ibrahim, M.H. Oil and food prices in Malaysia: A nonlinear ARDL analysis. *Agric Food Econ*. **2015**, *3*, 1-14. doi:10.1186/s40100-014-0020-3.
24. Kofi, P.A.; Zumah, F.; Mubarik, A.W.; Ntodi, B.N.; Darko, C.N. Analysing inflation dynamics in Ghana. *African Dev Rev*. **2015**, *27*, 1-13.
25. Bala, U.; Chin, L.; Ranjanee, S.; Ismail, N.W. The Impacts of oil export and food production on inflation in African OPEC members. *Int J Econ Manag*. **2017**, *11*, 573-590.
26. Balke, N.S.; Brown, S.P.A.; Yucel, M.K. Oil price shocks and the U.S. economy: Where does the asymmetry originate? *Energy J*. **2002,** *23*, 27-52.
27. Dillon, B.M.; Barrett, C.B. Global oil prices and local food prices: evidence from East Africa. *Am J Agric Econ*. **2016**, *98*, 154-171. doi:10.1093/ajae/aav040.
28. Brown, S.P.A.; Yucel, M.K. Energy prices and aggregate economic activity: An interpretative survey. *Q Rev Econ Financ*. **2002**, *42*, 193-208. doi:10.1016/S1062-9769(02)00138-2.
29. Shin, Y.; Yu, B.; Greenwood-Nimmo, M. Modelling asymmetric cointegration and dynamic

multipliers in a nonlinear ARDL framework. *Festschrift Honor Peter Schmidt*. **2014**, *44*, 1-35. doi:10.1007/978-1-4899-8008-3.

30. Pesaran, M.H.; Shin, Y. An autoregressive distributed lag modelling approach to cointegration analysis. *Econom Econ Theory*. **1999**, 1-31. doi:10.1017/CCOL521633230.
31. Pesaran, M.H.; Shin, Y.; Smith, R.J. Bounds testing approaches to the analysis of level relationships. *J Appl Econom*. **2001**, *16*, 289-326. doi:10.1002/jae.616.
32. Levin, A.; Lin, C.F.; Chu, C.S.J. Unit root tests in panel data: Asymptotic and finite-sample properties. *J Econom*. **2002**, *108*, 1-24. doi:10.1016/S0304-4076(01)00098-7.
33. Im, K.S.; Pesaran, M.H.; Shin, Y. Testing for unit roots in heterogeneous panels. *J Econom*. **2003**, 115(1), 53-74. doi:10.1016/S0304-4076(03)00092-7.
34. Maddala, G.S.; Wu, S. A comparative study of unit root tests with panel data and a new simple test. *Oxford Bull Econ Stat*. **1999**, *61*, 631–652.
35. Pedroni, P. Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxf Bull Econ Stat*. **1999**, *61*, 653–670.