Journal of Agriculture and Agricultural Technology 8(1): 27-36, 2017

CONNECTION BETWEEN PRODUCER PRICES AND RICE OUTPUT IN NIGERIA: AN APPLICATION OF KOYCK'S DISTRIBUTED-LAG MODEL

Orefi Abu
Department of Agricultural Economics, University of Agriculture Makurdi, Benue State, Nigeria
Email:orefi@yahoo.com

ABSTRACT
Favourable prices usually induce increased production in agricultural commodities globally. This study examined the relationship between producer prices and rice output in Nigeria using time series data spanning from 1980 to 2013. The study employed Koyck distributed-lag model. The results revealed that producer prices imposed a positive and significant effect on rice output. The producer price in a given year was found to impact significantly on the subsequent year's rice output while the lagged prices had a positive but decreasing effect on rice output. In terms of size, a one per cent change in a given year's producer prices resulted in increases in rice output by 0.102 ton whereas a one per cent change in the previous year's price increased rice output by 0.051 ton. In general, the time required for changes in producer prices to have a significant and noticeable effect on rice output in Nigeria was 1.01 year. Consequently, producer price stability could considerably result in a more predictable rice output in Nigeria. Government can stabilize price by guaranteeing a price to producers irrespective of the output produced.
.

Keywords: Rice, Producer Prices, Koyck distributed-lag model, Nigeria

INTRODUCTION
Rice (*Oryza sativa*) is the staple food for a greater part of the world's population, particularly in developing countries. According to Borrero *et al.* (2007), more than 75 per cent of the world's poorest people still depend on rice. In Nigeria, rice used to be classified as a luxury food item prior to independence, however, rice now holds the status of a staple food, along with cassava and yam among others (Daramola, 2005). Although per capita consumption of rice in the country increased from as low as 3.4kg/year in 1976 to 20.9kg/yr in 2009 (FAOSTAT, 2013), production has failed to catch up with the increasing demand for rice . As at 2016, the total demand for rice was 7 million metric tones, only 2.7 million metric tones was produced, leaving a gap of 4.3 million metric tones (Thisday Newspaper, 2016). This has lead to a wide gap between domestic production and demand. Consequently, enhancing cereal output in general and rice in particular is closely associated with national food security and wellbeing of majority of the farming population. Accordingly, the impact of price changes in the supply and demand for food is critical.

In addition to the uncertainty farmers face with regard to the amount of output that will result from a given bundle of inputs and management decisions due to uncontrollable factors such as weather, they have to deal with price uncertainties and instability (Demeke, *et al.*,2012). The knowledge of price at the time of planting and harvest is very crucial for farmers considering growing any crop. Given that more than 90 per cent of Nigeria's agricultural output comes from small-scale peasant resource poor farmers who reside in the rural areas (Ismaila *et al.*, 2010), low and fluctuating prices would cause problem for stable food production. This is because agricultural price volatility increases the uncertainty faced by farmers' especially small-scale farmers and affects their income and investment decisions as well as their productivity. It is therefore, very important that farmers have all the needed information for making good decision. As a consequence, price relationships have a significant influence on decisions regarding the type and quantity of agricultural production activity. It is against this backdrop that this study seeks to examine the connection between producer prices and rice output in Nigeria using the Koyck distributed lag model. Previous studies conducted in other crops using Koyck model to examine the relationship between production and prices include: Erdal (2006), Ozcelik and Ozer (2006), Erdal and Erdal (2008), Erdal *et al.,* (2009), De Silva *et al..* (2014) and Hasan and Khalequzzaman (2015).

The objectives of the study were to describe the trend in producer prices and rice output in Nigeria, determine the optimal lag of producer prices that could have an effect on rice output and determine the effect of producer prices on rice output. Findings from this study will assist rice farmers in making a good prediction of price and aid policy makers in formulating polices that will stabilize producer prices of rice in Nigeria.

LITERATURE REVIEW

Price is generally the channel through which economic policies are expected to affect agricultural variables such as output, supply and export and income (Phillips and Abalu, 1987; Dercon, 1993). Producer prices are prices received by farmers for primary crops, live animals and livestock products as collected at the point of initial sale, that is, prices paid at the farm-gate (Food and Agriculture Organization, FAO, 2017). These prices are considered at the farm gate, that is, at the point where the commodity leaves the farm and hence does not include the costs of transport and processing. According to Enete and Amusa (2010), producer prices are usually an inducement for farmers to produce. Farmers are more likely to consider past experiences and make the best guess of the price (Ndhlovu and Seshamani, 2016). Increased price variability can have adverse impacts on both consumers and producers of agricultural commodities, consequently leading to alteration in the production levels of the commodity involved (Shively, 1996). The instability of agricultural prices negatively impacts the activity of farmers, because when prices are volatile, it becomes impossible for farmers to select the right production techniques or to plan their investments (Malan, 2013). This volatility of agricultural prices causes severe damage to farmers in the terms of well-being (Matthews, 2010; Onour and Sergi, 2011; Rapsomanikis and Mugera, 2011). This is because in general poor farmers do not have enough investment capital to sustain such unpredictability (Huka, *et al.*, 2014) which could be made worse by meager producer prices.

Prices of commodities give signals to the producers regarding the type and quantity of commodity to be produced in a particular place at a particular time in a viable economic system (Reddy *et al.*, 2009). Farmers are commonly believed to be quick to respond to producer prices (Ezekiel *et al.*, 2007). According to Bor and Bayaner (2009), it is commonly thought that farmers have sufficient power to decide the physical procedure of agricultural production, meaning that the decisions on what to produce, how to produce and which inputs to use are in the hands of the farmers and the farmers take the prices as decision-making factor. Farmers are known to consider the previous year's price when planning what to produce and how much to produce. Such planning results in price and output fluctuations, which is referred to as the Cobweb theory in economic literature

The Cobweb theory describes the temporary equilibrium of market prices in a single market with one lag in supply (Hommes, 1994). The Cobweb theory is a dynamic analysis theory that employs the elasticity law to explain the different fluctuations in some commodities with long production periods when they lose balance (Zhan and Feng, 2008). The crucial supposition of the Cobweb theory is that the current production of the commodity is based on the price in the previous period. According to the assumptions of the Cobweb model, farmers will determine the current grain-sown area according to the price of the previous period before the grain production is carried out (Xie and Wang, 2017). Subsequently, the current grain price will have determined the grain yield of the next period to a certain extent. The higher the price of agricultural products, the stronger the enthusiasm of farmers and food production will increase (Xie and Wang, 2017). On the other hand, lower prices of agricultural products will reduce the eagerness of farmers to increase grain production leading to a decrease next year's planting plan, which will lead to a reduction of that year's grain production. Based on these structural features of agricultural production, relationship between agricultural output and price can be examined using distributed lag model.

THEORETICAL FRAMEWORK

Distributed-lag models play important roles in economic literature and econometric modeling. In estimating Distributed-lag models, the present values and past values are taken into account for modeling. Two major problems with distributed lag models are multicolinearity and the increasingly lowered degrees of freedom as lag length increases. In order to overcome these problems, Koyck model (Koyck, 1954) was developed for the estimation of parameters in distributed lag models. According to Gujarati (2003), the dependence of variable Y on variable (s) X is rarely instantaneous, because very often, Y responds to X with a lapse of time (lag). Given the following distributed-lag model in one explanatory variable (Gujarati, 2003):

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + ... + \mu_t \quad (1)$$

Assuming that the $\beta's$ are all of the same sign, Koyck assumes that they decline geometrically as follows:

$$\beta_k = \beta_0 \lambda^k \text{ Where } k = 0,1... \quad (2)$$

where λ, such that 0< λ < 1, is known as the rate of decline or decay of distributed lag and $1-\lambda$ is the speed of adjustment. Equation (2) postulates that each successive β coefficient is numerically less than each preceding β (since $\lambda < 1$), suggesting that as one goes back into distant past, the effect of that lag on Y_t becomes progressively smaller (Gujarati, 2003). β_k is the lag coefficient which varies by λ as well as by β_0. The closer λ is to 1, the less the decrease in β_k. On the other hand, the closer λ is to zero, the greater the decrease in β_k (Gujarati, 2003). In other words, when λ values is close to 1, it means that the values of the defining variables in remote past have a significant effect on dependent variable, and values of λ close to zero mean that values of the defining variable in the distant past have no significant effects of the dependent variable. Koyck's geometric-lag scheme implies that 'more recent values of X exercise a greater influence on Y than remote values of X.

As a result of equation (2), the infinite model in equation (1) may be written as:

$$Y_t = \alpha + \beta_0 X_t + \beta_0 \lambda X_{t-1} + \beta_0 \lambda^2 X_{t-2} + ... + \mu_t \quad (3)$$

Linear regression analysis cannot be applied to equation (3) since it has infinite lag and λ coefficients are not linear. In order to solve this setback, equation (3) is lagged by one period to obtain:

$$Y_{t-1} = \alpha + \beta_0 X_{t-1} + \beta_0 \lambda\ X_{t-2} + \beta_0 \lambda^2 X_{t-3} ... + ... \mu_{t-1} \quad (4)$$

Multiply equation (4) by λ to obtain

$$\lambda Y_{t-1} = \lambda\alpha + \lambda\beta_0 X_{t-1} + \beta_0 \lambda^2 X_{t-2} + \beta_0 \lambda^3 X_{t-3} ... + ... \lambda\mu_t \quad (5)$$

Subtracting equation (5) from equation (3) gives

$$Y_t - \lambda Y_{t-1} = \alpha(1-\lambda) + \beta_0 X_t + (\mu_t - \lambda\mu_{t-1}) \quad (6)$$

Rearranging equation (6) gives

$$Y_t = \alpha(1-\lambda) + \beta_0 X_t + \lambda Y_{t-1} + v_t \quad (7)$$

Where $v_t = (\mu_t - \lambda\mu_{t-1})$, a moving average of μ_t and μ_{t-1}.The procedure described above is known as the Koyck transformation. Equation (7) is the Koyck model. Instead of estimating α and an infinite number of β's, the Koyck's model allow the estimation of only three unknown: α, β_0, and λ. The problem of multicollinearity is resolved by replacing $X_{t-1}, X_{t-2}, ...$, by a single variable, that is, Y_{t-1}. The 'mean lag length' proposed by the model is: λ/ (1- λ) which can be expressed as the time period required for a unit change in the defining variable to have a noticeable effect on the dependent variable (Gujarati, 2003). Once the model is specified, the Classical Least Square method is used to estimate the parameters.

METHODOLOGY

Study Area: This study was carried in the Federal Republic of Nigeria. Geographically, Nigeria occupies a landmass of 923,768sq km. The country comprises 36 states with Abuja as the Federal Capital territory. The country's population was estimated to be 173.6 million (World Bank, 2015). The country's strength includes abundant land, labour, and natural resources. It has an area covering 92.4 million hectares, consisting of 91.1 million hectares of land. 1.3 million hectares of water bodies. The agricultural area is 83.6 million hectares, which comprises arable land (33.8 percent), land permanently in crop (47.9 percent) forest or woods (13.0 percent), pasture (47.9 percent) and irrigable land (2.4 percent) (Adetunji, 2006). Climate in Nigeria fluctuates from humid tropical in the South to sub-humid tropical in the north, having wet and dry seasons. Nigeria is agrarian, and agriculture remains the core of the economy, providing employment for over 70 percent of the population.

Data Source: This study used time series data on producer prices and rice output in Nigeria spanning from 1980 to 2013. Data on producer prices and rice output were obtained from FAOSTAT, statistical database of Food and Agriculture Organization of the United Nations (FAOSTAT, 2016).

Estimation Procedures: First, the Augmented Dickey Fuller (ADF) test was used to establish the time series characteristics of all the variables used in the study. This was done to avoid the problem of spurious regression which is the outcome of regressing of two or more non-stationary time series data. The Augmented Dickey Fuller (ADF) model is as specified below:

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \beta Y_{t-1} \sum_{i-1}^{p} \lambda_i \Delta Y_{t-1} + \mu_t \quad (8)$$

Where Δ = the change operator; Y_t = series being investigated for stationarity; Y_{t-1}= Past values of variables; t = time variable and μ_t is the white noise error. The ADF test that the series is not stationary is represented by the null hypothesis ($H_0 : \beta = 0$) while the alternative hypothesis ($H_1 : \beta < 0$) shows that the series is stationary. The decision rule is that if the computed ADF statistics is greater than the critical at the specified level of significance, then the hull hypothesis of unit root is accepted otherwise it is rejected. In other words, if the value of the ADF statistics is less than the critical values, it is concluded that Y_t is stationary i.e. Y_t ~ *I(0)*. When a series is found to be non-stationary, it is first-differenced (i.e. the series $\Delta Y_t = Y_t - Y_t\text{-}1$) is obtained and the ADF test is repeated on the first-differenced series. If the null hypothesis of the ADF test can be rejected for the first-differenced series, it is concluded that $Y_t \sim I(1)$.

Model Specification : To examine the connection between producer prices and rice output in Nigeria, this study estimated the following linear equation model.

$$RQ_t = \alpha + \beta_0 PP_t + \beta_1 PP_{t-1} + \beta_2 PP_{t-2} + .\beta_k PP_{t-k} + \mu_t \quad (9)$$

Where RQ_t , is rice output in period t (ton), PP_t is producer prices in period t (₦/ton), PP_{t-1} is the producer prices lagged one period, α and β are the regression parameters. In order to estimate the model in equation (9), it was necessary to first determine the lag value (lag length) of producer prices to include in the distributed lag model. In selecting the lag length for the producer prices, the Akaike and the Schwarz information criteria (Gujarati, 2003) were applied at different lags (four lags) see Table 2 for results.

Based on the determined lag length, the following Koyck model was specified in equation (10) as:

$$\Delta \ln RQ_t = \alpha + \beta_0 \Delta \ln PP_t + \lambda \Delta \ln RQ_{t-1} + \mu_t \quad (10)$$

The variables were transformed into natural logarithms and used for the estimation. This was done because according to Gujarati (2003), log transformation reduces problem of heteroscedasticity because it compresses the scale in which the variables are measured, thereby reducing a tenfold difference between two values to a twofold difference. Furthermore, the model was estimated in differences in order to prevent the possibility of spurious results owing to non-stationarity in the variables. The reason for doing this can be seen in the results of the ADF test (Table 1). The estimates of the Koyck Distributed-lag model equation (10) were analyzed with the aid of E-views statistics software package using the classical least squares method.

RESULTS AND DISCUSSION

Summary Statistics of Variables: The summary statistics of variables used in the study is presented in Table 1. Results show that the mean producer price of rice for the period under study was ₦ 489.0679/tonne with a maximum and minimum of ₦1246.942/tonne and ₦ 133.6736/tonne respectively. On average, the output of rice was 2935323 tonnes with a maximum and minimum of 5432930 tonnes and 1090000 tonnes respectively during the period under study. The graphical representation of trends in producer prices and rice output are shown in figures 1 and 2.

Augmented Dickey Fuller (ADF) Unit root test: Results of the ADF test for the presence of unit root are presented in Table 2. The results indicated that all the variables (PP and RQ) were found to have unit root at level. However, became stationary after first differencing. Differencing was needed so as to avoid the occurrence of spurious regression when series are used in their non-stationary form.

Optimal Lag Selection for Producer Prices: Lag length selection based on Alaike and Schwarz criteria is presented in Table 3. The results showed that producer prices lag one period (k=1) was the optimal lag. Since the lowest Alaike and Schwarz values were obtained for lag length k=1. Thus, effect of producer prices on rice output will be zero after one year.

Effect of Producer Prices on Rice Output: The model in equation (10) as mention earlier was estimated in differences in order to prevent the risk of spurious results due to non-stationarity in the variables. The reason for doing this was because after first difference, the non-stationary variables became stationary at 1% significance level based on the results obtained from ADF unit root test on producer prices and rice output as shown in Table 2. The estimates from the Koyck's distributed-lag model are reported in Table 4. The coefficient of determination (R^2) value, which is an indication of overall measure of goodness of fit, was relatively high. The result showed that R^2 was 0.892 indicating that 89.2% of the variation in rice output was explained by producer prices. The F-statistics being significant implies that the overall goodness of the model is satisfactory. The sign of the coefficient of the constant term was positive and significant for the model at 1% level. The results in Table 4, showed that the coefficient of producer prices were positive which is in agreement with theory and significant at 1% level. This result is consistent with Akpan (2007) and Ayinde *et al.* (2015) who found positive relationship between price and output for Nigerian grain sector. This implies that a change in producer price resulted in a change in rice output. In terms of volume, a one per cent change in producer price would cause about 0.102 per cent change in rice output. The reason for this is that high producer price would cause farmers to increase input use and land allocated to rice cultivation thereby leading to an increase in rice output. Consequently, rational producers are expected to increase the use of inputs in reaction to crop price increases, suggesting that producers base their decisions on the expected crop prices (Bor and Bayaner, 2009).

In addition, the coefficient of lagged rice output (Table 4), showed a positive and significant impact on successive output. This implies that a one per cent change in the ton of rice produce in the previous year would cause about 0.503 per cent change in rice output. This suggests that an increase in output in a given year could be enhanced by an increase in rice output in the preceding year. The mean lag length, $\lambda/(1-\lambda)$ of 1.01 suggests that it takes about a year for rice output to respond to changes in producer prices in Nigeria.

To obtain values for equation (10), which is the Koyck distributed lag model estimated for this study, given that $\beta_k = \beta_0 \lambda^k$ where $k = 0,1\ldots$ since $0 < \lambda < 1$, the following calculation was carried out:

$$\beta_0 = \lambda^0 \beta_0 = (0.503)^0 (0.102) = 0.102$$

$$\beta_0 = \lambda^1 \beta_1 = (0.503)^1 (0.102) = 0.051$$

$$\alpha = \alpha/(1-\lambda) = 6.433/1 - (0.503) = 12.954$$

From the results of the calculation, the Koyck distributed lag model estimated for this study can then be specified as:

$$RQ_t = 12.954 + 0.102PP_t + 0.051PP_{t-1} \quad (11)$$

Based on equation (11), lagged producer prices have a positive but decreasing effect on rice output, while a one per cent change in a given year's producer price increases rice output by 0.102 ton, a one per cent change in the previous year's price increased rice output by 0.051 ton. This implies that 'more recent values of producer prices exercise a greater influence on rice output than remote values of producer prices. This suggests that a given year's price were found to impact significantly on subsequent year's output than the lagged prices. This result is consistent with findings of Ozcelik and Ozer (2006), Erdal and Erdal (2008), Erdal *et al.* (2009), De Silva *et al*. (2014) and Hasan and Khalequzzaman (2015).

CONCLUSION AND RECOMMENDATION

This study examined the connection between producer prices and rice output in Nigeria using time series data spanning from 1980 to 2013. The study employed Augmented Dickey-Fuller (ADF) test, Koyck distributed-lag model and Ordinary Least Square (OLS) regression analysis. The results revealed that producer prices imposed a positive and significant effect on rice output. The producer price in a given year was found to impact significantly on the subsequent year's rice output while the lagged prices had a positive but decreasing effect on rice output. In terms of volume, a one per cent change in a given year's producer price resulted in increases in rice output by 0.102 ton while a one per cent change in the previous year's price increased rice output by 0.051 ton. In general, the time required for changes in producer prices to have a significant and noticeable effect on rice output in Nigeria was 1.01 year. Therefore, producer price stability could significantly result in a more predictable rice output in Nigeria. Government can stabilize price by guaranteeing a price to producers irrespective of the output produced

REFERENCES

Akpan, S.B.(2007). Relative Price Variability and Inflation: A case study of Grain Sub-sector iin Nigeria. Unpublished Master's Thesis. University of Uyo, Nigeria.

Ayinde, O.E., Aina, I.V., Babatunde, R.O. and Falola, A. (2015). Effects of Price Variation on Rice Production in Nigeria, 1970-2011. *PAT* 11(1): 75-82.

Bor, O and Bayaner, A. (2009): How Responsive is the Crop Yield to Producer Prices? A Panel Data Approach for the Case of Turkey. New Medit N. 28-33.

Borrero, A., Ramos, M., Arsenal, A., Lopez, K and Hettel, G. (2007). Linking users to public goods via open access. First Monday, *Scholarly Publishing Initiatives at the International Rice Research Institute:*, *12*(10):33-42..

Daramola, B. (2005). Government Policies and Competitiveness of Nigerian Rice Economy. Paper presented at the 'Workshop on Rice Policy & Food Security in Sub-Saharan Africa' Organized by WARDA, Cotonou, Republic of Benin, November 07-09, 2005.

Dercon, S. (1993). Peasant Supply Response and Macroeconomic Policies: Cotton in Tanzania. *Journal of African Economics*, 2(2): 157-194.

Demeke, M., Dawe, D., Tefft, J., Ferede, T., and Bell,W. (2012). *Stabilizing Price Incentives for Staple Grain Producers in the context of Broader Agricultural Policies:* Debates and Country Experiences. ESA Working paper No. 12-05. Agricultural Development Economics Division, Food and Agriculture Organization of the United Nations. www.fao.org/economic/esa

De Silva, M. S. K., Jayasinghe-Mudalige, U. K., Edirisinghe, J.C., Herath, H.M. L. K and Udugama, J.M. M. (2014). Assessing the Production vs. Price Relationship of Black Tea in Sri Lanka: An Application of Koyck's Geometric-Lag Model. *Sri Lanka Journal of Economic Research*, 2 (2): 43-53

Enete, A.A and Amusa, T. A. (2010). Challenges of Adaptation to Climate Change in Nigeria: a Synthesis from the Literature. *Field Actions Science Reports*.

Erdal, G. (2006). The analysis of the relation between production and price in agricultural products with Koyck model (tomato case). *Journal of Agric.Faculty of Gaziosmanpasa University,* 23: 17-24.

Erdal, G. and Erdal, H. (2008). The interaction between production and prices for dry onion. Journal of Agricultural Faculty of Gaziosmanpasa University, 25: 33-39.

Erdal, H., Erdal, G and Esengun, K. (2009). An Analysis of Production and Price Relationship for Potato in Turkey: A Distributed Lag Model Application *Bulgarian Journal of Agricultural Science,* 15 (3):243-250.

Ezekiel A.A., Oladeebo A.O., Oladejo, J.A and Olapade F. (2007). Farm-gate and Retail Price Relationship for Selected Foodstuffs: Implications for Increased Food Production in Nigeria. *Agricultural Journal*, 2(5): 542-543.

FAOSTAT (2013). Statistical Database of Food and Agriculture Organization of the United Nations, FAO, Rome, Italy. Accessed on September 06, 2013 Available at http://faostat.fao.org/faostat

FAOSTAT (2016). Statistical Database of Food and Agriculture Organization of the United Nations, FAO, Rome, Italy. Accessed on June 14, 2016 Available at http://faostat.fao.org/faostat/.

FAOSTAT (2017). Producer Prices: Annual. Statistical Database of Food and Agriculture Organization of the United Nations, FAO, Rome, Italy. Accessed on April 27, 2017 Available at http:www//fao.org/faostat/en/# data/PP.

Gujarati, D. N. (2003). Basic Econometrics. 4th Edition. The McGraw-Hill Companies, 659-675.

Hasan, Md. K and Khalequzzaman, K. M. (2015). Relationship between production and price of garlic in Bangladesh: an analysis by using distributed lag model. *Bull. Inst. Trop. Agr., Kyushu Univ.* 38: 31-38.

Hommes, C. H. (1994). Dynamics of the Cobweb Model with Adaptive Expectations and Nonlinear Supply and Demand. *Journal of Economic Behaviour and Organization*, 24: 15-335.

Huka, H., Ruoja, C and Mchopa, A. (2014). Price Fluctuation of Agricultural Products and its Impact on Small Scale Farmers Development: Case Analysis from Kilimanjaro Tanzania. *European Journal of Business and Management*, 6 (36):155-160.

Ismaila, U., Gana, A. S., Tswanya, N. M., and Dogara, D. (2010). Cereals Production in Nigeria: Problems, Constraints and Opportunities for Betterment. *African Journal of Agricultural Research,* 5(12): 341-1350.

Koyck, L. M. (1954). Distributed Lags and Investment Analysis. North Holland Publishing Company, Amsterdam, 21-50.

Malan, B. B. (2013). Volatility and Stabilization of the Price of Coffee and Cocoa in Côte d'Ivoire. *Agric. Econ.* *Czech*, 59, (7): 333–340.

Matthews, A. (2010). *Perspectives on Addressing Market Instability and Income Risk for Farmers*. IIIS Discussion Paper No. 324. Institute for International Integration Studies, Trinity College, Dublin

Ndhlovu, O and Seshamani, V. (2016). The linkage between price and output of cotton in Zambia. *African Journal of Agricultural Economics and Rural Development,* 4 (4), 328-336.

Onour, I.A and Sergi, B.S. (2011). Modeling and Forecasting Volatility in the Global Food Commodity Prices. *Agricultural Economics* – Czech, 57: 132–139.

Ozcelik, A. and Ozer, O. O. (2006) Analysis of Correlation of Wheat Production and Prices with Koyck Models in Turkey. *Journal of the Agriculture Sciences of Ankara University,* 12: 333-339.

Philip, D. O. A and Abalu, G.O.I. (1987). Price Expectation and Formulations and Revision in the Nerlovian Framework with Application to Nigerian Farmers. *Journal of Agricultural Economics, 38(2).*

Rapsomanikis, G and Mugera, H. (2011). Price Transmission and Volatility Spillovers in Food Markets. In: Piot-Lepetit I., M'Barek R. (eds.): *Methods to Analyze Agricultural Commodity Price Volatility*. New York, Springer, pp. 165–180.

Reddy S.S., Ram, P.R., Sastry, T.V.N and Devi I.B. (2009). *Agricultural Economics*. Oxford and IBH Publishing Company, India; ISBN 81-204-1596-5.

Shively, G. E. (1996). Food Price variability and Economic Reform: An ARCH Approach for Ghana. *American Journal of Agricultural Economics,* 78(1):126-136.

Thisday Newspaper (2016). The Rice Debate: Why Nigeria can't Meet Local Production Demand. Available at www.thisdaylive.com/index.php/2016/11/05. Accessed on 5th November 2016

World Bank. (2015). Nigeria. Available at www.worldbank.org/country/Nigeria. Accessed 09/03/2015

Xie, H and Wang, B. (2017). An Empirical Analysis of the Impact of Agricultural Product Price Fluctuations on China's Grain Yield. *Sustainability*, 9, 906; doi:10.3390/su9060906. Available at www.mdpi.com/journal/sustainability. Accessed 10/06/2017.

Zhan, S.W and Feng, Z.C. (2008). Analysis of the Influence of Grain Price Changes on the Acreage of Grain. *J. Inn. Mong. Univ.* 5 :54-58.

Table 1: Summary Statistics of Variables

Variable	Mean	Minimum	Maximum	Std. Dev	CV (%)
Producer Price (PP)	489.0679	133.6736	1246.942	255.1900	52.18
Rice output (RQ)	2935323	1090000	5432930	1118421	38.10

Source: Author's computations using E-views

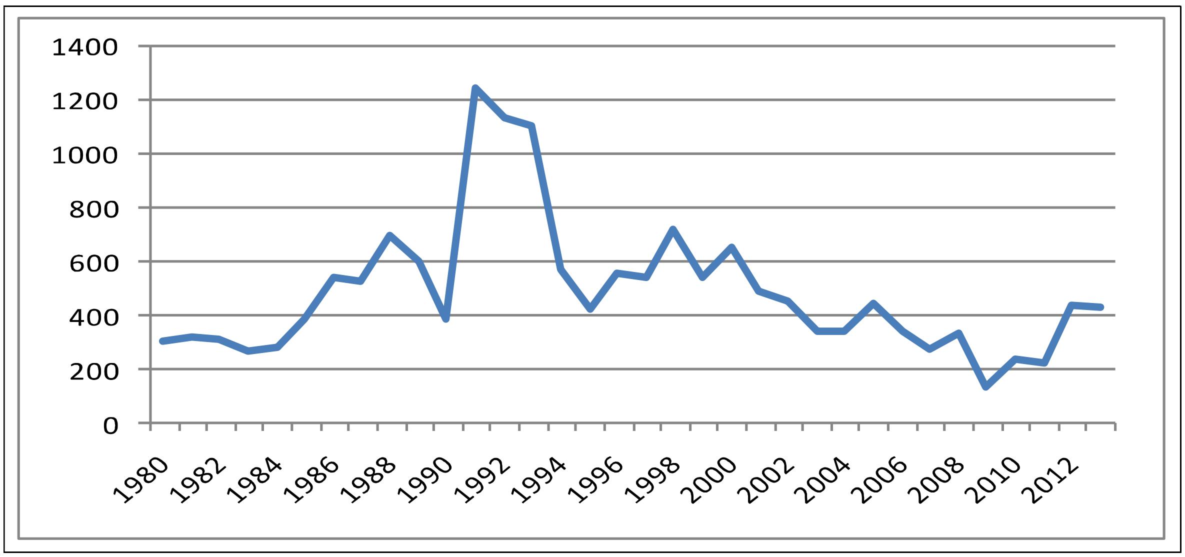

Figure 1: Trends in Producer prices in Nigeria, 1980-2013
Source: FAOSTAT (2016)

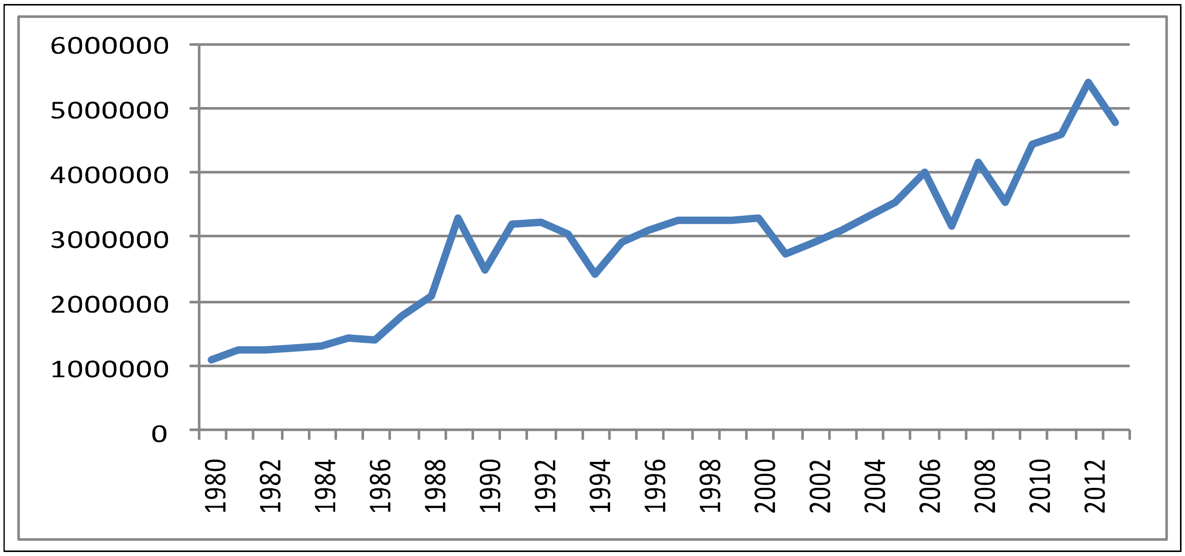

Figure 2: Trends in Rice Output in Nigeria, 1980-2013
Source: FAOSTAT (2016)

Table 2: Augmented Dickey-Fuller (ADF) Test Producer Price (PP) and Rice Output (RQ)

Variables	Levels			
	ADF Stat	Critical Values		
		1%	5%	10%
$\ln PP$	-0.721734	-3.653730	-2.957110	-2.617434
$\ln RQ$	-0.316594	-3.65370	-2.957110	-2.617434
	First Difference			
	ADF Stat	Critical Values		
		1%	5%	10%
$\ln PP$	-6.535917***	-3.661661	-2.960411	-2.619160
$\ln RQ$	-9.887052***	-3.653730	-2.957110	-2.617434

*** ' indicate variable is significant at 1% level; Lag length selection was automatic based on Schwarz information criterion (SIC).
Source: Author's computations using E-views

Table 3: Lag Length Selection based on Alaike and Schwarz Criteria

S/No.	Lag Length	Alaike Values	Schwarz Values
1	k=1	-0.71	-0.57
2	k=2	-0.64	-0.45
3	k=3	-0.57	-0.34
4	k=4	-0.46	-0.18

Source: Author's computations using E-views

Table 4: Estimates of Distributed-lag model

Dependent Variable: $\Delta \ln RQ_t$					
Variable	Parameter	Coefficient	Std. Error	t-Statistic	Prob.
C	$\alpha(1-\lambda)$	6.433312	2.043104	3.148794	0.0037***
$\Delta \ln PP_t$	β_0	0.102358	0.039552	2.587896	0.0147**
$\Delta \ln RQ_{t-1}$	λ	0.503355	0.161210	3.122358	0.0040***
R-squared		0.892333	Mean dependent var		14.83485
Adjusted R-squared		0.885155	S.D. dependent var		0.419054
S.E. of regression		0.142013	Akaike info criterion		-0.979295
Sum squared resid		0.605027	Schwarz criterion		-0.843249
Log likelihood		19.15836	Hannan-Quinn criter.		-0.933519
F-statistic		124.3178	Durbin-Watson stat		2.101078
Prob(F-statistic)		0.000000			
Mean lag length:	$\lambda/(1-\lambda)$	0.503/1-0.503 =1.01			

Note: *** and ** indicates significance at 1% and 5% level respectively
Source: Author's computations using E-views