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

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Abstract. Nigeria, like most African countries, has engaged in agricultural liberalization since 1986 in the hope that reforms emphasizing price incentives will encourage producers to respond. Thus far, the reforms seem to have introduced greater uncertainty into the market given increasing rates of price volatility. This study amongst other things therefore seeks to determine and model the responsiveness of rice supply to price risk in Nigeria. Statistical information on domestic and imported quantities of rice was obtained for 41 years (1970 to 2011) from various sources, such as the Food and Agriculture Organization (FAO) database, Federal Ministry of Agriculture statistical bulletins, Central Bank of Nigeria statistical bulletins and National Bureau of Statistic (NBS). Data were analyzed using equilibrium output supply function, co-integration models, and vector autoregressive distributed lag model. Rice importation was statistically significant and changes in output were also responsive to changes in price. The results indicate that producers are more responsive not only to price and non-price factor but also to price risk and exchange rate. It is therefore imperative to reduce the effects of price risk as to increase the response of producer to supply by bridging the gap in production.

Keywords: agricultural production, price risk, supply response, rice marketing, Nigeria

INTRODUCTION

Rice is a staple food in many Africa countries and constitutes a major part of the diet in most households. For over three decades, the crop has seen a steady increase in demand given its importance in the strategic food security planning policies of many countries (Saka et al., 2005). The challenges faced by countries with regards to rice production however varies from country to country in terms of population, preference attached to the commodity at each household, 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 to meet the demand of the growing population. Additionally, the gap between demand and domestic supply is increasingly being widened across the length and breadth of the country. As a result, Nigeria has become a major importer of rice. The 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 the shortage of rice to augment local supply, and there has been a steady decline in output of cereal between 1979 and 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 and Adewunmi, 2008). Supply response is fundamental to

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an understanding of this price mechanism (Nerlove and Bachman, 1960; Tanko and Alidu, 2016). The farmer's response to price changes for specific products aim 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. Furthermore, Darmawi (2005) also put forth 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, then supply of rice will be affected by the increase in price. Effectiveness and cost of alternative pricing policies depends on the magnitude and significance of the estimated response. Knowledge of the impact of other variables 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 (Keeney and Hertel, 2008). The role of the response of agricultural production has gained much attention in empirical studies 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 are defined here as events (which may or not happen) and are 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 a combination of four factors which may be endogenous or exogenous (Anderson and Huirne, 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 buy into 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 happening 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. There can be many causes, 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 many manufacturers are repellent risk (risk aversion) of at least limited income. If there is risk involved in the production process or import prices, and the output agent is 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.

In view of the above stated problems, 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. The main objective of this study was to the model the production and supply response in Nigeria rice production and consider how it is affected by price and price risk. Specifically, the study attempted to: analyze the trend of rice production in Nigeria; examine the pattern of supply of rice in Nigeria rice production; determine the factors responsible for the supply level of rice production in Nigeria, and estimate the responsiveness of rice supply to changes in price risk in Nigeria rice production.

METHODOLOGY

The study was carried out in Nigeria, located in West Africa between latitudes 4° to 14° North and between longitude 2°2[1] and 14°30[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 923,769 km^2; a North-south length of about 1450 km and west – east breadth of about 800 km. Its total land boundary is 4047 km while the coastline is 853 km. 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 analytics such as Descriptive Statistics, Supply function, and Vector Auto Regression Model.

Supply function model

The aggregate output supply pattern function following Nerlove (1958) and Quiggin (1991) and will be used to analyses the pattern of supply in rice production which was specified as follows:

$$Q_t = F\ (HA_t, Pt, Mt, RF_t, et)$$

Q_t = Output of rice in year t; HA = 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:

$$\ln Q_t = ß_0 + ß_1 \ln HA_1 + ß_3 \ln M_t + ß_4 \ln RF + U_t$$

All variables in natural logarithm form.

Vector auto regression model

Vector auto regression model from Johansen (1988, 1995) was adopted to analyse the supply response of rice in Nigeria. 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.

$$A_t = α_1 Pt + α_2 V + α_3 K + α_4 R$$

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

RESULT AND DISCUSSION

Descriptive information

Rice having an all-time maximum output of 4, 910, 415 tonnes and an all-time minimum output 297,862 tonnes with a mean 2 670 000 tonnes. Hectarage mean for rice, 1 340 000 ha. 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 655.576 mm showing a steady supply of rainfall to the production of rice in Nigeria.

Unit Root Tests

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 1. 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^{st} difference.

The results of Augmented Dickey- Fuller Unit Root Test shows that the variables, which are all yearly data, are Non-stationary, this may be due to the fact that they experience different levels of variabilities and randomness over the years, this is related to the findings of Ajetomobi (2010) and Ayinde et al. (2015).

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 2.

Co-integration test for rice

Table 2 shows results of Johansson co-integration Test between rice output and its determinants, with factors

Table 1. Results of augmented Dickey-Fuller unit root test
Tabela 1. Wyniki rozszerzonego testu pierwiastka jednostkowego Dickeya-Fullera

Variables Zmienne	Level Poziom	1st Difference Różnice I stopnia	AIC	SIC	Optimum lag length Optymalna długość opóźnienia		Decision Decyzja
					Level Poziom	1st difference Różnice I stopnia	
lnoutput	0.2669 (0.1305)	0.0093* (0.4826)	–1.2252	–0.7763	7	6	Non-stationary Szereg niestacjonarny
lnprice	0.5603 (0.1076)	0.0006* (0.1769)	0.2434	0.3687	0	0	Non-stationary Szereg niestacjonarny
lnqimp	0.4152 (0.0817)	0.0000* (0.1642)	1.9908	2.1597	1	0	Non-stationary Szereg niestacjonarny
lnhect	0.6218 (0.1054)	0.0000* (0.1576)	–0.3831	–0.2577	0	0	Non-stationary Szereg niestacjonarny
lnrainfall	0.7471 (0.0877)	0.0000* (0.1552)	0.3059	0.4313	0	0	Non-stationary Szereg niestacjonarny

AIC = Akaike Info Criterion, SIC = Schwarz Info Criterion, () = std. Error, * indicates significant level at 1%.
Source: own elaboration.
AIC = kryterium informacyjne Akaikego, SIC = kryterium informacyjne Schwarza, () = błąd standardowy, symbol * oznacza poziom istotności 1%.
Źródło: opracowanie własne.

Table 2. Johansen co-integration test
Tabela 2. Test kointegracji Johansena

Rank Stopień	Trace test Test śladu	Critical value Wartość krytyczna	p-value Wartość p	Maximum eigen value Maksymalna wartość własna	Critical value Wartość krytyczna	p-value Wartość p
0	0.6548	88.8038	0.0018	0.6548	38.3310	0.0155
1	0.5981	63.8761	0.0582	0.5981	32.1183	0.0138
2	0.2646	42.9153	0.7025	0.2646	25.8232	0.8540
3	0.2167	25.8721	0.6301	0.2167	19.3870	0.6436
4	0.1078	12.5180	0.6597	0.1078	12.5180	0.6597

Source: own elaboration.
Źródło: opracowanie własne.

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 $p < 0.05$. A 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, are necessary to further estimate the effect of those

Table 3. Summary of results of the short run relationship with Ordinary Least Square regression (OLS)
Tabela 3. Zestawienie wyników badania relacji krótkookresowych za pomocą zwykłej metody najmniejszych kwadratów

Variables Zmienne	Coefficient Współczynnik	Standard error Błąd standardowy	t-ratio Wskaźnik t	p-value Wartość p
const	0.0230375	0.0214431	1.0744	0.29001
d_lnprice	0.187046	0.0769948	2.4293	0.02040**
d_lnqtyimp	0.149148	0.0319554	4.6674	0.00004*
d_lnhectarage	0.461637	0.102493	4.5041	0.00007*
d_lnrainfall	–0.054742	0.0701412	–0.7805	0.44037
ECM (–1)	–1.11239	0.166531	–6.6798	<0.00001*

*, ** indicates 1% and 5% significant levels respectively AIC = –51.15111, SIC = –40.86968, D-W = 2.085087 Adjusted R-squared = 0.679917.
Source: own elaboration.
Symbole * i ** oznaczają odpowiednio poziomy istotności 1% i 5%, AIC = –51,15111, SIC = –40,86968, D-W = 2,085087, skorygowany współczynnik R kwadrat = 0,679917.
Źródło: opracowanie własne.

determinant on the output supply response by using vector auto regression model. This is relevant to the works of Ghatak and Seale (2001) and Tanko et al. (2016).

Output supply on rice production was forecast using trend analysis. On using Ordinary Least Square Regression, an estimated trend equation was used to forecast the output supply of rice, by using the appropriate estimate coefficient. Table 3 shows the result of the regression analysis estimate, and it goes in line with the results of Amikuzuno et al., (2013).

Vector auto regression for rice

Vector auto regression is an important model estimating time series data due to its flexibility in responding to direction. We say that 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. This is in line with the findings of Tanko and Alidu (2016), Amikuzuno et al. (2013) and Ajetomobi (2009).

Table 4. Result from vector autoregressive model
Tabela 4. Wyniki uzyskane w modelu wektorowej autoregresji

Variables Zmienne	Coefficients Współczynniki	f-ratio Wskaźnik f	p-value Wartość p
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: own elaboration.
Źródło: opracowanie własne.

RESPONSIVENESS OF SUPPLY OUTPUT RESPONSE TO CHANGES IN PRICE RISK

Responsiveness to price risk

Graphically the changes are represented in Fig. 1. From the graph output supply response has shown a positive response to changes in price within some year.

Responsiveness to output risk

In the figure shown, the output supply response indicates a positive response to output changes in the supply response of rice from the graph. The output change is obvious and shows 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 (Ajetumobi, 2010). The result suggested that rice output supply is responding to price risk. Therefore, the price risk and supply output risk should be meaningfully reduced in order for rice production to increase in Nigeria.

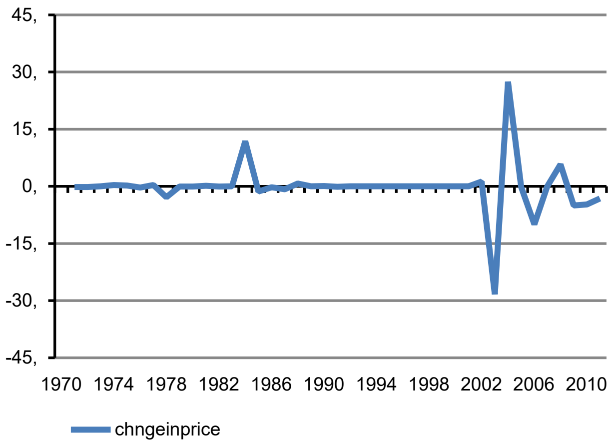

Fig. 1. Graphical representation of price risk
Source: own elaboration.
Rys. 1. Graficzne przedstawienie ryzyka cenowego
Źródło: opracowanie własne.

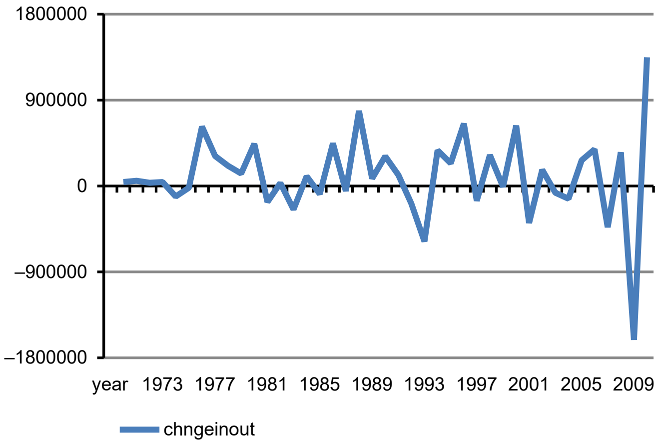

Fig. 2. Graphical representation of output risk
Source: own elaboration.
Rys. 2. Graficzne przedstawienie ryzyka produkcji
Źródło: opracowanie własne.

Table 5. Result of vector auto regression on risk
Tabela 5. Wynik wektorowej autoregresji w odniesieniu do ryzyka

Variables Zmienne	Coefficients Współczynniki	f-ratio Wskaźnik f	p-value Wartość p
Price – Cena	–2.75361e+08	3.775102	0.002633
Changes in price Zmiany cen	–2.75361e+08	5.366907	0.000204
Changes in out Zmiany wielkości produkcji	–0.683896	2.566669	0.024087
RER	0.988298	33.29785	0.00000

Source: own elaboration.
Źródło: opracowanie własne.

CONCLUSION AND RECOMMENDATIONS

The study revealed that supply response has the highest output supply during the era of policy implementation such as ban 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, as indicated in the findings of Ghatak and Seale (2001). The higher the producer price, the lower the output supply. Hectarage cultivated has also been significant and it can be deduced from the findings that the higher the hectarage cultivated, the higher the output supply of rice production in Nigeria. There is a 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 the 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 not only price, but also to price risk, and this is in line with the findings of Tanko and Alidu (2016). Price risk needs to be adequately reduced if meaningful improvement in the production of rice is to be gained. It is recommended that reasonable policies be implemented as to ensure that importation that will reduce output supply be curtailed. Also, it is therefore imperative and necessary to ensure that all gaps in the production and price be decreased to reduce price risk and thereby increase the response of producer to supply.

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ZMIANY PODAŻY I RYZYKO CENOWE W PRODUKCJI RYŻU W NIGERII

Streszczenie. Podobnie jak w większości krajów afrykańskich, władze Nigerii począwszy od 1986 r. podejmują działania na rzecz liberalizacji rynku rolnego w nadziei, że producenci odpowiednio zareagują na zachęty cenowe wprowadzane kolejnymi reformami. Jak dotąd można jednak odnieść wrażenie, że wdrażane zmiany na rynku spowodowały jeszcze większą niepewność ze względu na rosnące wahania cen. Jednym z celów niniejszego badania jest zatem ustalenie, w jaki sposób podaż ryżu reaguje na ryzyko cenowe w Nigerii oraz opracowanie modelu tego zjawiska. Dane statystyczne dotyczące wielkości krajowej produkcji i importu ryżu obejmują lata 1970–2011. Źródłem danych były: baza danych Organizacji Narodów Zjednoczonych do spraw Wyżywienia i Rolnictwa (FAO), biuletyny Federalnego Ministerstwa Rolnictwa, biuletyny statystyczne Centralnego Banku Nigerii oraz Krajowe Biuro Statystyki (NBS). Dane poddano analizie z wykorzystaniem funkcji podaży zrównoważonej, modeli kointegracji i modelu wektorowej autoregresji z rozkładem opróżnień. Wielkość importu ryżu była statystycznie istotna, a zmiany wielkości produkcji następowały między innymi w reakcji na zmiany cen. Jak pokazują wyniki, producenci reagują nie tylko na czynniki cenowe i pozacenowe, lecz także na ryzyko cenowe i kursy walut. Należy zatem koniecznie ograniczyć skutki ryzyka cenowego, tak aby producenci bardziej zdecydowanie reagowali wzrostem podaży, wypełniając w ten sposób lukę w produkcji.

Słowa kluczowe: produkcja rolna, ryzyko cenowe, zmiany podaży, handel ryżem, Nigeria

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