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Prices of Oil, Trend of Inflation, and Macroeconomic Performance in Nigeria Revisted

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Abstract. The study tested the validity of forecasting inflation in the short run through a Phillips curve inflation model or whether it follows a non-linear and asymmetric flow through its effects on changes in prices of oil, inflation and consequently on macroeconomic performance using Nigerian data from 1986 to 2020. Using the Autoregressive Distributive Lag Model (ARDL) approach, our results showed that there is cointegration among the variables and the existence of a relationship in the long run. So also, decomposition significantly affects the rate of interest and prices of oil in the long run. We therefore conclude with available data that prices of oil affect inflation and macroeconomic performance and thus follow an asymmetric non-linear flow. It therefore remains a better alternative in inflation forecasting unlike the Phillips forecasting model.

Keywords: Trends in Inflation, Prices of Oil, Macroeconomic Performance, DARDL, Phillips Model.

1. Background

The consequences of high inflation rates on macroeconomic performance as seen in negative interest rates, devalued currencies, reduced returns on investment, high rate of unemployment and reduced standard of living has led to the pursuit of stability in prices by most central banks. The impact of oil prices fluctuations influence the economies of emerging countries that are susceptible to the influences of external shocks especially as regards to changes in inflation and economic performance and is a subject of growing concern for macroeconomic and monetary policy modelling.

Stability of price and control of inflation has been a revolving issue for the government and policy makers in most economy. Simultaneously, the government in pursuant of its macroeconomic objectives of sustainable economic growth and stable domestic price level aims at improving the standard of living of their citizen. Conversely, inflation hinders the mechanisms of a market economy through welfare costs which alters efficient allocation of resources and discourages household savings and firms' investment by creating uncertainty about future prices. Hence, inflation reduces a country's international competitiveness and reduces long-term economic growth (Frimpong & Oteng-Abay, 2010; Ezeanyeji & Ugochukwu, 2015).

The government of Nigeria in attempt to stimulate aggregate demand through huge fiscal expenditure and monetary control in post recessionary period was also faced with persistent inflation and unstable domestic price level. Obviously, the Nigerian government have employed different measures-fiscal, monetary, exchange rate to mitigate the problems of inflation, but the measures had little or no success in achieving the expected macroeconomic objectives.

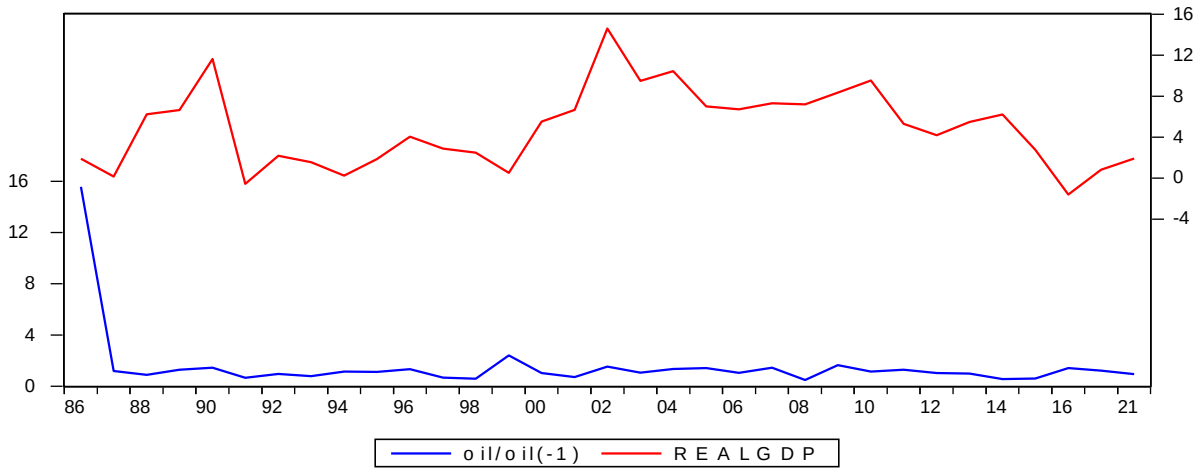

***Figure 1: Trends in annual growth rate in oil price and Economic Output, 1986-2021, Authors Computations, 2021*).**

Theoretically, the pass-through effect used in measuring the percentile changes in inflation as a resultant effect of changes in oil prices has been sufficiently to applied in the literature with evidences showing the weakening of the cost transmission channel argument due to the monothetic nature of most oil producing economies and their inability to withstand unmitigated economic shocks, presence of rigid labour markets, and the low energy intensities of their industries (Arinze, 2011; Bobai, 2012; Valcarcel and Wohar, 2013).

In addition, the extant literature is replete with differing attempts in forecasting inflation especially the demand-side through the mechanism of a Phillips inflation aggregate model or the recently used supply-side ARDL dynamic average selection models (Koop and Korobilis, 2012; Stock and Watson 2007). However, monetary policy responses to rising dynamics in inflation and oil price shocks have led to a mix of macroeconomic policy measures aimed at boosting macroeconomic performance with focus concentrated on managing the exchange rate policies necessary to stem the the deleterious impact of prices of oil fluctuations on inflation and the macroeconomy.

Thus, the study aims to test if forecasting inflation in the demand-side through the Phillips curve inflation models or through the effects of changes in prices of oil on inflation and consequently on macroeconomic performance follows a non-linear and asymmetric flow using Nigerian data (Salisu et al, 2017).
The remainder of the paper is structured as follows: section two reviews the theoretical literature on inflation and macroeconomic performance; section three reviews the empirical literature, section four presents the model and research methodology; section five presents the analysis and results; and section six provides the conclusion.

2. Theoretical Review

There are different school of thoughts on the nexus between inflation and macroeconomic performance from the earliest Classicals to Keynesians, Monetarist, Neo Classicals and Endogenous economists.
The classical theory propounded by Adam Smith (1987) recognized three factors of production such as land, labour, and capital. The production function is expressed as:
$Y = f(L, K, T)$ ……. *(1)*
Where Y is output, L is labour, K is capital and T is land. The theory considered saving as the most important factor affecting the growth rate.

Keynesian theory of inflation viewed increase in the aggregate demand to cause demand pull inflation, occasioned by government intervention of the market economy when the total demand for goods and services exceeds the aggregate supply of goods and services in the economy (Olu and Idih, 2015).
The monetarist led by Milton Friedman (1956) opined that money supply determines levels of price in an economy and manages the growth rate of money supply relative to the growth rate of output in the long run. Friedman (1956) believed that inflation occurs when money supply increases at a rapid pace than the rate of growth in output. The Fisherian identity of exchange equation is therefore stated as follows:

MV = (PT)…….……
……. (2)

With M representing money supply; V denoting the velocity of circulation; P representing the price level in the economy; T denoting the level of transactions in the economy and used to measure output and as such is often substituted for Y (national income).

Neo classical theorist were of the view that, inflation raises macroeconomic output growth rate permanently through capital accumulation as households tends to hold less in money balance and more in other asset (Solow,1956; Swan,1956; Mudell, 1963; & Tobin 1965).

However, an opposing view championed by the Stockman Model showed a negative relationship between inflation and macroeconomic output with rising inflation levels resulting in lower steady state level of macroeconomic output and decline in welfare (Stockman, 1981).

3. Empirical Review

The concomitant effect between prices of oil, trends in inflation and macroeconomic performance has attracted both theoretical and empirical arguments in the literature. There is no consensus among the theorist, from the classical, Keynesian, Structuralist, and monetarist. The bipolar divides has been between the role and causality of inflation on macroeconomic performance (Doguwa, 2012; Friedman, 1973; Stockman, 1981). The empirical findings of several studies are also inconclusive, while some studies found positive relationship (Osuala, & Onyeike, 2013); others like Ngouhouo and Nkemgha, (2018) found a negative relationship between these two macroeconomic variables.

Empirically, Hussain and Malik (2011) investigated the relationship and determine the direction of causality between inflation and economic growth in Pakistan using annual data from 1960 to 2006 through the error correction model and found that inflation granger causes growth and thus establishing a positive relationship between inflation and economic growth.

Babatunde and Shuaibu (2011) developed a monetary growth model for Nigeria by examining the existence of a long run relationship between money supply, inflation and growth whilst identifying through determinants of portfolio holdings between 1975 and 2008. Their study employed error correction mechanism (ECM) and the bounds testing approach for cointegration tests within an autoregressive distributed lag (ARDL) framework with results showing a positive relationship between money supply, capital formation and economic growth in Nigeria and a negative relationship between inflation and growth.

Bakare, Kareem and Oyelekan (2015) looked at the impact of inflation on economic growth in Nigeria between 1986 and 2014 using secondary through the Augmented Dickey-Fuller (ADF) technique adopted to test the unit root property of the series while Granger causality was used to test the causation between GDP and inflation. Their analysis showed a fluctuating trend in inflation rate and causality suggests that GDP Granger cause inflation and not inflation causing GDP. The results concluded that inflation rate had a negative impact on economic growth of Nigeria.

Chude and Chude (2015) studied the impact of the relationship between inflation and economic growth in Nigeria with Consumer price index (CPI) proxied for inflation and the GDP proxied for economic growth with study covering a period of 2000 to 2009. Ordinary least square method and t-test were employed to test the variables most likely to impact on economic growth in Nigeria due to inflation and discovered the existence of a strong relationship between inflation and economic growth in Nigeria; with the exchange rate having a positive impact on economic growth and that high interest rate discourages investment and hence forestalls economic growth.

Enejoh and Tsauni, (2017) studying the effect of rise in prices on economic growth in Nigeria for the period 1970 to 2016. The unit root properties of the series were tested. The result shows that the variables were I (0) and I (1). Therefore, they employed ARDL approach to co-integration and error correction mechanism (ECM) to test both the short and long run impact of inflation on economic growth. The result showed that inflation and foreign exchange have positive impact on economic growth both in the short and long run.

Riyath, (2018) whilst examining the long run causal relationship between the inflation and economic growth in Sri Lanka over the period from 1960 to 2015 deploying the Johansen co-integration technique and Vector Error Correction Model (VECM) with results confirming a bi-directional causality between the inflation and Economic growth. However, there was no short run causality between inflation and economic growth.

Ngouhouo and Nkemgha (2018) examine a comparative analysis of the effect of inflation on growth between Cameroon, French speaking Central Africa Country where inflation is not a big concern and Ivory Coast. Using the Least Squares methodology, they found that inflation have no effect on economic growth in Cameroon during the study period. However, inflation has negative and significant effect on economic growth in Ivory Coast. Also, the analysis of the causal relationship between inflation and economic growth using the Toda - Yamamoto framework and the Vector Autoregressive model show that there is a unidirectional causality from inflation to economic growth in Ivory Coast, while there is no causality between these variables in Cameroon.

Akinsola and Odhiambo (2017) evaluates the impact of inflation on economic growth in Nigeria, using time series data spanning thirty years (1986-2016) obtained from the Central Bank of Nigeria (CBN). The nature of relationship existing between the focused variables- economic growth (proxy by real Gross Domestic Product, GDP) and inflation rate was explored. They used Augmented Dickey Fuller (ADF) to test for the stationarity of the variables while the granger causality test was employed to ascertain the direction of influence between inflation and economic growth in Nigeria. They found no evidence of causal relationship between inflation and economic growth in Nigeria. Again, there was no leading variable in the relation between inflation and economic growth in Nigeria. They therefore concluded that inflation does not stimulate economic growth and vice versa.

4. Model and Research Methodology

4.1 Model

Adapting Salisu et al (2017) using a variant of asymmetric and symmetric benchmark models to describe the effects of oil prices and inflation and consequently economic output;

$$\lambda \dot{g}t = \propto + + \pi t + \gamma Pt + \varepsilon t \quad \ldots\ldots (3)$$

Where $\dot{g}t$: $\dot{g}t$ = log (yt/ $\bar{y}$t)…….. (4) is the computed growth rate in real GDP and it's a difference between real economic output potential economic output, πt: (CPI = log (cpit/cpit − 1); denotes the growth rate of the log of consumer price index and Pt = log (oilpricet/oilpricet-1)……(5) capturing both the supply and demand side of inflation forecasts.

In addition, following Shin et al, (2014); Van Hoang et al, (2016), the asymmetric variant of our model involve the decomposition of oil prices through the instrument of an Autoregressive Distributed Lag (ARDL) model which becomes:

$$\pi t = \alpha + \delta i \pi t - 1 + \lambda j \dot{g}t - j + \gamma j Pt - j + \varepsilon t \quad \ldots\ldots (6)$$

With variables remaining as earlier defined.

The decomposition of prices of oil as a variable as seen in Myse (2018) is based on the consideration that macroeconomic agents such as households, firms and government react differently to fluctuations in oil prices and defined theoretically as:

$Oil^{+}_{t} = \Delta Oil^{+}_{j} = Max (\Delta Oilj, 0)$…….. (7)

$Oil^{-}_{t} = \Delta Oil^{-}_{j} = Max (\Delta Oilj, 0)$…… (8)

With the long run effect of the model estimation only possible with the presence of cointegration of variables involving a Bound-test distribution with null hypothesis of no cointegration amongst variables represented as $H_0 = \alpha_1 = \alpha_s = 0$ against am alternative hypothesis of $H_1 \ddagger \alpha_1 \ddagger \alpha_s \ddagger 0$ and Wald test to prove the existence of asymmetry in the short run and long run (Olofin & Salisu, 2017; Fasanya, Odudu & Adekoya, 2019).

4. 2. Research Methodology

The paper adopts ex-post facto research design, since the researchers has no direct control over the variables involved. This is because the issues investigated relates to events that have already taken place and for which a causal- comparative evaluation was carried out to analyze the objectives of the study. The paper makes use of secondary data, which are annual time-series. The data covered a period of 34 years, 1986 to 2020. Data was sourced from Central Bank of Nigeria (CBN) various statistical bulletins, National Bureau of Statistics (NBS) Annual Reports and International Financial Statistic (IFS) data. The variables that was used in this study were selected on the basis of their theoretical importance, usefulness as a measure of the key construct of the study namely, inflation and economic growth, and findings from their usage in previous empirical literature. The E-views 10 econometric software package was used to analyze the data.

In a bid to analyse the impact of prices of oil on inflation and economic output in Nigeria, we specified the following econometric model. The independent variables are growth rates of consumer price index as a proxy for inflation (Salisu, Isah,

Oyewole, and Akanni, 2017); growth rates of oil prices, interest rate and exchange rate while the dependent variable is economic output. The model is stated as follows:

GDP=f[(log(growth rate of consumer price index, interest rate, exchange rate, log(oilprice/oilprice$_{t-1}$)]……(9)

5. Presentation of Results

5.1 Descriptive Statistics

Table 1: Descriptive Statistics of Variables

Variables	CPI	ER	IR	OILPRICE	REALGDP
Mean	3.85	101.95	7.33	1.54	4.85
Maximum	72.50	306.08	18.80	15.56	14.60
Minimum	0.02	2.02	1.41	0.49	-1.58
Jarque-Bera	1041.32	2.39	4.69	1129.08	1.24

Authors Computations (2021)

The descriptive statistics shows that the average value of exchange rate for our observation period was sufficiently greater than those of other variables and this could be traced to the impact of the different exchange rate regimes and interventions employed in the country in the last decades.
The maximum values of both the growth rate of consumer price index as seen in (Burdekin and Burkett, 1996); and exchange rate were also sufficiently greater than the values of other explanatory variables with their values greater skewed around their means.

Lastly, the test statistics for normal distribution to show if our variables are normally distributed rejects the null hypothesis at 10% level of significance.

5.2 Unit-Root Test Results

Table 2: Unit Root of Log (CPI/CPI (-1)), ER, IR, Log (OilP/OilP (-1)), Real GDP

	Unit-Root without Structural Break						Unit-Root with Structural Break		
	DFGLS			Ng-Perron			Perron (2006)		
Variable	Level	First Diff	I(d)	Level	First Diff	I(d)	Coefficient	t-test	
LogCPI/CPI(-1)	-2.64^{a}*	-2.65^{a*}	I(0)	-8.10^{b*}	-17.3^{b*}	I(1)	-1.36	-8.58	
ER	-2.63^{a*}	-3.96^{b***}	I(1)	-5.70^{a***}	-14.2^{b***}	I(1)	0.05	0.05	
IR	-2.63^{a*}	-3.19^{b**}	I(1)	-5.72^{a***}	-14.2^{b***}	I(0)	-0.06	-0.06	
Log(OilP/OilP(-1))	-1.61^{a***}	-1.95^{a**}	I(0)	-5.72^{a***}	-14.2^{b***}	I(0)	-1.035	-1.035	
RealGdp	-3.19^{b**}	-3.77^{b*}	I(1)	-13.8^{a*}	-17.3b**	I(1)	-0.47	-0.47	

Source: Authors Computations (2021)

Note: ^{a} indicates model with intercept without deterministic trend; ^{b} is a model with intercept and deterministic trend with the Schwarz Information Criterion determining the exogenous lags. ***, **, * represents series stationary at 10%, 5% and 1% respectively. DFGLS denote Dickey-Fuller GLS Unit Root test. The null hypothesis for DFGLS and Ng-Perron and Phillip-Perron is that an observable time series is not stationary (i.e. has unit root).

Time series analysis recommends unit-root testing. We used the Dickey-Fuller GLS, Ng-Perron, and Phillip-Peron tests that accommodated for structural breaks. The integration properties of variables vary between I(0) and I(1) thus exhibiting non-stationarity and justify our choice of the Autoregressive Distributive Lag (ARDL) model.

5.3 Robustness and Diagnostics Tests

5.3.1 ARDL Regression Results

Dependent Variable: Real GDP

Variable	Coefficient	Std Error	t-test	Probability
REALGDP(-1)	1.026602	0.328783	3.122428	0.0123
REALGDP(-2)	-0.369730	0.220304	-1.678275	0.1276
REALGDP(-3)	-0.372956S	0.235260	-1.585292	0.1474
LOG(CPI_CPI__1_)	-0.750085	0.704969	-1.063997	0.3150
LOG(CPI_CPI__1_(-1))	2.949316	0.724555	4.070524	0.0028
LOG(CPI_CPI__1_(-2))	1.547640	0.875597	1.767526	0.1109
LOG(CPI_CPI__1_(-3))	-1.189776	0.831684	-1.430564	0.1863
ER	0.083135	0.070777	1.174605	0.2703
ER(-1)	-0.001212	0.101030	-0.011992	0.9907
ER(-2)	-0.303245	0.127013	-2.387506	0.0407
ER(-3)	0.232562	0.075644	3.074442	0.0133
IR	1.050524	0.478803	2.194061	0.0559
IR(-1)	-1.478687	0.534279	-2.767633	0.0218
IR(-2)	1.050794	0.598575	1.755495	0.1131
IR(-3)	-1.384187	0.683580	-2.024909	0.0735
IR(-4)	0.920521	0.617792	1.490017	0.1704
LOG(OIL_OIL__1_)	-0.066454	1.893639	-0.035093	0.9728
LOG(OIL_OIL__1_(-1))	10.88082	3.867568	2.813349	0.0203
LOG(OIL_OIL__1_(-2))	9.276496	3.654288	2.538523	0.0318
C	1.280412	7.338053	0.174489	0.8653
R-squared	**0.948945**	**F-statistic**	**8.804208**	
Adjusted R squared	**0.841162**	**Durbin-Watson stat**	**2.592458**	

Authors Computations (2021)

5.3.2 Coefficients Diagnostics/Bound Test

ARDL Long Run Form and Bound Test

Variable	Coefficient	Std Error	t-test	Probability
LOG(CPI_CPI__1_)	3.570942	2.403380	1.485800	0.1715
ER	0.015697	0.053796	0.291780	0.7771
IR	0.221993	0.720161	0.308255	0.7649
LOG(OIL_OIL__1_)	28.05656	11.65653	2.406938	0.0394
C	1.788075	10.05890	0.177760	0.8628
Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	4.704397	10%	2.2	3.09
EC = REALGDP - (3.5709*LOG(CPI_CPI__1_) + 0.0157*ER + 0.2220*IR + 28.0566*LOG(OIL_OIL__1_) + 1.7881)				

Authors Computations (2021)

5.3.3 Wald Test Estimation

Test Statistics	Value	Degree of Freedom	Probability
F-statistic	6.060739	(5, 9)	0.0100
Chi-square	30.30369	5	0.0000
Normalized (=0)	**Value**	**Standard Error**	
C(2)	-0.369730	0.220304	

C(3)	-0.372956	0.235260	
C(4)	-0.750085	0.704969	
C(5)	2.949316	0.724555	
C(6)	1.547640	0.875597	

Authors Computations (2021)

5.3.4 Asymmetry Wald Test Estimation

Variables	Wald Statistics		Is there Presence of Asymmetry	
Real GDP	-0.3697* [0.2203]	No evidence of long run relationship	No	No evidence of long run relationship
Log(CPI/CPI(-1))	-0.3795** [0.2353]	No evidence of long run relationship	No	No evidence of long run relationship
ER	-0.7500* [0.7049]	No evidence of long run relationship	No	No evidence of long run relationship
IR	2.9493** [0.7246]	2.9493 [0.7246]	Yes	Yes
Log(OilP/OilP(-1))	1.5476** [0.8756]	1.5476 [0.8756]	Yes	Yes
***, ** indicates significance at 1% and 5%.**				

Authors Computations (2021)

6. Conclusions

Our calculated F-statistics is sufficiently greater than the critical value bound for both the lower bound I(0) and upper bound I(1) and therefore we conclude that is cointegration among the dependent and explanatory variables in the long run i.e there exist a long run relationship.

Thus, we accept the alternative cointegrating hypothesis that H_1: $\alpha_1 \ddagger \alpha_2 \ddagger 0$ and the assumption of asymmetric behaviour of oil prices as it affects inflation and macroeconomic output.

The Error Correction regression helps to capture the long run equilibrium of our estimating model and also depicts the lag in time it takes for the Nigerian economy to adjust to shocks in oil prices in the long run (Swaray & Salisu, 2018).

The Wald test restrictions also helps to ascertain the eligibility of our explanatory variables and the asymmetry in our estimating model both in the short and long run. The asymmetry test result conducted to test the null hypothesis of the non-significance of the impact of decomposed oil prices on our explanatory variables proved insufficient and was rejected as against the alternative hypothesis that decomposition of oil prices economic output which was accepted.

Our results showed that decomposition significantly affects interest rates and oil prices in the long run. We therefore conclude with available data that the effect of oil prices on inflation and macroeconomic output follows an asymmetric non-linear flow and remains a better alternative in inflation forecasting unlike the traditional Phillips curve model.

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