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
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 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°21' and 14°30'. It is bounded to the north by
the Niger Republic and Chad: in the west by Benin re-
public, 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 on-
line database maintained by Food and Agricultural Or-
ganization (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:

$$Q_t = F (HA_t, P_t, M_t, RF_t, e_t)$$

$Q_t$ = 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:

$$\ln Q_t = \beta_0 + \beta_1 \ln HA_t + \beta_3 \ln M_t + \beta_4 \ln RF_t + U_t$$

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.

$$A_t = a_1 P_t + a_2 V + a_3 K + a_4 R$$

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 im-
ported 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 estimat-
ing spurious regression, this study conducted the Aug-
mented 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 Ta-
ble 1. Natural logarithm was taken to linearize the vari-
able 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$^{\text{st}}$ 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 random-
ness over the years, this is related to the findings of

**Test for co-integration**

For any meaningful long run relationship to exit be-
tween 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-inte-
gration 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
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 (H₀: 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 ≤ 1 and r ≤ 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 variables.

Table 1. Results of augmented Dickey-Fuller unit root test

<table>
<thead>
<tr>
<th>Variables</th>
<th>Level Poziom</th>
<th>1st Difference Różnice I stopnia</th>
<th>AIC</th>
<th>SIC</th>
<th>Optimum lag length Optymalna długość opóźnienia</th>
<th>Decision Decyzja</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zmienne</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Level Poziom 1 st difference Różnice I stopnia</td>
<td></td>
</tr>
<tr>
<td>Inoutput</td>
<td>0.2669</td>
<td>0.0093* (0.4826)</td>
<td>-1.2252</td>
<td>-0.7763</td>
<td>7 6 Non-stationary Szereg niestacjonarny</td>
<td></td>
</tr>
<tr>
<td>Inprice</td>
<td>0.5603</td>
<td>0.0006* (0.1769)</td>
<td>0.2434</td>
<td>0.3687</td>
<td>0 0 Non-stationary Szereg niestacjonarny</td>
<td></td>
</tr>
<tr>
<td>Inqimp</td>
<td>0.4152</td>
<td>0.0000* (0.1642)</td>
<td>1.9908</td>
<td>2.1597</td>
<td>1 0 Non-stationary Szereg niestacjonarny</td>
<td></td>
</tr>
<tr>
<td>Inhect</td>
<td>0.6218</td>
<td>0.0000* (0.1576)</td>
<td>-0.3831</td>
<td>-0.2577</td>
<td>0 0 Non-stationary Szereg niestacjonarny</td>
<td></td>
</tr>
<tr>
<td>Inrainfall</td>
<td>0.7471</td>
<td>0.0000* (0.1552)</td>
<td>0.3059</td>
<td>0.4313</td>
<td>0 0 Non-stationary Szereg niestacjonarny</td>
<td></td>
</tr>
</tbody>
</table>

AIC = Akaike Info Criterion, SIC = Schwarz Info Criterion, () = std. Error, * indicates significant level at 1%.
Source: own elaboration.

Table 2. Johansen co-integration test

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

Source: own elaboration.

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 (H₀: 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 ≤ 1 and r ≤ 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 variables.
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 bi-directional 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 3. Summary of results of the short run relationship with Ordinary Least Square regression (OLS)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard error</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>const</td>
<td>0.0230375</td>
<td>0.0214431</td>
<td>1.0744</td>
<td>0.29001</td>
</tr>
<tr>
<td>d_lnprice</td>
<td>0.187046</td>
<td>0.0769948</td>
<td>2.4293</td>
<td>0.02040**</td>
</tr>
<tr>
<td>d_lntyimp</td>
<td>0.149148</td>
<td>0.0319554</td>
<td>4.6674</td>
<td>0.00004*</td>
</tr>
<tr>
<td>d_lnhectarage</td>
<td>0.461637</td>
<td>0.102493</td>
<td>4.5041</td>
<td>0.00007*</td>
</tr>
<tr>
<td>d_lnrainfall</td>
<td>–0.054742</td>
<td>0.0701412</td>
<td>–0.7805</td>
<td>0.44037</td>
</tr>
<tr>
<td>ECM (–1)</td>
<td>–1.11239</td>
<td>0.166531</td>
<td>–6.6798</td>
<td>&lt;0.00001*</td>
</tr>
</tbody>
</table>

* ** indicates 1% and 5% significant levels respectively \( \text{AIC} = -51.15111, \text{SIC} = -40.86968, \text{D-W} = 2.085087 \) Adjusted \( R \)-squared = 0.679917.

Source: own elaboration.

### Table 4. Result from vector autoregressive model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPRODPRICE</td>
<td>0.633357</td>
<td>8.569545</td>
<td>0.0000</td>
</tr>
<tr>
<td>INHECTARAGE</td>
<td>–1.51350</td>
<td>30.50054</td>
<td>0.0000</td>
</tr>
<tr>
<td>I NQTYIMP</td>
<td>–0.0214239</td>
<td>105.7948</td>
<td>0.0000</td>
</tr>
<tr>
<td>INRAINFALL</td>
<td>0.551404</td>
<td>24.84371</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

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.

Table 5. Result of vector auto regression on risk

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>f-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price – Cena</td>
<td>–2.75361e+08</td>
<td>3.775102</td>
<td>0.002633</td>
</tr>
<tr>
<td>Changes in price</td>
<td>–2.75361e+08</td>
<td>5.366907</td>
<td>0.000204</td>
</tr>
<tr>
<td>Changes in out</td>
<td>–0.683896</td>
<td>2.566669</td>
<td>0.024087</td>
</tr>
<tr>
<td>RER</td>
<td>0.988298</td>
<td>33.29785</td>
<td>0.000000</td>
</tr>
</tbody>
</table>

Source: own elaboration.

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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.

REFERENCES


ZMIANY PODAŻY I RYZYKO CENOWE W PRODUKCJI RYŻU W NIGERII


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

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