

Analysis of Price Instability and Determinants of Price Difference of Tomato in Nigeria

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ABSTRACT

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This study analysed price instability and price difference of tomato in Nigeria. Specifically, the study determined the degree of instability of prices of tomato; measured the speed of tomato price adjustment process to the long-term multipliers; and examine tomato price differences and their drivers in Nigeria. This study employed time series data on monthly prices per kilogram of fresh tomato in different states from January 2016 to December 2020 obtained from the National Bureau of Statistics (NBS). Descriptive statistics, Cuddy-Della Valle index and fully modified least square were used to achieve the objectives of the study. The results revealed that Cross River state had the highest tomato price in Nigeria followed by Rivers state and Lagos state. While tomato price in Bauchi was the cheapest in Nigeria followed by Taraba state and Kaduna states. The value of the Cuddy Della Valle index of 89.22 shows that the tomato prices across Nigerian markets were highly unstable. The absolute tomato price difference in Nigeria tomato markets was ₦156 per one kilogram of tomato. The fully modified least square result revealed that population, distance and transportation cost had a positive and significant influence on tomato price differences while self-sufficiency and telephone had a negative and significant effect on tomato prices difference in Nigeria. To reduce the instability in tomato markets and reduce the price difference, there is a need for effective and mukquate means of transporting tomato from the producing states to the demanding states.

1.0 Introduction

The price of agricultural commodities and its stability is a continuous issue among policy-makers and all other actors along the food supply chain because of its crucial role in the pace and direction of agricultural production and marketing system. Poor marketing system and function leads to several setbacks in agricultural production and casues price fluctuation (Mukaiila et al., 2021). It consequently forced farmers to sell at any available price due to perishable nature of agricultural product which posed them to risk. A perfect pricing system will encourage the production of commodities thereby resolving some failed conditions in the economy. A major feature of Nigeria's agricultural markets is the inter and intra-

priced disparities between its metropolitan and rural retail markets caused by demand and supply forces (Adenegan & Adeoye, 2011). Therefore, a possibility exists that a price change in one market would result in a series of price responses spreading across contiguous market areas.

These price shifts, in this case, may not have reflective results on distant markets, which make it a mirage to achieve an integrated food market system (Akintunde et al., 2012). Thus, recognizing the movement of market prices of agricultural commodities is one way of encouraging flexibility in the use of farm resources. It is also a means of curbing some of the vices of the



spill over, such as unemployment, and inflation, among others. These concerns about fluctuations in commodity prices have led to widespread intervention (such as Price Control Act, regulation of tariff, tax and import) by national governments in commodity policy in order to achieve price stability.

Prices constitute the readiest and most accurate information available which serve as a guide to farmers planting decisions. These decisions depend on expected gains which are dependent on expected future crop prices. As a result, prices are seen as an important instrument in economic analysis of markets (Moshood & Momoh, 2013). Price influences food availability. Price increases as food supply relatively decreases due to demand (e.g., low production and limited food imports). The prices tend to fall as supply increases (e.g., period of bumper harvest). Many agricultural commodities in Nigeria including tomato continue to have price instability. Akpan et al. (2014) stated that instability of agricultural commodity price is a common phenomenon in Nigerian markets. The instability is attributed to such conditions as seasons, variations in prices of materials, output, marketing technologies and consumer preferences (Akanni, 2013). Price instability affects vegetable crops marketing and consumption.

Vegetables play significant roles in sub-Saharan Africa countries including Nigeria as it contributes to nutrition and food security, livelihoods, economic status of people especially rural population who produce it and urban areas where the products are being marketed (Mukaila et al., 2021). Tomato is among the highly valued vegetables whose prices in Nigeria are highly unstable between seasons. In different markets, separated by a few kilometres, consumers pay different amounts for the same commodity. Adenegan (2012) reported that tomato prices were not stable across seasons and states in Nigeria. Although government enacted policies to stimulate production and returns to farmers, tomato output in Nigeria is still short of local demand with a shortfall of 1.2 million tonnes valued at about \$2.5 billion annually (CBN Governor's speech, Feb., 2020 during tomato factory launching in Kaduna).

Due to the perishable nature of tomato, there are frequent variations in tomato price and trade between regional markets depending on their supply position. Tomato farmers in Nigeria mostly sell their products in unorganized markets. And as such, the prices of tomatoes are not stable; most farmers cannot sell by weight rather they sell in baskets. The tomato price in Nigeria is somewhat volatile as a 60kg basket of tomato can sell for ₦5,000 sometimes and may sell for

₦25,000 in another period (Veggiiegrow, 2021). Despite Nigeria being one of the biggest tomato producers, it buys about 80% of tomato paste from China (George, 2018). In 2017, a new tomato policy was announced by the Federal Government to increase domestic production. The major goal of the policy is to discourage tomato concentrate importation by increasing its tariff from 5% to 50% and introducing USD1,500 levy per tonne (GROWAFRICA, 2018).

Given the importance of tomato crop and the effect of price stability in stimulating production, efficient marketing and income to farmers, and also to facilitate government policy interventions, there is a need to understand the price instability and causes of price difference. Several previous studies on price fluctuation of agricultural commodities markets concentrated on cereal, roots and tuber crops (e.g., Goletti et al., 1995; Moshood & Momoh, 2007; Akpan et al., 2016; Adeoye et al., 2013; Taru, 2014; Zakari et al., 2014; Ayinde et al., 2016; Etuk & Effiong, 2016; Moses, 2017; Sadiq et al., 2018; Onubogu and Dipeolu, 2019). While vegetable crops such as tomato which provide income to many households, serve as means of livelihood in developing nations and which are faced with the problem of price instability received less attention, especially in the area of price analysis. The few studies on tomato (e.g. Adenegan, 2012; Shrestha et al., 2014; Baiyegunhi et al., 2018) examined the level of market integration.

Based on the foregoing, the tomato price instability and the factors underlying the large variations in their prices need to be examined. Therefore, the present study intends adding to existing literatures and filled the gap by identifying drivers of price differences in Nigeria tomato markets. Thus, the following research questions necessarily arose:

1. What is the degree of instability of tomato prices?
2. What is the absolute tomato price difference?
3. What are the factors influencing tomato price differences in Nigeria?

2.0 Methodology

2.1 The Study Area

The research was conducted in Nigeria. Nigeria comprises of 36 states and the Federal Capital Territory, Abuja which were grouped into six geopolitical zones (North West, North East, North Central, South West, South East and South-South). Nigeria lies about latitude $2^{\circ}40'$ to $15^{\circ}45'$ east of Greenwich meridian and from a longitude of $4^{\circ}15'$ to $13^{\circ}55'$ north of the equator (World Map, 2015). The

country is located in West Africa on the Gulf of Guinea with a total land area of 923,768 km². The country shares borders with Cameroon and Chad in the east, the Republic of Benin in the west and Niger in the north. Nigeria is an agrarian nation endowed with rich natural resources, suitable weather conditions for agricultural production (Mukaiila et al., 2021). Agriculture contributes greatly to Nigeria economy and employs about 70 percent of the workforce (Obetta et al., 2020). One of the major vegetable crops produced in Nigeria is tomato. Nigeria is the 11th largest producer of tomato in the world, 2nd in Africa and 1st in sub-Sahara Africa (FAOSTAT, 2020). Tomato is grown in almost all the states in Nigeria but predominantly produced in the northern part of the country. Most states in the northern Nigeria, for example, Bauchi, Benue, Gombe, Jigawa, Kaduna, Katsina, Kano, Plateau, Kebbi, Sokoto, Nasarawa, Zamfara, Taraba and Kogi state have large tomato plantations. These states accounted for the largest proportion of the 3.9 million tonnes tomato output in the country. Regardless of the level of production, tomato is marketed in all states of the federation.

2.2 Data and Source

To have a good representation and considering the fact that tomato is marketed and consumed across the country, all the six geopolitical zones in Nigeria were used for this study. Twelve states and the Federal Capital Territory, Abuja, were used for the study. This makes a total of 13 locations for this study.

This study employed secondary data. Time series data on monthly prices per kilogram of fresh tomato in different states from 2016 – 2020 were obtained from the National Bureau of Statistics (NBS). This was long enough to measure the instability in price as it gives sixty data points or observations. This is, however, considered a large sample and acceptable to conduct research on market integration and price analysis (Baiyegunhi et al., 2018). Data on other variables were also sourced from NBS.

2.3 Data Analysis Techniques

Descriptive statistics was used to present the results and inferential statistics was used to analyse the data. Cuddy-Della Valle index was used to determine the degree of instability in the prices of tomato, descriptive statistics was used to examine tomato price difference and a fully modified least square model was used to identify determinants of tomato price differences in Nigeria.

Augmented Dickey-Fuller (ADF) Model

Before proceeding on analysing any time series data there is a need to check for the stationarity level of the

series to adopt appropriate model in a view to avoid spurious regression (Mukaiila, 2021). This would allow understanding the behaviour, nature and order of integration of the series (Mukaiila, 2021). To test for the unit root properties of the variables ADF test was employed as it was used by Makama and Amruthat (2016).

This is specified as:

$$\Delta\gamma_t = X_t \beta + \delta\gamma_{t-1} + \alpha_i \sum_{i=1}^p \Delta\gamma_{t-i} + \varepsilon_t \quad (3.1)$$

Where:

Δ = difference operator

γ_t = vector of the n variables (price of tomatoes from difference markets)

X_t = are optional exogenous regressors

β = coefficients

\sum = summation

ρ = number of lags

ε_t = error term

Cuddy Della Valle index (CDVI)

To measure the degree of instability in the price of tomatoes CDVI was used. It is specified as:

$$CDVI = CV\sqrt{x}$$

Where, $X = 1 - \underline{R}^2$,

CV = coefficient of variation,

\underline{R}^2 = adjusted coefficient of determination.

The ranges of CDVI (Sihmar, 2014) are given as follows:

Low instability = 0 to 15,

Medium instability = 16 to 30

High instability = above 30

Tomato Price differences

Following Varela et al. (2012), price difference is the average tomato price over the period. This was measured by taking the difference between price of tomato in a state against all other states. It is represented as:

$$TPD = state_i - state_j$$

Where,

TPD is the tomato price differences

$state_i$ is the price of tomato in state i .

$state_j$ is the price of tomato in state j .

The formula was applied to all the markets used for this study. This was done to examine the absolute tomato price difference and was used as regressand to identify the drivers of tomato price differences across Nigeria.

Fully Modified Least Square Model

The fully modified least square model was used to identify the determinants of tomato price difference across tomato markets in Nigeria. The fully modified least square has the advantage of accounting for serial correlation and endogeneity in the regressor. The average tomato price difference across the markets in Nigeria was regressed against some explanatory variables. This is to explain divergences from law of one price (Varela *et al.*, 2012). It is specified as:

$$TPD = \beta_0 + \beta_1 Trancost_{1i} + \beta_2 Tele_{2i} + \beta_3 Dist_{3i} + \beta_4 Cont_{4i} + \beta_5 Pop_{5i} + \beta_6 Self_{6i} + \varepsilon_i$$

Where,

TPD is the tomato price difference

Trancost is the transportation cost. This measures the level of infrastructural facilities such as good road network, a low transport cost suggests a good transportation network while a high transportation cost suggests a poor transportation network.

Tele is the telephone density. It is a proxy for availability of information.

Dist is the distance from one state to the other.

Cont is the contiguity (1 if the state shares a border, 0 if not). This will measure additional cost involved in tomato marketing cost.

Pop is population (number of people living in the state).

Self is self-sufficient in tomato (1 if a major tomato producer, 0 otherwise). This measures the level of tomato production in terms of meeting the state demands.

β_0 = constant

ε_i = Stochastic error term

Results and Discussion

Descriptive Statistics of Tomato Price Difference in different Nigeria Markets

Table 1 presents the descriptive statistics of tomato prices in different markets in Nigeria. Cross River state had the highest tomato average price in Nigeria followed by Rivers state and Lagos state. This could be because the states were major demanding states of tomato in Nigeria. Tomato price in Bauchi was the cheapest in Nigeria followed by Taraba state and Kaduna states which were due to large scale tomato production in the states. As shown in Table 1, tomato prices in the demanding states were higher than tomato prices in supplying states. The higher price of tomatoes in the demanding states could be because of the transportation cost incurred to move tomato from the producing or supplying states to the consumption and demanding states.

Table 1: Descriptive statistics of tomato price in different Nigeria states

States	Mean	Media	Max	Min	Std dev.
Bauchi	173.45	170.10	281.64	96.28	50.01
Taraba	202.22	190.03	405.89	110.94	61.68
Benue	256.38	251.58	397.62	142.52	47.88
Plateau	231.53	217.99	394.46	162.77	53.97
Sokoto	226.38	223.23	397.92	105.92	77.84
Kaduna	222.90	214.71	395.70	54.98	69.75
Lagos	379.92	380.28	592.51	208.65	107.07
Ondo	283.53	277.71	437.12	142.73	67.50
Enugu	329.85	298.39	956.53	195.93	137.04
Anambra	348.83	327.12	811.90	200.66	117.61
Rivers	436.04	425.45	606.22	239.65	76.37
Cross river	442.63	424.45	770.23	313.97	87.25
Abuja	259.18	252.28	438.35	184.52	55.11

Source: Data analysis, 2021

Unit Root Property of Tomato Price

The unit root property of tomato prices across spatially separated markets in Nigeria were presented in Table 2. The results revealed that tomato prices in Bauchi, Benue, Sokoto, Kaduna, Lagos and Ondo states were not stationary in the level form. They, however, became stationary after the first difference. This means that the variables are order one. While tomato prices in Taraba, Plateau, Enugu, Anambra, Rivers, Cross River states and Abuja (FCT) were stationary at level form. This implies that these variables are order zero.

Table 2: Unit root property of tomato price

Variables	Level	First Difference
Bauchi	-0.803226 (0.8093)	-5.85478 (0.0000)
Taraba	-2.765427 (0.0695)	8.2863 (0.0000)
Benue	-2.549004 (0.1094)	-7.81098 (0.0000)
Plateau	-2.876504 (0.0542)	-7.865429 (0.0000)
Sokoto	-1.77882 (0.3873)	-8.930966 (0.0000)
Kaduna	-1.61370 (0.4692)	-11.8404 (0.0000)
Lagos	-2.28944 (0.1787)	-10.29302 (0.0000)
Ondo	-2.5269 (0.1144)	-7.52985 (0.0000)
Enugu	-4.8996 (0.0002)	-6.4889 (0.0000)
Anambra	-3.50798 (0.0111)	-7.128149 (0.0000)
Rivers	-2.72809 (0.0754)	-9.45669 (0.0000)
Cross River	-3.61088 (0.0084)	-6.72578 (0.0000)
Abuja	-3.13119 (0.0268)	-9.30195 (0.0000)

Note: *, ** and *** denote rejection of the null hypothesis at 10%, 5% and 1% significant levels respectively based on the Mackinnon critical values. P-values of test statistics are in parenthesis.

Source: Data analysis, 2021

Degree of Instability of Prices of Tomato in Nigeria

The degree of instability of prices of tomato in Nigerian markets was presented in Table 3. The value of the Cuddy Della Valle index was 89.22. According to Sihmar (2014), the Cuddy Della Valle index greater than 30 indicates a higher level of instability. Thus, the Cuddy Della Valle index of 89.22 implies that the tomato price across Nigerian markets was highly unstable. In addition, the mean value of tomato price (₦289.27) per kilogram in Nigerian markets with a standard deviation of 118.45 suggests a wide variation in the tomato prices in Nigerian markets. This result supports the finding of Adenegan (2012) that tomato prices in Nigerian markets were not stable.

Table 3: Degree of instability of prices of tomato

Variable	Coefficient of variation	Adjusted R-Square	CDVI	Inference
Tomato prices	244.20	0.8665	89.22	High instability

Source: Data analysis, 2021

Tomato Price Differences And Their Drivers In Nigeria

The absolute tomato price difference in Nigeria tomato markets was ₦156 per one kilogram of tomato. This implies that tomato price in spatially separated tomato markets in Nigeria differs by ₦156 per one kilogram.

Determinants of tomato price different in Nigeria

Table 4 presents the determinants of tomato price differences in Nigeria. The result revealed that distance, population, self-sufficiency, telephone and transportation cost were the significant factors that influenced tomato price differences in Nigeria.

The coefficient of distance positively influences tomato price differences in Nigeria. This implies that the longer the distance covered from one tomato market to another, the higher the price difference. This could be as a result of the cost incurred from moving the tomato from the producing states to the demanding states. Thus, the tomato price difference reduces as the distance covered reduces. Goletti et al. (1995) reported a similar finding that distance increased rice price difference in Bangladesh

The population also had a significant and positive effect on tomato prices different in Nigeria. This implies that the population in a location increased the tomato price different. This could be because a location with a high population will have a high demand for tomato, *ceteris paribus*, which will command high prices tagged to tomato. While a location with a low population will have low demand for tomato which will command a low-price tag to tomato, *ceteris paribus*. These will, in turn, result in different tomato prices.

Self-sufficiency had a negative and significant effect on tomato prices different in Nigeria. This implies that being self-sufficiency in tomato production will reduce the tomato price difference in the market spatially located. This could be because being able to produce tomato in all states at a sufficient level will maintain almost the price as all states are likely to incur the same cost of production. Self-sufficiency may also increase the output of tomato in the country. An increase in output will, in turn, reduce price differences (Varela et al., 2012).

The telephone had a negative and significant influence on tomato price differences. This result implies that the presence of the telephone in different locations reduced the tomato price difference in Nigeria. This could be because the telephone enhances the means of

communication and transmission of tomato prices across the country.

The transportation cost had a positive and significant influence on price differences. This implies that an increase in transportation costs will increase the price difference in spatially separated markets. This is because transportation cost is a major cost in tomato marketing to move tomato from producing states to demanding states. Thus, a low transportation cost will lead to a low tomato price difference while a high transportation cost will lead to a high tomato price difference.

Table 4: Determinants of tomato price difference in Nigeria

Variables	Coefficient	Standard error	t-statistics	Prob.
Contiguity	-0.585935	0.827172	-0.708360	0.5104
Distance	0.004619***	0.000702	6.577409	0.0012
Population	1.52E-06**	5.15E-07	2.944464	0.0321
Self sufficiency	-6.573598***	0.957999	-6.861803	0.0010
Telephone	-9.52E-07**	2.84E-07	-3.357927	0.0202
Transportation cost	0.030003***	0.006473	4.635088	0.0057
Constant	-17.60886	4.211989	-4.180652	0.0086

Source: Data analysis, 2021

Conclusion

This study analysed price instability and price difference of tomato in Nigeria. The results revealed that Cross River state had the highest tomato price in Nigeria followed by Rivers state and Lagos state. This could be due to the low production of tomato in these states. While tomato price in Bauchi was the cheapest in Nigeria followed by Taraba state and Kaduna states which could be due to large scale tomato production. The Cuddy Della Valle index (89.22) shows that the tomato price across Nigerian markets was highly unstable. It can be inferred from this study that tomato prices in the demanding states were higher than tomato prices in supplying states. Distance, transportation cost and telephone played a significant role in the tomato price difference. Distance between the producing states and demanding states influenced tomato price difference positively; thus, the longer the distance covered, the higher the tomato price difference. Meanwhile, the higher the telephone concentration, the lower the tomato price difference.

To reduce the instability in tomato markets and reduce the price difference, there is a need for effective and adequate means of transporting tomato from the

producing states to the demanding states. This could be achieved by constructing new roads and/or renovate the existing ones to enhance the movement of tomato and reduce the time tomato spent in transit. Construction of rails from the major producing states to the major demanding states would go a long way to reduce the transportation cost incurred during the distribution of tomato. Furthermore, provision of rural mass transit, by the government, that will carry tomato from the producing states to the consuming states at subsidised rate is needed to reduce the transportation cost. These would consequently reduce tomato spoilage during transportation. Due to the perishable nature of tomato, the provision of modern processing facilities and storage facilities will reduce the price difference in tomato markets. This would enable storing of tomato during the production season to the off-season.

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