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Akwa Ibom State University

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I. ABSTRACT

Petrol in Nigeria's economy serves as intermediate input to production. Change in price, quality and quantity affect agricultural productivity and profitability. This study assesses the petrol pump prices fluctuations and its impact on agricultural productivity from 1970-2016 using ordinary least square and multivariate Vector Error Correction framework respectively. Findings revealed that a positive growth rate (7.86%) had a negative impact on the economy in the long run while the VECM results showed that petrol price significantly impacted negatively on agricultural productivity and major macroeconomics policies variables both in the long and short run. This was because low agricultural productivity and high-interest rate would discourage investment during this period. The study recommends full deregulation policies of petroleum downstream sector by the government which will not hamper the productivity of the agricultural sector while ensuring check and balances (using anti-corruption agencies) in the Nigeria National Petroleum Corporation for financial prudence.

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Author α σ ρ: Department of Agricultural Economics and Extension, Akwa Ibom State University, Obio Akpa Campus, P.M.B. 1167, Uyo, Akwa Ibom State, Nigeria.

II. INTRODUCTION

Nigeria, blessed with abundant natural resources of which crude oil is considered the most important. Currently, the country ranks as the 8th world oil producing countries (Odularu, 2008) and oil is the mainstay of the country beating agriculture to the second position. The discovery of oil in the country in commercial quantities, apart from bringing about radical changes in the economy of the nation, seems to have sent all other sectors to oblivion. Thus, making the country completely dependent on oil; not only for her foreign exchange earnings but for domestic budgetary finance. Ever since the soar of oil into prominence, agriculture have been neglected (Adepibe, 2004; Odularu, 2008); all efforts made to diversify the economy of the country and give back agriculture it rightful place have yielded a little result (Ocheni, 2015). One of the refined petroleum products is petrol - Premium Motor Spirit, (PMS). This fuel which is used to drive virtually all light vehicles and generators in the country is a determinant in the commercial sector of the country both regarding price and availability. Pump price and availability of petrol affect both the micro and macro economy of every nation and Nigeria is of no exception. Therefore, any change in the pump price of this fuel whether in oil producing or non producing country affects both sides of the market.

The erratic petroleum pump price increment in Nigeria dates back to the 1970s (Philip and Akintoye, 2006). Many reasons have been offered for this. Apart from the official fuel pump price increment by a successive government in the

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name of "subsidy withdrawal", illegal increase occurs and the reasons range from: frequent attacks on oil installations, sabotage from bunkers, oil spillages and the kidnapping of foreign personnel by militants in the Niger Delta region (Suleiman 1998). Other reason might be due to the inefficiencies of the nation's refineries leading to the importation of refined petroleum products and attitude of some marketers. It has been observed that between 1978 to 2007, that fuel pump prices have been officially increased eight consecutive times with most of the increment occurring in the 1990-2007 period (Arenze, 2011). The multiple negative effects of this disruption on the nation's economy can better be imagined. This is because whatever happens in the oil sector affects all other sectors of the economy and by implication, the macro-economic policies of the country (Ogunbodede, Ilesanmi and Olururankinse, 2010). These invest relationship between upward adjustment of petroleum products prices and the states of the nation have been reported by Jones, Paul and Paik (2004), Arenze (2011), Shaari, Pie and Rahim (2013). They all confirm that an upward adjustment of petroleum products prices causes inflation, a high cost of living, inequitable distribution of income, turnover and profitability as well as productivity.

Productivity which is defined as entrepreneur's receipts from output minus cost of production is at the center of every enterprise. Equally, in any agricultural enterprise, it is the farmer's net returns (profitability) that propelled him to go into production. This enterprise is not absolved from the effect of fuel price fluctuations. The impact of frequent fuel price fluctuation on the agricultural sectors is probably due to the important role of agriculture as a safety net in poverty alleviation. Fuel price increment affects the agricultural sector in two ways. The first is in production and second in the transportation of the product to the consumers. Researchers like Dhuyvetter and Kastens (2005) have lent their voices with other researchers to submit that the agriculture sector is one of the economic sectors that are harmed by higher oil price. This is because most agricultural machinery and technology are powered using PMS and any increase in its pump price in the world market could lead to an increase in the cost of production of agricultural products. This is evidenced even in the industrial production of goods and services. Equally, if agricultural production expenditures increase due to fuel rise, the profit margin decreases and producers usually incur losses. Similarly, an increase in fuel prices would snowball to an increase in the transport cost of the produce which subsequently would increase the product's price. This is agrees with the law of one price (LOOP). This implies that the prices of food in the local market would rise to cut loses that the investors and producers incurred in production and transportation. Of course, this assertion holds for only fossil fuel. On the other hand, Davidson *et al.,* (2011) found the contrary when alternative sources of energy are involved. They reported that fuel prices do not have a direct effect on the prices of food because more countries are now using alternative sources of energy. Today, industrial agriculture consumes fossil fuel for several purposes like fertilizer production, water consumption, farm equipment and lot more. Consequently, fuel price affects the cost of production in the agricultural sector.

Several studies have related petrol pump price fluctuation with some macroeconomics variables in Nigeria. For instance, Ocheni (2015) examines the impact of fuel price increase on the Nigerian economy using a survey research design approach. His findings reveal that there was a significant relationship between the increase in fuel price and economic growth in Nigeria. Akpan (2009) investigates oil price shocks on Nigeria`s macroeconomy using VAR methodology for the period 1970 to 2007. The study reveals the asymmetric effects of oil price shocks. He reported that positive and negative oil price shocks significantly increased inflation and directly increased real national income through higher export earnings, though part of this gain was seen to be offset by losses from lower demand

for exports caused by economic recession suffered by trading partners. The findings of the work further show a strong positive relationship between positive oil price changes and real government expenditures. However, the result identified a marginal impact of oil price fluctuations on industrial output growth, though significant real effective exchange rate appreciated, amidst the "Dutch Disease" syndrome. The variance decomposition analysis further reveals that exchange rate, government expenditure and domestic investment are mainly affected by oil price shock, particularly in the short-run. Hodo, Akpan and Offiong (2013) employing VAR on 1970-2010 data confirmed the asymmetric effect of oil price shocks on exchange rate volatility and domestic investment in Nigeria. The study reveals that the government expenditure exhibited positive response while public investment, private investment and industrial production exhibited a negative response to oil price shock, with the presence of the "Dutch disease syndrome". Similar work by Englama et al, (2010) examines the effects of oil price volatility, demand for foreign exchange and external reserved on exchange rate volatility in Nigeria using monthly data. The co-integration technique and vector error correction model (VECM) used for the long-run and the short-run analysis, respectively shows that 1% permanent increase in oil price at the international market increases exchange rate by 0.54% in the long-run and by 0.02% in the short-run. Also a permanent 1% increase in demand for foreign exchange increases exchange rate by 14.8% in the long-run. The study confirms the direct relationship between foreign exchange demand and oil price volatility with exchange rate movements. Another work by Jawad (2013) in Pakistan to determine the relationship of oil price and economic growth utilizes the Augmented Dickey - Fuller (ADF) test model. The results show that all the variables were integrated at level one and with the adopted linear regression model, the result showed that trade balance and private sector investment were key determinants of gross domestic product while oil price and public sector investment were insignificant determinants. Ayoola (2013) examines the effect of crude oil price on economic activities in an oil-dependent economy (Nigeria) using structural vector autoregressive (SVAR) technique. The result of the Impulse Response Function (IRF_S) and the Forecast Error Variance Decompositions ($FEVD_S$) suggested that domestic policies, instead of oil boom should be blamed for inflation. Also, oil price variations were driven mostly by oil shocks; however, domestic shocks were responsible for a reasonable portion of oil price variation. The study concludes that oil has a very important indirect impact on the Nigeria economy and that monetary policy is the transmission channel. The negative impact on the economy by oil price changes was also corroborated by Alper and Torul (2009), Rodriguez and Sanchez (2004), Petersen *et al.*, (1994), even when they made use of different analytical models.

Specifically, oil price shocks on the agricultural sector have been investigated. Hanson *et al.* (2010) employed the input-output model to investigate the effects of oil price shocks on the United States agricultural sector. The results showed that agricultural sector is dependent on energy such as oil and a rise in oil prices causes prices of agricultural products such as grains and cotton to increase and thus reduce the income of the sector. Similar research by Binuomote and Odeniyi (2013) on the effect of crude oil price on agricultural productivity in Nigeria using Augmented Dickey-Fuller (ADF) unit root test, Co-integration and Error Correction modeling, indicated that the exchange rate, capital, labor and trend were the major determinants of agricultural productivity in the long-run, while price of crude oil price was the most important determinant of agricultural productivity in the short–run. Additionally, the results showed that the Error Correction Mechanism (ECM) indicated a feedback of about 112.5% of the previous year's disequilibrium from long-run domestic agricultural production.

The empirical works reviewed so far have only examined oil price changes on some macroeconomic variables. The literature is silent on the impact of petrol price fluctuation on Agricultural productivity in Nigeria. This study is to bridge these data and the literature gap. The main objective of this study is to analyze the effect of petrol price fluctuations on agricultural productivity in Nigeria. Specifically, the study seeks to assess the growth rates of petrol pump price as well as the impact of petrol price fluctuation on agricultural productivity in Nigeria.

III. MATERIALS AND METHODS

3.1 Data Sources

The study employed secondary data publication obtained from Central Bank of Nigeria (CBN), Statistical Bulletin, Annual Report and Statements of Account of Central Bank of Nigeria (CBN), National Bureau of Statistics (NBS) and International Monetary Fund from 1970-2016.

3.2 Analytical Techniques

Data collected were analyzed according to specific objectives. For objective one which is to evaluate the fluctuating trend and growth rates of petrol pump price, both descriptive and inferential statistics such as mean and simple percentages were used. Ordinary least square (OLS) procedure in a time trend was used to evaluate the fluctuating trend and growth rates of petrol pump price. The growth rate was conducted by fitting exponential function in time to the data following (Akpaeti *et al.*, 2013 and 2014).

The function is specified as follows:

$$Q = b_o e^{bt} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Linearizing the equation in logarithms, it becomes

$$\text{In } Q = b_o + b_1 t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where,
Q = Prices of petrol pump price in Naira
b_o = Intercept
b_1 = Slope (regression parameters estimated)
t = Time trend Variable (Years in number)
The coefficient from the equation was used to derive the growth rate (r) as specified by Onyenweaku and Okoye (2005); Akpaeti *et al.* (2013) as follows:

$$r = (e^b - 1) \times 100/1 \text{ (Okoye et al., 2008); (Akpaeti } et\ al.,\ 2013;\ 2014) \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where e is Euler's exponential constant (2.71828). To investigate the existence of acceleration, deceleration or stagnation in the growth rate of petrol pump price, quadratic equation in time variables was fitted to the data for the period following (Akpaeti *et al., 2013;* 2014) as follows:

$$\text{Log } Q = a + bt + ct^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

In the above specification, the linear and quadratic time terms give the secular path in the dependent variable (Q). The quadratic time term t^2 allows for the possibility of acceleration or deceleration or stagnation in growth during the period of the study. Significant positive value of the coefficient of t^2 confirms significant acceleration in growth, a significant negative value of t^2 confirms significant deceleration in growth while a non-significant coefficient of t^2 implies stagnation or absence of either acceleration or deceleration in the growth process for the two periods.

Objective two considers the effects of petrol pump price fluctuation on agricultural productivity. A Vector Error Correction Model (VECM) was used based on theoretical exposition and following the extant literature as evidenced in the works of Akpaeti (2015); Olarinde and Abdullahi (2014). According to Engle and Granger (1987), both short-run and long-run equilibrium model exist in VECM once the variables are co-integrated of the order 1(1). As such, the short-run analysis of the system would include the error correction term with a view of correcting the adjustment arising from the deviation of its long-run equilibrium. The VECM specifications employed in this study are presented in eight endogenous variables as shown below:

pump

$$= \theta_0 + \theta_1 \sum_{i=1}^{k} \Delta LNARGDP_{q,t-i} + \theta_2 \sum_{i=1}^{k} \Delta LNEXR_{q,t-i} + \theta_3 \sum_{i=1}^{k} \Delta LNFI_{q,t-i} + \theta_4 \sum_{i=1}^{k} \Delta LNFPI_{q,t-i} + \theta_5 \sum_{i=1}^{k} \Delta LNGCAA_{q,t-i} + \theta_6 \sum_{i=1}^{k} \Delta LNINF_{q,t-i} + \theta_7 \sum_{i=1}^{k} \Delta LNINTR_{q,t-i} + \mu_{2t} \quad 6$$

$$\Delta LNEXR = \lambda_0 + \lambda_1 \sum_{i=1}^{k} \Delta LNARGDP_{q,t-i} + \lambda_2 \sum_{i=1}^{k} \Delta LNFUEP_{q,t-i} + \lambda_3 \sum_{i=1}^{k} \Delta LNFI_{q,t-i} + \lambda_4 \sum_{i=1}^{k} \Delta LNFPI_{q,t-i} + \lambda_5 \sum_{i=1}^{k} \Delta LNGCAA_{q,t-i} + \lambda_6 \sum_{i=1}^{k} \Delta LNINF_{q,t-i} + \lambda_7 \sum_{i=1}^{k} \Delta LNINTR_{q,t-i} + \mu_{3t} \quad 7$$

$$\Delta LNFI = \beta_0 + \beta_1 \sum_{i=1}^{k} \Delta LNARGDP_{q,t-i} + \beta_2 \sum_{i=1}^{k} \Delta LNFUEP_{q,t-i} + \beta_3 \sum_{i=1}^{k} \Delta LNEXR_{q,t-i} + \beta_4 \sum_{i=1}^{k} \Delta LNFPI_{q,t-i} + \beta_5 \sum_{i=1}^{k} \Delta LNGCAA_{q,t-i} + \beta_6 \sum_{i=1}^{k} \Delta LNINF_{q,t-i} + \beta_7 \sum_{i=1}^{k} \Delta LNINTR_{q,t-i} + \mu_{4t} \quad 8$$

$$\Delta LNFPI = \gamma_0 + \gamma_1 \sum_{i=1}^{k} \Delta LNARGDP_{q,t-i} + \gamma_2 \sum_{i=1}^{k} \Delta LNFUEP_{q,t-i} + \gamma_3 \sum_{i=1}^{k} \Delta LNEXR_{q,t-i} + \gamma_4 \sum_{i=1}^{k} \Delta LNFI_{q,t-i} + \gamma_5 \sum_{i=1}^{k} \Delta LNGCAA_{q,t-i} + \gamma_6 \sum_{i=1}^{k} \Delta LNGINF_{q,t-i} + \gamma_7 \sum_{i=1}^{k} \Delta LNINTR_{q,t-i} + \mu_{5t} \quad 9$$

$$\Delta LNGCAA = \psi_0 + \psi_1 \sum_{i=1}^{k} \Delta LNARGDP_{q,t-i} + \psi_2 \sum_{i=1}^{k} \Delta LNFUEP_{q,t-i} + \psi_3 \sum_{i=1}^{k} \Delta LNEXR_{q,t-i} + \psi_4 \sum_{i=1}^{k} \Delta LNFI_{q,t-i} + \psi_5 \sum_{i=1}^{k} \Delta LNFPI_{q,t-i} \psi_6 \sum_{i=1}^{k} \Delta LNINF_{q,t-i} + \psi_7 \sum_{i=1}^{k} \Delta LNINTR_{q,t-i} + \mu_{6t} \quad 10$$

$$\Delta LNINF = \sigma_0 + \sigma_1 \sum_{i=1}^{k} \Delta LNARGDP_{q,t-i} + \sigma_2 \sum_{i=1}^{k} \Delta LNFUEP_{q,t-i} + \sigma_3 \sum_{i=1}^{k} \Delta LNEXR_{q,t-i} + \sigma_4 \sum_{i=1}^{k} \Delta LNFI_{q,t-i} + \sigma_5 \sum_{i=1}^{k} \Delta LNFPI_{q,t-i} + \sigma_6 \sum_{i=1}^{k} \Delta LNGCAA_{q,t-i} + \sigma_7 \sum_{i=1}^{k} \Delta LNINTR_{q,t-i} + \mu_{7t} \quad 11$$

$$\Delta LNINTR = \varphi_0 + \varphi_1 \sum_{i=1}^{k} \Delta LNARGDP_{q,t-i} + \varphi_2 \sum_{i=1}^{k} \Delta LNFUEP_{q,t-i} + \varphi_3 \sum_{i=1}^{k} \Delta LNFEXR_{q,t-i} + \varphi_4 \sum_{i=1}^{k} \Delta LNFI_{q,t-i} + \varphi_5 \sum_{i=1}^{k} \Delta LNFPI_{q,t-i} + \varphi_6 \sum_{i=1}^{k} \Delta LNGCAA_{q,t-i} + \varphi_7 \sum_{i=1}^{k} \Delta LNINF_{q,t-i} + \mu_{8t} \quad 12$$

Where:

LNARGDP = Log of Agriculture Real Gross Domestic Product (proxy for Agricultural Productivity)
LNFUEP = Log Petrol pump price (Naira)
LNEXR = Log of Exchange Rate (Naira)
LNFI = Log of Food import (Naira)
LNFPI = Log of Foreign Private Investment (Naira)
LNGCAA = Log of Government Capital Allocation to Agricultural Sector (Naira)
LNINFLA = Log of Inflation Rate (Percent)
LNINTR = Log of Interest Rate (Percent)

$\mu_t = (\mu_{1t}, \mu_{2t}, \ldots \mu_{nt})$ = the 8x1 vector of independent and identically distributed error terms (I.I.D).

$\varphi_{0,} \theta_{0,} \lambda_0 \ldots \phi_0$ are the intercept terms while $\varphi_1 \theta_{1,} \lambda_1 \ldots \phi_1$ are the coefficients for the variables estimated

k = the number of lagged terms.

3.3 Estimated Procedures

Preliminary diagnostics on the time series properties of the variables used in the model were investigated to confirm their order of integration to avoid spurious regression using Augumented Dicky Fuller and Philip Peron in order to allow for robustness. The test for unit root for a series is carried out using the following equation:

$$\Delta Y_t = \sigma_1 + \sigma_{1t} + \sigma_2 + \sigma_1 Y_{t-1} + \sum_{i=0}^{k} \beta_1 \Delta Y_{t-i} + \mu_t \quad \ldots\ldots 13$$

Where $\sigma_1 + \sigma_{1t} + \sigma_2$ and $\beta_1 \ldots \beta_p$ are parameters to be estimated while μ_t is the error term, which is assumed to be normally and identically distributed. To ensure that the results obtained is not spurious (Maddala, 2002), co-integration test is conducted. Economically speaking, two variables are co-integrated if they have a long-term or equilibrium relationship (Gujarati, 2003). To test for the presence of a long-run relationship, the maximum likelihood method developed by Johansen (1988 and 1991) was utilized. Using the Johansen approach, two test statistics can be used in testing the number of co-integrating vectors: the Trace and the Maximum Eigenvalue statistics. The null hypothesis for the trace test is that there are at most r co-integrating vectors, while for the Max Eigenvalue test, the null of $r = 0$ was tested against the alternative that $r = 1$; $r = 1$ was tested against the alternative that $r = 2$ and so on. The Schwarz Information Criterion (SIC) was used to select the optimal lag length for the co-integration test. This was followed by estimation of both the long and short run macroeconomics variables within the Vector Error Correction Model. To test for long-run causality, the null hypothesis that the coefficient of t-1 is zero was tested in equations (4-11) while Granger causality tests (a Wald F-test non-causality) was performed for the short run by setting the coefficients of all order-lagged

differences of each of the variables on the right-hand side equal to zero for the same equations.

After estimating the co-integrated VECM, innovation accounting was conducted to determine the dynamic responses of the variables to one-standard deviation shocks for other variables in the system. This was done by generating the impulse response functions from the system. Impulse Response Functions (IRF), trace the responsiveness of the dependent variable in the (VECM) to a unit shock in the error terms. For each variable from each equation, a unit shock was applied in the error term and the effects upon the (VECM) to a unit shock in error terms were observed over a period of time. If there were *K* endogenous variables in the model, then a total of K^2 impulse responses can be generated. In this study, the analysis was confined to the responses of LNARGDP, LNFUEP, LNEXR, LNFI, LNFPI, LNGCAA, LNINF and LNINTR to the shocks in LNFUEP.

To further to obtain information concerning the relative importance of each innovation towards explaining the behaviour of the endogenous variables, variance decomposition analysis (VDC) was conducted. The generalized forecast error variance decomposition technique attributed to Koop *et al.,* (1996) and; Pesaran and Shin (1998) were used. This technique has the advantage that its results are not sensitive to the ordering of the variables in the (VECM).

IV. RESULTS AND DISCUSSION

4.1 Fluctuating Trend and Growth Rate of Petrol Price on Productivity

The trend analysis result of petrol price in Nigeria is presented in Table 1. The result shows that petrol price has a positive trend during the period (1970-2016). As shown in the result, the coefficient of the trend variable is positive (0.0756) and highly significant at 1%. This implies that time trend accounted for 1% of the aggregate level of petrol price. The positive trend suggests a positive and increasing relationship between time and petrol price. F-ratio for petrol price as indicated in the result is significant at 1%, which implies that the estimated parameters are highly significant with respect to the dependent variable.

Table 1: Estimated Trend Equation for Petrol Price

Dependent variable/ period	B_0 (Constant)	B_1 (Slope)	R^2	R^{-2}	F-Ratio
Petrol Price	1.2307 (5.0064)***	0.07557 (8.4990)***	0.6161	0.6076	72.23***

Source: Computed by Author, 2017

Table 2 shows the growth rates of petrol price for the period under review. Petrol price has a positive growth rate of 7.86%. The positive growth rate reveals that at the long run, the growth rate will negatively impact on the economy as indicated in Table 3 with a coefficient of -0.0013. This negative effect of petrol price rise will cause a rise in the prices of commodities and a drain on consumer's resources. The reason is that, petrol is one of the basic inputs in production and an increase on its price leads to an increase in production costs. This corroborates the work of Ahmad (2013) in Pakistan and Hanson *et al.*, (2013) in the USA. The former found that high fuel prices induces high costs of production and ultimately lowered output, employment rate, purchasing power; hike prices of food commodities other commodities and; increases inflation, while the later reported an inverse relationship between oil price shock and agricultural output.

Table 2: Growth Rate of Petrol Price

Dependent Variable/ Period	Growth Rates in Percentages
Petrol Price	7.86

Source: Computed by Author, 2017

To determine whether there was acceleration, deceleration or stagnation in the movement and growth rate of petrol price in the period under review, a quadratic equation was estimated in time variable. The result in Table 3 indicates that the coefficient of time variable is negative which confirms a deceleration. This implies that the increase in petrol price negatively affects agricultural productivity and this will result in the increase in the prices of goods, inflation, lowered consumer's purchasing power and discouraged investment in the agricultural sector.

Table 3: Quadratic Equations in Time Variables for Petrol Price

Dependent variable/ period	B_0 (Constant)	B_1 (Slope)	B_2 (Slope)	R^2	R^{-2}	F-Ratio
Fuel Price	0.7344 (1.9832)*	0.1366 (3.8369)***	-0.0013 (-1.7611)	0.6414)	0.6251)	39.35S***

Source: Computed by Author, 2017

4.2 Results of Augmented Dicker Fuller (ADF) and Phillips-Perron (PP) Unit root test

The results of Augmented Dicker Fuller *(ADF)* and Phillips-Perron *(PP)* unit root tests are presented in Table 4. Results shows that all the variables are homogenous in order one. They are stationary by first difference prior to subsequent estimations to forestall spurious regressions. Therefore, they are integrated in the order of 1 {i.e,*1(1)*} using intercept specification.

Table 4: Results of Augmented Dicker Fuller (ADF) and Phillips-Perron (PP) unit root test

Logged Variable	ADF		PP		Conclusion
	Level Intercept	1st Difference Intercept	Level Intercept	1st Difference Intercept	
ARGDP	-1.0494[0]	-.57704[0]***	-1.1819[2]	-5.7657[2]***	*I(1), I(1)*
FUEP	-2.0064[0]	-6.0108[1]***	-1.9788[3]	-5.9394[4]***	*1(1), I(1)*
EXR	-0.1404[0]	-5.4253[0]***	-0.2519[3]	-5.4211[2]***	*I(1), I(1)*
FI	-0.4726[1]	-8.9687[0]***	-0.6370[4]	-8.7267[4]***	*I(1), I(1)*
FPI	-1.9819[0]	-6.4586[0]***	-1.9867[4]	-6.4917[4]***	*I(1), I(1)*
GCAA	-0.2634[0]	-8.2848[1]***	-0.3011[23]	-24.1118[35]***	*I(1), I(1)*
INF	-2.0299[0]	-6.8340[0]***	-2.0800[2]	-7.2563[8]***	*I(1), I(1)*
INTR	-1.8309[0]	-7.7774[0]***	-1.7017[2]	-7.7810[1]***	*I(1), I(1)*

*Source: Computed by Author, 2017. Notes: *** indicates significance at 1% level. The values in bracket [ ] for the ADF test shows the optimal lag length selected by the SIC within a maximum lag of 9 .The values in bracket for PP test indicates bandwidth selection, using the Newey-West's Bartlett Kerne*

4.3 Co-integration Test

The unit root tests in Table 4 shows that all the variables in the study became stationary at first difference and integrated of order 1 {i.e,*1(1)*}. This prompted the need for another test to investigate the existence of a co-integrating relationship between the non-stationary variables. The results of the Johansen co-integration tests are presented in Tables 5 and 6 respectively. As indicated in the Tables, both the Trace and the Maximum Eigen value tests reveals the presence of two

co-integrating vectors relationship among agricultural real gross domestic product, petrol price, exchange rate, food import, agricultural foreign private investment, government capital allocation to agricultural sector, inflation and interest rate at 5% level of significance respectively. This is an evidence of a long-run relationship among these variables in Nigeria. Therefore, applying the Vector Error Correction Model (VECM) would enable us to track the long-run relationship between the variables and tie it to a deviation that may occur in the short-run (Lorde, Jackson, Thomas, 2009).

Table 5: Johansen co-integration trace test

Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value
r = 0	r = < 1	203.5754	159.5297**
r = 1	r = < 2	130.8984	125.6154**
r = 2	r = < 3	76.37781	95.75366
r = 3	r = < 4	47.29553	69.81889
r = 4	r = < 5	29.63759	47.85613
r = 5	r = < 6	17.61104	29.79707
r = 6	r = < 7	7.219215	15.49471
r = 7	r = < 8	1.237968	3.841466

*Source: Computed by Author, 2017. Notes: r indicates the number of co-integrating vector. ** is the significance levels at 5% respectively. P-values are obtained using response surfaces in Mackinnon et al., (1999).*

Table 6: Johansen co-integration maximum eigen value test

Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value
r = 0	r = 0	72.67703	52.36261**
r = 1	r = 1	54.52055	46.23142**
r = 2	r = 2	29.08228	40.07757
r = 3	r = 3	17.65794	33.87687
r = 4	r = 4	12.02654	27.58434
r = 5	r = 5	10.39183	21.13162
r = 6	r = 6	5.981248	14.26460
r = 7	r = 7	1.237968	3.841466

*Source: Computed by Author, 2017. Notes: r indicates the number of co-integrating vector. ** is the significance levels at 5% respectively. P-values are obtained using response surfaces in Mackinnon et al., (1999).*

4.4 Vector Error Correction Model Estimates

4.4.1 Long Run Result

The result of the long run vector error correction Model (VECM) in Table 7 validates the earlier co-integration results in Tables 5 and 6 respectively. It confirms a long run relationship and close movement among the variables in the model. The VECM estimated using optimum lag of 1 shows that four of the variables: petrol price (LNFUEP), exchange rate (LNEXR), government capital allocation to agricultural sector (LNGCAA) and inflation (LNINF) are significant determinants of agricultural productivity in Nigeria during the period of analysis and were statistically different from zero at 1% and 5% respectively. The coefficients of the other three variables; food import (LNFI), foreign private investment (LNFPI) and interest rate (LNINTR) were not significantly different from zero though correctly signed. This implies that previous food import (LNFI), foreign private investment (LNFPI) and interest rate (LNINTR) did not significantly affect the present variables. It was

observed that both petrol price (LNFUEP) and inflation (LNINF) were negative but significant while exchange rate (LNEXR) and government capital allocation to agricultural sector (LNGCAA) were positively significant. This suggests that past fuel price (LNFUEP) and inflation (LNINF) negatively determined the current flow of petrol price (LNFUEP) and inflation (LNINF) to agricultural productivity (LNARGDP) while past exchange rate (LNEXR) and government capital allocation to agricultural sector (LNGCAA) positively influence the current flow of exchange rate (LNEXR) and government capital allocation to agricultural sector (LNGCAA) to agricultural productivity in Nigeria. Thus, an increase or decrease in these significant variables will either increase or decrease agricultural gross domestic products (LNARGDP) - agricultural productivity in Nigeria under the period reviewed.

Vector Error Correction Estimates included Observation:44 after adjustment for Standard errors in ( ) & t-statistics in [ ]

Co-integrating Eg:	Co-integrated Eq. 1
LNARGDP(-1)	1.000000
LNFUEP(-1)	-2.040399
	(0.21694)
	[-9.40538]**
LNEXR(-1)	0.452408
	(0.17943)
	[2.52136]***
LNFI(-1)	0.024039
	(0.35794)
	[0.06716]
LNFPI(-1)	-0.376989
	(0.34892)
LNGCAA(-1)	0.917698
	(0.39765)
	[2.30781]**
LNINF(-1)	-2.948237
	(0.31824)
	[-9.26407]***
LNINTR(-1)	0.451568
	(0.48024)
	[0.94030]
C	-5.245717

4.4.2 Short Run Causality Test

To examine the significant relationship existing between the macroeconomic variables and tie it to deviation that may occur in the short-run in the study, a Vector Error Correction Granger Causality test was carried out as presented in Table 8. The result reveals five significant dependent variables namely: petrol price (LNFUEP) [cell 2], food import (LNFI) [cell 4], government capital allocation to agricultural sector (LNGCAA) [cell 6], inflation (LNINF) [cell 7] and interest rate (LNINTR) [cell 8] were determinants of short run relationship within the Vector Error Correction Granger Causality test. These dependent variables had significant unidirectional relationship between some of their independent variables as shown in Table 8. For example, under the dependent variable of lagged petrol price (LNFUEP) [cell 2], the result indicates that there is a unidirectional relationship between agricultural productivity (LNARGDP), exchange rate (LNEXR), foreign private investment (LNFPI), inflation (LNINF) and fuel price (LNFUEP) and it flows from agricultural productivity (LNARGDP), exchange rate (LNEXR), foreign private investment

(LNFPI), inflation (LNINF) to fuel price (LNFUEP). This implies that the null hypothesis at 10% and 1% of statistical significance is rejected since the coefficients on the lagged variables-agricultural productivity (LNARGDP), exchange rate (LNEXR), foreign private investment (FPI), inflation (LNINF) are statistically different from zero. Therefore, agricultural productivity (LNARGDP), exchange rate (LNEXR), foreign private investment (LNFPI), inflation (LNINF) granger cause fuel price (LNFUEP). However, the null hypothesis is not rejected at all levels of statistical significance [food import (LNFI), government capital allocation to agricultural sector (LNGCAA) and interest rate (LNINTR). This implies that fuel price (LNFUEP) does not granger cause food import (LNFI), government capital allocation to agricultural sector (LNGCAA) and interest rate (LNINTR) since the coefficient on the lagged fuel price (LNFUEP) is statistically different from zero. The same decision rules are applicable to the remaining four dependent variables - food import (cell 4), government capital allocation to agricultural sector (cell 6), inflation (cell 7) and interest rate (cell 8).

The results further show two bi-directional relationships between fuel price (LNFUEP) and food import (LNFI); food import (LNFI) and interest rate (LNINTR) respectively. This implies the estimated coefficients on the lagged fuel price (LNFUEP) and the lagged food import (LNFI) is statistically different from zero likewise the estimated coefficients on the lagged food import (LNFI) and the lagged interest rate (LNINTR) is statistically different from zero respectively. Both the unidirectional and the bidirectional relationship of these dependent variables with their significant independent variables confirm a short-run relationship between them within the Vector Error Correction Granger Causality test in Nigeria under the period reviewed. However, dependent variables of agricultural gross domestic products (LNARGDP) [cell 1], exchange rate (LNINTR) [cell 3], and foreign private investment (LNFPI) [cell 5] had no relationship with their independent variables since they were not significant different from zero, as such, were not discussed further.

Table 8: Short Run VEC Granger Causality/Block Exogeneity Wald Tests. Sample: 19702016. Included Observations: 44

Dependent variable: D(LNARGDP) CELL1				Dependent variable: D(LNFUEP) CELL 2		
Excluded	Chi-sq	Df	Prob.	Excluded	Chi-sq	Df Prob.
D(LNFUEP)	0.707363	2	0.7021	D(LNARGDP)	6.190441	2 0.0453*
D(LNEXR)	0.391812	2	0.8221	D(LNEXR)	5.568583	2 0.0618*
D(LNFI)	0.058793	2	0.9710	D(LNFI)	1.376800	2 0.5024
D(LNFPI)	2.965000	2	0.2271	D(LNFPI)	5.989464	2 0.0501*
D(LNGCAA)	3.765039	2	0.1522	D(LNGCAA)	0.906869	2 0.6354*
D(LNINF)	0.034484	2	0.9829	D(LNINF)	14.60812	2 0.0007**
D(LNINTR)	0.700556	2	0.7045	D(LNINTR)	1.761145	2 0.4145
All	7.396388	14	0.9183	All	34.32936	1 4 0.0018
Dependent variable: D(LNEXR) CELL 3				Dependent variable: D(LNFI) CELL 4		
Excluded	Chi-sq	Df	Prob.	Excluded	Chi-sq	Df Prob.
D(LNARGDP)	0.519022	2	0.7714	D(LNARGDP)	0.394884	20.8208
D(LNFUEP)	0.915583	2	0.6327	D(LNFUEP)	5.025974	20.0810*

D(LNFI)	1.968452	2	0.3737	D(LNEXR)	0.600211	20.7407
D(LNFPI)	0.248812	2	0.8830	D(LNFPI)	15.93327	20.0003**
D(LNGCAA)	1.634689	2	0.4416	D(LNGCAA)	5.167860	20.0755*
D(LNINF)	2.293083	2	0.3177	D(LNINF)	5.742832	20.0566*
D(LNINTR)	2.921413	2	0.2321	D(LNINTR)	7.338629	20.0255*
All	8.381770	14	0.8685	All	35.73204	4 0.0011
Dependent variable: D(LNFPI) CELL 5				Dependent variable: D(LNGCAA) CELL 6		
Excluded	Chi-sq	Df	Prob.	Excluded	Chi-sq	Df Prob.
D(LNARGDP)	1.698111	2	0.4278	D(LNARGDP)	6.879888	20.0321*
D(LNFUEP)	3.085725	2	0.2138	D(LNFUEP)	4.991570	20.0824*
D(LNEXR)	1.027494	2	0.5982	D(LNEXR)	8.485024	20.0144*
D(LNFI)	0.320814	2	0.8518	D(LNFI)	4.429417	20.1092
D(LNGCAA)	0.272520	2	0.8726	D(LNFPI)	9.835463	20.0073*
D(LNINF)	1.244482	2	0.5367	D(LNINF)	10.68075	20.0048**
.D(LNINTR)	0.195473	2	0.9069	D(LNINTR)	1.023687	20.5994
All	12.84552	14	0.5387	All	32.22816	1 4 0.0037
Excluded	Chi-sq	Df	Prob.	Excluded	Chi-sq	Df Prob.
D(LNARGDP)	1.871222	2	0.3923	D(LNARGDP)	0.241911	2 0.8861
D(LNFUEP)	2.114694	2	0.3474	D(LNFUEP)	0.827668	2 0.6611
D(LNEXR)	5.135990	2	0.0767*	D(LNEXR)	0.458556	2 0.7951
D(LNFI)	2.777647	2	0.2494	D(LNFI)	4.932863	2 0.0849*
D(LNFPI)	3.129297	2	0.2092	D(LNFPI)	0.390867	2 0.8225
D(LNGCAA)	3.879955	2	0.1437	D(LNGCAA)	0.747862	2 0.6880
D(LNINTR)	0.963399	2	0.6177	D(LNINF)	0.562679	2 0.7548
All	16.92742	14	0.2601	All	8.219967	1 4 0.8776

Source: Computed by Author, 2017.

*Note: *** and * =1% and 10% significance levels respectively*

Going by the Johansen co-integration results, a VECM (2) with at least two co-integrating vectors was carried out to ascertain that the estimated VECM was not false, the residual auto correlation and correlogram tests were also conducted. The results reveal that the residuals of the estimated VECM were appropriately uncorrelated, implying that the estimated VECM was correctly specified or unbiased and the parameters estimated were consistent. This was because the spikes from the correlograms revealed the relative correlation of the error terms in the VECM equations and the closer the spikes are to the zero line, the more uncorrelated the error terms (Akpaeti, 2015). The coefficients from the estimated VECM were not of primary interest in this empirical work. Instead, focused was on the Impulse Response Functions (IRFs) and Variance Decomposition (VDC) generated from the VECM.

4.5 Impulse Response Functions

The Impulse Response Functions traced out the responsiveness of the dependent variable in the VECM to shocks on each of the variables using the Cholesky one standard deviation innovations

(Choleskey one Standard deviations examine the dynamic interactions among variables). This implies that impulse responses show the path of agricultural productivity (LNARGDP) when there are innovations in macroeconomics policy variables. For each equation, a unit shock is applied to the error, and the effects upon the VECM system over 10 years are examined. The VECM system has eight variables, thus a total of 64 impulses could be generated. But the primary objective was to examine the impact of petrol price shocks on the other seven macro-economic or endogenous variables and itself. Thus, only the responsiveness of the petrol price on the macro-economic variables (LNARGDP, LNFUEP, LNEXR, LNFI, LNFPI, LNGCAA, LNINF and LNINTR) is traced out.

Figure 1, presented eight panels of impulse response graphs indicating how innovations in petrol price variable affected agricultural productivity, itself and other policy variables in Nigeria over a period of 10 years. Each panel illustrates the response of the policy variables to a one standard deviation innovation (corresponding to a positive shock) in the policy variable (Akpaeti, 2015).

Panels A, B, D, E, F, G and H reveals the impulse responses of agricultural productivity, petrol price, food import, foreign private investment, government capital allocation to agriculture, inflation and interest rate respectively to the one time shock in the petrol price as presented in Figure 1. These seven macro-economic policy variables responded negatively in an undulating but significant manner over the period reviewed to the positive shock of petrol price. This implies that an increase in the price of petrol, negatively impacted on agricultural productively, food import, foreign private investment, government capital allocation to agriculture, inflation and interest rate respectively both in the short and long run. This result validates the earlier result in Table 3 where incessant and unstable petrol price in Nigeria increases the prices of goods, inflation, lowering of consumer's purchasing power and discourage investors from investing in the agricultural sector. This is also in line with the economic postulation that the lower the interest rate arising from unstable price fluctuation, the lower the investments opportunities, and vice versa. The result correlated with that of Hasan *et al.,* (1996) which reveals that low interest ceiling is noted to unduly restrict the real flow of loan-able funds, thus depressing the quality of productive investment. That is, investment is negatively related to the effective real rate of interest on loans, but positively related to the growth rate of the economy. However, the negative food import is a blessing in disguise for the local producers but, where there is a lag in purchasing power, the wherewithal and propensity for importation of food is questioned? The negative but significant impact of the petrol price shock on these macro-economic variables shown in Figure 1 confirms the weak and unstable nature of the Nigeria mono market (oil) economy. Panel C shows the negative response of exchange rate in the first two years before becoming positive but fluctuating trend over a period of ten years to the shock of petrol price. This implies that petrol price have a positive impact on macro-economic policy (exchange rate) in Nigeria. This may be attributed to the fact that exchange rate controls the crude oil market and the crude oil market and cost of refining determines the price of petrol. This is contrary to the negative theoretical postulation considering the seasonal nature of agricultural production in a country with an open economy having many trading partners.

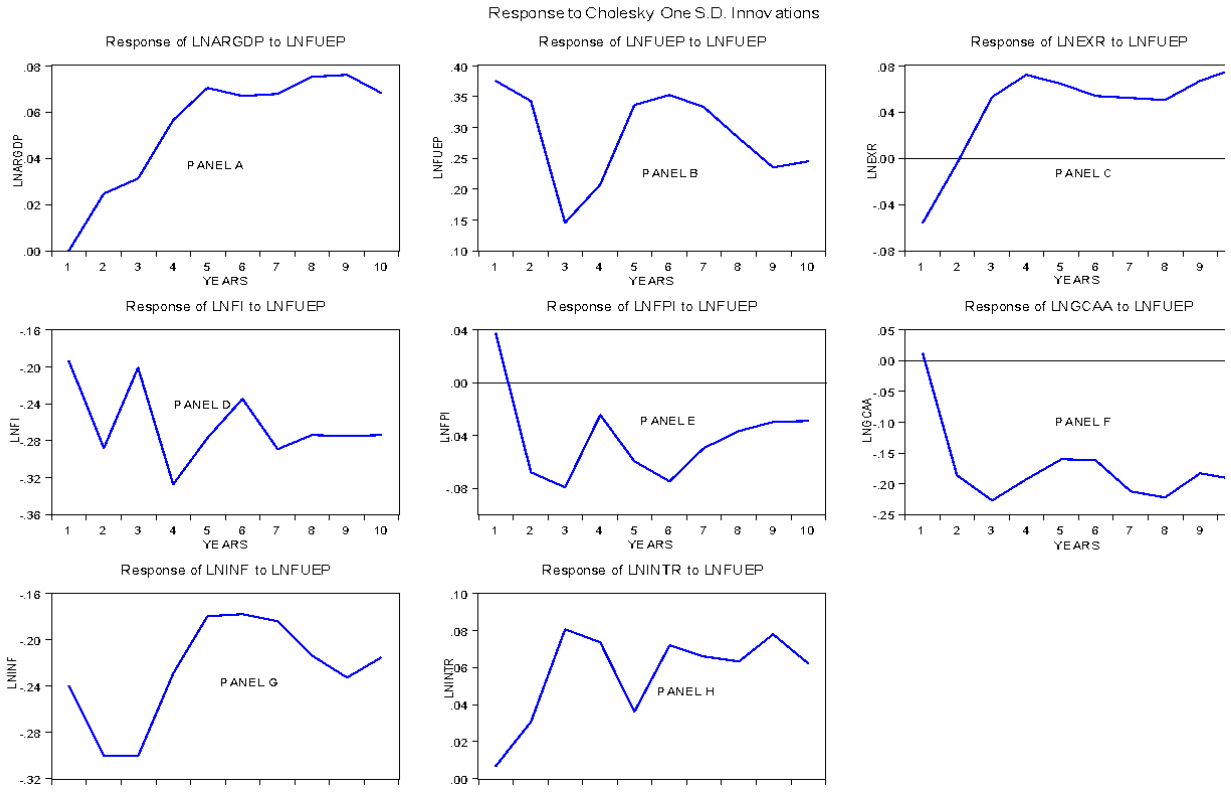

Figure 4.1: Response of LNAGINV, LNAGRGDP1, LNSAV, LNPCI, LNLFA, LNER, and LNIR to LNFSRGDP shock in choleskey one standard deviation (Choleskey one Standard deviations examine the dynamic interactions among variables).

4.6 Variance Decomposition Analysis (VDC)

The Variance Decomposition Analysis (VDC) provides a means of analysis to determine the relative importance of the dependent variable in explaining the variations in the explanatory variables. The result of variance decomposition over a 10 year time period is displayed in Table 9. The values in the table confirm the results obtained from the Impulse Response analysis (IRFs). On the average, 47.75% of most of the variation in the forecast error for petrol price is explained by the shocks to itself while agricultural productivity shock has a value of 2.82% of the variation of petrol price. Average contributions of LNEXR, LNFI, LNFPI, LNGCAA, LNINF and LNINTR are 9.83%, 1.89%, 1.80%, 6.22%, 23.55% and 6.15% respectively. A careful look reveals that food import and foreign private investment values were low while that of exchange rate, government capital allocation to agriculture and inflation were high during the ten period horizon. This is very instructive, as the petrol price impacted on the economy; it raises inflation and exchange rate while government tries to curb their effects by increasing the capital allocation to agriculture because of the low effect on agricultural productivity and high interest rate which will discourage investment both in the long and short run. This result corroborate with the findings earlier reported in the long and short run analysis.

Table 9: Variance Decomposition of LNFUEP

Period	S.E.	LNARGDP	LNFUEP	LNEXR	LNFI	LNFPI	LNGCAA	LNINF	LNINTR
1	0.375657	0.228913	99.77109	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.584605	3.349256	75.76066	0.725415	0.022149	4.031745	6.851858	5.270403	3.988517
3	0.674964	5.140684	61.50358	0.849816	1.161402	3.238121	8.969594	9.304228	9.832572
4	0.786126	3.793124	52.34338	5.485895	2.435254	2.566429	7.830342	16.73125	8.814335
5	0.956850	2.816259	47.75333	9.828833	1.888751	1.795224	6.221568	23.54829	6.147747
6	1.127139	2.335314	44.17702	15.47192	1.831763	1.573263	5.793692	24.30502	4.512017
7	1.267518	2.248647	41.84323	21.34872	1.897139	1.547502	5.496684	21.93758	3.680493
8	1.371028	2.032588	39.99690	25.40310	1.824248	1.412826	5.117122	20.69450	3.518723
9	1.446005	1.836632	38.61715	27.01771	1.702873	1.281778	4.923863	20.78428	3.835723
10	1.525940	1.682222	37.26778	27.61231	1.591569	1.151944	5.047404	21.66379	3.982985

Source: Computed by Author, 2017. Note: S.E (Standard Error), LNARGDP (log of Agric.GDP), LNFUEP (log of Petrol price), LNEXR (Exchange rate), LNFI (Food Import), LNFPI (log Foreign Private Investment), LNGCAA (Log of Government Capital Allocation to Agricultural Sector), LNINF (Log of Inflation) and LNINTR (log of Interest Rate).

V. CONCLUSION AND RECOMMENDATIONS

The study empirically investigates the impact of petrol price fluctuations on agricultural productivity in Nigeria from 1970 to 2016 using a multivariate Vector Error Correction framework. Results from VECM reveal existence of both long and short-run relationship between petrol price and major agricultural productivity. However, impulse response results show that petrol price negatively impacted agricultural productivity and other macro-economic policy variables such as food import, foreign private investment, government capital allocation to agriculture, inflation and interest rate respectively both in the short and long run. The negative but significant impact of the petrol price shock on these macroeconomic variables confirms the weak and unstable nature of Nigeria mono market (oil) economy. On the other hand, the variance decomposition results reveal that petrol price impact on these macro-economic policies in the economy raises inflation and exchange rate while government tries to check mate these effects on the economy by increasing the capital allocation to agriculture (6.22%) in order to achieve food security in the country. This is because low agricultural productivity and high Interest rate will discourage investment both in the long and short run. Therefore, there is need for government to embark on full deregulation of petroleum downstream sector in order to ensure product market competitiveness, fast tract the construction of modular refineries for all the states tin the Niger delta of Nigeria, construct at least two tank farms per geographical zone of the country and ensure fast efficient and effective petroleum product transportation. Finally, the government should pursue policies that would control the price of petrol to ensure that it unstable price will not hamper the productivity of the agricultural sector while ensuring check and balance (using anti-corruption agencies) in the Nigeria National Petroleum Corporation (NNPC) for financial prudence. Above all, effort should be geared toward the development of solar energy technology in line with the developed countries like Britain who has proposed to ban the use of fossil fuel vehicles.

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