DOWNSTREAM PRICE ADJUSTMENT IN OIL BASED CROPS IN SOUTH- SOUTH REGION OF NIGERIA

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ABSTRACT

Price relationship of homogenous commodity in spatial market depends on several factors. This study tested the long and short run price relationship in palm oil, palm kernel oil, groundnut oil and shell groundnut markets in South South region of Nigeria. Monthly prices of these commodities in rural and urban markets were extracted from quarterly publications of Akwa Ibom State (one of the states in the region) Agricultural Development Programme (AKADEP). The study covers the period from January 2004 to June 2015. The study used the Engle Granger (1987) and Enders - Siklos (2001) methodologies to verify the symmetric and asymmetric price relationships between the rural price and its corresponding downstream price alone the food chain in each of this commodity. The result confirmed significant short and long run integrations between the upstream and downstream market prices in palm oil, groundnut oil and shell groundnut in the region. However, there was no evidence of long run stability in palm kernel oil market in the region. The study also discovered that, the rural price equilibrium in the long run followed symmetric adjustment with respect to urban price in palm oil, groundnut oil and shell groundnut. There was no evidence of asymmetric price transmission in these commodities. The symmetric price adjustment was not instantaneous, while the coefficient of market integration showed consistent positive impact in both short and long runs. Based on these results and to achieve more efficiency in agricultural commodity marketing in the region, it is recommended that, government should strive to improve the existing marketing infrastructure in the region. Also, activities of market unions should be moderated in order to further reduce transaction cost and activities of intermediary agents in the marketing chain. Finally, there is an overwhelming need to establish information centers on agricultural commodity prices in the region.

Keywords: Market integration, asymmetric price, symmetric price transmission and agriculture

INTRODUCTION

Agricultural commodity markets are characterized by several intermediaries in the marketing chain especially in developing economies (Akpan *et al,* 2014a and Edet *et al,* 2014). This has given rise to price volatility both at the upstream and downstream markets. Food and Agricultural Organization (FAO) *et al.* (2011) has also linked volatility of agricultural prices to factors including: climate change, stronger demand for food crops and animal products in conjunction with slow growth in agricultural

productivity and currency fluctuations as well as policy inconsistency. Based on these marketing externalities (including transaction costs) and other factors, agricultural commodity's markets do not usually adjust instantaneously to equilibrium position among spatial markets (Carman, 1997). This has often resulted to non-synchronization of the upstream price with downstream price changes, hence leading to asymmetric price transmission. Asymmetric price transmission has been a subject of considerable attention in agricultural economics in recent years. As noted by Meyer and von Cramon-Taubadel (2002), this phenomenon is significant because its presence is often considered as evidence of market failure. Findings based on asymmetric price transmission may allow a researcher to make some inferences about the behaviour of agents in the market, particularly as their actions impact on links across different market levels (Goodwin and Schroeder, 1991). Vavra and Barry (2005) also hinted that, the speed with which markets adjust to shocks is determined by the actions of market agents who are involved in the transactions that link market levels. Whereas, Ben- Kaabia and Gil (2007) also observed that, market power in downstream sectors may affect price transmission by depressing purchasing prices in upstream sectors below the level of a perfectly functioning market, and/or deter entry or foster exit. On the other hand, symmetric price adjustment has been noted to helps optimized resource use; increase farm incomes; signal the degree of competitiveness, widen commodity markets and encourage value addition as well as create employment (Sexton *et al.,* 1991, Acquah and Rebecca 2012 and Akpan *et al.,* 2014b).

Several researchers have reported symmetric price transmission in agricultural commodities (Akpan *et al* 2014a, Akpan et al 2014b and Akpan et al 2014c) and also asymmetric price transmission (Ben-Kaabia and Gil (2007) in various locations. As noted by Ben-Kaabia and Gil (2007), this result could leads to a general conclusion that the presence of symmetric or asymmetric price transmission in agricultural commodity is conditional on local circumstances. This means that, agricultural price transmission should be investigated on the theoretical frameworks of symmetric and asymmetric adjustment. It is believed that, this will produce sound economic policies that are anchored on reality and practicable scenarios and not on theoretical predictions. This is why this study attempt to provide answer to the nature of price adjustment between the rural price and the downstream prices of palm oil, palm kernel, groundnut oil and shell groundnut in one of the coastal states in Nigeria. The findings provided fundamental framework on how policy on food marketing should be implemented in the region taking into cognizance the issues of symmetric and asymmetric adjustments in prices. It also gives first-hand information on the performance evaluation of the sub sector in the region. In order to provide this fundamental information, the study specifically established the nature of rural price adjustment in palm oil, palm kernel, groundnut oil and shell groundnut in relation to their respective urban prices in the Southern region of Nigeria.

METHODOLOGY

Study Area and Data Source

The study was carried out in the South-South region of Nigeria. Time series data were used and were collected in Akwa Ibom State; one of the states in the region. The state was picked for this study because of its peaceful disposition and also being one of the major producers of palm oil and palm kernel in Nigeria. The state has well organized statistical office that collates and store daily data on food prices. The State is located between latitudes 4°32' and 5°33' north and longitudes 7°25' and 8°25' east. It has a total land area of areas of 7,246km^2. It is bordered on the east by Cross River State, on the west by Rivers State and Abia State, and on the South by the Atlantic Ocean. Akwa Ibom State has a population of 3,902,051 (National Population Commission (NPC), 2006). More than 80% of the State population is involved in agricultural activities.

Source and Duration of Data

Secondary data were used in the analysis. The data were obtained from the publications of the Akwa Ibom State Agricultural Development Programme reports (AKADEP). It consisted of the average monthly prices (measured in naira per kilogram) of oil palm, Palm Kernel oil, and groundnut oil as well as shell groundnut in both rural and urban markets in Akwa Ibom State. The study covers the period from January 2004 to June 2015. A total of 138 months of urban and rural prices of oil based commodities were used in the study.

Analytical Techniques

The study applied Engle-Granger (1987) and Enders and Siklos (2001) cointegration methodologies to analyze the nature of price movement and adjustment between the rural and urban prices of the oil based commodities used in the study.

Stationarity Analysis of Variables used in the study

Augmented Dickey-Fuller (ADF) test

Stationarity in time series is needed to avoid the incidence of spurious regression. It is therefore necessary to convert non- stationary series to stationarity status in order to obtain reliable regression estimates. According to Kennedy (1996), a variable is integrated of order d, *I(d),* if it has to be differenced *d* times to become stationary. In order to apply the models specified, this study applies the Augmented Dickey- Fuller (ADF) test to first examine the stationarity characteristics of the series. **As suggested by** Dickey and Fuller (1981), equation (1) is used to test the stationarity of price series

$$\Delta X_t = \alpha_0 + \alpha_{1t} + \alpha_2 X_{t-1} + \sum_{i=1}^{k} \delta \Delta X_{t-i} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where X represents variables to be tested, represents the first difference operator; *t* is

the time drift; *k* represents the number of lags used and is the error term, which is assumed to be normally and identically distributed with constant means and variance;' and are the model bounds. It is a one-sided test whose null hypothesis is versus the alternative <0.

Test for Engle Granger Symmetric and Enders and Siklos Asymmetric co-integrations between Rural and Urban prices of Palm Oil, Palm Kernel Oil and Groundnut oil as well as shell groundnut

The concept of co- integration as developed by Granger (1981) involved the determination of the long-run associations among non-stationary time series. If two markets are co-integrated in Engle Granger methodology, then there exists an equilibrium long run relationship with underlying symmetric adjustment between them (Goodwin and Schroeder 1991; Gonzalez-Rivera and Helfand, 2001). The study firstly applied the Engle and Granger two-step technique to examine the co-integration relationship between the rural and urban *prices of commodities used in the study*. For instance, the time dependent price equation of i[th] commodity is specified as follows:

$$LnP_{rt} = \gamma_0 + \gamma_1 \sum_{t=1}^{n} LnP_{ut} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$RPO_t = Producer\ price\ of\ palm\ oil\ in\ rural\ market\ (naira\ per\ Kg)$

$UPO_t = Retail\ price\ of\ palm\ oil\ in\ urban\ market\ (Naira\ per\ Kg)$

$RKO_t = Producer\ price\ of\ palm\ kernel\ in\ rural\ market\ (Naira\ per\ Kg)$

$UKO_t = Retail\ price\ of\ palm\ kernel\ in\ urban\ market\ (Naira\ per\ Kg)$

$RGO_t = Price\ of\ groundnut\ oil\ in\ the\ rural\ market\ (Naira\ per\ Kg)$

$UGO_t = Price\ of\ groundnut\ oil\ in\ the\ urban\ market\ (Naira\ per\ Kg)$

$RSO_t = Price\ of\ shell\ groundnut\ in\ the\ rural\ market\ (Naira\ per\ Kg)$

Poss$USO_t = Price\ of\ shell\ groundnut\ in\ the\ urban\ market\ (Naira\ per\ Kg)$er of integration of the residual from equation 2, using the Augmented Dicker-Fuller test as describe below:

$$\Delta\varepsilon_t = \rho\varepsilon_{t-1} + v_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Following the Granger Representation Theorem, we specified the Engle Granger error correction model (ECM) model for the co-integrating series in the study with underlying symmetric adjustment in the long run. The general specification of the error correction model (ECM) specified for i[th] crop in the study area is shown below:

$$\Delta \text{LnP}_{rt} = \gamma_0 + \gamma_1 \sum_{i=1}^{n} \Delta LnP_{rt-1} + \gamma_2 \sum_{i=1}^{n} \Delta \text{LnP}_{ut-i} + \gamma_3 ECM_{t-1} + U_t \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Variables are as defined previously in equation (2), and coefficients (γ) of the ECM_{t-1} ($\gamma < 0$) measures the deviations from the long-run equilibrium in period ($_{t-1}$) in The study applied these methodologies for prices of palm oil, palm kernel, groundnut oil and shell groundnut in the study area. The implicit assumption of symmetric price Adjustment could be problematic if error adjustment in these commodity prices assumed asymmetric pattern. Based on this assertion, Enders and Siklos (2001) argued that the test for cointegration could be wrongly specified and thus proposed a two-regime threshold cointegration approach to entail asymmetric adjustment in the cointegration analysis. The proposed model modifies equation 3, to test for the long run equilibrium that allows for asymmetric adjustment such that:

$$\Delta \varepsilon_t = M_t \rho_1 \varepsilon_{t-1} - (1 - M_t)\rho_2 \varepsilon_{t-1} - \sum_{i=1}^{k} \delta_i \Delta \varepsilon_{t-i} + V_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where ρ_1, ρ_2 and δ_i are coefficients, ε_t is a white noise disturbance, k is the number of lags and M_t is an indicator function such that:

$$M_t = \begin{cases} 1 \text{ if } \varepsilon_{t-1} \geq 0 \\ 0 \text{ if } \varepsilon_{t-1} < 0 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Hence, model consisting of equation 3, 5 and 6 is called threshold autoregressive (TAR) cointegration model. In the modified version, Enders and Granger (1998) and Enders and Siklos (2001) suggested an alternative threshold based on the change in ε_{t-1} in the previous period. They proposed a new indicator function Z_t such that;

$$Z_t = \begin{cases} 1 \text{ if } \Delta\varepsilon_{t-1} \geq 0 \\ 0 \text{ if } \Delta\varepsilon_{t-1} < 0 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Also, model consisting of equation 3, 5 and 7 is called momentum-threshold autoregressive (M-TAR) cointegration model The asymmetric cointegration between the rural price (P_{rt}) and urban price (P_{ut}) using TAR and M-TAR models is determined by testing the null hypothesis of no cointegration.

$H_0: \rho_1 = \rho_2 = 0$ *Enders and Siklos (2001) referred to the* F-statistic of this null hypothesis as Φ and Φ^* in TAR and M-TAR respectively because it has non-standard distribution. They also described Monte Carlo experiments that can be used to test the null hypothesis of no cointegration against the alternative cointegration with threshold (i.e. TAR and M-TAR) adjustment. The asymmetric adjustment is tested when the null hypothesis is rejected. Secondly, in the presence of asymmetric cointegration, the null hypothesis of symmetric adjustment can be examined using a standard F-statistics.

$$H_0: \rho_1 = \rho_2$$

The confirmatory test of asymmetric adjustment of the error correction is indicated when both hypotheses are rejected $(i.e.\ H_0: \rho_1 = \rho_2 = 0\ and\ H_0: \rho_1 = \rho_2)$. when the threshold cointegration is found, the transmission are tested using the threshold error correction model.

$$\Delta P_{rt} = \delta_0 - \theta_{11} M_t \varepsilon_{t-1} - \theta_{12}(1 - M_t)\varepsilon_{t-1} \sum_{i=1}^{k} \delta_{1i} \Delta P_{rt-i} - \sum_{i=1}^{k} \delta_{2i} \Delta P_{ut-i} - \xi_{1t} \ldots\ldots\ldots\ldots (8)$$

and,

$$\Delta P_{ut} = \beta_0 - \theta_{21} M_t \varepsilon_{t-1} - \theta_{22}(1 - M_t)\varepsilon_{t-1} \sum_{i=1}^{k} \beta_{1i} \Delta P_{rt-i} - \sum_{i=1}^{k} \beta_{2i} \Delta P_{ut-i} - \xi_{2t} \ldots\ldots\ldots\ldots (9)$$

Where θ_{11} and θ_{12} represent the speed of adjustment coefficient of ΔP_{rt} if P_{rt-1} is above and below its long run equilibrium respectively. Also, θ_{21} and θ_{22} represent the speed of adjustment coefficients of ΔP_{ut} of the two regimes respectively. Note; the entire processes were performed on prices of palm oil, palm kernel, groundnut oil and shell groundnut in the study area.

RESULTS AND DISCUSSION

To ascertain the stationarity of variables specified in the model, the standard Augmented Dickey Fuller test was performed. Test statistics for each price variable at level and first difference are presented in Table 1. The result of the ADF unit root test showed that, price series were non-stationary at levels but stationary at first difference for ADF equation without constant and trend. However, the result was mixed for ADF equation that contains constant only. For certainty and high precision of estimates, it was considered that, price variables specified were non stationary at level but stationary at first difference. Following the result of the unit root tests, equations specified in the study cannot be analyzed at the level of variables without the risk of obtaining spurious regression. Hence, the result implies that, series should be tested for co-integration and possible error correction mechanism.

Table 1: Result of ADF unit root test for price variables used in the analysis

Logged Variables	ADF Test No Constant and Trend Lag	Level	1st diff.	OT	ADF Test Constant only Lag	Level	1st diff.	OT
RPO	0	-0.152	-12.466***	1(1)	0	-2.773	-12.412***	1(1)
UPO	0	0.046	-13.209***	1(1)	0	-3.242	-13.154***	1(1)
RGO	0	-0.201	-12.636***	1(1)	0	-2.753	-12.573***	1(1)
UGO	0	0.645	-11.695***	1(1)	0	-2.771	-11.638***	1(1)
RSO	0	1.422	-16.677***	1(1)	0	-3.626***	-	1(0)
USO	0	1.468	-19.057***	1(1)	0	-4.589***	-	1(0)
RKO	0	0.593	-17.083***	1(1)	0	-5.753***	-	1(0)
UKO	0	0.533	-20.956***	1(1)	0	-5.747***	-	1(0)
1% critical value		**-2.582**	**-2.582**			**-3.479**	**-3.479**	

Note: OT means order of integration. Critical value (CV) is defined at 1% significant level for ADF. Asterisks ** represents 1% significance level. Variables are expressed in logarithm and as previously defined in equation 2.

Descriptive Analysis of Prices

The descriptive statistics of p*alm oil, palm kernel oil, groundnut oil and shell groundnut prices used* in the analysis is shown in Table 2 and Table 3. The result showed that, the average price of palm oil in the rural and urban markets was N209.49/kg and N213.88/kg respectively. The same trend was obtainable in palm kernel oil. The data showed clear demarcation of the producer price and consumers' prices as well as the cost of transportation. The state is a major palm oil producing state; hence the distributive market is the rural market. The rural market price therefore represents the producer price of these commodities. The price volatility in palm oil is higher in rural (0.281) market compared to urban (0.278) market. Contrary to what is obtained in palm oil price, the volatility in urban price of palm kernel oil (0.386) is higher than the rural (0.357) market. The average price of groundnut oil in the urban market (N288.78/Kg) is higher than the same price in the rural market (N292.39/Kg). The same observation is also applied to the price of shell groundnut.

Table 2: Descriptive statistic of price variables used in the Study

Item	Rural price of Palm oil (RPO) (₦/Kg)	Urban price of Palm Oil (UPO) (₦/Kg)	Rural Price of Groundnut Oil (RGO) (₦/Kg)	Urban price of Groundnut Oil (UGO) (₦/Kg)
Mean	209.49	213.88	292.39	288.78
Median	205.27	213.01	294.44	289.91
Minimum	100.00	100.00	134.00	120.00
Maximum	376.77	381.71	379.98	394.71
Std. deviation	58.86	59.48	62.71	64.58
Coeff. of Variation	0.281	0.278	0.214	0.224
Skewness	0.197	0.199	-0.317	-0.265

Note: Computed by authors, and prices are expressed in nominal terms.

The possible reason for this result is linked to the fact that, groundnut is not produced in commercial quantity in the State, the bulk of the quantity is brought from other parts of the country. The urban market is the depot or distributive market for these commodities in the State. Also, the coefficients of variability and standard deviation in these commodities exhibited clear marked differences. This also foretells the differences in prices between the two markets.

Table 3: Descriptive statistic of price variables used in the Study

Item	Rural Price of Shell Groundnut (RSO) (₦/Kg)	Urban Price of Shell Groundnut (USO) (₦/Kg)	Rural Price of Palm Kernel Oil (RKO) (₦/Kg)	Urban Price of Palm Kernel Oil (UKO) (₦/Kg)
Mean	186.20	183.27	73.35	76.19
Median	178.38	173.69	69.21	70.53
Minimum	88.49	94.38	33.87	35.52
Maximum	500.00	500.00	200.00	200.00
Std. deviation	71.65	70.89	26.19	29.45
Coeff. of Variation	0.385	0.387	0.357	0.386
Skewness	0.942	1.003	1.475	1.381

Note: Computed by authors, and pricesare expressed in nominal terms

Engle Granger Co-Integration results *for Palm oil, Palm kernel oil, Groundnut oil and Shell Groundnut prices*

The co-integration test result using Engle and Granger two-step technique is presented in the lower portion of Table 4 and Table 5. The order of integration of the residuals generated from the long run equation as specified in equation 2 for each of the four category of commodity's prices were evaluated and were found significant at 1% probability level. Following the EngleGranger two-step co-integration tests, the null hypothesis of no co-integration was rejected for each of the category of commodity equations.The result tentatively implies that, there is a long run symmetric equilibrium relationship between the rural price of p*alm oil, palm kernel oil, groundnut oil and shell groundnut prices a*nd their respective urban prices. The upper part of Table 4 and Table 5 also contain the long run estimates of the rural price equation for each of the commodity used in the analysis.

Table 4: Long run Relationships between Rural and Urban Prices of Palm oil and Palm kernel in Akwa Ibom State

Variables	Rural price of Palm oil (RPO)	Rural price of Palm Kernel oil (UKO)
	Coefficient and t- test	**Coefficient and t test**
Constant	0.1436 (1.055)	0.7010 (4.337)***
Urban Price	0.9689 (37.99)***	0.8289 (21.970)***
Diagnostic Statistics		
R^2	0.9137	0.7801
F-cal	1440.44***	482.47***
DW-Test	1.6935	2.004
Normality test	66.220***	44.370***
RESET test (square)	1.234	3.24,
CUSUM test	4.889***	0.394
Correlation coefficient	0.956(37.953)***	0.883(21.965)***
ADF unit root test for Residuals of above Equations		
Without const.	-9.993***	-11.693***
With const.	-9.956***	-11.649***

Note: Values in bracket represent t-values. The asterisks *, ** and *** represent 10%, 5% and 1% significance levels respectively. Variables are as defined previously in equation 2.

Engle Granger (Symmetric) Error Correction Models for the rural price of palm oil, Palm Kernel, groundnut oil and shell groundnut

The presence of co-integration relationship between the rural price of *palm oil, Palm Kernel, groundnut oil and shell groundnut* and its corresponding urban price demanded the specification of the error correction model. Table 6 and Table 7 contain estimates of ECM generated from equation 4 for all categories of commodity used. The essence was to determine the speed of adjustment of the rural price to exogenous shock generated by the urban price with underlying assumption of symmetric adjustment in the error term.

Table 6: Engle Granger adjust ment mechanism (ECM) for Rural Price of Palm oil and Palm kernel oil

Variable	Rural price of Palm oil	Rural Price of Palm Kernel Oil
Constant	0.0008 (0.127)	-0.0007 (-0.0545)
$LnRural\ Price_{t-1}$	-0.0434 (-0.475)	0.1315 (1.518)
$?LnUPO_t$	0.7821 (18.171)***	-
$?LnUKO_t$	-	0.7621 (15.320)***
$?LnUPO_{t-1}$	-0.3801 (-0.477)	-
$?LnUKO_{t-1}$	-	-0.0472 (-0.577)
ECM_{t-1}	**-0.7317 (-6.730)*** **	**-1.0905 (-9.027)*** **
Diagnostic Statistics		
R^2	0.7320	0.7402
F-Cal	89.473***	93.287***
Normality	77.640***	26.061***
RESET test	30.783***	2.745*
CUSUM Test	0.8611	1.1917

Note: Values in bracket represent t-values. The asterisks *, ** and *** represent 10%, 5% and 1% significance levels respectively. Variables are as defined previously in Table 1.

Table 7: Engle Granger adjustment mechanism (ECM) for Rural Price of Fisheries

Variable	Rural Price of Groundnut Oil (RGO)	Rural Price of Shell Groundnut (RSO)
Constant	1.7985e-05 (0.004)	0.0029 (0.265)
$LnRural\ Price_{t-1}$	-0.0260 (-0.284)	-0.0412 (-0.468)
$?\text{Ln}UGO_t$	0.8672 (23.230)***	-
$?\text{Ln}USO_t$	-	0.7162 (15.980)***
$?\text{Ln}UGO_{t-1}$	-0.0039 (-0.046)	-
$?\text{Ln}USO_{t-1}$	-	-0.0399 (-0.509)
ECM_{t-1}	**-0.9842 (-7.632)*** **	**-0.6995 (-6.565)*** **
Diagnostic Statistics		
R^2	0.8233	0.7243
F-Cal	152.613***	86.0223***
Normality	60.852***	36.488***
RESET test	6.842***	0.1550

Note: Values in bracket represent t-values. The asterisks *, ** and *** represent 10%, 5% and 1% significance levels respectively. Variables are as defined previously in Table 1.

The result presented in Table 6 and Table 7 validates the existence of the long-run symmetric equilibrium relationships between the rural price of *palm oil, groundnut oil and shell groundnut* and their respective urban price. The error correction (ECM) coefficient for palm kernel is outside the theoretical limits of zero and unity. The estimated coefficient connotes an explosive ECM and hence does not represent stability position in the long run. For *palm oil, groundnut oil and shell groundnut, the* slope coefficient of the error correction term is correctly signed and significant and lies within the theoretical specification. This represents the speed of adjustment of the rural price in the long run. In other words, the ECM slope coefficient is consistent with the hypothesis of convergence towards the long-run equilibrium once the rural price equation is disturbed. The result showed that, disequilibrium in the rural price of *palm oil, groundnut oil and shell groundnut* in the short run; would be corrected in the long run. The significant nature of the Engle Granger error term implies that, the urban price of *palm oil, groundnut oil and shell groundnut* will always react to bring stability in the rural price whenever it experienced significant variation.

The value of the coefficient of the Engle -Granger error correction term in the rural price equation of *palm oil* implies that, about 72.20% of the symmetric adjustment in the rural price takes place in a month due to exogenous shock induced by its urban price. Similarly, 98.40% and 69.90% of symmetric long run adjustments occur monthly in the rural price of groundnut oil and shell groundnut respectively. These results confirmed the long and short runs market integration between the rural price of *palm oil, groundnut oil and shell groundnut* and their respective urban price with assumption that, the error

adjustment is linear and symmetric in nature. In summary, it is obvious that the co-integrated character of the rural price of these commodities is evident, so they are linked by a relationship of long-term equilibrium. This means that a deviation of the rural price from a steady state triggers a process of self-balancing for a return to equilibrium in the long run. This connotes interdependence or market integration of the two markets.

Several authors (McNew and Fackler, 1997; Balke and Fomby, 1997, Enders and Siklos, 2001 and Barrett and Li, 2002) have criticized the Engle Granger methodology on the assumption that, the adjustment of the error term in the long run might not follow the fundamental hypothesis embedded in the methodology. Non linearity in price relationships are inevitably due to arbitrage activity, unsynchronized price cycles, discontinuous trade and non-stationary transfer costs among others. According to George *et al.*, 2004 and Blay *et al.*, 2015, these marketing activities are capable of rendering linear and symmetric assumptions of the normal cointegration and ECM inaccurate

Enders and Siklos (Asymmetric) Cointegration Models for rural Price of Palm oil, Palm kernel oil, Groundnut oil and Shell Groundnut

By implication, the Engle Granger results discussed earlier might be wrongly specified if the error terms generated from the price relationship have underlying asymmetric adjustments. To confirm the true nature of error adjustment, Enders-Siklos asymmetric cointegration test was conducted. The result is presented in Table 8. The result reveals that the null hypothesis of no asymmetric cointegration between the rural and urban prices of p*alm oil, palm kernel oil, groundnut oil and shell groundnut*were not rejected. This result suggests that, the Engle Granger cointegration specification is appropriate for the rural prices of palm oil, groundnut oil and shell groundnut respectively in the study area. The result connotes that, the long run relationship between the rural and urban prices of p*alm oil, groundnut oil and shell groundnut can* be described as symmetric. This means that the long run relationship in these commodities assumed a linear relationship.

Table 8: Enders-Siklos asymmetric Cointegration test for the Rural Price of oil crop and its corresponding urban Price

Variables	$H_0: \rho_1 = \rho_2 = 0$ $t_{Max.}$	TAR Φ	K	M-TAR Φ^*	$t_{Max.}$	K	$H_0: \rho_1 = \rho_2$ TAR: F-test	M-TAR: F-test
Model 1 — RPO	-5.073*	29.184*	1	29.006*	-5.589*	1	0.303	0.055
Model 2 — UGO	-5.995*	28.075*	2	28.154*	-5.969*	2	0.063	0.173
Model 3 — USO	-3.527*	8.858*	4	9.039*	-3.490*	4	0.064	0.381
Model 4 — UKO	-4.642*	12.758*	4	12.735*	-4.544*	4	0.043	0.003

Note: Monte Carlos stimulated critical value at 10% was used. Asterisk * means significant at 10% level. Threshold value (tau) = 0. K was determined by AIC.

Discussion of the Long and Short runs Results and its implication for policy making

The estimated results revealed that, the rural price of Palm oil, Palm kernel oil, Groundnut oil and Shell Groundnut and their respective urban price have long run relationships with varying degrees of symmetric error adjustment. The long run or cointegration coefficient in prices of palm oil price (0.97), palm kernel oil (0.83), groundnut oil (0.93) and groundnut shell (0.93) were significant but did not perfectly converged to the law of one price. These results suggest that in the long run the rural price of palm oil, palm kernel oil, groundnut oil and shell groundnut prices have varied degrees of interdependency. For instance, the result has shown that the rural price of palm oil has positive and strong long run market integration relationship with the urban price. This implies that, changes in the rural market price of oil palm will be transmitted immediately to urban market price. Similarly, about 83% and 93% of long run price shock relationship existed in palm kernel and groundnut oil market prices respectively. This implies that the speed at which price shock of oil based crops synchronize among markets in the region is high. Empirically it connotes that, for every 10% increase in the urban price of palm oil, palm kernel oil, groundnut oil and shell groundnut; about 9.7%, 8.3%, 9.3% and 9.3% increase in their respective rural price will occur. This further revealed inelastic relationship in rural urban price transmission among oil based crops in the region, signifying that, price change in urban or downstream market is greater than equivalent change in the source or rural market.

The bilateral Pearson coefficient of correlation also confirms a strong and positive relationship between the rural and urban prices in palm oil, palm kernel oil, groundnut oil and shell groundnut in the region. This indicates strong market integration between the rural and urban prices of these commodities. For instance, palm oil price transmission revealed correlation coefficient of 0.956 which suggests high degree of positive co-movement between the rural and the downstream price. Similarly, palm kernel oil, groundnut oil and groundnut shell exhibited positive correlation coefficients of 0.883, 0.974 and 0.925 respectively.

The short run model (ECM) also revealed a strong and positive inter-relationship between the rural and urban price of palm oil, groundnut oil and shell groundnut in the study area. These results suggest thatin the short run prices of palm oil, groundnut oil and shell groundnut in the rural market responded positively to change in their respective urban prices. In addition, results in the short run revealed inelastic price relationship, which supported the earlier results for the long run relationship. This means that, changes in the downstream prices of these commodities are greater than equivalent change in their respective rural price. The combined result of the short and long run models indicated that the urban price of palm oil, groundnut oil and shell groundnut do not have perfect deterministic characteristic on their respective upstream prices in the study area.

The short and long run price transmission results in these agricultural commodities have some economic and policy insinuations. From the theoretical perspective, the existence of symmetric price transmission implies lower arbitrage activities in the marketing chain of these commodities. It also reflected lower transportation costs associated with the marketing and smooth or non-dominating marketing intermediaries in the chain. In the process of policy making it implies that interventions at the rural markets will have positive, immediate and sustainable impact (*citeris paribus*) on the urban market. The result has shown evidence of fast and positive synchronization of the downstream price with the rural price when there is significant disturbance in the chain.

CONCLUSION

The findings have shown that the rural price of palm oil, groundnut oil and shell groundnut followed symmetric adjustment with respect to shock in their respective urban prices. Though the price relationship was significant and positive in palm kernel, but there was no evidence of long run stable relationship in the study area. The degree of linear correlation further confirms a strong and positive relationship between rural and downstream prices in palm oil, groundnut oil and shell groundnut. This result indicates remarkable improvement in marketing infrastructures and services in regards to these agricultural commodities in the region. This result also calls for a broad policy package that should strive to consolidate on the existing marketing infrastructures in the region. Also, government of the region should check and moderate the activities of market unions in order to further reduce activities of intermediary agents in the marketing chain. It is also recommended that governments of the region should established market information centers and awareness programmes on mass media (such as radio, television and newspaper), to further facilitate efficient communication among markets and marketing agents in the region.

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