Nigerian Agricultural Policy Research Journal (NAPReJ) Agricultural Policy Research Network (APRNet)
Vol. 10, Special Issue. Website:http:// www.aprnetworkng.org ©2022

ISSN 2536-6084 (Print) & ISSN 2545-5745 (Online)

Co-integration Analysis of Market Prices of Edible Oil in Rural and Urban Markets of Niger Delta Region in Nigeria

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A R T I C L E I NFO

Keywords:

Co-integration,

Granger Causality,

Edible oil,

Marketing,

Niger Delta

ABSTRACT

Co-integration technique was applied to determine the level of integration between rural and urban markets' prices of edible oil in the Niger Delta region. It also established the price causality and transmission in edible oil marketing. Primary data were generated from 432 edible oil marketers composed of wholesalers and retailers from three States in the region. Secondary data on rural and urban markets prices of palm oil and vegetable oil were sourced from the Central Bank of Nigeria (CBN) bulletin. Results of the vector error correction model (VECM) applied to measure the short-run dynamics among rural and urban edible oil markets indicate that a 1% increase in rural price of vegetable oil would in the long run increase its urban price by 4% but not same with palm oil. Estimated short-run coefficients for edible oil rural and urban markets' prices were negative and statistically significant at the 5% level. Adjustment towards the long-run equilibrium in the short-run also revealed that the price changes in the vegetable oil rural and urban markets were transmitted to other markets at a rate of 26% and 38% respectively within a week. The direction of causality between urban and rural prices of vegetable oil showed that urban prices of the vegetable oil manifested a two-way causation with its rural price at 5% while that of palm oil was at 1% level of significance. Capacity building workshops is recommended for marketers on strategies in marketing and business conduct to help equip them on how to access price and other related market information.

Introduction

Edible oils are oils extracted from plants which are good for human consumption and they include palm oil, groundnut oil, soya oil, olive oil, sunflower oil, coconut oil, palm kernel oil, almond oil, corn oil, carrot oil and others. Edible oils in addition to domestic use (as food) are applied to a wide variety of uses including the manufacture of candles, soaps, margarine, fats, drugs and several others. These contribute to the high demand of the edible oil and the consequent need to increase production and therefore marketing. Hence, there are enormous potential gains that will be realized from efficient marketing of edible oil. Edible oil marketing focuses on all the activities that are responsible for delivering the edible oil from the producers to the consumers.

Edible oil in the context of this study is categorized into two, namely palm oil which is red in color and extracted from oil palm and vegetable oil which is extracted from a variety of plants like soybean, groundnut etc. and it is a light or nearly colorless transparent oil.

Palm oil is world's second major edible oil after soybean oil. In 2019/2020, palm oil consumption in Nigeria amounted to about 1.56 million metric tons. In 2021, the production of palm oil in Nigeria was estimated to be 1,015 thousand metric tons, remaining stable compared to the previous year. Nigeria is one of the leading five producers of palm oil worldwide (Statista, 2021;

ISSN 2536-6084 (Print) & ISSN 2545-5745 (Online)

Simona, 2021; Igiri, Arigor, Bassey and Edet, 2015). The Southern part of Nigeria is the Oil Palm belt which supplies most of the palm oil consumed in the South and also in the North (Ezealaji, 2012). In Nigeria, the demand for palm oil is very high and remains relatively constant all through the year. Hence this has triggered off shortages in supply in some periods in the year. Diverse oil-bearing seeds are produced in Nigeria from which vegetable oil are separated and they play the same role as palm oil in food preparation, hence, both are substitutes. There are several brands of vegetable oils marketed in Nigeria.

FAO (2020) had noted the contribution of edible oil in agri-food trade in the African Continental Free Trade Area (Afcfta); that Africa's participation in the global market for agri-food products has steadily expanded in the last half century, with exports growing by 4 percent and imports by 6 percent per year. Among the agri-food imports are vegetable oils (sunflower oil) imported from Europe and palm oil from Asia (FAO, 2020).

An efficient marketing system is that which ensures the flow of commodity and services at minimum price acceptable by all participants. The producers are able to break even and earn income; the various middle men (marketers) earn income from the margins while consumers are not exploited. Many persons and institutions are involved in marketing of edible oils in the Niger Delta, thus a better understanding of the market is moving towards better delivery of standard of living of the many persons, households and institutions involved in marketing. Marketing delivers goods and services from place of production to final consumers. Appropriate market information with regards to availability, price and others for edible oils in both urban and rural markets in the area is a task performed by myriads of persons (marketing functions). How these information are handled and how they impact on edible oil prices in urban and rural markets of the Niger Delta region becomes a challenge. Thus a clear understanding of the co-integration of the rural and urban markets prices of edible oils in Niger Delta will positively impact on a significant proportion of Nigerian population who are stakeholders involved in marketing edible oil. This study applied co-integration technique to determine the level of integration between prices in rural and urban markets of edible oil in Niger Delta region and thus tested the hypothesis that Rural and urban markets' prices of edible oil (palm oil and vegetable oil) are not integrated.

Establishing the price causality and transmission in edible oil marketing will guide the key players in the edible oil industry including the marketers to make knowledgeable choices on the products.

This study will serve as a source of perspective record for analysts who set out on investigations of the equivalent or related sorts in other parts of the country. It is also envisaged to generate valuable information on edible oil (palm oil and vegetable oil) marketing that would assist policymakers in designing appropriate policies for intervention. Findings on the level of market integration will show researchers and students where further studies can be conducted.

Materials and Methods

Study Area: Niger-Delta region is the study area and it sits on the Gulf of Guinea on the Atlantic Ocean in Nigeria. It incorporates the six States of the South-South geopolitical zone, Ondo State from South West and Abia and Imo States from South East geopolitical zones. All Niger Delta States are crude oil-producing except Cross River. The area is a thickly populated locale sometimes called the Oil Rivers since it was a major producer of palm oil. The territory was known as British Oil Rivers Protectorate between 1885 and 1893, before it became expanded and turned into Niger Coast Protectorate. The Niger-Delta occupies about 70,000 km^2 (27,000 sq. mi) which approximates 7.5% of Nigeria's land mass and is inhabited by 31 million people (NPC, 2006).

Sampling and Data Collection: The study population comprised all the palm oil and vegetable oil marketers in the nine Niger Delta States. A multistage random sampling procedure using the table of arbitrary numbers was adopted for selecting the sample. In stage I, three States comprising Delta, Edo and Rivers were randomly chosen. In stage II, six Local Government Areas (LGAs) were randomly sampled from each of the selected three States of the region; two LGAs from each of the three agricultural zones of the selected States and this gave a total of 18 LGAs. Two markets (1 in urban area and 1 in rural area) were sampled from each of the selected LGAs, and this gave a total of 36 markets comprising of 18 markets in urban areas and 18 markets in rural communities. Urban areas in the context of this study refer to major towns in the particular LGA with population densities above 150 inhabitants per square kilometer and higher business activities compared with other towns in the same LGAs; while the rural areas refer to population densities below 150 residents per square kilometer and lower commercial activities equated with other areas within the same LGA (OECD 1994). In most cases, markets in the selected local government headquarters formed the urban markets.

Three wholesale and three retail palm oil marketers as well as three wholesale and three retail vegetable oil marketers were randomly sampled from each of the 18 markets in urban area. This gave a total of 108 palm oil marketers (54 wholesalers and 54 retailers) and 108 vegetable oil marketers (54 wholesalers and 54 retailers). This gave a total of 216 palm oil and vegetable oil marketers that were sampled from urban markets. In the context of this study, wholesalers are marketers who purchase edible oil straight from the producers in large quantities and volumes like a lorry load of the edible oils

ISSN 2536-6084 (Print) & ISSN 2545-5745 (Online)

containing hundreds of litres of the oils in tens of gallons and they sell the products in smaller tens of litres in units of gallons to retailers, then retailers are those who sell to the final consumers in small units of litres (OECD 2014). Proportionate random sampling was applied to replicate the selection of palm oil wholesalers and retailers and vegetable oil wholesalers and retailers from markets in rural areas and this generated a sample of 216 palm oil and vegetable oil marketers from markets in rural areas. Primary data were collected for the study using semi-structured questionnaires that were given to the respondents; wholesalers and retailers of palm oil and vegetable oil using trained enumerators. Secondary data on rural and urban markets prices of palm oil and vegetable oil were gotten from Central Bank of Nigeria (CBN) Statistical Bulletin.

Measurement of Variables

Unit root test: A co-integrating relationship exists between non-stationary series if there is stationary linear mixture among them. Therefore there is need to test stationarity of the time series first. Augmented Dickey-Fuller (ADF) ascertained whether or not the series are stationary. The testing procedure for the ADF was as follows:

$\Delta Xt = \beta_o + \beta_2 X_{t-1} + \beta_i \Sigma X_{t-i} + \Sigma_i$

Where,

Xt = individual explanatory variables at time, t;

β_o = constant

Δ = the difference term.

The unit root test was then undertaken for the null hypothesis, $t \neq 0$.

$$ADF_t = \frac{\hat{U}}{SE\left(\hat{U}\right)}$$

The computed value test statistic was compared with the pertinent critical value for the ADF_t. If the statistic is greater (in absolute value) than the critical value at 5% or 1% level of significance, then the null hypothesis of $\mu \neq 0$ would not be accepted and no unit root is present. Once this is established, the test for co-integration would be carried out.

A typical regression model to test for market integration between two markets under the traditional static method is specified as follows:

MI = f (POrp + POup + VOrp+ VOup)

Where:

MI = Market Integration

POrp = Palm oil price series for rural market

POup = Palm oil price series for urban market

VOrp = Vegetable oil price series for rural market

VOup = Vegetable oil price series for urban market

Granger causality model: This determined the price causality in the rural/urban marketing of edible oil. The model can be expressed as follows;

POrp = f (POup)

POup = f (POrp)

VOrp = f (VOup)

VOup = f(VOrp)

Where;

POrp = Palm oil price in rural market

POup = Palm oil price in urban market

VOrp = Vegetable oil price in rural market

VOup = Vegetable oil price in urban market

The following causality relationships were tested by placing the appropriate limitations on the model and using the F-test for statistical significance. The result of the analysis would take any of these forms;

(a) Independence causality i.e. no causality

(b) Bilateral causality also known as feedback causality

The study of Obayelu and Salau (2010) on Application of Co-Integration and Error Correction Model to examine the response of agriculture to price and exchange rate in Nigeria reported that markets were poorly integrated and there was also the presence of some form of price leadership in the market system. They also revealed that the major sources of poor integration and inefficiency in Nigeria markets include poor price formation transmission channels, too many intermediaries and the high cost of transportation, as well as the sources and validity of price data. It was also noted that price co-movements and price transmission are heavily affected by government intervention.

The work of Adakaren, Arene and Chidebelu (2013) on Application of Co-integration and market integration to Raphia palm wine markets in Niger Delta Area of Nigeria revealed that the prices of raphia palm wine in all the markets in area showed evidence of integration in the long run and there was interdependent and bi-directional causality between urban price and the rural price of raphia palm wine.

Results and Discussions

Market integration of edible oil (vegetable oil and palm oil): Establishing extent of integration of rural and urban markets' prices of edible oil in Niger Delta region involved the use of co-integration and error-correction model. The use of co-integration procedure involves some steps. The first of the steps is carrying out a unit root test on the data.

Unit root test: Average monthly time series data for urban and rural market prices for both vegetable oil and palm oil spanning from 1995 to 2018 was generated from Central Bank of Nigeria data base. First, the unit root test result of logged price series data at levels and at first differences using the Augmented Dickey Fuller (ADF) Test are as presented in Tables1 and 2.

As shown in Table 1, the result indicated that all edible oil price series in the model were non-stationary at both 1% and 5% levels of significance. This is because the absolute values of critical statistic were greater than the absolute values of the t-statistic and hence contains unit root and are non-stationary that is 1(0). This prompted the test of stationarity of the first difference.

ISSN 2536-6084 (Print) & ISSN 2545-5745 (Online)

After the differencing, the price series attained stationarity because the absolute values of the t-statistic were greater than critical values and hence, all the variables were integrated to order one, 1(1) (Table 2). Thus, the null hypothesis of unit root was accepted at levels but rejected at first difference for all the price series both at 1% and 5% levels of significance. The reason for this process according to Okoroafor *et al* (2010) as reported by Nwankwo (2018) was to avoid the consequences of regressing non-stationary time series data with the attendant problem of spurious results due to inflation and seasonality. This finding concur with earlier findings and conclusion that food commodity price series are mostly stationary of order one i.e. 1(1) (Okoroafor *et al*, 2010).

Co-integration result: Co-integration test was carried out to determine whether there were long-run relationships between the markets. The presence of co-integration between two series is an indication of their inter-dependence and its absence reflects market segmentation. Co-integration was tested with the aid of Johansen's maximum likelihood procedure using two test statistics, namely the trace (λ-trace) and eigenvalue (λi-max.). The result of the co-integration analysis on vegetable oil and palm oil is presented in Tables 3 and 4.

The result as shown revealed that the two tests statistics-the maximum eigenvalue and trace tests were absolutely harmonized during the period as to the number of co-integrating vectors at the conventional 0.05 probability level. Both the λ-trace and eigenvalue statistic exceeded the critical value at 5% level for null hypothesis of r = 0 and r = 1, therefore the null hypothesis of no co-integrating relationships is rejected at the 0.05 level. Hence, edible oil markets are integrated.
The implication of the outcome of the overall analysis shows the existence of inter-dependence between edible oil in Niger Delta region of Nigeria. The markets operated as unified market which is an indication that most of the markets adjusted significantly to price changes. This implies that vegetable oil and palm oil markets were strongly linked together and therefore, the long-run equilibrium is stable. Hence, if there are shocks (deficit or surplus) from any of the States, it will quickly be transferred until equilibrium is re(established).

As observed by Mafimisebi (2012), the arbitrage activities of marketers, who ship commodities between low and high price locations, will raise price in some markets whilst lowering them in others until price differentials equal transfer costs and all opportunities for earning excess profit have been exhausted. In other words, prices of edible oil in one market do not significantly differ from that of the corresponding market within the study area. There is a tendency for the prices in both vegetable oil and palm oil rural and urban markets to converge in the long run according to a linear relationship, and that in the short run, the prices may drift apart, as shocks in one market may not be instantaneously transmitted to other markets due to delays in transport. This discovery as reported by Nwankwo (2018) may be attributed to free flow of information on prices within and across the States of the study.

Vector error correction model (VECM) showing the short and long run price dynamics: The vector error correction model (VECM) was applied to measure the short-run dynamics among rural and urban edible oil markets. The linear VECM results for vegetable oil and palm oil are presented tables 5, 6, 7 and 8. The VECM results as shown indicates that a 1% increase in the rural price of vegetable oil would in the long run increase its urban price by 4% (Table 5) unlike palm oil (Table 7). The result also showed that all the estimated short-run coefficients for vegetable oil rural and urban markets' prices were negative and statistically significant at the 5% level. Adjustment towards the long-run equilibrium in the short-run also revealed that the price changes in the vegetable oil rural and urban markets were transmitted to other markets at a rate of 26% and 38% respectively, within a week. In other words, 26% distortion in the rural prices of vegetable oil was corrected within a week. This implies that it took approximately 38 days for rural price of vegetable oil to return to equilibrium. This invariably suggests that the transmission of price changes from one market to another at the time interval was weak. Adjustment towards the long-run equilibrium in the short-run was slow. Also, the speed with which the system will adjust to shocks and restore equilibrium for the urban price of vegetable oil was 38% which was however faster than the vegetable oil rural price. Based on the results, it is concluded that vegetable oil rural and urban markets are not well integrated in the short run.
Finally, when vegetable oil is compared with palm oil, it was observed that increase in the rural price of vegetable oil led to an increase in urban price, while any increase in the rural price of palm oil decreased its urban price. The reason was that vegetable oil market prices followed the same trend while palm oil prices follow different trends. Also, the speed of price adjustment of palm oil in the short run was faster than that of vegetable oil. The presence of co-integration between vegetable oil and palm oil market prices implied that the prices do follow the same long-run trend (presence of integration). As a result, the market price of either vegetable oil or palm oil would not drift above or below each other in the long run.

Price causality and transmission in edible oil marketing: The direction of causality between urban and rural prices of vegetable oil is presented in table 9. The result showed that urban prices of the vegetable oil manifested a two-way causation with its rural price at 5% level. This implied that no vegetable oil market was exclusively given the leadership position in the study area. An increase in the past urban price of vegetable oil caused that of the current rural price to increase whereas

ISSN 2536-6084 (Print) & ISSN 2545-5745 (Online)

increase in the past rural price did not Granger cause the current urban price.

The direction of causality between urban and rural prices of palm oil in the Niger Delta region is presented in table 10. The null hypothesis of no causality was rejected. In the first market pair, rural price of palm oil Granger caused its urban price at 1% level of significance. This is an indication of strong causality, that is, the rural market dominated price formation with urban market. The result indicated that rural price of palm oil Granger caused the urban price; whereas the urban price of palm oil did not Granger cause the rural price. In other words, an increase in the rural price of palm oil brought about an increase in the urban price while increase in the urban price did not lead to increase in rural price. This finding is in tandem with the works of Ike (2014) on structure, causality and price transmission tests in the marketing of *Irvingia* seed (Ogbono) in Enugu State, Nigeria and Nwanko (2018) who established a similar relationship in the marketing of palm wine in the urban and rural markets of south east Nigeria.

Conclusion and Recommendation

The study concludes that there is presence of co-integration between vegetable oil and palm oil market prices as the prices follow the same long-run trend. Also there is an established Granger causality among urban and rural prices of palm oil in the Niger Delta region as the rural market ruled price formation at the urban market. The study therefore recommends an appropriate policy measure whereby capacity building workshops are organized for marketers from time to time on strategies in marketing and business conduct. This will help to equip them on how to access price and other related market information.

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Table 1: ADF Unit root test for edible oil market prices at level

Series	ADF @ t-statistic	5% critical value	P value
Vegetable oil rural price	-0.443115	-2.087561	0.7581
Vegetable oil urban price	0.457107	-2.055870	0.9245
Palm oil rural price	-0.537271	-2.05568	0.6378
Palm oil urban price	-0.602924	-2.05559	0.5687

Table 2: ADF Unit root test for edible oil market prices at first difference

Series	ADF @ t-statistic	5% critical value	P value
Vegetable oil rural price	-12.03452	-2.087561	0.000
Vegetable oil urban price	-8.94576	-2.055870	0.000
Palm oil rural price	-11.67321	-2.05568	0.000
Palm oil urban price	-9.26174	-2.05559	0.000

Table 3: Co-integration test result for vegetable oil markets

Hypothesized No of CEs	Trace Test Statistics	5% Critical Value	Maximum Eigenvalue	5% Critical Value
None	56.65**	15.49	51.90**	14.26
At most 1	17.77**	3.84	32.74**	3.84

**Significant at 0.05 level

Table 4: Co-integration test result for palm oil markets

Hypothesized No of CEs	Trace Test Statistics	5% Critical Value	Maximum Eigenvalue	5% Critical Value
7None	86.64**	15.49	51.90**	14.26
At most 1	32.74**	3.84	32.74**	3.84

**Significant at 0.05 level

Table 5: Long-run estimates of rural and urban market prices of vegetable oil

Regressors	Long-run Estimates	Standard Error	t-value
Constant	-5432.786		-126.097
Rural	1.0000		
Urban	4.006261	0.5525877	7.250000

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Table 6: Short-run estimates of rural and urban market prices of vegetable oil

Error Correction	D(Rural Price)	D(Urban Price)
Constant	-3.200511	-0.518179
Conteq 1	-263572	-0.385229
t-value	-3.018	-7.13
D(rural price(-1)cf	0.726603	0.285949
t-value	-7.39	3.12
D(rural price(-2)cf	-0.495901	0.208683
t-value	-4.09	3.42
D(urban price(-1)cf	0.353905	0.525629
t-value	2.701	4.38
D(urban price(-2)cf	0.352351	0.165765
t-value	0.29	0.58
R^2	0.546784	0.578702

Table 7: Long-run estimates of rural and urban market prices of palm oil

Regressors	Long-run Estimates	Standard Error	t-value
Constant	-267.786		-126.097
Rural	1.0000		
Urban	-0.309468	0.12874	2.403821

Table 8: Short-run estimates of rural and urban market prices of palm oil

Error Correction	D(Rural Price)	D(Urban Price)
Constant	0.239363	-0.913845
Cointeq 1	-2.76059	0.775762
t-value	-8.2018	3.13
D(rural price(-1)cf	0.481101	-0.470545
t-value	3.09	2.93
D(rural price(-2)cf	0.298979	-0.207355
t-value	1.82	-1.49
D(urban price(-1)cf	-0.453905	-0.625629
t-value	-3.801	5.49
D(urban price(-2)cf	-0.252351	-0.465765
t-value	-1.29	-4.18
R^2	0.546784	0.578702

Table 9: Pairwise Granger causality test of vegetable oil in Niger Delta region

Null Hypotheses	Observation	F-Statistic	Probability
Rural price of vegetable oil does not Granger cause the urban price	144	2.435125	0.1793
Urban price of vegetable oil does not Granger cause the rural price	144	7.79352**	0.02

** Significant at 5% level

Table 10: Pairwise Granger causality test of palm oil in Niger Delta region

Null Hypotheses	Observation	F-Statistic	Probability
Rural price of palm oil does not Granger cause the urban price	144	12.76924***	0.000
Urban price of palm oil does not Granger cause the rural price	144	3.220122	0.2492

*** Significant at 1% level