Horizontal Price Transmission in Ghana: - An Asymmetric Error Correction Model (AECM).

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Abstract

The objective of this paper is to (i) Examine the statistical relationship between world food prices and domestic food prices in Ghana. (ii) Investigate how price transmission changes before and during the Planting for Food and Jobs programme. To ensure self-sufficiency in food production and to reduce the vulnerability of Agricultural commodity price volatilities, the government of Ghana introduced the flagship programme the Planting for Food and Jobs (PFJ) programme in 2017, to revamp the declining growth of the agricultural sector in Ghana. Using Asymmetric Error Correction Model (AECM), we employed monthly time series data of World and local retail market prices of Maize and Rice (local and import) from the World bank source and the Statistics, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture in Ghana for the period 01st January, 2009 to 31st, December 2019. Our empirical findings revealed a heterogeneous long run causality with respect to positive and negative shocks. We experienced a long run relationship among local and world rice prices in the period before the PFJ, while the times series in the period during PFJ are much more interconnected and we find three cointegration relationships. Maize prices were not cointegrated in the period before PFJ, but in the period during PFJ we observed one long run relationship between local and world maize prices. Ghana as a price taker in the global trade has limited policy instruments to respond to the global food price volatilities. The main policy advice is to increase budgetary support to PFJ in order to improve the programme and increase productivity of agriculture in Ghana.

Key words: Agro-commodities, Price Transmission, World prices, Local prices, times series and cointegration.

JEL classification: C32, Q02, Q10, Q11, Q17, Q18

1. Introduction

The interest of policy makers to associate prices changes and transmission process from world to domestic Agricultural markets has recently provoked large body of research globally (Braha et al 2015): (Minot 2010): (Amikuzunu et al 2013), (Abdulai. 2000). In Sub Saharan Africa the dramatic rise in agricultural price volatilities have forced many Agro-commodity exporting countries governments to responded to rising food prices by adopting or strengthening specific policy measures (Tangermann, 2011), such as the Block farm concept and Planting for food and Jobs programme (Rantšo & Seboka 2019) and (Tanko et al 2019) in order to keep prices low within domestic food markets. Food commodities have a dominant position on the structure of imports in Ghana since independence in 1957. Ghana still imports about 70% and 15% respectively of rice and maize consumed (Darfour et al 2016). To ensure self-sufficiency in food production and keep prices of Agricultural commodities low the government of Ghana in 2017 implemented the Planting for Food and Jobs (PFJ), a flagship policy in the agricultural sector with the main goal of addressing the declining growth of agriculture in Ghana by modernising the agriculture sector to lead structural transformation of the national economy through food security, employment opportunities and reduced poverty (Esoko 2015-2019) report. According to (Tanko et al 2019) the policy is focused on increasing food production and ensuring food security in the country as well as reducing the food import bills to the barest minimum. The project consists of five significant pillars; supply of improved seeds to farmers at subsidised prices (50% subsidy), supply of fertiliser at subsidised prices (50% price cut out), free extension services to farmers, marketing opportunities for produce after harvest, and E-Agriculture-a technological platform to monitor and track activities and progress of farmers through a database system (PFJ, 2017). The five main crops selected are Maize, Rice, Soybeans, Sorghum and Vegetables including tomato, onion and Chili pepper in line with priority crops as proposed in Food and Agriculture Sector Development Policy II (FASDEP II) and its investment programme, the Medium-Term Agricultural Sector Investment Plan (METASIP) (PFJ, 2017).

PFJ seeks to motivate and encourage farmers to adopt certified seeds and fertilisers through a private sector-led marketing framework, by raising the incentives and complimentary service provisions on the usage of inputs, good agronomic practices, and marketing of outputs over an E-Agriculture platform (PFJ, 2017). The PFJ programme empower the beneficiaries with knowledge and skills on maximising the benefits of the usage of subsidised inputs like fertiliser through proximity extension services (MOFA, 2017). The outcome of the PFJ programme is measurable in terms of increased productivity, Agricultural income, and the trickle-down effect on consumption expenditure, among other variables. The development of the agriculture sector is a priority to the government of Ghana (FAO, 2015). In rising up to this challenge, the government of Ghana proposed an average annual budget of GH¢ 765 million (or US$ 160 million) to support the Planting for Food and Jobs (PFJ) policy. These interventions, however, raise serious concerns about their actual direct effects in terms of lowering Agricultural commodity prices across agricultural markets. Therefore, the objective of this paper is to (i) Examine the statistical relationship between world food prices and domestic food prices in Ghana. (ii) Investigate how price transmission changes before and during the Planting for Food and Jobs programme.

The paper is organized as follows: Section 1 provides a descriptive background into the studied topic, Materials and Methods are presented in section 2, Section 3 presents the empirical results and discussion, Concluding remarks are presented in Section 4 of the paper.

1.1. Previous studies on Price Transmission

Horizontal price transmission means the linkage occurring among different markets at the same position in the supply chain. The notion of horizontal price transmission usually refers to price linkages across market places ie. spatial price transmission, however, it can also concern the transmission across different agricultural commodities Markets. (Listorti 2012)

In recent times research on price transmission has been motivated largely due to the belief that co-movement of prices in different markets can be interpreted as a sign of efficient and competitive markets, while absence of co-movement is an indication of market failures. There is a relatively large number of studies that have sought to examine the degree of price transmission between markets within a country (see Rashid, 2004; Meyers, 2008; Negassa and Meyers, 2007and Moser et al, 2009).

Early studies of price transmission used simple correlation coefficients of contemporaneous prices. (Mundlak and Larson 1992) estimate the transmission of world food prices to domestic prices in 58 countries using annual price data from the FAO. Their findings revealed a very high rates of price transmission: the median elasticity of transmission was 0.95, implying that 95% of any change in world markets was transmitted to domestic markets.

Around the 1980s, researchers became aware of the problem of non-stationarity. Standard regression analysis assumes that the mean and variance of the variables are constant over time. This signifies that the variable seeks to return toward its mean value, so the best estimate of the future value of a variable is its mean value. However, in the analysis of time-series data, prices including many other variables are often non-stationary, denoting that they move randomly instead of attempting to return to a mean value. One implication of this random walk behavior is that, the best estimate of the future price is the current price. When standard regression analysis is performed with non-stationary variables, the estimated coefficients are unbiased but the distribution of the error is non-normal, so the usual tests of statistical significance are invalid. As a matter of fact, with samples large enough, any pair of non-stationary variables would appear to have a statistically significant relationship, even if they are actually not related to each other (Granger and Newbold, 1974; Phillips, 1987).

(Conforti 2004) explored price transmission in 16 countries, including three in sub-Saharan Africa, using the error correction model. found in Ethiopia statistically significant long-run relationships between international and local prices in four out of the seven cases, including retail prices of maize, sorghum and wheat. In Ghana, there was a long-run relationship between world and local wheat prices, but no such relationship for maize and sorghum. And in Senegal, he found a long-run relationship in the case of rice, but not maize. Generally, the degree of price transmission in the sub-Saharan African countries was less than in the Latin American and Asian countries. This current study attempt to use the error correction model to analyse the rate of price transmission before and after the planting for food and jobs policy intervention initiated by the Government of Ghana.

2. Materials and Methods

2.1. Methodology

We apply time-series modeling techniques to evaluate horizontal price transmission from world market to local markets in Ghana and vice versa. As the first step, we test the stationarity of time series the augmented Dickey-Fuller (ADF) unit root test. The number of lags of a dependent variable is determined by the Akaike Information Criterion (AIC). If both time series are not stationary, they are suitable to test for cointegration relationship between them. We employ the Johansen approach to test for cointegration.

The Johansen approach starts with a vector autoregressive model and reformulates it into a vector error correction model:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + \varepsilon_t \qquad \textbf{(1)}$$

$$\Delta Z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + \Pi Z_{t-k} + \varepsilon_t \qquad \textbf{(2)}$$

where Z_t is a vector of non-stationary variables (retail prices), A different matrices of parameters, *t* is time subscript, *k* is the number of lags and ε_t is the error term assumed to follow i.i.d. process with a zero mean and normally distributed N (0, σ2) error structure. The estimates of Γ_i measure the short-run adjustment to changes in the endogenous variables, while *Π* contains information on the long-run cointegrating relationships between variables in the model. We test the adequacy of our VEC model by a series of tests: The Lagrange multiplier test for autocorrelation in the residuals, the Jarque-Berra test for normality of the residuals, and the stability test of the VEC model estimates.

The above cointegration tests assume symmetric price transmission. In order to capture asymmetric movements in the residuals, (Enders and Granger 1998) and (Enders and Siklos 2001) propose to use threshold cointegration approach. Assuming the long run relationship between two nonstationary variables *X and Y*

$$\mathrm{Y_t} = \lambda_0+\lambda_1 X_t+\mu_t \ldots\ldots(3)$$

Where *μ* is the error term. Engle and Granger (1987) show, that cointegration exists if the null hypothesis *ρ=0* is rejected in:

$$\Delta\mu_t=\rho\mu_{t-1}+\xi_t \ldots\ldots(4)$$

Where ξ is the error term for the residuals. Adjustment of the series of residuals expressed in $\rho\mu_{t-1}$would be symmetric. To capture the assymetry in adjustment process, a two-regime threshold cointegration approach should be used:

$$\Delta\mu_t=l_t\rho_1\mu_{t-1}+(1\text{-}I_t)\rho_2\mu_{t-1}+\xi_t \ldots\ldots(5)$$

Where *It* is the Heaviside indicator *It=1 if μt-1* ≥ *τ* or *It=0 if μt-1 < τ.* If *μt-1* is bigger than the threshold *τ*, then adjustment is at the rate *ρ1.* If *μt-1* is smaller than the threshold *τ,* adjustment is shown in *ρ2*. When *ρ1=ρ2*, then the adjustment process is symmetric. If the null hypothesis *ρ1=ρ2*=0 is rejected, then *X* and *Y* are cointegrated and the following TAR model is estimated:

$$\Delta Y_t=\theta_y+\Sigma_y^+E_{t-1}^+ +\Sigma_y^-E_{t-1}^- +\Sigma_{j=1}^{j}\alpha_{yj}^+\Delta Y_{t-j}^+ +\Sigma_{j=1}^{j}\alpha_{yj}^-\Delta Y_{t-j}^- +\Sigma_{j=1}^{j}\beta_{yj}^+\Delta X_{t-j}^+ +\Sigma_{j=1}^{j}\beta_{yj}^-\Delta X_{t-j}^- +\mathrm{U}_{yt}\ldots(6)$$

Where *ΔYt* and *ΔXt* are dependent and independent variables in their first differences, *E* is the error correction term, δ represents the speed of adjustment coefficients of *ΔYt* if *Yt-1* is above and below its long-run equilibrium, *θ, δ, α* and *β* are coefficients and *υ* is the error term, *t* is time subscript and *j* is the number of lags. Two error correction terms are defined as:

$$E_{t-1}^+=I_t\mu_{t-1} \ldots\ldots(7)$$

$$E_{t-1}^-=(1\text{-}I_t)\mu_{t-1} \ldots\ldots(8)$$

(Enders and Granger 1998) and (Enders and Siklos 2001) proposed also a model for cointegration, known as momentum threshold autoregressive model. The term “momentum” describes the rate of acceleration of prices and takes into account steep variations in the residuals; it is especially valuable when the adjustment is believed to exhibit more momentum in one direction than the other. Heaviside Indicator in this case is *It=1 if Δμt-1* ≥ *τ* or *It=0 if Δμt-1 < τ.*

Threshold error correction models were used for example by (Goodwin and Holt 1999); (Goodwin and Harper 2000); (Goodwin and Piggott 2001); (Serra and Goodwin 2003); (Gonzales *et al*. 2003); (Vavra and Goodwin 2005); (Liao and Sun 2011) or (Ning and Sun 2012). (Abdulai 2000) used both TAR and M-TAR models and found out, that the M-TAR models fit data better than the others.

To summarize, four asymmetric models are considered in our study. They are threshold autoregression model with threshold value equal to zero; threshold autoregression model with threshold value estimated (consistent threshold autoregression model); momentum threshold autoregression model with threshold value equal to zero; and consistent momentum threshold autoregression model with threshold value estimated. A model with the lowest AIC and BIC will be used.

2.2. Data

Data used in this analysis is based on monthly observations of retail prices of Maize, Local rice and Imported rice in Agbogbloshie Market (Accra), Kumasi Central Market (Kumasi), Techiman central Market (Techiman), Tamale Aboabo market (Tamale) and Wa central market (Wa) respectively and obtained from the Statistics, Research and Information Directorate (SRID) of the Ministry of Food and Agriculture in Accra, Ghana. The data cover the period from 01st January, 2009 to 31st, December 2019. World market monthly price data of Maize and Rice (Vietnams rice 5%) for the period spanning from January 2009 to December 2019 was obtained from the World bank source and all prices, expressed in Cedis per kilogram.

3. Results and Discussion

3.1. Testing the stationarity of time series:

Table 1. Results of ADF Unit Root Tests on the Monthly Price Series

	Level		1st Diff	
	ADF_c	ADF_t	ADF_c	ADF_t
lnmaize_local_accra	-1.398	-2.634	-8.776***	-8.767***
lnmaize_local_kumasi	-1.579	-2.919	-8.780***	-8.753***
lnmaize_local_techiman	-2.120	-2.854	-9.204***	-9.321***
lnmaize_local_tamale	-1.843	-2.092	-8.466***	-8.542***
lnmaize_local_wa	-1.619	-0.564	-4.937***	-5.080***
lnrice_import_accra	-1.331	-3.219*	-8.390***	-8.352***
lnrice_local_accra	-1.082	-2.027	-9.196***	-9.192***
lnrice_import_techiman	-1.236	-1.306	-7.933***	-7.970***
lnrice_local_techiman	-1.893	-2.105	-5.404***	-5.488***
rice_import_tamale	-2.009	-3.336*	-8.532***	-8.498***
rice_local_tamale	-2.092	-1.813	-8.754***	-8.880***
rice_import_wa	-1.720	0.537	-4.084***	-4.392***
rice_import_kumasi	-1.943	-2.997	-9.071***	-9.060***
rice_local_kumasi	-1.072	-2.559	-8.584***	-8.557***
rice_local_wa	-1.707	0.075	-5.151***	-5.392***
maize_world	-1.559	-2.329	-8.115***	-8.116***
rice_world	0.028	-3.296*	-7.598***	-7.615***

Source: Author's estimation result: Note: ADF_c is the ADF with an intercept and ADF_t with an intercept and a deterministic trend. *, **, *** denote significance at the 1%, 5% and 10% significance levels

The initial step of our empirical approach involves test on stationary of time series using the Augmented Dickey-Fuller (ADF) unit root tests: The results of the unit root tests are presented in Table 1. The results of the Augmented Dickey-Fuller unit root test confirm that all our time series are non-stationary; we stationarized them by taking first differences. The tests indicated that all variables were stationary in first differences. The lags of the dependent variable in the tests were determined by Akaike Information Criterion (AIC). The implication of this finding is that all the price series were generated by similar stochastic processes and can exhibit the tendency toward long-run equilibrium. This result is well supported by earlier findings that food commodity price series are mostly stationary after first-differencing in Ghana and elsewhere (Alexander & Wyeth, 1994; Ogundare, 1999) perhaps owing to the possession by such series of trends arising from price inflation and cyclical variations from season leading to mean non-stationarity.

3.1. Cointegration Test Results

In the second step we tested for the existence of long-run relationship between variables. First we performed the multivariate Johansen cointegration test for two periods, before and after the 30. October 2017. From the results in Table 2, it follows that, there is one long run relationship among local and world rice prices in the first period, while the times series in the second period in Table 3, are much more interconnected and we find three cointegration relationships. The findings imply that similar stochastic processes, possibly induced by efficient information flow, drive the dynamics of prices in the system of markets (Motamed et al. 2008). In this way, world and local prices do not drift apart in the long run.

Table 2. Cointegration Results for rice prices in the period before 30. October 2017.

Johansen tests for cointegration

Trend: constant **Numbers of obs = 102**
Sample: 3-104 **Lags= 2**

maximum rank	parms	LL	eigenvalue	Trace statistics	5% critical value	1% critical value
0	110	852.49695		264.6067	233.13	247.18
1	129	889.67449	0.51760	190.2516*1*5	192.89	204.95
2	146	911.4319	0.34729	146.7368	156.00	168.36
3	161	931.0479	0.31930	107.5048	124.24	133.57
4	174	947.77343	0.27960	74.0538	94.15	103.18
5	185	960.26024	0.21717	49.0801	68.52	76.07
6	194	969.32579	0.16285	30.9491	47.21	54.46
7	201	977.03626	0.14031	15.5281	29.68	35.65
8	206	982.70457	0.10519	4.1915	15.14	20.04
9	209	984.36494	0.03203	0.8707	3.76	6.65
10	210	984.80032	0.00850			

maximum rank	parms	LL	eigenvalue	Max statistics	5% critical value	1% critical value
0	110	852.49695		74.3551	62.81	69.09
1	129	889.67449	0.51760	43.5148	57.12	62.80
2	146	911.4319	0.34729	39.2320	51.42	57.69
3	161	931.0479	0.31930	33.4511	45.28	51.57
4	174	947.77343	0.27960	24.9736	39.37	45.10
5	185	960.26024	0.21717	18.1311	33.46	38.77
6	194	969.32579	0.16285	15.4209	27.07	32.24
7	201	977.03626	0.14031	11.3366	20.97	25.52
8	206	982.70457	0.10519	3.3207	14.07	18.63
9	209	984.36494	0.03203	0.8707	3.76	6.65
10	210	984.80032	0.00850			

Source: *Author's estimation results.*

Table3: Cointegration Results for rice prices in the period after 30. October 2017

Johansen tests for cointegration

Trend: rconstant **Numbers of obs = 27**
Sample: 106-132 **Lags= 1**

maximum rank	parms	LL	eigenvalue	Trace statistics	5% critical value	1% critical value
0	0	284.83769		357.2477	202.92	215.74
1	18	347.37024	0.99027	232.1826	165.58	177.20
2	34	385.27318	o.93965	156.3767	131.70	143.09
3	48	417.89038	0.91073	91.1423*1*5	102.14	111.01
4	60	435.49938	0.72866	55.9243	76.07	84.45
5	70	447.45638	0.58758	32.0103	53.12	60.16
6	78	454.04095	0.38599	18.8412	34.91	41.07
7	84	458.12612	0.26111	10.6708	19.96	24.60

8	88	461.37995	0.21418	4.1632	9.42	12.97
9	90	463.46153	0.14289			

maximum rank	parms	LL	eigenvalue	Max statistics	5% critical value	1% critical value
0	0	284.83769		125.0651	57.42	63.71
1	18	347.37024	0.99027	75.8059	52.00	57.95
2	34	385.27318	o.93965	65.2344	46.45	51.91
3	48	417.89038	0.91073	35.2180	40.30	46.82
4	60	435.49938	0.72866	23.9140	34.40	39.79
5	70	447.45638	0.58758	13.1691	28.18	33.24
6	78	454.04095	0.38599	8.1703	22.00	26.81
7	84	458.12612	0.26111	6.5077	15.67	20.20
8	88	461.37995	0.21418	4.1632	9.24	12.97
9	90	463.46153	0.14289			

***Source**: Authors estimation results.*

The results of the cointegration test for Maize prices in the period before 30. October 2017 show that maize prices were not cointegrated in the first period, in the second period (see Table 4) which is the period after 30. October 2017, we can observe one long run relationship between local and world maize prices. However, the cointegration analysis cannot predict the direction of causality between the price series.

Table 4: Cointegration Results for maize prices in the period before 30. October 2017

Johansen tests for cointegration

Trend: rtrend				**Numbers of obs = 103**		
Sample: 2-104					**Lags= 1**	
maximum rank	parms	LL	eigenvalue	Trace statistics	5% critical value	1% critical value
0	6	602.61939		113.0539*1*5	114.90	124.75
1	18	624.22187	0.34260	69.8489	87.31	96.58
2	28	641.18513	0.28063	35.9224	62.99	70.05
3	36	648.77306	0.13700	20.7466	42.44	48.45
4	42	653.81745	0.09331	10.6578	25.32	30.45
5	46	656.69841	0.05441	4.8959	12.25	16.26
6	48	659.14634	0.04642			

maximum rank	parms	LL	eigenvalue	Max statistics	5% critical value	1% critical value
0	6	602.61939		43.2050	43.97	49.51
1	18	624.22187	0.34260	33.9265	37.52	42.36
2	28	641.18513	0.28063	15.1759	31.46	36.65
3	36	648.77306	0.13700	10.0888	25.54	30.34
4	42	653.81745	0.09331	5.7619	18.96	23.65
5	46	656.69841	0.05441	4.8959	12.52	16.26
6	48	659.14634	0.04642			

Source: Author’s estimation results

Table 5: Cointegration Results for Maize prices in the period after 30. October 2017

Johansen tests for cointegration

Trend: rtrend **Numbers of obs = 103**
Sample: 2-104 **Lags= 1**

maximum rank	parms	LL	eigenvalue	Trace statistics	5% critical value	1% critical value
0	6	602.61939		113.0539*1*5	114.90	124.75
1	18	624.22187	0.34260	69.8489	87.31	96.58
2	28	641.18513	0.28063	35.9224	62.99	70.05
3	36	648.77306	0.13700	20.7466	42.44	48.45
4	42	653.81745	0.09331	10.6578	25.32	30.45
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maximum rank	parms	LL	eigenvalue	Max statistics	5% critical value	1% critical value
0	6	602.61939		43.2050	43.97	49.51
1	18	624.22187	0.34260	33.9265	37.52	42.36
2	28	641.18513	0.28063	15.1759	31.46	36.65
3	36	648.77306	0.13700	10.0888	25.54	30.34
4	42	653.81745	0.09331	5.7619	18.96	23.65
5	46	656.69841	0.05441	4.8959	12.52	16.26
6	48	659.14634	0.04642			

Source: Author’s estimation results.

3.2. Vector Error Correction Model Test results.

The evidence of significant cointegrating relation among the variables however provides an ideal setting for the use of Vector Error Correction Model techniques to identify causal relationships and the nature of price transmission and market integration between the markets. As seen in Table 6, the results of the econometric estimation of the VECM for rice price transmission in the first period in selected markets reveals that, the speeds or magnitudes of price transmission, which measures the response of price shock show varying degrees of price relationships. The coefficient of the prices in the first period are significant and show the expected signs of negative and positive relations respectively. We can observe one cointegrating relationship interconnecting several variables also there is a long run impact of local rice prices in Accra, import rice prices in Techiman, import rice prices in WA, import rice prices in Kumasi and local rice prices in Kumasi on the import rice prices in Accra in the period before PFJ.

Table 6: Cointegrating equations for rice prices in the first period

Equation	Parms	chi2	p>chi2			
_cel	**9**	**95.19607**	**0.0000**			
Identification: beta is exactly identified						
Johansen normalization restriction imposed						
beta	Coef.	Std. Err	z	p>|z|	[95% conf. interval]	
_cel						
Inrice_import_accra	1					
Inrice_local_accra	15.27504	2.941322	5.19	0	9.510157	21.03993
Inrice_import_techiman	-56.7855	6.088769	-9.33	0	-68.7193	-44.8518
Inrice_local_techiman	2.437368	3.033186	0.8	0.422	-3.50757	8.382302

Inrice_import_tamale	-0.28597	1.630382	-0.18	0.861	-3.48146	2.909519
Inrice_local_tamale	-0.92101	2.06876	-0.45	0.656	-4.9757	3.133686
Inrice_import_wa	33.02395	6.931046	4.76	0	19.43935	46.60855
Inrice_import_kumasi	7.590334	2.504165	3.03	0.002	2.682261	12.49841
Inrice_local_kumasi	18.89978	5.197091	3.64	0	8.713672	29.0859
Inrice_local_wa	-3.04514	5.928465	-0.51	0.607	-14.6647	8.574434
_cons	-0.7125					

Source: Author's estimation results

The results of the econometric estimation of the VECM for rice price transmission in the second period in selected markets in Ghana revealed that in the period during PFJ local rice prices in Techiman, import rice prices in Wa, import rice prices in Tamale, import rice prices in Kumasi, local rice prices in Kumasi and local rice price in WA experienced a long run impact see table 7.Agro-commodity prices in Ghana react with different speed to positive and negative deviations, while world prices do not react to shocks in Ghanaian prices.

Table 7. Cointegrating equations model for rice prices in the second period.

Equation	**Parms**	**chi2**	**p>chi2**			
_ce1	**6**	**388.3971**	**0.0000**			
_ce2	**6**	**266.7376**	**0.0000**			
_ce3	**6**	**238.8953**	**0.0000**			
Identification: beta is exactly identified						
Johansen normalization restriction imposed						
beta	Coef.	Std. Err	z	p>|z|	[95% conf. interval]	
_ce1						
Inrice_import_accra	1	.	.	.	.	.
Inrice_import_techiman	0	(omitted)				
Inrice_local_techiman	6.94E-18	.	.	.	.	.
Inrice_import_tamale	-0.00562	0.017818	-0.32	0.752	-0.04054	0.029303
Inrice_local_tamale	-0.00799	0.004911	-1.63	0.104	- ,0176141	0.001637
Inrice_import_wa	0.083386	0.007349	11.55	0	0.068982	0.09779
Inrice_import_kumasi	-0.03477	0.003152	11.03	0	-0.04095	-0.02859
Inrice_local_kumasi	-0.01215	0.005554	-2.19	0.029	-0.02304	-0.00127
Inrice_local_wa	-0.12004	0.008823	- 13.61	0	-0.13733	-0.10275
_cons	-1.4671	.	.	.	.	.
_ce2						
Inrice_import_accra	0	(omitted)				
Inrice_import_techiman	1	.	.	.	.	.
Inrice_local_techiman	0	(omitted)				
Inrice_import_tamale	-3.7973	2.053149	-1.85	0.064	-7.8214	0.226793
Inrice_local_tamale	-0.96485	0.565917	-1.7	0.088	-2.07403	0.144326
Inrice_import_wa	8.478861	0.846832	10.01	0	6.819102	10.13862
Inrice_import_kumasi	-4.03367	0.363192	- 11.11	0	-4.74551	-3.32183
Inrice_local_kumasi	-2.22913	0.640001	-3.48	0	-3.48351	-0.97475

lnrice_local_wa	-10.3707	1.016712	-10.2	0	-12.3634	-8.37793
_cons	17.59119	.	.	.	.	.
_ce3						
lnrice_import_accra	0	(omitted)				
lnrice_import_techiman	0	(omitted)				
lnrice_local_techiman	1	.	.	.	.	.
lnrice_import_tamale	1.330873	0.952287	1.4	0.162	-0.53557	3.19732
lnrice_local_tamale	0.455287	0.262482	1.73	0.083	-0.05917	0.969743
lnrice_import_wa	-2.86053	0.392776	-7.28	0	-3.63036	-2.09071
lnrice_import_kumasi	1.666277	0.168455	9.89	0	1.336112	1.996443
lnrice_local_kumasi	1.418946	0.296844	4.78	0	0.837143	2.000749
lnrice_local_wa	2.331096	0.471569	4.94	0	1.406838	3.255354
_cons	-7.7342	.	.	.	.	.

Source: Author's estimation results.

As presented in Table 9. the results of the econometric estimation of the VECM for maize price transmission in the second period in selected markets revealed that in the period during PFJ maize prices in Kumasi and Tamale experienced a long run impact.

Table 9. Cointegrating equations for maize prices in the second period.

Cointegrating equations						
Equation	**Parms**	**chi2**	**p>chi2**			
_ce1	**5**	**93.62528**	**0.0000**			
Identification: beta is exactly identified						
Johansen normalization restriction imposed						
beta	Coef.	Std. Err	z	p>|z|	[95% conf.	interval]
_ce1						
lnmaize_local_accra	1	.	.	.	.	.
lnmaize_local_kumasi	1.48551	0.242052	6.14	0	1.011096	1.959924
lnmaize_local_techiman	-1.38244	0.389262	-3.55	0	-2.14537	-0.6195
lnmaize_local_tamale	2.671206	0.541286	4.93	0	1.610306	3.732106
lnmaize_local_wa	-0.5308	0.184513	-2.88	0.004	-0.89244	-0.16916
maize_world	-2.85802	0.472212	-6.05	0	-3.78353	-1.9325
_cons	0.51485	0.351353	1.47	0.143	-0.17379	1.203488

Source: Author's estimation results.

3.3. Granger causality test between price series

We tested the causality between price series using Granger causality test. It is important to note that there was no cointegration equation for maize in the first period, because there was no evidence of cointegration relationship detected in the price series. Secondly, some of the variables had to be excluded from the model for rice prices in the second period due to collinearity problems. That is why there are more variables in the first period than in the second period. Granger causality test revealed that the prices series do not have very volatile development which is also depicted in the results.

4. Conclusion

The objective of this paper was to first examine the statistical relationship between world food prices and domestic food prices in Ghana and secondly to investigate how price transmission changes before and during the Planting for Food and Jobs programme. For this purpose, we chose five local regional markets: Accra market, Kumasi market, Techiman Market, Tamale market and Wa market, and three Agricultural commodities namely Maize, Imported rice and Local rice. Selection of commodities reflected their importance connected on local food diet. Analysis consisted of unit root test, cointegration tests, Granger causality tests, estimation of error correction models and test of price transmission asymmetry.

The main findings show that there was one long run relationship among local and world rice prices in the first period, whilst in the second period the times series were very much more interconnected and we find three cointegration relationships. This implies that world and local prices do not drift apart in the long run.

Maize prices were not cointegrated in the first period but in the second period we observed one long run relationship between local and world maize prices. However, the cointegration analysis could not predict the direction of causality between the price series.

Based on the error correction model our Investigations revealed that the speed or magnitudes of price transmission show varying degrees of price relationships. The coefficient of the prices in the first period are significant and show the expected signs of negative and positive relations respectively. We discovered one cointegrating relationship interconnecting several variables. We noticed a long run impact of local rice prices in Accra, import rice prices in Techiman, import rice prices in WA, import rice prices in Kumasi and local rice prices in Kumasi on the import rice prices in Accra in the first period but in the second period local rice prices in Techiman, import rice prices in Wa, import rice prices in Tamale, import rice prices in Kumasi, local rice prices in Kumasi and local rice price in WA experienced a long run impact. Maize price transmission show a long run impact only in Kumasi and Tamale markets in the second period but in the first period the prices in the various markets were not cointegrated. It can be concluded that generally price series do not have very volatile development which is also depicted in main results. The main policy advice is to increase budgetary support to PFJs in order to improve the programme and increase productivity of agriculture in Ghana.

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References

1. Abdulai., 2000. “Spatial price transmission and asymmetry in the Ghanaian maize market.” *Journal of Development Economics* 63: 327–349.
2. Amikuzuno, J., Issahaku, G., and Daadi B., 2013 ‘’Price Transmission between Imported and Local Rice Markets in a Liberalised Economy: Are Ghana’s Rice Wars Just Much I Do About Nothing?’’ Journal of Economics and Sustainable Development, Vol.4, No.20, ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
3. Braha, K., Qineti, A., Cupák, A. and Lazorčáková, E. 2017. “Determinants of Albanian Agricultural Export: The Gravity Model Approach", AGRIS on-line Papers in Economics and Informatics, Vol. 9, No. 2, pp. 3 - 21. ISSN 1804-1930. DOI 10.7160/aol.2017.090201.
4. Conforti, P. 2004. Price Transmission in Selected Agricultural Markets. FAO Commodity and Trade Policy Research Working Paper No. 7, Basic Foodstuffs Service, Commodities, and Trade Division, Food and Agriculture Organization, Rome.
5. Darfour B and Rosentrater K, 2016 ‘’Agriculture and Food Security in Ghana ‘’Paper Number: 162460507, DOI: 10.13031/aim.20162460507
6. FAO. Food and agriculture organisation of the united nations. Country fact sheet on food and agriculture policy trends- march, (2015). Ghana.
7. Gonzales, F., Guillotreau, P., LeGrel, L., and Simonini, M. 2003. Asymmetry of price transmission within the French value chain of seafood products. INRA Working Paper http://netec.mcc.ac.uk/WoPEc/data/Papers/reainrawp49.html
8. Goodwin, B.K. and Harper, D.C. 2000. Price transmission, threshold behavior, and Asymmetric Adjustment in the US pork sector. Journal of Agricultural and Applied Economics, 32: 543-553

9. Goodwin, B. K. and Piggott, N. 2001. Spatial Market Integration in the Presence of Threshold Effects. American Journal of Agricultural Economics, 83: 302-17
10. Granger, C. W. J. and Newbold, P. 1974. Spurious Regressions in Econometrics, Journal of Econometrics 2:111-120
11. Enders, W. and Granger, C.W.J. 1998. Unit-root tests and asymmetric adjustment with an example using the term structure of interest rates. *Journal of Business and Economic Statistics*, 16: 304–311.
12. Enders, W. and Siklos P.L. 2001. Cointegration and threshold adjustment. *Journal of Business and Economic Statistics*, 19 (2): 166–177
13. GLSS6. 2014. Ghana living standard survey round 6 –main report, Ghana statistical service august, 2014. Undp
14. Liao, X. C. and Sun, C. 2011. Asymmetric price transmission in the wood products sector in the Southern United States. In Proceedings of the 2010 Southern Forest Economics Workers Annual Meeting, pp. 14-31.
15. Listorti, G., & Esposti, R. 2012. Horizontal price transmission in agricultural markets: fundamental concepts and open empirical issues. Bio-based and Applied Economics, 1(1), 81-108
16. Meyers, R. 2008. "Evaluating the efficiency of inter-regional trade and storage in Malawi maize markets." Report for the World Bank. Michigan State University, East Lansing, MI.
17. MOFA. Ministry of food and agriculture, Ghana. Agricultural sector progress report 2017. Retrieved from http://mofa.gov.gh/site/wp-pontent /uploads/2018/09/MoFA%202017% 20AGRICULTURAL%20PROGRESS%20REPORT_Final. PPMED.MoFA.pdf
18. Moser, C., C. Barrett, and B. Minten. 2009. "Spatial integration at multiple scales: Rice markets in Madagascar." Agricultural Economics 40: 281–294.
19. Minot, 2010. ''Transmission of World Food Price Changes to African Markets and Its Effect on Household Welfare''. Food Security Collaborative Working Paper No. 58563, Department of Agricultural Food and Resource Economics, Michigan State University.
20. Mundlak, Y., and D. F. Larson. 1992. "On the Transmission of World Agricultural Prices." The World Bank Economic Review 6:399–422.
21. Negassa, A., and R. Myers. 2007. Estimating policy effects on spatial market efficiency: An extension to the parity bounds model. American Journal of Agricultural Economics 89:338–352.
22. Ning, Z. and Sun, C. 2012. Vertial price linkage between timber and forest products pri ces in the South. In S.R. Mehmood, editor, Proceedings of the 2011 Southern Forest Economics Workers (SOFEW) Annual Meeting, Little Rock, AR. 15 pp.
23. PFJ. 2017. Planting for food and jobs strategic plan for implementation (2017–2020) ministry of food and agriculture. Ghana: Republic of Ghana.
24. Phillips, P. C. B. 1987. Time series regression with a unit root. Econometrica 55:277–301.
25. Rantšo & Seboka, 2019''Agriculture and food security in Lesotho: Government sponsored block farming programme in the Berea, Leribe and Maseru Districts''Vol 5: 1657300 doi.org/10.1080/23311932.2019.1657300
26. Rashid, S. 2004. Spatial Integration of Maize Markets in Post-Liberalised Uganda Markets, Trade and Institutions Division (MTID). Accra: IFPRI discussion Paper No. 7L.
27. Serra, T. and Goodwin, B.K., 2003. Price transmission and asymmetric adjustment in the Spanish dairy sector. Applied Economics, 35: 1889-1899.
28. Tanko et al., 2019''planting for Food and Jobs (PFJ): A panacea for productivity and welfare of rice farmers in Northern Ghana Cogent Economics & Finance, Vol 7: 1693121 doi.org/10.1080/23322039.2019.1693121.
29. Tangermann, S. 2011. Policy Solutions to Agricultural Market Volatility: a Synthesis. International Center for Trade and Sustainable Development, Issue Paper No. 33.
30. Vavra, P. and Goodwin, B.K. 2005. Analysis of Price Transmission Along the Food Chain. OECD Food, Agriculture and Fisheries Working Papers, No. 3, OECD Publishing. http://dx.doi.org/10.1787/752335872456