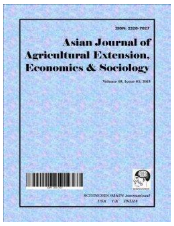

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Estimation of Price Transmission of Food Grains along the Food Grains Supply Chain: A Comparative Approach between Prior and Post Trade Liberalization Era in Tanzanian Context

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Authors' contributions

This work was carried out in collaboration between all authors. Author JC designed the study. Author VN wrote the protocol and supervised the work. Authors JC and SK carried out all laboratories work and performed the statistical analysis. Author JC managed the analyses of the study and wrote the first draft of the manuscript. Author SK managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The empirical paper was undertaken to estimate price transmission of food grains along the food supply chain prior and post trade liberalization era.
Study Design: The paper adopted an observational research design based on time series data set.

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Place and Duration of Study: The empirical paper was conducted in Tanzania Mainland by employing time series data set collected for thirty (30) years period (1981 – 2010).
Methodology: The Error Correction Mechanism (ECM) model was employed to measure the price transmission of producers' and consumers' monthly prices of food grains along the food supply chain. The Ordinary Least Squares (OLS) was employed to estimates the ECM model. Unit root test was carried out by the Dickey-Fuller (DF) technique. The Augmented Engle-Granger (AEG) method was employed to test cointegration. The Serial Correlation Matrix (SCM) was employed to compare price transmission of producers' and consumers' monthly prices of food grains prior and post trade liberalization era (1981 - 1995 and 1996 - 2010) in Tanzanian context.
Results: Empirical results revealed that price transmission of producers' and consumers' monthly prices of food grains were cointegrated from upstream to downstream during prior and post trade liberalization era. The serial correlation matrix results showed that producers' and consumers' monthly prices of food grains were positive correlated during prior and post trade liberalization era.
Conclusion and Policy Implications: According to empirical findings, the study suggested that the price stabilization policies formulated and implemented by the Tanzanian government should focus much more on prices of food grains as the main food staples consumed by the majority of food consumers in rural and urban areas of the country.

Keywords: Error correction mechanism (ECM); serial correlation matrix (SCM); Tanzania.

1. INTRODUCTION

Tanzania's economic recovery efforts started in 1981 with the National Economic Survival Program (NESP) and the structural adjustment program in 1982. This was followed by the first Economic Recovery Program (ERP) which won the first International Monetary Fund standby arrangement in mid1986, and then the second ERP in 1989, also known as the Economic and Social Action Program (ESAP). The macroeconomic policy reforms which were sequenced earliest in combination with structural reforms intensification in the 1990s gave momentum to the high growth rate of the economy; hence, Tanzania has been enjoying since the late 1990s. Policy consistency and political commitment to the reforms were critical factors. However; the irreversibility of these efforts became underpinned by the Tanzania Development Vision (TDV) 2025 (its formulation commenced in 1995), which in effect consolidated the paradigm shift from a state managed economy to a market based economy under private enterprise [1].

However, by the early years of the 1990s, many years of declining per capita incomes had persuaded the Tanzanian authorities as a result they began a cautious liberalization and started to allow greater private sector engagement in economic activities. This commitment was intensified from 1996 with a major International Monetary Fund and World Bank program to which other donors rapidly added their support. The results of this are also evident in sustained real GDP growth from 1996 to 2005; the first time that Tanzania has achieved ten years of uninterrupted growth in the post war years. Independent estimates indicate that about one third of the GDP growth since 1996 has come from agricultural activities as the main source of livelihoods for the majority of the Tanzanian population. Trade and services (tourism) contributed another one third of the total GDP with the balance of growth coming from industry, mining and construction [1].

The trade of agricultural commodities has been in existence prior trade liberalization era in 1980's to early 1990's in Tanzania. However, in this period trade of agricultural commodities has been done by the Tanzanian government. Moreover, in the late 1990's to early 2000's the Tanzanian government adopted the trade liberalization policy by privatizing most of the public companies to private sector. Furthermore, in the late 2000's the Tanzanian government adopted the Public Private Partnership (PPP) policy in the agriculture sector [2]. This policy allowed the local and foreign investors to produce and supply the agricultural products to processing plants with the aim of processing the raw materials into finished products and supply it to consumers. Moreover, through vertical coordination, supermarkets have increased efficiency by sourcing from small scale farmers and food processors. The small scale farmers may also supply either directly to the supermarkets or to food processors that supply to the supermarkets. Both alternatives allow for the inclusion of small scale producers into mainstream of agri-food systems [3].

Price transmission refers to the effect of prices in one market on prices in another market [4]. It can be categorized into two types, namely; spatial and vertical price transmissions. However, this study is focused on vertical price transmission of food grains along the food supply chain during prior and post trade liberalization era in Tanzanian context. However, several studies have been undertaken to estimate price transmission of agricultural products in America, Asia, Europe, and Sub Saharan Africa; these studies include:

Muhammad and Masood [5] Carried out a study on agricultural products prices, money supply, exchange rate, and industrial prices in Pakistan using Vector Error Correction Method (VECM), they pointed out that agricultural prices adjusted faster than industrial prices in the long run due to short run changes in the money supply and exchange rate. [6] Conducted a study on Spatial and vertical price transmission in food staples market chains in Southern and Eastern Africa using Parity Bounds Model (PBM) and Threshold Autoregressive (TAR) model, he pointed out that the prices of maize market are spatial and vertical integrated and the trade liberalization which took place in 1987 has influenced the market integration of the maize markets in southern and eastern part of Africa.

[7-8] Studied on market integration of the maize market in Tanzania and Malawi using a Threshold Autoregressive (TAR) model; they revealed that when the price difference is large, justifying trade between the markets and co-movement of prices, and when the price difference is small, during which no co-movement is expected. [9] Analyzed the behavior of spatial tests asymmetric price transmission using monthly data for seven large cities in the United States fluid milk market by employing Error Correction Model (ECM), they found that farm to retail price transmission process for fluid milk is asymmetric.

[10] Investigated the links between retail and farm gate milk prices, in the UK, Denmark, France and German. The study found that, in the UK, a unit increase in the retail price of liquid milk is fully transmitted to the farm gate price. In German, the study also found that farm gate milk price is transmitted to retail milk prices. In Denmark, no evidence was found of price transmission in any direction at all. In France, farm gate price changes were mostly, but imperfectly, transmitted to retail prices.

However, the empirical study focused on bridging the research knowledge gap between producers and consumers of food grains along the food supply chain prior trade liberalization era (1981 – 1995) and post trade liberalization era (1996 – 2010) in Tanzanian context. Moreover, the empirical study aims to provide future inputs to food producers, traders, consumers, researchers as well as policy makers in Tanzania.

2. METHODOLOGY

2.1 Types of Data

The secondary data on producers' and consumers' monthly prices of food grains (maize, rice, sorghum, wheat and dry beans) were collected from National Bureau of Statistics (NBS), Ministry of Industry, Trade and Marketing (MITM), as well as Ministry of Agriculture, Food Security and Cooperatives (MAFSC) for thirty (30) years period (1981 – 2010) in Tanzania Mainland. The thirty years period was used to capture the broad spectrum of statistical data with the aim of obtaining wide range of variation between producers and consumers monthly prices of food grains along the food supply chain in Tanzania.

2.2 Model Specification

2.2.1 Estimation of price transmission

The estimation of price transmission of food grains from the upstream to downstream was carried out by employing Error Correction Mechanism (ECM) model. The model was estimated by Ordinary Least Squares (OLS). The cointegration test was carried out by employing Augmented Engle-Granger (AEG) method to test for long run linear relationship of producers' and consumers' monthly prices of food grains (maize, rice, sorghum, wheat and dry beans).

2.2.1.1 The error correction mechanism (ECM) model

The empirical analysis adopted in this study follows the Error Correction Mechanism (ECM) model first developed by [11] and popularized by [12]. Furthermore used by [13,14]. This model was employed to measure the price transmission of food grains supply chain from the upstream to downstream in Tanzanian context. However, the model attempted to measure the vertical integration of producers' and consumers' monthly prices of food grains along the food supply chain from the upstream to downstream. The Error Correction Mechanism (ECM) model can be expressed as shown in equation one (1) below:

$$\Delta Y_t = \delta + \psi Y_{t-1} + \mu_t \quad (1)$$

Where:

$$\Delta Y_t = Y_t - Y_{t-1}. \quad (2)$$

ΔY_t = Price change
Y_t = Current price
Y_{t-1} = Lag price (lagged by one period)

ECM is appropriate if two conditions are met:

1. Each variable is nonstationary and integrated to degree 1, written as I (1). This means that the variable follows a random walk, but the first difference (Y_t - Y_{t-1}) is stationary, written as I(0).
2. The variables are cointegrated, meaning that there is a linear combination of the variables that is stationary. Two monthly prices (producer, and consumer prices) were analyzed at a time, so that the cointegrating equation can be depicted as shown in equation three (3) and four (4) below:

$$P_{pt} = \beta_1 + \beta_2 C_{pt} + \mu_t. \quad (3)$$

After Ordinary Least Squares (OLS) estimation of the residual $\hat{\mu}_t$ the equation three (3) above becomes as shown in equation four (4) below.

$$\hat{\mu}_t = \mathrm{P}_{pt} - \hat{\beta}_1 - \hat{\beta}_2 C_{pt} \quad (4)$$

Where:

P_{pt} = Producer price
C_{pt} = Consumer price
$\hat{\beta}_1$, $\hat{\beta}_2$ = OLS parameter estimates
$\hat{\mu}_t$ = OLS residual estimator

2.2.1.2 Unit root test

Unit root test is a univariate test for checking stationarity and non-stationarity of time series data set. The recent literature on unit root has provided a variety of possibilities of detecting stationarity and non-stationarity in observed time series data. The Dickey-Fuller (DF) test can be used for this purpose [15,16]. The DF test is applied to regression runs in equation five (5) below:

$$\Delta Y_t = \delta + \psi Y_{t-1} + \mu_t \quad (5)$$

Where *t* is the time or trend variable, δ is a drift parameter, ψ is a coefficient of Y_{t-1} which implies that (ψ = ρ -1, there is a unit root, if and only if ψ = *0 and* ρ =*1*) and u_t is a white noise error term. More precisely, Yt could be characterized as having a unit root and a random walk with a drift. A random walk is an example of a nonstationary time series, even if δ equals zero.

The next step here is to divide the estimated ψ coefficient by its standard error to compute the Dickey-Fuller tau (τ) statistic and refer to Dickey-Fuller tables to see if the null hypotheses ψ = 0 (there is a unit root). If the computed absolute value of the τ-statistics (i.e., | τ |) is less than the absolute critical values, the time series is considered nonstationary [17]. On the other hand if the computed absolute value of the τ-statistics (i.e., | τ |) is greater than the absolute critical value, the time series is stationary.

2.2.1.3 Cointegration test

Cointegration test is the bivariate / multivariate test for testing the long run linear relationship of price time series data from the upstream to downstream. The Augmented Engle-Granger (AEG) test was employed to test for cointegration of producers' and consumers' monthly prices of food grains. The significance of Error Correction Mechanism (ECM) is modeling cointegrated time series data. According to [12], when variables are cointegrated there exists a valid long term linear relationship between variables involved in the Error Correction Mechanism (ECM) model. The concept of cointegration developed by [18-19], therefore, provides a formal statistical support for the use of Error Correction Mechanism (ECM) model. However, cointegration requires the residual terms of two or more time series to be integrated of order zero, I(0); with *m* time series Y_{t1}... Y_{tm}, each of which is integrated of order one, i.e., I(1).

The Augmented Engle-Granger (AEG) method was undertaken to test for cointegration as expressed in regression equation six (6) below:

$$\Delta\hat{\mu}_t = \eta\hat{\mu}_{t-1} + \nu_t \qquad (6)$$

Where:

$\Delta\hat{\mu}_t$ = Change in OLS residual estimator

$\hat{\mu}_{t-1}$ = OLS residual estimator lagged by one period

η = Coefficient of OLS residual estimator,

ν_t = Error term

Test statistics is a t-ratio test for $\eta = 0$ (the τ-test). If this null hypothesis is not rejected (against the alternative η < 0), then the variables are not cointegrated. If the null hypotheses is rejected, then the conclusion would be that the estimated μ_t is stationary (i.e. does not have a unit root), and, therefore, the time series $Y_{t1},....,Y_{tm}$, despite being individually nonstationary, are cointegrated.

2.2.2 The Serial Correlation Matrix (SCM)

The comparison of price transmission between prior and post trade liberalization era was carried out by employing Serial Correlation Matrix (SCM) of producers' and consumers' monthly prices of food grains (maize, rice, sorghum, wheat and dry beans). However, in order to acquire this objective two periods were considered under the study namely, prior trade liberalization era (1981 – 1995) and post trade liberalization era (1996 – 2010). The Serial Correlation Matrix (SCM) can be expressed as shown in equation seven (7) and eight (8) below:

$$r_1 = \frac{\sum X_1 X_2 - \frac{\sum X_1 \sum X_2}{n}}{\sqrt{\sum X_1^2 - \frac{(\sum X_1)^2}{n}}\sqrt{\sum X_2^2 - \frac{(\sum X_2)^2}{n}}}. \qquad (7)$$

$$r_2 = \frac{\sum X_1 X_2 - \frac{\sum X_1 \sum X_2}{n}}{\sqrt{\sum X_1^2 - \frac{(\sum X_1)^2}{n}}\sqrt{\sum X_2^2 - \frac{(\sum X_2)^2}{n}}}. \qquad (8)$$

Where: r_1 and r_2 = correlation coefficients of producers' and consumers' monthly prices for two periods (prior and post trade liberalization era). X_1, and X_2 = producers' and consumers' monthly prices of food grains; n = number of years. ∑ = summation.

3. RESULTS AND DISCUSSION

3.1 Estimation of Price Transmission

3.1.1 Unit root test

The unit root test was carried out to test for nonstationarity and stationarity of time series data of producers and consumers' monthly prices of food grains (maize, rice, sorghum, wheat and dry beans). The empirical results for nonstationarity and stationarity test of producers and consumers' monthly prices of food grains are presented in Table 1. The producers and consumers' monthly prices of food grains were transformed from nonstationarity to stationarity by first differencing them. Then the Random Walk Model (RWM) with drift was regressed and estimated by using Ordinary Least Squares (OLS). However, slope coefficient (ψ) value was divided to its standard error value to obtain the tau (τ) statistical value (= t-statistic value), then the computed tau value was compared to the critical tau value. The stated null hypothesis was (ψ = 0), given that ψ = ρ -1 such that ρ = 1 indicates unit root which implies nonstationarity of the time series data. Moreover, from the Table 1 the computed absolute tau |τ| statistical value was less than the critical absolute |τ| tau statistical value obtained from the Dickey-Fuller (DF) t-statistic table at 360 numbers of observations and 5% level of significance. Hence, the results failed to reject the null hypothesis and concluded that even though the producers and consumers' monthly prices of food grains were 1st differenced and then regressed; still they were nonstationary at 5% level of significance (Table 1). Similar findings have been reported by [15,16] for estimation of autoregressive time series data with a unit root. They revealed that time series data are non stationary.

3.1.2 Cointegration test of producers' and consumers' monthly prices of food grains

The results revealed that the producers' and consumers' monthly prices time series data were

Table 1. Results for nonstationarity and stationarity test of monthly prices of food grains

Food grain	Price	Variable	Coefficients	Std error	t-statistics	P-value
Maize	1st differenced producer price (∆Yt)	Constant δ1	1.4556	1.1677	1.2465	0.2134
		ψYt-1	-0.0051	0.0084	-0.6082	0.5434
	1st differenced consumer price (∆Yt)	Constant δ1	2.8132	1.9066	1.4755	0.1409
		ψYt-1	-0.0096	0.0091	-1.0504	0.2942
Rice	1st differenced producer price (∆Yt)	Constant δ1	2.5957	2.2943	1.1314	0.2587
		ψYt-1	-0.0001	0.0059	-0.0215	0.9828
	1st differenced consumer price (∆Yt)	Constant δ1	3.3449	2.9625	1.1291	0.2596
		ψYt-1	-0.0010	0.0066	-0.1559	0.8762
Sorghum	1st differenced producer price (∆Yt)	Constant δ1	2.8464	1.7391	1.6367	0.1026
		ψYt-1	-0.0145	0.0099	-1.4678	0.1430
	1st differenced consumer price (∆Yt)	Constant δ1	2.2472	2.4545	0.9155	0.3605
		ψYt-1	0.0006	0.0089	0.0618	0.9507
Wheat	1st differenced producer price (∆Yt)	Constant δ1	2.4629	2.0149	1.2223	0.2224
		ψYt-1	-0.0034	0.0073	-0.4658	0.6416
	1st differenced consumer price (∆Yt)	Constant δ1	5.4001	4.2562	1.2688	0.2054
		ψYt-1	-0.0082	0.0111	-0.7370	0.4616
Dry beans	1st differenced producer price (∆Yt)	Constant δ1	2.3767	2.4376	0.9749	0.3302
		ψYt-1	0.0015	0.0065	0.2321	0.8165
	1st differenced consumer price (∆Yt)	Constant δ1	3.9547	3.3373	1.1849	0.2368
		ψYt-1	-0.0032	0.0077	-0.4106	0.6816

Note that: Critical absolute |τ| tau statistical value is 2.875 obtained from the Dickey-Fuller t-statistic table at 360 numbers of observations and 5% level of significance

cointegrated (symmetric price transmission). The results found that the computed absolute |τ| tau (τ) value was greater than the critical absolute |τ| tau (τ) value, hence; the null hypothesis was rejected and concluded that there was statistically significant cointegration (symmetric price transmission) of time series data at 5% level of significance (Table 2). The empirical results implied that producers' and consumers' monthly prices of food grains were moving in tandem during recession and boom periods; hence, prices were transmitted from the upstream to downstream and vice versa as shown in Figs. 1- 5.

Similar empirical findings have been reported by [6] for spatial and vertical price transmission in food staples market chains in Sothern and Eastern Africa, he revealed that prices of maize market are spatial and vertical integrated. [20] For cointegration of agricultural commodity markets in Tanzania, they argued that regional agricultural commodity markets are integrated. Other similar findings have been reported by [21] for analysis of vertical price transmission of pork meat market in Hungary using Johansen's Maximum Likelihood approach, they pointed out that the retail and farm gate prices in the Hungarian pork meat market move together in the long run, that is they are cointegrated (symmetric) from January 1996 to December 2002 period. Moreover, similar findings have been reported by [22] who examined the price transmission mechanism between consumers and producers in three markets (vegetables, fruits and food) of the Greek economy using Error Correction Model (ECM). They found that in the three markets, the price transmission flows from consumers to producers (downstream to upstream) and vice versa.

Table 2. Cointegration test of producers' and consumers' monthly prices of food grains

Food grains	Variable	Coefficient	Std error	Computed absolute |τ| tau (τ) value	Critical absolute |τ| tau (τ) value	P-value
Maize	$\hat{\mu}_{t-1m}$	-0.1406*	0.0272	5.1727	2.875	0.0001
Rice	$\hat{\mu}_{t-1r}$	-0.1475*	0.0278	5.3282	2.875	0.0001
Sorghum	$\hat{\mu}_{t-1s}$	-0. 1406*	0.0272	5.1727	2.875	0.0001
Wheat	$\hat{\mu}_{t-1w}$	-0. 1410*	0.0275	5.1287	2.875	0.0001
Dry beans	$\hat{\mu}_{t-1b}$	-0. 5121*	0.0462	11.0845	2.875	0.0001

**implies variable coefficients are significant at 5% level of significance. m-maize, r-rice, s-sorghum, w-wheat, b-beans*

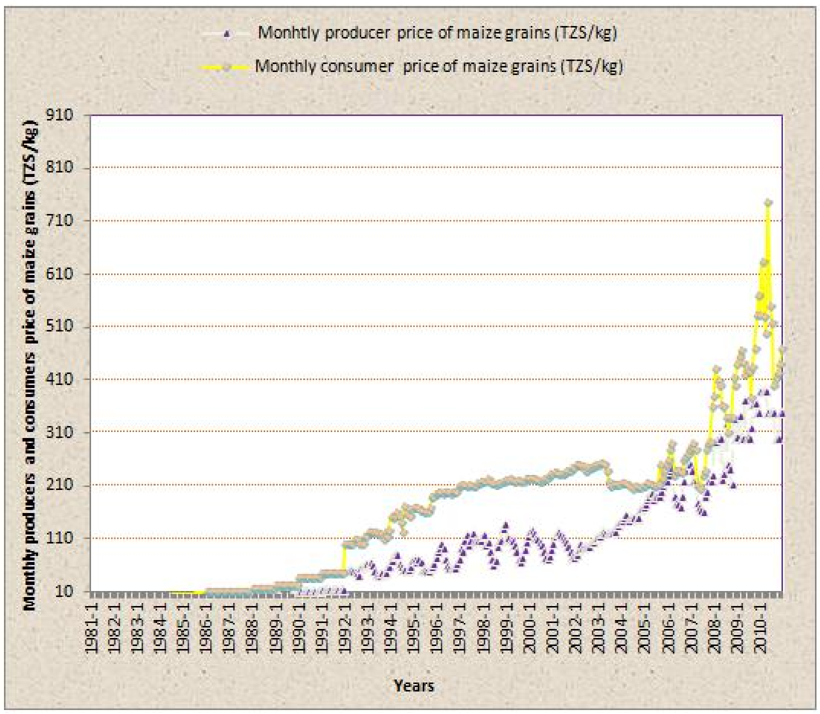

Fig. 1. Tanzania Mainland: Trends of monthly producer and consumer prices of maize grains from 1981 – 2010 (TZS/kg)

3.2 Comparison of Price Transmission of Food Grains between Prior and Post Trade Liberalization Era

The results for comparison of correlation coefficients of food grains price transmission prior and post trade liberalization era are presented in Table 1. The results revealed that price transmission of food grains prior trade liberalization era were positively correlated with correlation coefficients (r) value of dry beans (r= 0.9802), rice (r= 0.9750), maize grains (r = 0.9681), wheat grains (r = 0.9565) and sorghum grains (r = 0.9348) as compared to price transmission of food grains post trade liberalization era which were positively correlated with correlation coefficients (r) value of rice (r = 0.9697), wheat grains (r = 0.9526), dry beans (r = 0.9236), maize grains (r = 0.8667) and sorghum grains (r = 0.8653); respectively (Table 3). The implication of empirical result is that there is no significant difference between producers' and consumers' monthly prices of food grains during prior and post trade liberalization era. The situation was attributed by price stabilization programmes of food grains intervened by

Tanzanian government such as buying food grains during harvesting period through national food agencies such as National Milling Corporation (NMC), Strategic Grain Reserve (SGR) and currently National Food Reserve Agency (NFRA), and sell to consumers during food deficit with the aim of controlling food inflation in the country.

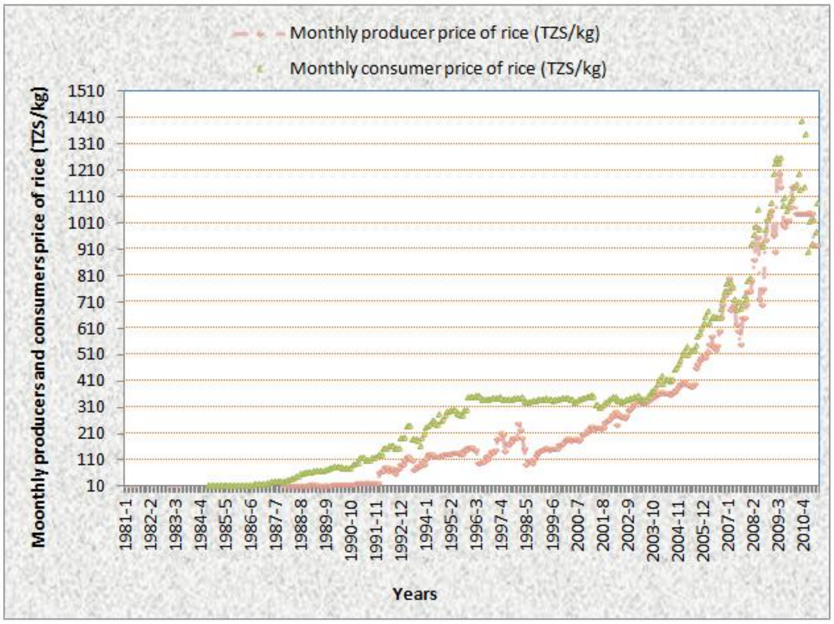

Fig. 2. Tanzania Mainland: Trends of monthly producer and consumer prices of rice from 1981 – 2010 (TZS/kg)

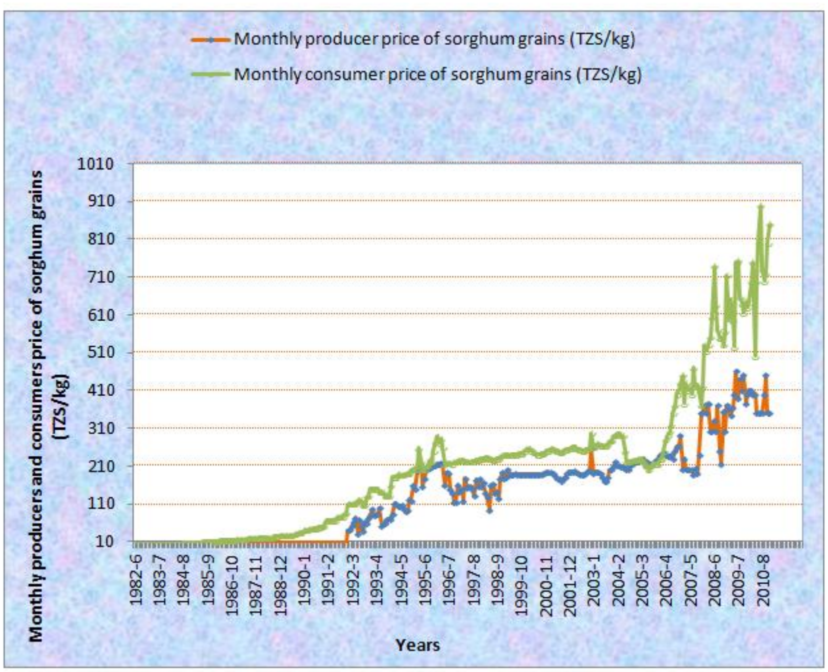

Fig. 3. Tanzania Mainland: Trends of monthly producer and consumer prices of sorghum grain from 1981 - 2010 (TZS/kg)

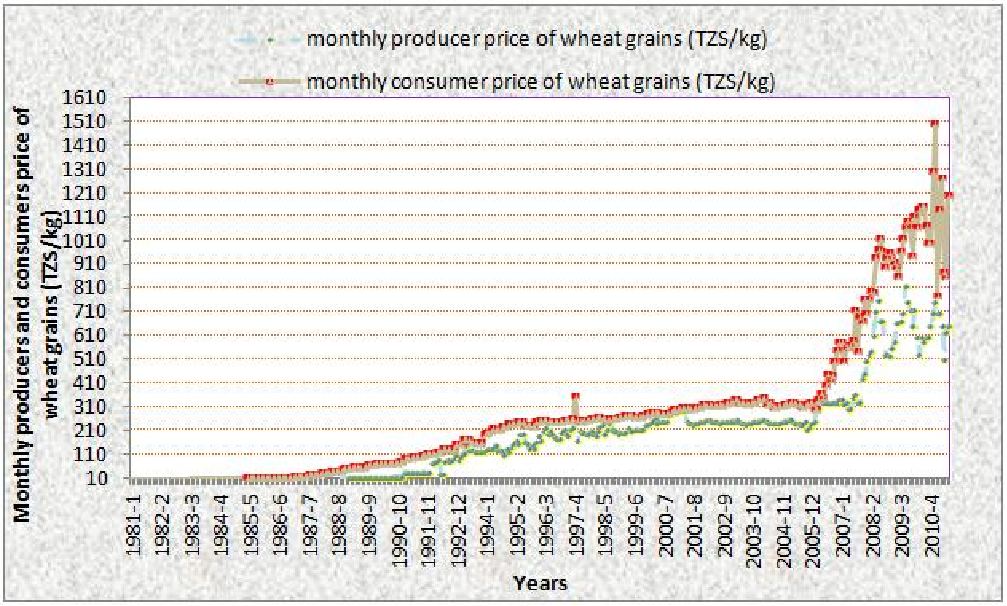

Fig. 4. Tanzania Mainland: Trends of monthly producer and consumer prices of wheat grains from 1981 – 2010 (TZS/kg)

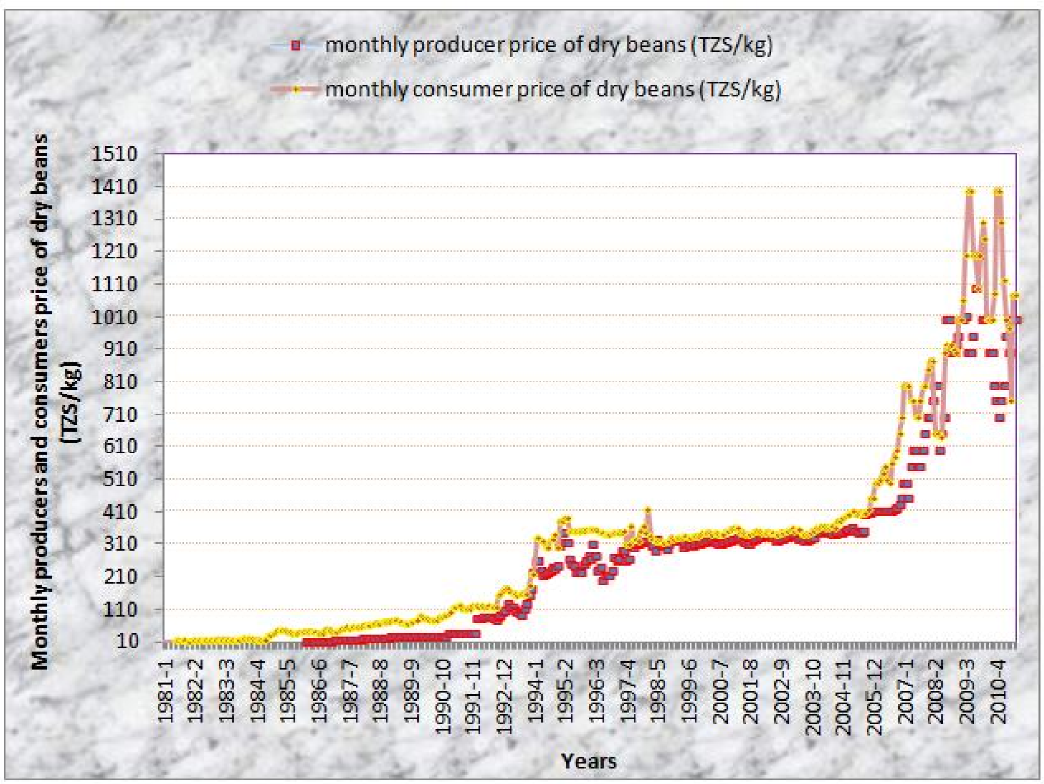

Fig. 5. Tanzania Mainland: Trends of monthly producer and consumer prices of dry beans from 1981 – 2010 (TZS/kg)

Table 3. Tanzania Mainland: Comparison between values of correlation coefficients of price transmission of food grains prior trade liberalization era (1981-1995) and post trade liberalization era (1996 – 2010)

	Maize grains	Rice	Sorghum grains	Wheat grains	Dry beans
Correlation coefficients prior trade liberalization	0.9681	0.9750	0.9348	0.9565	0.9802
Correlation coefficients post trade liberalization	0.8667	0.9697	0.8653	0.9526	0.9236
Difference	0.1014	0.0053	0.0695	0.0039	0.0566

4. CONCLUSION AND POLICY IMPLICATIONS

The empirical study estimated the price transmission of food grains prior and post trade liberalization era by employing the Error Correction Mechanism (ECM) model. However, the study revealed that producers' and consumers' monthly prices of food grains were cointegrated from the upstream to downstream. The implication of the empirical result is that producers' and consumers' monthly prices of food grains have long-term linear relationship shown by tandem movement of monthly prices of food grains from upstream to downstream. Hence, the study suggested that the price stabilization policies formulated and implemented by the Tanzanian government should focus much more on prices of food grains as the main food staples consumed by the majorities of food consumers in the country.

Furthermore; the producers' and consumers' monthly prices of food grains during prior and post trade liberalization era were positively correlated. The situation was attributed by price stabilization programmes of food grains intervened by Tanzanian government such as buying food grains during harvesting period through national food agencies. Moreover, the trade integration between the domestic and foreign food markets has helped to stabilize food prices in the country. Hence, Tanzanian government can continue to strengthen its international trade policies with the aim of integrating the domestic food market into the world food market so that to promote trade competitiveness of food grains.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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