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# **ANALYSIS OF SUPPLY RESPONSE AND PRICE RISK ON RICE PRODUCTION IN NIGERIA**

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# PAPER 1

## ANALYSIS OF SUPPLY RESPONSE AND PRICE RISK ON RICE PRODUCTION IN NIGERIA

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### ABSTRACT

Rice, which is one of the major sources of energy, vital nutrients and a staple food, is in short supply in many Nigerian households. Nigeria is among many African countries that have engaged in agricultural liberalization since 1986 in the hope that reforms emphasizing price incentives will encourage producers to respond. Hitherto, the reforms seem to have introduced greater uncertainty into the market given increasing rates of price volatility (Ajetomobi 2010). This study therefore models supply responses in Nigerian Rice production that include the standard arguments as well as price risk. Statistical information on domestic and imported quantities of rice was obtained for 41 years (1970 to 2011) from the AGROSTAT system of the statistical division of the Food and Agriculture Organization (FAO), Federal Ministry of Agriculture statistical bulletins, Central Bank of Nigeria statistical bulletins and National Bureau of Statistic. (NBS). The data are analyzed using descriptive, equilibrium output supply function and co-integration models and vector autoregressive distributed lag. Producer price of rice was positive and statistically significant with coefficient 0.6334. The output response of rice to hectareage was statistically significant but was negative with the coefficient 1.5135. Rice importation showed a negative sign and was statistically significant in Nigeria at 0.05, with Changes in output also responsive to changes in price. There is the tendency for the price of agricultural products to drop, which may consequently reduce the level of domestic production and thus discourage commercial production. The results indicate that producers are more responsive not only to price and non-price factor but to price risk and exchange rate. It is therefore imperative to reduce price risk as to increase the response of producer to supply by bridging the gap in production.

### INTRODUCTION

Rice is the staple food in many countries of Africa and constitutes a major part of the diet in many other. During the past three decades the crop has seen a steady increase in demand and its growing importance is evident given its important place in the strategic food security planning policies of many countries (Saka *et al*, 2005)

The challenges faced by countries regards rice production however differs from one country to the other in term of population, the preference attached to the commodity in the list of household

menu, natural endowment for expanded production and the productivity of the rice farms (Saka *et al*, 2005). Nigeria, though naturally endowed has not been able to produce enough rice for the domestic need of her teeming population and the gap between demand and domestic supply has further been widened by decades of growing importance of the commodity among households across the length and breadth of the country. This has culminated with enormous rice report in consequence of which Nigeria has emerged as a major importer of rice. High cost of production as a result of increase in price of input, low farm income, low efficiency of resource utilization and inadequate capital are some of the other reasons responsible for shortage in rice to augment local supply. There has been a steady decline in output of cereal between (1979 – 2007) (Akanni and Okeowo, 2011).

One of the most important issues in Agricultural development economic is supply response of crops (Mushtaq and Dawson 2002). This is because the responsiveness of farmers to economic incentive determines agriculture contribution to the economy where the sector is the largest employer of labour. Agricultural policies play a key role in increasing farm production (Rahji et al, 2008). Supply response is fundamental to an understanding of this price mechanism (Nerlove and Bachman 1960). The development of this production that while effective in recent year, may be relatively difficult to be repeated in the future (Anonymous, 2008). This is because of economic crisis and financial difficulties which result in reduced subsidies for this activity with these conditions, some area of Agricultural policy experts interested in observing the response to supply and demand for input in rice farming.

The farmer's response to price changes for specific products aimed at many conditions, which include applying resource especially land and family labour, plant selection and techniques, opportunities outside labour, the price of the product and presence of income uncertainty as well

as farmers attitude to risk. Further according to Darmawi (2005) also asserted that in any business activity, especially in agribusiness, the business is always face with situation of risk and uncertainty.

The farmer's response to price changes is useful for policy formulation. If farmers respond positively to prices movement supply of rice will be affected by the increase in price. Effectiveness and cost of alternative pricing policies depends on the magnitude on the magnitude and significance of the estimated response. Knowledge of the impact of other variable on the response of production is important for policy makers important variables include, input prices, changes in technology, farm management, risk and financial constraint must be considered in studying the response of production for this study is more realistic and useful (Kerney and Hertel, 2008). The role of the response of agricultural production has gained much attention in empirical study today. If there is risk involved in the production process or input prices expected utility of profits. Depending on the agents risk preferences the marginal expectation of the input may not balance with the price factor. Risk is the effect of uncertainty on objective. Uncertainties include events (which may or not happen) and uncertainties caused by a lack of information or ambiguity. This definition also includes both negative and positive impact on objectives, risk and uncertainty may result from one or combination of four factors which may be endogenous or exogenous (Anderson, *et al*1997). These factors include prices, production input, farm output and institutional factors all or some of the factor affect supply response but majorly price risk.

Risk can be either price risk or economic risk. A price risk is the risk that an investor in an equity that will eventually be worth less than what they paid for it. There are ways to manage price risk. But as long as there is some investment going on in unsecured products, there is no way to totally eliminate it. Therefore, the question is often how to mitigate market price risk and what to

do when it starts to become a severe problem. Price risk management is meant to help lessen any potential impacts of devaluation. This may be done with a standing order to a stock broker, for example. Economic risks can be manifested as lower income or higher expenditure than expected. The causes can be many, for instance, the hike in the price for raw material, the lapsing of deadline for construction of a new operating facility, disruption in a production process, emergence of a serious competitor on the market, the loss of key personnel, the change of political regime, or natural disaster was developed to eliminate or reduce economic risk.

Although many problems in its estimation, production response has a value of better consideration of policy makers in examining the basic programme of farming in Nigeria to efficiency, the impact of distribution and production improvement. Key consideration in testing the response of production are the production decision made under ex-ante expectation and may manufacturers are repellent risk (risk aversion) of at least limited income. If there is risk involved in the production process or import prices and output the agent assumed to behave as if they maximize expected utility of profit depending on the agents risk preference, the marginal expectation of the input may not balance with the price factor. If an agent is repellent risk and production risk, the imbalance will depend on how risk into the production function and although the input will increase the risk or reduce the risk marginally.

In view of the above stated problem of these researches, it is pertinent to ask the following fundamental research questions: What is the trend of rice production in Nigeria? What is the pattern of supply of rice in Nigeria? What are the determinants of the rice supply level in Nigeria? What is the responsiveness of rice supply to price risk in Nigeria? This study therefore provides answers to these and other relevant questions.

### **Objective of the Study**

The main objective of this study was to model the production and supply response in Nigeria rice production and how it is affected by price and price risk.

Specifically the study attempted to:

- i. analyze the trend of rice production in Nigeria;
- ii. examine the pattern of supply of rice in Nigeria rice production;
- iii. determine the key factors responsible for the supply level of rice production in Nigeria;
- iv. estimate the responsiveness of rice supply to changes in price risk in Nigeria rice production.

### **THEORETICAL AND EMPIRICAL FRAMEWORK**

The theoretical framework is based on the concept of supply response in agricultural production. Supply response generally refers to the variation of agricultural output and increase mainly as a result of variation in price (Olayide and Heady, 1982). This implies that the concept refers to shift curves and the movement along the curves. Basically, supply response concerns output response to a change in price of the product. This may be due to the use of more or less resources that may be as a result of price increase or decrease. Again, the response may be occasioned by a change in farm size. Furthermore technological changes under the influence of production variables like credit, price, weather, market information and so on may bring out supply response hence supply response has to do with factors that move the supply curve. (Akanmi and Okeowo, 2011).

Price policy analysis has been found pivotal in agricultural production studies, price being fundamental in determining farm output. In theory following the neoclassical economic perspective regarding optimization behaviour of the farm, price is seen as most relevant factor that influences production level, in that *ceteris paribus* an increase in price level of output increases returns to factors of production thereby giving producers incentives to employ more

input and produce more output. While for different goods, a relative change in price brings a shift in production from one output to the other via resource reallocation, as adjustment is made in response to changing relative profitability of different outputs. The latter could explain why cross border activities sometimes arises including smuggling in a situation where decline in produces price relative to those in neighbouring countries induces domestic movement of resources between crops, sometimes from staple to cash crop, taking advantage of price incentives in nearby nations (Ellis 1992; and Fosu, 1992; Srivastava, *et al* 1999). The traditional Nerlovian approach to analyzing decision making by farmers has been concerned with the effect of price expectation formulated from past prices. The Nerlovian approach used OLS to estimate the dynamic specification of the supply response. This means that the estimates of aggregate agricultural supply response are based on the assumption that the underlying data process is stationary (Ajetomobi, 2010). Most economic variables including agricultural time series tend to be non-stationary. Using OLS with non-stationary variables may result in spurious regressions (Granger and Newbold, 1974). To ensure stationary variables, the equation could be reformulated in terms of differences, but this loses important information conveyed by the levels, such as information on long-run elasticities. To avoid this problem, cointegration analysis can be used (Banerjee et al., 1993). When combined with error correction model (ECM), it offers a means of obtaining consistent, yet distinct estimates of both long-run and short-run elasticities. Abdulai and Rieder (1995), and Townsend (1996) have used co-integration analysis and ECMs to estimate supply response at a commodity level on the basis that these approaches are preferable to the traditional Nerlovian dynamic model. (Ajetomobi, 2010). The economic model will be tested using Augmented Dickey-fuller. Having ascertained that the series in the economic model is non-stationary in their level, but stationary in their first difference, it became obvious



that least square technique would not be appropriate to determine the factors responsible for supply level bearing in mind the need to accommodate the inter dependence between variable it is therefore, imperative to reconceptualise as vector Auto regression system allowing possible co-integration of endogenous variables.

## **METHODOLOGY**

The study was carried out in Nigeria, located in West Africa between latitudes  $4^0$  to  $14^0$  North and between longitude  $2^02^1$  and  $14^030^1$ . It is bounded to the north by the Niger Republic and Chad: in the west by Benin republic, in the east by Cameroon Republic and the south by the Atlantic Ocean. Nigeria has a land area of about 923,769km<sup>2</sup>; a North-south length of about 1450km and west – east breadth of about 800km. Its total land boundary is 4047km while the coastline is 853km. This study was based on time series secondary data obtained from various sources spanning from 1970 -2011. Data are obtained from various AGROSTAT Bulletins which include various edition of National Bureau of Statistics review of external trade, National Bureau of Statistics summary and annual abstract of statistics, Central Bank of Nigeria's economic and financial review and an online database maintained by Food and Agricultural Organization (FAO). The study employed analytical such as Descriptive Statistics, Supply function and Vector Auto Regression Model

### **1 Descriptive Statistics**

Descriptive and inferential statistical technique such as graph is used to show the trend in rice production output and real prices in the rice production. Percentage is used to get the output level of the production in order to represent them on the graph.

### **2 Supply Function Model**

The aggregate output supply pattern function following Ghana and Ignescient (1984) will be used to analyses the pattern of supply in rice production which was specified as follows:  $Q_t = F$

$(HA_t, P_t, M_t, RF_t, e_t)$

$Q_t$  = Output of rice in year t;  $HA_t$  = Hectarage in year t;  $P_t$  = producer price per tonne;  $M_t$  = quantity imported in year t;  $RF_t$  = weather variable (rainfall) in millimetres;  $e_t$  = error term.

Following the model output supply is determined by adopting a double logarithmic form as follows:  $\ln Q_t = \beta_0 + \beta_1 \ln HA_t + \beta_2 \ln M_t + \beta_3 \ln RF_t + U_t$

All variable in natural logarithm form

### 3. Vector Auto regression Model

This model will also be used to estimate the responsiveness of rice supply to changes in price risk using this model variable will be fitted into model to co-integrate.

$$A_t = \alpha_1 P_t + \alpha_2 V_t + \alpha_3 K_t + \alpha_4 R_t$$

Where A = output of rice; P = price; V = change in price; K = change in output R = real exchange rate.

## RESULT AND DISCUSSION

### Descriptive Information

Table 1 shows descriptive statistics which mean, minimum and maximum were analyzed for the data series of rice. Rice having an all-time maximum output of 4, 910, 415 tonnes and an all-time minimum output 297,862 tonnes with a mean 2670000 tonnes. Hectarage mean for rice, 1340000ha. Producer price for rice per tonnes having a mean value N20, 100. Average quantity of rice imported within the time frame being 622,000 tonnes. The average rainfall as it affects rice production taking the value 655.576mm showing a steady supply of rainfall to the production of rice in Nigeria.

**Table 1:Descriptive Statistics**

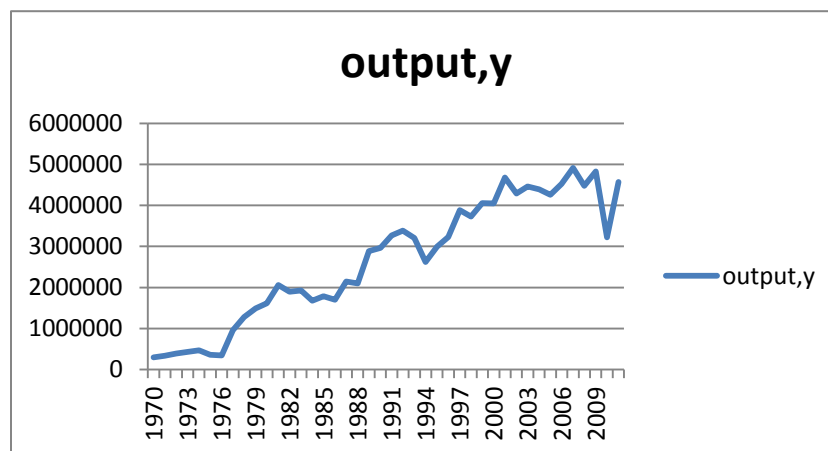
|  | N | Minimum | Maximum | Mean | Std. Deviation |
|--|---|---------|---------|------|----------------|
|  |   |         |         |      |                |

|              |    |        |         |         |             |
|--------------|----|--------|---------|---------|-------------|
| output y     | 42 | 297862 | 4910415 | 2.67E6  | 1504603.324 |
| p price x    | 42 | 136    | 78249   | 2.01E4  | 24833.733   |
| r price x2   | 42 | 10.8   | 10287.0 | 2.409E3 | 3256.1562   |
| import x3    | 42 | 1069   | 1905333 | 6.22E5  | 535444.846  |
| rainfall x5  | 42 | 193.0  | 1789.0  | 655.576 | 527.5239    |
| hectarage x4 | 42 | 172000 | 2725000 | 1.34E6  | 859188.511  |

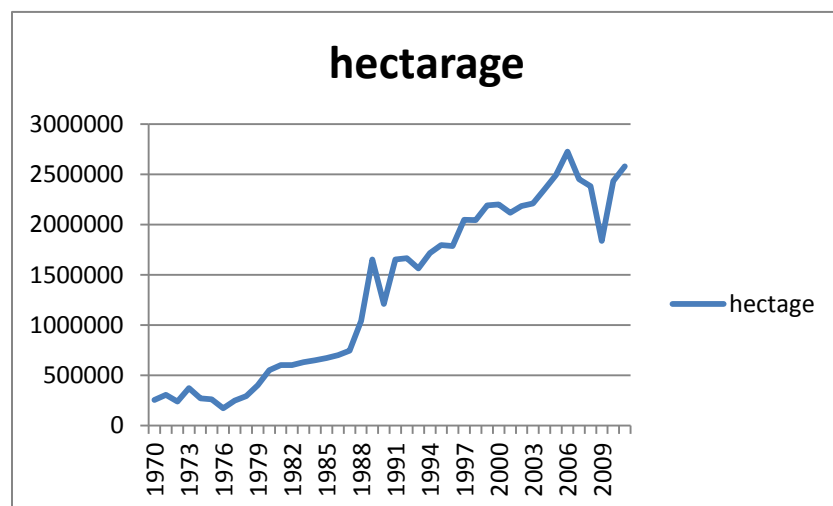
**Source: Data analysis 2013**

Relevant graphical representations of the trend in rice output levels hectarage cultivated, the producer price, rainfall and import are illustrated in figure 1 to 5

**Figure 1: Output trend for rice**

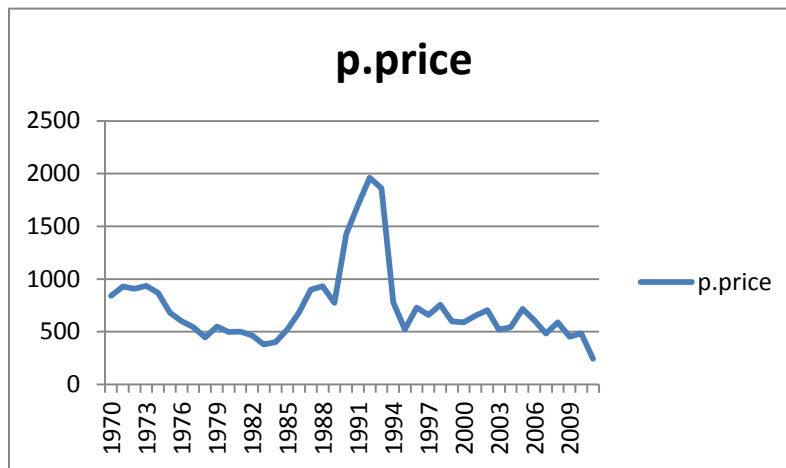


From the graph output trend of rice during the structural adjustment programme involving the ban on importation of rice. The output was increasing and during the late 2000. The output quantity suddenly fell due to the lifting of the policy on importation of rice.



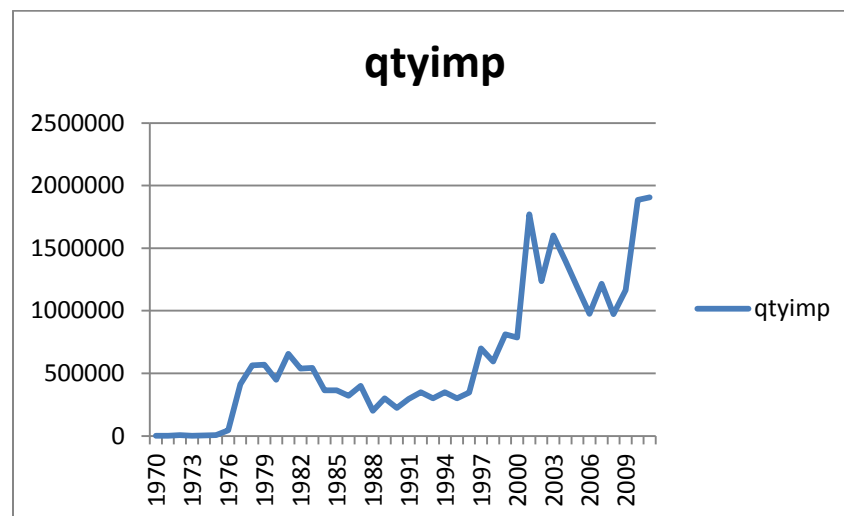
**Figure 2: Hectarage trend for rice**

The trend of Hectarage for rice cultivation is corresponding to the output of rice as the hectare in cultivation increases output will also increase and as it falls also, the output falls.



**Figure 3: Producer price trend for rice**

Producer price of rice is said to have no relation with the output of rice because during the increase with producer price. The output is increasing and also decreases while the producer price is still increasing.



**Figure 4: Import quantity trend for rice.**

Quantity imported of rice is during the era of structural adjustment programme. The quantity imported of rice was low but during the era when the ban was lifted, the importation of rice was high.

### Unit Root Tests

Against the background that test for constancy of economic series must precede their inclusion in regression model as to avoid estimating spurious regression, this study conducted the Augmented Dukey Fuller unit root tests on the levels and first difference of the economic series in the study.

The result of the ADF unit root test is summarized in table 2. Natural logarithm was taken to Linearize the variable for easy attainment of stationarity, ADF was used to test for stationary and non-stationary of the variable. On testing using ADF unit root test, some of the variables were stationary at level while virtually all was stationary at 1<sup>st</sup> difference.

**Table 2: Result of ADF root test for level and 1<sup>st</sup> difference**

| Parameter   | Non trended         | Trended            | Non trended        | trended            | Decision       |
|-------------|---------------------|--------------------|--------------------|--------------------|----------------|
| Inoutput    | -3.708<br>(0.0040)  | -2.638<br>(0.2630) | -1.663<br>(0.4504) | -4.283<br>(0.0033) | Stationary     |
| Inprodprice | -1.426<br>(0.5603)  | -1.543<br>(0.7978) | -2.247<br>(0.1897) | -2.307<br>(0.4295) | Non stationary |
| Inqtyimp    | -2.529<br>(0.1162)  | -6.011<br>(0.0000) | -3.341<br>(0.0132) | -6.419<br>(0.0000) | Stationary     |
| Inhectarage | -0.9820<br>(0.7618) | -1.910<br>(0.6490) | -8.144<br>(0.0000) | -8.092<br>(0.0000) | Stationary     |
| Inrainfall  | 0.78790<br>(0.9939) | -1.669<br>(0.7471) | -7.899<br>(0.0000) | -3.202<br>(0.0840) | Non Stationary |

**Source: Data analysis 2013**

Output supply on rice production was forecast using trend analysis. On using Ordinary Least SquareRegression, estimate a trend equation was estimated to forecast the output supply of rice, by using the appropriate estimate coefficient. Table 4 shows the result of the regression analysis estimate

### **Test for Co-Integration**

For any meaningful long run relationship to exit between non-stationary series. It is important that some linear combination of the series must be co-integrated; such that even though the individual non-stationary may drift apart in the short run. They follow a common trend which permits a stable long run relationship between them. Hence this study conducted a Johansen co-integration test for the linear combination of the series in the output supply response model for rice. The result is summarized in Table 3.

**Table 3:Johansen co-integration test.**

| Rank | Eigen value | Trace test | p-value  | C.V    | p-value  |
|------|-------------|------------|----------|--------|----------|
| 0    | 0.83206     | 154.10     | [0.0000] | 66.015 | [0.0000] |

|   |         |        |          |        |          |
|---|---------|--------|----------|--------|----------|
| 1 | 0.74079 | 88.085 | [0.0007] | 49.954 | [0.0001] |
| 2 | 0.38644 | 38.130 | [0.2999] | 18.074 | [0.5009] |
| 3 | 0.23059 | 20.057 | [0.4300] | 9.6989 | [0.7732] |
| 4 | 0.15648 | 10.358 | [0.2588] | 6.2964 | [0.5825] |
| 5 | 0.10395 | 4.0612 | [0.0439] | 4.0612 | [0.0439] |

Source: data analysis 2013

### **Co- integration test for rice.**

Table 3 shows results of Johansson co-integration Test of between rice output and its determinants, factors using both the trace test and the maximum Eigen value test. Both tests provide evidence of co-integration. The result of the trace reveals, that the hypothesis of no co-integration ( $H_0: r = 0$ ) is rejected at  $p < 0.05$  given that the calculated trace test statistic (154.10) is higher than the critical value (66.015) at  $p < 0.05$ . Similar result was obtained for  $r \leq 1$  and  $r \leq 5$ . Thus trace test and maximum Eigen value test reveal that the series in rice output supply response model are co-integrated with more than 1 co-integrating equation existing between them.

Co- integration of variables, those not mean effect, it is necessary to further estimate the effect of those determinant on the output supply response by using vector auto regression model.

### **Vector auto regression for Rice**

Vector auto regression which is an important model estimating time series data due to its flexibility in responding to direction, we say vector auto regression is bidirectional in response.

From Table 4, the result shows that the independent variable has significant effect on the output supply response of rice given that the  $P < 0.05$ . On analyzing the data using vector auto regression, the supply output response of rice form an equation with the producer price, hectarage, quantity imported and rain and show a positive response to the supply response output in each case as shown in the table.

**Table 4: Result from Vector Autoregressive Model**

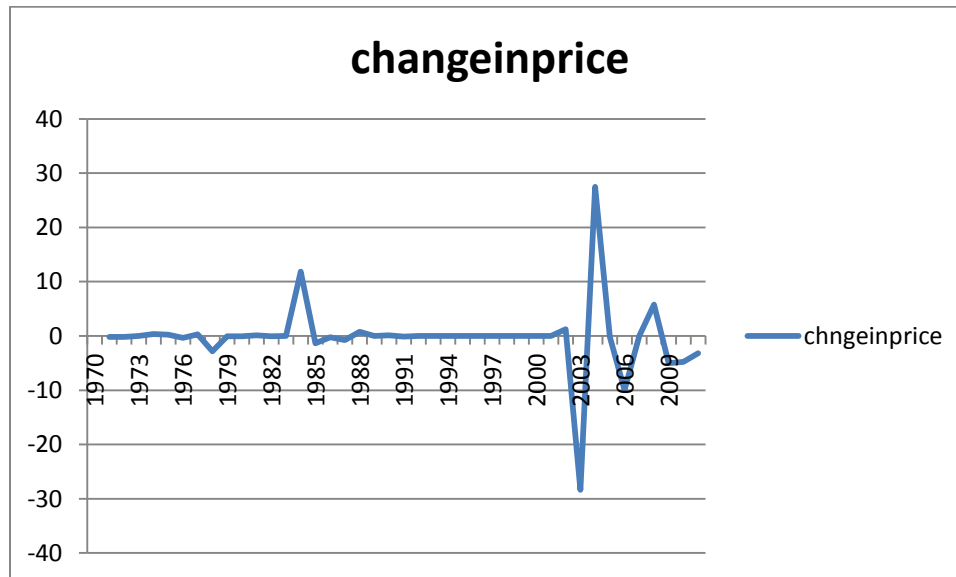
| VARIABLES   | COEFFICIENTS | F-RATIO  | P-VALUE |
|-------------|--------------|----------|---------|
| INPRODPRICE | 0.633357     | 8.569545 | 0.0000  |
| INHECTARAGE | -1.51350     | 30.50054 | 0.0000  |

|            |            |          |        |
|------------|------------|----------|--------|
| INQTYIMP   | -0.0214239 | 105.7948 | 0.0000 |
| INRAINFALL | 0.551404   | 24.84371 | 0.0000 |

**Source: Data analysis 2013**

**Responsiveness of supply output response to changes in price risk.**

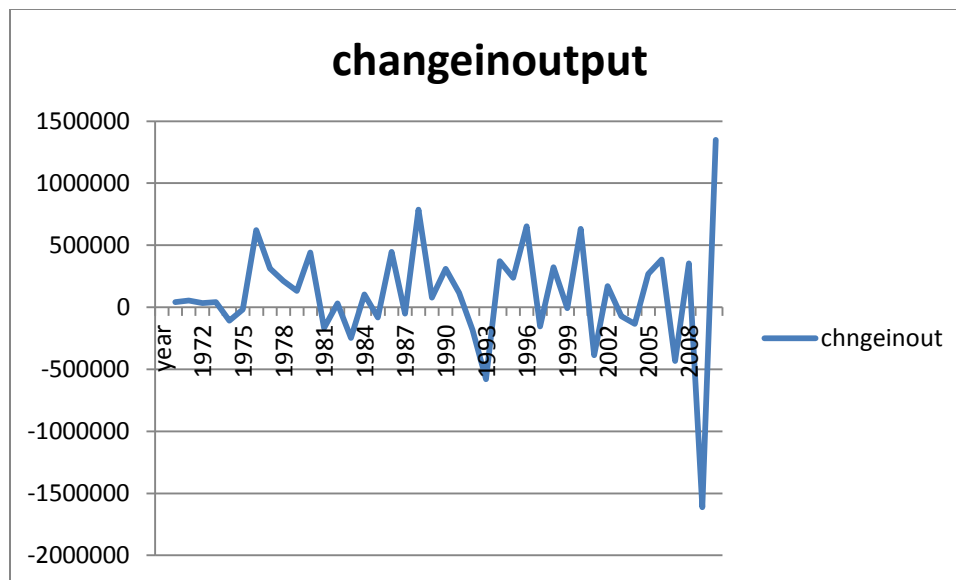
**Responsiveness to price risk**



**Figure 5: Graphical Representation of Price Risk**

Graphically the changes in figure 6. From the graph output supply response has shown a positive response to changes in price within some year.

**Responsiveness to Output Risk.**



**Figure 6: Graphical Representation of Output Risk**

In the figure shown the output supply response has shown a positive response to output changes in the supply response of rice from the graph the output change is very obvious and this has shown a positive responsiveness of output supply response to output risk.

### Vector Auto regression on Risk

The result from vector auto regression model shown in Table 5 shows the responsiveness of output supply of rice to price risk the result shows a negative coefficient of price risk which is statistically significant at 95% confidence interval (0.05). The negative coefficient of price risk is however not contrary to theoretical expectation. The result suggested that rice output supply is responding to price risk. The price risk and supply output risk, therefore price, price risk and output risk should be meaningfully reduced for rice production to be increase in Nigeria.

**Table 5: Result of Vector Auto regression on Risk**

| Variables        | Coefficients | F-ratio  | P-value  |
|------------------|--------------|----------|----------|
| Price            | -2.75361e+08 | 3.775102 | 0.002633 |
| Changes in price | -2.75361e+08 | 5.366907 | 0.000204 |
| Changes in out   | -0.683896    | 2.566669 | 0.024087 |



|     |          |          |         |
|-----|----------|----------|---------|
| RER | 0.988298 | 33.29785 | 0.00000 |
|-----|----------|----------|---------|

**Source: Data analysis 2013**

## **CONCLUSION AND RECOMMENDATIONS**

The study revealed that supply response has the highest output supply during the era of policy implementation such as band of importation of rice and this has contributed immensely to the supply response of rice output in Nigeria. Other factors that affect supply response of rice output in Nigeria include the producer price which has a negative effect on the output supply of rice. The higher the producer price the lower the output supply. Hectarage cultivated has also been significant can be deduced from the findings that the higher the hectarage cultivated, the higher the output supply of rice production in Nigeria. There is need to reduce the quantity imported into the country as to ensure adequate supply output in Nigeria. The output supply of rice in Nigeria will increase if he hectarage cultivated will be improved as to allow greater production of rice in Nigeria.

From the results of the empirical analysis, the producers are responsive to only not price but also to price risk. Price risk needs to be adequately reduced if meaningful improvement in production of rice is to be gained. It is recommended that reasonable policies should be implemented as to ensure that importation that will reduce output supply should be curtailed. Also it is therefore imperative ad necessary to ensure that all gaps in the production and price should be reduced to reduce price risk as to increase the response of producer to supply.

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