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Empirical Assessment of Maize Price Dynamics and Market Integration in Selected Regional Markets of Benue State, Nigeria.

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Abstract:- This study investigated how maize prices move in selected regional markets in Benue State, Nigeria. The researchers looked at monthly maize price data from January 2008 to December 2018 to determine if the price series in these different markets were connected. Specific tests were used to determine if the prices influenced each other over time (market integration) and, if so, which market (rural or urban) tended to lead the price changes in the state. The result revealed that maize prices eventually stabilized over time (became stationary) and that rural and urban markets were indeed connected. There was also evidence of some level of market integration in the short term. Interestingly, the price changes in one market didn't always directly cause changes in the other market. In some cases, price changes seemed to flow in both directions. Based on these results, this study therefore recommends that the all stakeholders provide information centers and use media channels to improve communication between maize producers and consumers in the state; as this would allow actors to make more informed decisions about maize marketing.

Keywords:- *Benue; Dynamics; Market; Maize; Price; Statinarity.*

I. INTRODUCTION

In Nigeria, information flow and its impact on pricing are not well understood. Farmers are increasingly planting crops based on market prices, not just their own needs. [16]. According to [1], Market integration is defined as a process where prices for the same goods, move together across geographically separated markets. This seamless dynamics of price signals and information is crucial for farmers in Nigeria. Several researchers have investigated this topic, focusing on how food crop prices behave and how integrated these markets are within the Nigerian context.

Imagine two markets selling the same product, but the prices differ significantly, with the difference being greater than the cost of transporting the product between them. This price gap triggers arbitrage activity. Arbitrageurs are like market matchmakers; they buy the product in the cheaper market and resell it in the more expensive one, evening out the price difference. This situation indicates a lack of integration between the two markets. In contrast, integrated markets for the same product experience a strong, long-term connection in prices. This happens because information about price changes travels smoothly between the markets, allowing them to adjust and become more similar over time [5]. The most integrated scenario would be perfect integration, where a price shift in one market instantly affects the other.

Therefore, by studying how maize prices move in selected regional markets in the study area, policymakers can gain valuable insights. This knowledge can be used to create effective agricultural policies for the state. Ultimately, this can help achieve food self-sufficiency and reduce poverty for citizens, not just in Benue but across the entire nation. This information is crucial for governments at all levels, as it allows them to assess how efficiently maize prices transmit across different agricultural regions within their domains [5].

Maize (*Zea mays*) is one of the basic items found in the food basket of many households, whose prices are very volatile in seasons in Nigeria. Consumers pay different amounts for the same product in different markets separated by few kilometers apart. According to [5], price fluctuations for agricultural goods are normal, as long as these changes are similar across different markets. However, large price differences between markets can disrupt the movement of agricultural resources and negatively impact the food security goal of the nation. Researches on agricultural price transmission, such as [5], [16], [7], [10], [15], [4] among others gathered considerable attention. Food price swings have become a major concern, especially after the dramatic price spikes of 2007-2008. This period saw international agricultural markets experience sharp volatility, including rapid price increases and potential shifts in the long-term downward trend of food prices. The boom and bust cycle in food prices around 2008 sparked many concerns on how these fluctuations affect people's well-being and the agricultural economy [11]. Therefore, understanding how markets work

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is crucial for governments to ensure their citizens have enough food on their tables at all times and in adequate proportion. This includes knowing how prices move throughout the supply chain within the country, as well as how international markets affect domestic prices [16]. This study aims to answer these key questions: How connected are markets within Benue State? Which market drives price changes, and in which direction?

➢ *Objectives of the Study*

The main objective is to investigate price dynamics of maize in selected regional markets of Benue State, Nigeria. The specific objectives were to: (i) determine the market integration of maize prices in the study area (ii) assess the market that causes such integration and (iii) identify the direction of causality in the study area.

II. METHODOLOGY

A. The Study Area

The study was carried out in Benue State, Nigeria. The State is one of the Middle Belt States in Nigeria with an estimated population of 6,588,889 in 2024 [12]. The State is located on longitude 7°47' and 10°0'E. Latitude 6°25' and 8°8'N; shares boundaries Nassarawa (North), Taraba (East), Cross-River (South), Enugu (South-west) and Kogi (West). With a landmass of 34,059SqKm, the state experiences two distinct seasons; the wet season (April – October) with annual rainfall between 100-200mm and the dry season (November – March). Average daily temperature ranges from 21^0C to 37^0C throughout the year.

The major inhabitants are Tiv, Idoma and Igede spread across the twenty-three (23) Local Government Areas. Benue State is rich in agricultural produce (yam, rice, beans, cassava, sweet-potato, maize, soybean, sorghum etc) and as such referred to as the food hub of the nation. Agriculture is the mainstay of the economy, engaging over 75% of the state farming population. In addition, it has twenty-four (24) urban and eighty-five (85) rural markets, in which two urban and rural markets, namely Otukpo and Aliade, and Taraku and Adoka were randomly selected for the urban and rural markets respectively.

B. Method of Data Collection and Analytical Techniques

This study used secondary data of maize prices in Benue State, Nigeria. This data covered a ten-year period, from January 2008 to December 2018, and was collected from two sources: the National Bureau of Statistics (NBS) and the Benue State Agricultural Development Programme (BSADP). To analyze the connection between maize prices in rural and urban markets, variety of statistical tools were used. These tools included tests for price stability (Augmented Dickey-Fuller test), co-movement over time (Johansen co-integration test), market integration level (Index of Market Concentration), and the direction of price influence (Granger causality test).

➢ *Augmented Dickey Fuller (ADF) Unit Root Test:*

In a time series analysis, it's crucial to check for "unit root." This ensures that the data's trends and patterns are not misleading. The study used the ADF test to determine if maize price series were stable over time (stationary). This test also helps to identify how many times the data needs to be differenced to achieve stability. The specific details of the ADF test are explained in equations 1 and 2 .

$$\Delta P_{Bt} = \beta_0 + \beta_t P_{Bt-i} + \sum C_j \Delta P_{Bt-I} + \varepsilon_i \quad (1)$$

$$\Delta P_{At} = \gamma_0 + \gamma_t P_{At-i} + \sum d_j \Delta P_{At-I} + \varepsilon_i \quad (2)$$

Where; Δ = first difference operator and ε_t= error term based on the classical assumptions. The series is said to be non-stationary, if the ADF statistic at a stated level of significance is less than the critical value and vice versa.

➢ *Index of Market Concentration (IMC):*

This was used to measure the relationship of maize prices between integrated markets as presented in equation 3.

$$P_t = \beta_0\ \beta_1 P_{t-1} + \beta_2(R_t - R_{t-1}) + \beta_3 R_{t-1} + \varepsilon_t \quad (3)$$

Where: R_t = urban, P_t= rural price, R_{t-1} = lagged price for urban markets, R_t-R_{t-1} = difference between urban price and its lag, ϵ_t = unexplained term, β_0= constant, β_1 = coefficient of rural lagged price, β_2 = coefficient of $R_t - R_{t-1}$ and β_3 = coefficient of urban lagged price.

$$IMC = \beta 1/\beta 3 \quad (4)$$

Where $0 \leq IMC \leq \infty$

IMC < 1 (high short-run integration), IMC > 1 (low short-run integration), IMC = ∞ (no integration), and IMC = 1 (high or short-run integration) [11].

➢ *Johansen Co-Integration Test:*

This was used to test for co-integration of the price series. The null hypothesis tested stated that:

- **H_0**: The time series variables are not co integrated (r=0).

As in equation 5, if two series are individually stationary at same order, the theories of [8] and [9] can be used to estimate the long run co-integrating vector from a Vector Autoregression (VAR) model of the form:

$$\Delta_{pt} = \alpha + \sum_{i=1}^{k-1} \tau_i \Delta P_{t-1} + \pi P_{t-1} + \mu_t \quad (5)$$

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Where: P_t is a (n x 1) vector containing the price series at time (t), Δ is the first difference operator. Γ_I and Π are (m x n) matrix of parameters on the i^{th} and k^{th} lag of p_t, $\tau_i = (\sum_{i=1}^{k} A) - I_g$, $\pi_i = (\sum_{i=1}^{k} Ai) - I_g$, I_g is the identity matrix of dimension g, α is constant term, μ_t is (n x 1) white noise vector. Throughout, p is restricted to be (at most) integrated of order one, denoted by 1(1), where 1(j) variable requires j^{th} differencing to make it stationary.

➢ *Granger Causality Test:*

The Granger-causality test comes to play if a pair of series is co-integrated in at least one direction, which reflects the direction of influence between series (in this case, price) [15]. Theoretically, if the current or lagged terms of a time-series variable, as in equation 6, determine another time-series variable, as in equation 7 then there exists a Granger-causality relationship between equations 6 and 7 in which equation 7 is Granger caused by equation 6.

$$\Delta P_{Bt} = \theta_{11}\Delta P_{Bt-1} + \ldots + \theta_{In}\Delta P_{Bt-n} + \theta_{21}\Delta P_{At-1} + \theta_{2n}\Delta P_{At-n} - \gamma_1(P_{Bt-1} - \alpha P_{At-1} - \delta) + \varepsilon_{1t} \quad (6)$$

$$\Delta P_{Bt} = \theta_{31}\Delta P_{Bt-1} + \ldots + \theta_{3n}\Delta P_{Bt-n} + \theta_{41}\Delta P_{At-1} + \theta_{4n}\Delta P_{At-n} - \gamma_2(P_{Bt-1} - \alpha P_{At-1} - \delta) + \varepsilon_{2t} \quad (7)$$

The following two assumptions, as in (Equations 8 and 9) have to be tested using the above two models as stated in (equations 6 and 7) to determine the Granger causality relationship between prices.

(No causality from P_{Bt} to P_{At})

$$\theta_{21} = \Delta = \theta_{2n} = \Delta = \gamma_1 = 0 \quad (8)$$

(No causality from P_{Bt} to P_{At})

$$\theta_{41} = \Delta = \theta_{4n} = \Delta = \gamma_2 = 0 \quad (9)$$

The causality test procedures offer a framework for the assessment of which market (rural or urban) cause the integration and in which direction is the movement [15].

III. RESULT AND DISCUSSIONS

A. *Summary Statistics of Variables used for Analysis*

Table I, summarizes the average maize prices in selected regional markets across the study area. On average, maize was more expensive in urban markets (₦105.00/kg) compared to rural markets (₦68.43/kg). The table also shows the price range for each market, with rural prices fluctuating more widely (₦64.59/kg to ₦175.00/kg) compared to urban markets (₦50.96/kg to ₦90.92/kg). This wider range is confirmed by the standard deviation, which is much higher for rural prices (₦31.46/kg) than urban prices (₦14.42/kg). To further illustrate this difference, the coefficient of variation shows that rural maize prices varied almost five times more (98.90%) than urban prices (20.70%).

Table 1: Descriptive Statistics of Maize Price Series Used

	Maize Price Series (₦/Kg)	
Parameters	**Rural Market**	**Urban Market**
Mean	68.429	105.002
Minimum	64.590	50.960
Maximum	175.000	90.920
Standard Deviation	31.459	14.422
Coefficient of Variation	0.989	0.207
Skewness	0.907	0.492
Kurtosis	3.595	1.943

Source: Field Survey Data (2024).

B. *Time Series Properties of Maize Price Series in Benue State, Nigeria*

Augmented Dickey Fuller (ADF) test was used to determine the stationarity of the price series under consideration as presented in Table II. The ADF results revealed that the maize market price series in the study area were non stationary at levels for all the markets considered but became stationary after first differencing with the order of integration 1, I (1). The results further show that the rural markets; Adoka and Taraku were statistically significant at 1% levels while for the urban markets, the analysis showed that the price data needed to be adjusted once (differenced) to become stationary for both Otukpo and Aliade markets. This result (significant at 5% for Otukpo and 1% for Aliade) confirms that the rejection of the null hypothesis that the prices were not stable at the beginning of the study. This result supports the assertion of [6] who examined how rice marketing varies in price across different markets in Osun State, Nigeria and reported that the rice price series were non stationary at levels, except when adjusted (differenced).

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Table 2: Results of Unit Root Test for Maize Price Series

Market price series	Level	1st Difference	Order of Integration
Otukpo	-2.729 (0.069)	-2.896** (0.045)	I(1)
Aliade	-2.105 (0.243)	-3.708*** (0.004)	I(1)
Adoka	-2.308 (0.169)	-4.083*** (0.001)	I(1)
Taraku	-2.018 (0.279)	-5.035*** (0.000)	I(1)

Source: Field Survey Data (2024).
***and**: 1% and 5% significant levels respectively.
Probability values are in parenthesis.

C. Johansen Co-integration Test for Maize Markets in Benue State, Nigeria

The test for the existence of long run relationship was carried out for the rural and urban price series using Johansen Co-integration test and the results were presented in Table III. For the urban markets, the analysis revealed that the trace statistic was 35.51, which is higher than a critical value of 29.68 and the max statistic was 62.40 and also exceeded a critical value of 27.07. Both of these findings were significant at the 5% level ($p < 0.05$), which statistically means there's a strong likelihood that the rural and urban maize prices move together in the long run. The results showed that there were at least two co-integration equations and one co-integrating equation among the maize price series for trace and max statistics respectively. The rural markets also showed that there were at least four co-integrating equations among the price series as indicated by 5.89 at 5% level of significance for both trace and max statistics. Therefore, based on the decision rule, the null hypothesis of no co-integration among maize market price series in the rural and urban markets of Benue State was rejected. This implied that there was a long run linear relationship among the maize price series in the study area during the period of study and therefore the variables in the model were co-integrated. This is an indication that maize price series in the rural and urban markets form part of a system of maize prices that may vary independently in the short run but in the long run will vary simultaneously as part of a single market. [6] also reported a strong connection (co-integration) between rice prices in the long run, with a significance level of 5%. This means that rice prices in different markets tend to move together over time.

Table 3: Results of Johansen C0-Integration Rank Test for Maize Price Series

Markets	Trace Statistics	Critical Value (5%)	Max Statistics	Critical Value (5%)
Rural Markets				
r = 0	165.10	68.52	86.32	33.46
r = 1	79.68	47.21	34.85	27.07
r = 2	44.83	29.68	23.34	20.97
r = 3	21.49	15.41	15.60	14.07
r = 4	5.89*	3.76	5.89**	3.76
Urban Markets				
r = 0	187.16	68.52	89.25	33.46
r = 1	97.91	47.21	62.40**	27.07
r = 2	35.51*	29.68	20.90	20.97
r = 3	14.61	15.41	12.49	14.07
r = 4	2.12	3.76	2.12	3.76

Source: Field Survey Data (2024).
*and** number of co-integrating equation at 5% levels of significance for Trace and Max statistics respectively.
r: Co-integrating equation

D. Index of Market Concentration (IMC) for Maize Markets in Benue State, Nigeria

Index of Market Concentration (IMC) was used to measure how connected the rural and urban maize markets are in Benue State. The results, shown in Table IV, indicate a value of 0.6586 for the IMC. This value is less than 1 ($IMC < 1$) and statistically significant, suggesting a high level of integration between these markets in the short term. This therefore implies that, maize price changes in rural markets seem to quickly influence prices in urban markets. This suggests an efficient system where price information travels fast between rural and urban areas This findings corroborates the assertion of [13] that the indices of market concentration for onion, sweet pepper, fresh pepper and chili pepper were less than one ($IMC < 1$), suggesting high short run market integration in Oyo State but contradicts the report of [3] that the index of market concentration of fish in Oyo State exhibits low short run market integration as indicated by the IMC which was greater than one ($IMC > 1$).

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Table 4: Results of Index of Market Concentration for Maize Markets

Markets	β_1	β_2	β_3	IMC
Benue State	0.2761 (0.45)	0.0907 (1.80)	0.4192 (8.57)***	0.6586

Source: Field Survey Data (2024).
***and**: 1% and 5% significant levels respectively.
Probability values are in parenthesis.

E. Granger Causality Test on Maize Markets in Benue State, Nigeria

The granger causality test was used to determine the market that causes integration and the direction of causality of the listed maize markets in the study area. Lags were chosen on the basis of Akaike Information Criterion (AIC) and the nature of the product. The lags of best fit with the actual price changes in the market were tested and chosen based on the capacity to minimize the AIC. Therefore, 4 lags were used for the lag length of maize markets in Benue State.

The results as presented in Table V showed that four and five market pairs were statistically significant at 1% and 5% significant levels respectively as indicated by the F-statistics for both rural and urban markets in the study area. This therefore led to the rejection of the null hypotheses of no granger causality between maize market pairs in the study area. From the nine (9) markets with causal relationships, the result revealed that three (3) market pairs had unidirectional causalities while six (6) market pairs had bidirectional causalities. The implication of unidirectional causalities between two markets is that, a price change in one market caused a price change in the other market, but not the other way around. This suggests that the first market plays a stronger role in setting prices, while the second market simply reacts to those changes. While the bidirectional causalities implies that, price changes in both markets seemed to affect each other. This indicates that both markets are important for price setting and respond to changes in each other. These findings, combined with evidence of prices moving together in the long run, strongly suggest that the rural and urban maize markets are well-connected (integrated). This result supports the findings of another study [14] in Delta State, Nigeria. The study looked at how saw-wood prices moved between rural and urban markets, and also found evidence of price changes influencing each other in both directions (bidirectional causality). However, [2] reported a contradictory result that none of the rural and urban market links in the study area exhibited bidirectional granger causality. Based on the results of the pair-wise granger causality of maize in Benue State, it was deduced that there was no market leader whose prices changes affects all other prices within the rural and urban markets.

Table 5: Pair-Wise Granger Causality Test for Maize Markets

Null Hypothesis	F-Statistics	P-Value	Direction of Causality
Otupko → Aliade	5.0684***	0.0048	Unidirectional
Otupko ↔ Taraku	6.9017***	0.0000	Bidirectional
Taraku ↔ Otupko	2.6745**	0.0367	Bidirectional
Adoka → Otupko	3.7033**	0.0188	Unidirectional
Taraku → Aliade	12.319***	0.0000	Unidirectional
Aliade ↔ Adoka	2.5905**	0.0412	Bidirectional
Adoka ↔ Aliade	3.5195**	0.0229	Bidirectional
Taraku ↔ Adoka	12.495***	0.0000	Bidirectional
Adoka ↔ Taraku	2.7094**	0.0412	Bidirectional

Source: Field Survey Data, (2024).
↔ and →: indicates direction of causality
*** and**: 1% and 5% significant levels respectively.

IV. CONCLUSION AND RECOMMENDATIONS

The study empirically analyzed maize price dynamics and market integration in selected regional markets of Benue State, Nigeria and therefore concludes that, there were deviations across the regional market price of maize; the maize market price series for all the markets considered were non-stationary at levels; the results showed that these markets are integrated in both the short and long term. In some cases, price changes in one market caused changes in the other (one-way influence), while in others, price changes flowed in both directions (two-way influence). Based on this, the study recommends that the government set up information centers and use media channels to improve communication between maize producers and consumers in the state. This would allow everyone to make more informed decisions about buying and selling maize.

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