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Vertical Price Transmission between Grains and Processed Foods: Does Price Stability in Grains Market Stabilize Prices of Processed Foods? *(The Case of Cereals and Bread and Other Prepared Foods in Addis Ababa)*

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Abstract

Nowadays, food inflation has become a common phenomenon in Ethiopia. The soaring food price is expected to affect food security of especially poor households. Bread and other prepared foods are among the major food items facing this problem for which demand is higher and consumers are much responsive to the price change, as the situation intends to affect the livelihood of majority of the people. Hence, the aim of this paper is to show the extent to which cereals market is efficiently coordinated with market of bread and other prepared foods, in Addis Ababa. In order to figure out this, secondary data of monthly price series was extracted from Central Statistical Agency for the period from September, 1996 to April, 2012 (having 188 observations). The data was analyzed using Johansen's and Julius co-integration test, vector error correction model and threshold error correction model coupled with other descriptive approaches. Findings of the study reveals that price of cereals and bread and other prepared foods are co-integrated having simultaneous causality; however, different results were found related to symmetry/asymmetry in price transmission between prices of the two categories of commodities, depending on the period of adjustments. The result shows that there is symmetric price transmission in the long-run implying that policies targeted on stability of prices of grains such as cereals may stabilize prices of processed commodities like bread and other prepared foods, slowly. However, this is not the case if immediate price stability is required in the two markets because there is asymmetric price transmission between the two commodities, in the short-run. Therefore, separate policy measures are recommended if we are interested in immediate (urgent) price stability in the two markets.

Keywords: Price stability; Bread and Other Prepared Foods; Cereals; Market Coordination, Price Transmission.

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1. Introduction

The rising food price in recent years is a global issue. In Ethiopia, since 2005, the rise in food prices has been tremendous. It has been 15.1% in 2006, 28% in 2007, 57.4% in 2008 and stands at 36.4% in 2009. The non-food price index has also been rising since 2000, but is relatively stable compared to the food price index (FPI). In 2007-2008, the food prices increase in Ethiopia accounted for almost 62% of the total inflation. Generally, the consumer price index (CPI) and FPI are highly correlated with about 57 percent of consumption expenditure spent on food (Jema *et al.*, 2011).

In Ethiopia, prices of food items surged by 47.4 percent, while the non-food inflation increased by 27.8 percent in July 2011 as compared to the prices of July 2010. The common feature is that prices of almost all commodities have risen in the same period. The 47.4 percent increase in food index is due to increases in the prices of Cereals (42.1 percent), Pulses (82.1 percent), Bread and Other Prepared Food (19.5 percent), Meat (32.2 percent), Milk, Cheese and Eggs (36.2 percent), oils and Fats (90.2 percent), Vegetables and fruits (25.3 percent), Spices (45.4 percent), Potatoes, Other Tubers and Stems (44.4 percent), Coffee and Tea Leaves (104.8 percent), Other Food Items (9.5 percent), Milling Charge by (15.8 percent), and Food Taken Away from Home (33.3 percent) (CSA, 2011).

This dramatic increase in food prices and its consequences has remained an issue of policy makers, researchers, and the society at large. The traditional economic theory asserts that inflation will have redistributive effect by imposing 'inflation tax' and can hurt particularly the lower income groups and those people whose income is relatively less flexible (Jema *et al*., 2011).

As cited in Jema *et al.* (2011), Zhu (2008) noted that the rising food and energy prices significantly impact people of all countries; however, the social unrest occurring in some developing countries shows that the survival of the local poor is threatened. Food price inflation affects poor people's purchasing power. It has an income effect on household budgets and also increases the risk of food insecurity. Zhu (2008) considers inflation as a "Poor Man's Tax". Poor people are disproportionately affected because they spend larger proportion of their income on food. Rising food prices thus decrease the real income of the most vulnerable people, with serious nutritional and health consequences.

Analysis of food inflation for different income groups, in South Africa, shows that poor households experienced higher inflation rates than wealthier. At its peak in October 2002, poor households were confronted with year-on-year food inflation of 23.1% while richer households only experienced food inflation of 19%. The benefit to the poor of the recent lower prices for most staple foods is reflected in a food inflation rate of 3.35% compared to that of richer households of 4.21% (Anonymous, n.d.).

Addis Ababa is one of the mostly affected regions, in Ethiopia, by the current food price soaring. In Addis Ababa, the food inflation was estimated to be about 19.6% in 2006 and 27% in 2007 which is the highest of all the regions of Ethiopia. In terms of price variability, Addis Ababa was ranked third with price variability rate of 14.9% next to Harari (19.1%) and Gambella (15.9%), in 2008. Due to the price soaring, households in Addis Ababa, Harari and Dire Dawa face relatively higher consumption loss as compared to other regions (Ulimwengu *et al.*, 2009). Consequently, food security of poor households of the region is expected to be adversely affected (WFP, 2009).

In order to ensure the food security, as a response to the rising of food prices, different policies are being recommended. According to Mondiale (2008), policy interventions can be divided into three broad classes: (i) interventions to ensure household food security by strengthening targeted safety nets; (ii) interventions to lower domestic food prices through short-run trade policy measures or administrative action, and (iii) interventions to enhance longer-term food supply.

In Ethiopia, in order to mitigate the impact of rising food prices, the Government assistance programs have been expanded to urban areas with an introduction of the urban grain market stabilization program in 2007. The program started initially in Addis Ababa, and then expanded to cover 12 urban centers namely: Bahar Dar, Gondar, Dessie, Kombolcha, Mekele, Adigrat, Dire Dawa, Harar, Awassa, Nazareth and Jimma, reaching out to a total of over 800,000 households who bought wheat grain at subsidized prices. The Government continued with the program from mid-August 2008 in a different form and sold 150,000 MT of wheat to wholesalers, consumers, millers and traders at *Birr* 3.5 per kg on a first come first served basis, removing the coupons or ration cards system (WFP, 2009).

Such policy intervention directly affects prices of certain types of commodities (i.e. grains) for a while, and later, may indirectly affect prices of other commodities (processed), as well,

if there is efficient market integration. If there is no or little integration (coordination) in the markets, the reduction in prices of the grains, such as cereals, as the result of the policy interventions, has nothing to do with prices of domestically processed commodities like breads and other prepared foods which are purchased and consumed by majority of the people; hence, no or little changes are observed on the livelihood of final consumers. Even when the markets are co-integrated but do not show symmetry in price transmission (in such a way that fall in price of the grains is not reflected on price of the processed commodities), the problem still persists.

A well-functioning input and output markets may assure vertical integration and coordination functions. However, this may not be the case in developing countries like Ethiopia where market imperfections are usually prevalent.In cognizant of this, this study deals with the extent to which cereals markets are integrated with bread and other prepared food items, in Addis Ababa. Hence, the question we raise here is that whether stability in prices of cereals can stabilize prices of bread and other prepared foods, in Addis Ababa.

Bread and other prepared foods are expected to be purchased for consumption by majority of the people, for which, a small change in price can significantly alter the livelihood of the people, especially the poor. Hence, if livelihood of the poor should be improved through pro-poor policies, more emphasis should be given to price stability of such kinds of commodities. Bread and other prepared foods, according to the report of Central Statistical Agency (2011), include bread, “enjera” – Teff mixed, “dabo – ambasha”, “dabo – sheleto”, bread - wheat (bakery), biscuits and others.

The major inputs for production of these commodities are cereals. Hence, as breads and other prepared foods and cereals markets are expected to be interrelated, policies enacted for stabilizing prices of cereals may intend to be reflected on prices of bread and other prepared foods. In other words, if there is efficient market integration, prices of bread and other prepared foods can be stabilized through stability of prices in cereals market. Therefore, it is worth noting to figure out how these markets are integrated, empirically. In cognizant of this, this study was undertaken to show the short-term and long-term association between prices of cereals and bread and other prepared foods, in Addis Ababa; indicate the type of causality existing between prices of these products, and; show the efficiency of the market through analysis of symmetry/asymmetry of price transmission between these markets.

2. Material and Method

This study was conducted making use of secondary data extracted from Central Statistical Agency. The data is time series having 188 observations of monthly recorded price series of cereals and bread and other prepared foods, in Addis Ababa, for the period from September, 1996 to April, 2012. The data was analyzed using descriptive and time series econometric approaches. The descriptive analysis deals with comparison of trend of price movements for the two categories of commodities. This involves graphical presentation of the price series and comparison of price variations using F-statistic and coefficient of variation. With regard to the time series econometric approach, co-integration tests and Vector Error Correction Model (VECM) were used which intend to show how markets of cereals and bread and other prepared foods are integrated. Generally, the time series econometric approach involves the following steps:

i) Test of stationarity of the two price series using Augmented Dickey Fuller test
ii) Test of co-integration of the two price series using Johansen and Juselius' (1990) approach
iii) Analysis of the manner of causality between the two price series
iv) Analysis of symmetry/asymmetry of price transmission between the two markets

2.1. **Model Specification**

i) Test of stationarity(unit root test)

It is often expected that price levels exhibit non-stationary covariance, which may lead to autocorrelation problems in the price response functions. This may result in spurious regression when we estimate the relationship between the price series. Hence, the unit root test was undertaken to know if the monthly market prices are stationary or not, using Augmented Dickey Fuller test. This is done to pretest each variable and to determine its order of integration (Verbeek, 2004).

If we express the two prices (cereals' price and bread and other prepared foods' price) as an autoregressive process of order one as:

$P_t^C = \alpha + \beta P_{t-1}^C + \varepsilon_t$ and $P_t^B = \rho + \theta P_{t-1}^B + \nu_t$ ……..…… (1)

Where: P_t^C is price of cereals

P_t^B is price of bread and other prepared foods

α, β, ρ, and θ are constants

ε_t and ν_t are error terms

The Augmented Dickey-Fuller test involves regressing the first difference of these price series on own lagged values and testing for stationarity or non-stationarity.

$$\Delta P_t^C = \delta + \gamma P_{t-1}^C + \sum_{t-1}^{t} \Delta P_{t-1}^C + \varepsilon_t$$

$$\Delta P_t^B = \sigma + \varphi P_{t-1}^B + \sum_{t-1}^{t} \Delta P_{t-1}^B + \nu_t$$

Where: $\gamma = \beta - 1$ and $\varphi = \theta - 1$ …… (2)

The set of hypotheses is defined as:

Ho: $\gamma = 0$ for cereals price (i.e. cereals price series have a unit root or are non-stationary) and

Ho: $\varphi = 0$ for bread and other prepared foods' price (i.e. bread and other prepared foods price series have a unit root or are non-stationary).

If the variables are non-stationary (or if we accept the null hypothesis), the co-integration test will follow.

ii) Test of co-integration

[4]In the second step of our econometric approach, we examine the existence of cointegration between the two variables in our VAR system. In simple words, we search for the existence of the number of co-integrated vectors, r, within Johansen and Juselius' (1990) framework. Using their technique, we implement a k-dimensional VAR of the following form:

$$P_t = \mu + \sum_{j=1}^{k} \Pi_i P_{t-1} + e_t. \quad \text{……} \ldots(3)$$

Where P_t is a (2 x 1) vector matrix of the cereals and bread and other prepared foods prices, respectively; and e_t are Gaussian residuals. The VAR in Equation 3 can be re-parameterized into a VECM form as:

[4] Before the test of co-integration, LR, FPE, AIC, HQIC and SBIC were used as criteria for selection of the number of lags, to determine the maximum number of lags that should be included in the model (see appendix 3). Accordingly, these criteria show that there should be 4 lags in the model.

$$\Delta P_t = c + \Pi P_{t-1} + \sum_{j=1}^{k-1} B_j \Delta P_{t-j} + \varepsilon_t \quad \text{……...…….. (4)}$$

Where $\prod$ is a (2x2) matrix of long-run and adjustment parameters, B_j is a (2x2) matrix of the short-run parameters, ε_t is the vector of residuals and j is the number of lags. Following Johansen's procedure, the co-integration relationship between prices was examined under equation 4, where each price is a function of its own lagged values and the lagged values of the other price series. The trace and maximum eigenvalue statistics are used to determine the rank of $\prod$ and to reach a conclusion on the number of co-integrating equations, r, in our bivariate VAR system.

iii) Analysis of the direction of causality

In the third stage of our approach, we have to define the direction of causality between the two variables. Therefore, we implement a complete dynamic Granger–Engle VECM test of the following form (as indicated in Reziti and Panagopoulos, 2008):

$$\Delta P_t^B = \mu_1 + \sum_{i=1}^{n1} \beta_b \Delta P_{t-i}^B + \sum_{i=1}^{n2} \beta_c \Delta P_{t-i}^C + \pi_1 Z_{t1-1} + e_{t1} \quad \text{……} \quad (5)$$

$$\Delta P_t^C = \mu_2 + \sum_{i=1}^{n1} \beta_b \Delta P_{t-i}^B + \sum_{i=1}^{n2} \beta_c \Delta P_{t-i}^C + \pi_2 Z_{t2-1} + e_{t2} \quad \text{……...……...…..} \quad (5')$$

Where Z_{t1-1} and $\pi_1 Z_{t2-1}$ are adjustment or error correction terms whereas π_1 and π_2 are their respective coefficients and the β are short-run coefficients.

The set of hypotheses and options which are now available are as follows:

(a) $\pi_1 \neq 0$ and $\pi_2 \neq 0$ (a feedback long-run relationship between the two variables)

(b) $\pi_1 = 0$ and $\pi_2 \neq 0$ (price of bread and other prepared foods causes price of cereals in the long-run)

(c) $\pi_1 \neq 0$ and $\pi_2 = 0$(price of cereals causes price of bread and other prepared foods in the long-run)

For testing the three alternative options, a weak exogeneity test is implemented according to Johansen's (1992) methodology.

iv) Analysis of symmetry/asymmetry of price transmission

In this stage, we have already decided on the direction of causality between the examined variables (assume that price of cereals causes price of bread and other prepared foods), and we move to the final step of the estimation for the existence of asymmetry price transmission

in the examined market with the help of an asymmetric ECM (Threshold Vector Error Correction Model). In general, as indicated in Minot (2011), the Error Correction Model, including many lags, can be presented as shown by equation 5. That is;

$$\Delta P_t^B = \mu + \sum_{i=1}^{n1} \beta_b \Delta P_{t-i}^B + \sum_{i=1}^{n2} \beta_c \Delta P_{t-i}^C + \pi Z_{t-1} + e_t \quad \ldots\ldots (6)$$

Given the above equation, the procedure of testing for asymmetry price transmission requires decomposition of the data into two adjustment processes for P_t^B(i.e. in response to positive and negative deviations from equilibrium). This can be represented using Threshold Error Correction Model of the following form (Chen *et al.*, 2005).

$$\Delta P_t^B = \mu + \begin{cases} \sum_{i=1}^{n1} \beta_b^+ \Delta P_{t-i}^B + \sum_{i=1}^{n2} \beta_c^+ \Delta P_{t-i}^c + \Pi^+ Z_{t-1} + e_t \ldots\ldots if P_{t-1}^c < P_t^c \\ \sum_{i=1}^{n1} \beta_b^- \Delta P_{t-i}^B + \sum_{i=1}^{n2} \beta_c^- \Delta P_{t-i}^c + \Pi^- Z_{t-1} + e_t \ldots\ldots otherwise \end{cases} \ldots\ldots$$

(7)

Splitting the error correction term into positive and negative components (i.e. positive and negative deviations from the long-term equilibrium as indicated by Π^+ and Π^-) makes it possible to test for asymmetric price transmission (in the long term) according to Meyer and Von Cramon –Taubadel (2004). Where $\Pi^+ Z_{t-1}$ measures the movement towards equilibrium by the price of bread and other prepared foods when there is a positive shock to cereals price (or an increase in cereals price) and $\Pi^- Z_{t-1}$ measures the movement towards equilibrium by the price of bread and other prepared foods when there is a negative shock to cereals price (or a decrease in cereals price).

The null hypothesis in the test for asymmetry is that the response by price of bread and other prepared foods is the same whether the shock or the deviation is positive or negative in cereals price i.e. the coefficients Π^+ and Π^- are not statistically different from each other. Symmetric price transmission is rejected if Π^+ and Π^- are significantly different from one another, which can be evaluated using an F-test (Wald test). A Joint F-test is used to determine the symmetry or asymmetry of the price transmission process at a 0.1, 0.05 or 0.01 level of significance (Acquah and Onumah, 2010). In general, the test for the null and alternative hypothesis can be written as:

a) Ho: $\Pi^+ = \Pi^-$ (i.e. price transmission is symmetric)
b) Ha: $\Pi^+ \neq \Pi^-$ (i.e. price transmission is asymmetric)

As indicated in the study of Chen *et al.* (2005), it is also possible to test the symmetric/asymmetric price transmission in the short run by comparing the short run effects of the negative and positive shocks in the independent variable. This is carried out by comparing coefficients of the negative and positive short-run adjustments. That is β_b^+ and β_c^+ are compared with β_b^- and β_c^-, jointly. If they are equal, we say there is symmetry in price transmission in the short-run, or not if otherwise.

3. RESULTS AND DISCUSSION

A. Descriptive analysis

As an insight for our point of interest, the descriptive analysis shows how the prices of bread and other prepared foods and cereals are associated. In addition, in this section, comparative analysis of variation of the two price series is reported. The trends of prices of cereals and bread and other prepared foods are presented using Figure 1. Generally, the visual presentation of Figure 1 indicates that there is strong association between prices of bread and other prepared foods and cereals, for the period between 1996 and 2012. As indicated by the figure, the price series show almost similar trend of movements.

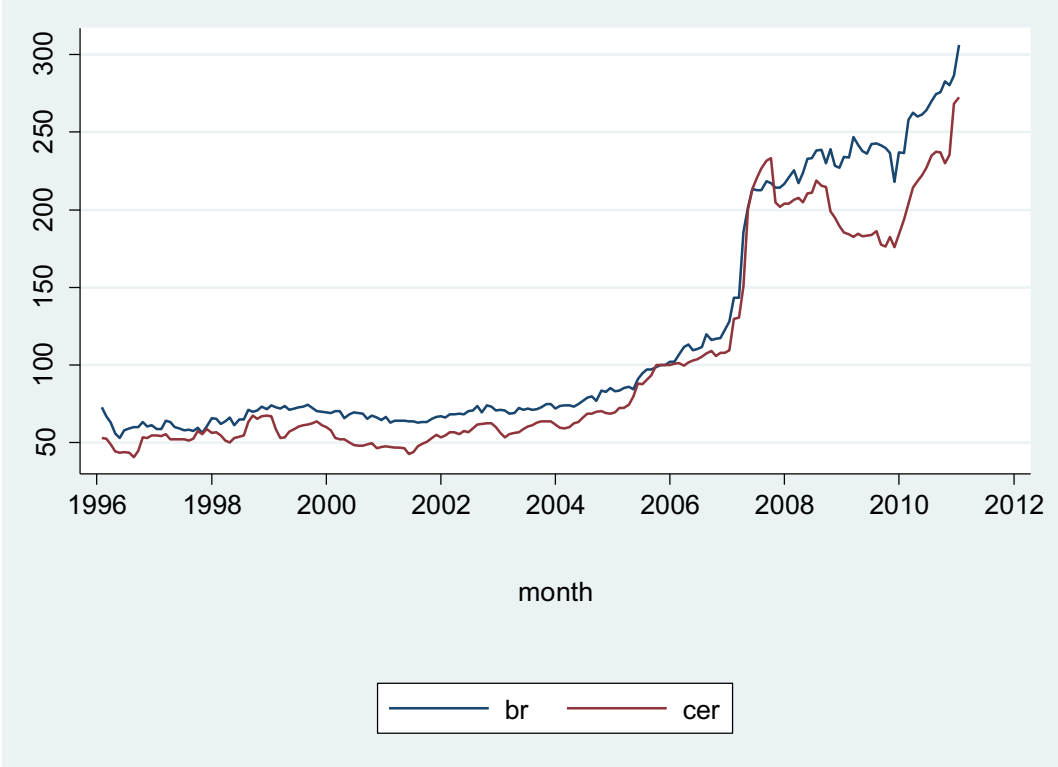

Figure 1: Trends of price of cereals and price of bread and other prepared foods

However, the figure indicates that price of bread and other prepared foods relatively shows smother trend of continuous rise whereas price of cereals has relatively more difficulties. It is common to see seasonal increase and fall of agricultural products. As cereals are primary products of the agricultural sector, we usually observe fall in their price during wet season (when the weather condition is favorable); and rise in their price during dry season (when the weather condition is unfavorable). Nevertheless, this may not be the case for processed products like bread and other prepared foods.

The Figure shows that for a rise in price of cereals, the price of bread and other prepared foods also rises almost in all cases. However, this is not necessarily true when the price of cereals fall. For instance, for the period between 2000 and 2002, the price of cereals shows a slight decrease where; at the same period, the price of bread and other prepared foods does not show any tendency to fall. Between 2002 and 2008 when the price of cereals rises continuously, so does the price of bread and other prepared foods. Between 2008 and 2010, by the time the government provides subsidies of provision of grains with lower price for households in Addis Ababa, the price of cereals has shown significant fall; but at the same period, the price of bread and other prepared foods does not show such a fall. This may somehow diagnose the presence of asymmetry in price transmission.

As additional information, comparative analysis of the overall trends of the variation in the two price series was made using F-statistics and Coefficient of variation. Estimation result of the F-statistics and Coefficient of variations is presented using Table 1. Table 1 shows that standard deviations of price of bread and other prepared foods and that of cereals are 74.12 and 65.65 whereas standard errors of the two price series are 5.41 and 4.79, respectively. As indicated in the table, the value of the F-statistic is 1.2748 which is greater than the tabulated value (1.26), implying that we should reject the null hypothesis that the extents of variations of the two price series are the same, at 5% level of significance.

Table 1: Variance ratio test and coefficient of variation of the two price series

Variables	Observations	Standard Error	Standard Deviation
Price of bread and other prepared foods	188	5.405939	74.1225
Price of cereals	188	4.787927	65.64874
Combined	376	3.631327	70.41405
f = 1.2748		CV_{br} = 0.63	
Degree of freedom = 187, 187		CV_{cer} = 0.65	

Source: own computation, 2021

As indicate in the table the coefficients of variation of the two price series are 0.65 and 0.63 for cereals and bread and other prepared foods, respectively. This indicates that, given the difference in the variations in the two price series as shown by the F-statistics, the value of the coefficients of variation show that price of cereals is relatively highly variable than that of bread and other prepared foods. This may imply that price of bread and other prepared foods changes (show variation) mostly for upward movements in price of cereals; and it seems to remain unchanged (or shows little change) for down ward movements in price of cereals. This may also be another sign of the presence of asymmetry in price transmission.

Table 2: Variance ratio tests for positive changes (rise) and negative changes (fall) in price of the two commodities

Variables	Positive change (rise in price)			Negative change (fall in price)		
	Observations	Standard Deviation	Coefficient of variation	Observations	Standard Deviation	Coefficient of variation
Price of bread and other prepared foods	116	6.230609	1.76	68	4.059199	1.44
Price of cereals	110	5.595966	1.48	74	2.834485	1.15
Combined	226	5.918243		142	3.46708	
F-statistic	1.24			2.05		
Degree of freedom	115, 109			67, 73		

Source: Own computation, 2021

In order to confirm this, comparison of the positive and negative variations of the two prices was taken into account, separately. This is presented in Table 2. Table 2 indicates that the positive variations in the two prices are not significantly different as revealed by the F-test which is 1.24 (i.e. less than the tabulated value of 1.26 at 10% level of significance). On the other hand, for the negative (the falling) segment of the variation in the two prices, the F-statistic was found to be 2.05 (which is greater than the tabulated value of 1.53 at 1% level of significance). This means the variations in the two prices for the falling segment of the change in the two prices are significantly different; where coefficient of variation for price of

cereals is greater than that of price of bread and other prepared foods (i.e. 1.44 > 1.15). The implication is that price of cereals experience significantly more falls in price than that of price of bread and other prepared foods.

B. Time series econometric analysis

As indicated in the methodology part, this section involves four steps/points of analysis including test of stationarity, test of co-integration, test of direction of causality and test of symmetry/asymmetry of transmission between the two price series.

i. Test of stationarity (unit root test)

This test was undertaken to know if the variables have unit roots or not (if they are stationary or not), as well as to determine their order of integration, individually. As indicated in Table 3, both price series (in logarithm) were found to be non-stationary in level.

Table 3: Augmented Dickey Fuller test for unit root of prices of bread and other prepared foods and cereals[5](in logarithm)

Commodities		Bread and other prepared foods	Cereals
Inlevel	Test statistic	1.429	-0.013
	1% critical value	-3.481	-3.482
	5% critical value	-2.884	-2.884
	10% critical value	-2.574	-2.574
	MacKinnon approximate p-value for Z(t)	0.9972	0.9574
	Lag	1	4
First difference	Test statistic	-13.710	-5.829
	1% critical value	-3.481	-3.482
	5% critical value	-2.884	-2.884
	10% critical value	-2.574	-2.574
	MacKinnon approximate p-value for Z(t)	0.0000	0.0000
	Lag	0	3

Source: Own computation, 2021

As indicated in Table 3, the MacKinnon approximate p-values for Z(t) of price of bread and other prepared foods and price of cereals, in level, are 0.9972 and 0.9574, respectively. But both variables are stationary in their first difference as indicated by the MacKinnon approximate p-values for Z(t) (i.e. 0.0000 for both). The implication of this result is that both

[5]In table 2, *L is lag length determined using LR, FPE,* AIC, HQIC and SBIC statistics of information criteria. Appendix 1 and Appendix 2 present the statistical results for determination of the lag length.

variables are integrated of order one. Hence, there is possibility of long-run relationship (co-integration) between the two price series, in their first difference.

ii. Test of co-integration between the two price series

To test for cointegration, we must first specify how many lags to include. Nielsen (2001) has shown that the methods implemented in lag-order selection statistics for VARs and VECMs can be used to determine the lag order for integration. Accordingly, the lag-order selection statistics (*LR, FPE,* AIC, HQIC and SBIC) were computed. All these statistics show the same result that four lags should be used in the estimation of the co-integration equation (see appendix 3).

Table 4: Result of Johansen's tests for co-integration of the price series (in logarithm)

Rank	Eigen value	Trace		Max	
		statistics	5% critical value	statistics	5% critical value
r = 0	------	22.1598	15.41	21.5783	14.07
r ≤ 1	0.11066	0.5815*	3.76	0.5815	3.76
r ≤ 2	0.00316	----------	---------	--------	--------
Number of obs = 184 Lags = 4					

Source: own computation, 2021

Once the number of lags has been determined, the Johansen and Juselius' (1990) framework was implemented to determine the number of co-integrating equations. The estimation result is presented in Table 4. This estimation was carried out to determine the rank of the co-integration matrix. As indicated in the table, we reject the hypothesis that there is no co-integration between price of bread and other prepared foods and price of cereals (i.e. r = 0). Because both the trace and the max statistics are greater than their respective 5% critical values when r = 0. That is, 22.1598> 15.41 and 21.5783> 14.07. But, we don't have any evidence to reject the hypothesis that the number of co-integrating equations are not more than one since both the statistical values are less than their respective 5% critical values when r ≤ 1(i.e. 0.5815< 3.76 for both). Hence, we can ensure that there is one co-integrating equation between the two price series.

iii. Analysis of the direction of causality between the two price series

By now, we have assured that there is co-integration between the two price series. Given this, we need to test which price causes the other. This was analyzed using Engel Granger - Vector Error Correction Model, as applied by Reziti and Panagopoulos (2008). The estimation result of the VECM is presented in Table 5. We can see that the estimates (coefficients of the adjustment parameters) have the correct signs implying that there is rapid adjustment toward equilibrium. The negative sign of coefficient of the adjustment parameter for bread and other prepared foods indicates, when price of bread and other prepared foods is higher or far away from the equilibrium, it has to fall towards the equilibrium over time; on the other hand, the positive sign of coefficient of the adjustment parameter for price of cereals shows that when price of bread is higher, price of cereals should also increase in order to keep the equilibrium.

Table 5: Result of Estimation of the VECM

Dependent variables	Independent variables	Coefficient	Standard error	P-value
Δlogpbr	ECT_b	-0.064508	0.0324808	0.047
	$\Delta logpbr_{t-1}$	-0.126668	0.0802595	0.115
	$\Delta logpbr_{t-2}$	-0.0013733	0.0805309	0.986
	$\Delta logpbr_{t-3}$	-0.0764769	0.078925	0.333
	$\Delta logpcer_{t-1}$	0.0967872	0.0694786	0.164
	$\Delta logpcer_{t-2}$	0.1055257	0.0715233	0.140
	$\Delta logpcer_{t-3}$	0.0303694	0.0687028	0.658
	$Constant_b$	0.0080884	0.0029008	0.005
Δlogpcer	ECT_c	0.1115772	0.0381247	0.003
	$\Delta logpbr_{t-1}$	0.1657351	0.0942057	0.079
	$\Delta logpbr_{t-2}$	0.1511132	0.0945242	0.110
	$\Delta logpbr_{t-3}$	0.0584214	0.0926392	0.528
	$\Delta logpcer_{t-1}$	0.2785714	0.0815514	0.001
	$\Delta logpcer_{t-2}$	-0.0621345	0.0839514	0.459
	$\Delta logpcer_{t-3}$	0.1858461	0.0806408	0.021
	$Constant_c$	0.0046763	0.0034048	0.170

Source: own computation, 2021

Table 5 shows that, in our estimation of the VECM, there are two types of parameters of interest; including the adjustment and the short-run coefficients. The adjustment parameter on price of bread and other prepared foods (i.e. ECT_b) has coefficient of -0.064508 and P-value of 0.047 implying that it is significant at 5% level of significance. Similarly, the adjustment parameter on price of cereals (i.e. ECT_c) has coefficient of 0.1115772 and P-value of 0.003, implying that it is significant at 1% level of significance. This indicates that we have two

directions of causality. In other words, price of cereals causes price of bread and other prepared foods at 5% level of significance; and price of bread and other prepared foods causes price of cereals at 1% level of significance[6].

According to the result, comparatively, the significance of both coefficients of the adjustment parameters and the short-run parameters indicates that, relatively, price of bread and other prepared foods affects price of cereals with more significance than that of the effect of price of cereals on price of bread and other prepared foods. This implies that sellers of cereals are relatively much responsive for the change in price of processers' products (bread and other prepared foods) than the responsiveness of the processors for the change in price of cereals. In other words, the market is relatively, much led by processers of bread and other prepared foods than sellers of cereals. This has its own implication on symmetry/asymmetry of price transmission or efficiency of the market. This is dealt in brief in the next section.

iv. Analysis of symmetry/asymmetry of price transmission between the two prices

This part deals with analysis of efficiency of the market in terms of symmetry/asymmetry of price transmission between the two categories of products. This analysis was undertaken in such a way that adjustment parameters of our estimation result of the VECM were decomposed into positive and negative adjustments; thereby test of equality of coefficients of the long-run and short-run adjustments was carried out using F-statistic.

In the preceding sessions, it was indicated that there are two ways of directional of causality between the two price series. Accordingly, the comparison was made for both cases (when causality goes from cereals to bread and other prepared foods and when it goes from bread and other prepared foods to cereals). The result is reported using Table 6.

Table 6: Test of symmetry/asymmetry of price transmission[7]

Direction of causality	Coefficients of short run and long run adjustments			F-test for equality of the coefficients	
From cereals to bread and other prepared foods	Independent variables	When $P^c_t > P^c_{t-1}$	When $P^c_t \leq P^c_{t-1}$	F-statistic	P-value
	Dlogcer_1	0.0768836	0.013912	3.74	0.0257
	Dlogbr_1	0.0094895	.0061782		

[6] The use of VECM is expected to be a reliable model when there is simultaneous interaction between variables so as to avoid problem of simultaneity in our estimation.
[7] Before estimation of our Threshold Error Correction Model, the number of lags to be considered in the model was determined a priori (see appendix 4).

	ECT_{t-1}	-0.0960441	-0.0930618	0.00	0.9600
	For all jointly			2.50	0.0612
From bread and other prepared foods to cereals	Independent variables	When $P^b_t > P^b_{t-1}$	When $P^b_t \leq P^b_{t-1}$		
	Dlogcer_1	0.2457781	0.2582549	2.88	0.0241
	Dlogcer_2	0.1015581	-0.0391502		
	Dlogbr_1	0.3061499	0.1664439		
	Dlogbr_2	-0.3054781	-0.1705221		
	ECT_{t-1}	-0.0998154	-0.1252048	0.10	0.7468
	For all jointly			2.31	0.0462

Source: Own computation

As indicated in Table 6; when price of cereals causes price of bread and other prepared foods, coefficients of short-run adjustments, for positive and negative changes in the independent variable (i.e. when $P^c_t > P^c_{t-1}$ and When $P^c_t \leq P^c_{t-1}$), were found to be jointly significantly different at 5% level of significance, as indicated by P-value of the F-test which is 0.0257. As indicated in the table, coefficients of first lags in logarithm of price of cereals (Dlogcer_1) and price of bread (Dlogbr_1) when $P^c_t > P^c_{t-1}$ (0.0768836 and 0.0094895) are jointly significantly greater than that of the case when $P^c_t \leq P^c_{t-1}$ (0.013912 and 0.0061782). This implies, in this case, processors of bread and other prepared foods are more reactive for a rise in price of cereals than for a fall in price, in the short-run.

However, the situation is different in the long-run because the long-run coefficients (-0.0960441 and -0.0930618) were found to be not significantly different from each other; as indicated by the F-test having P-value of 0.9600. In fact, the result also shows that all the short-run and long-run coefficients are not jointly different from each other at 5% level of significance, as indicated by the P-value of the F-test which is 0.0612. Therefore, we may confirm that processors of bread and other prepared foods are equally reactive for both the rise and fall of price of cereals, in the long run; there by pricing policies formulated in the cereals market have meaningful impact on prices of bread and other prepared foods.

Similarly, when the causality goes from bread and other prepared foods, coefficients of the short-run adjustments, for the negative and positive changes in the independent variable, were not found to be equal. However, coefficients of the long-run adjustments are not significantly unequal. Hence, we can also say that pricing policy which is formulated for bread and other prepared foods likely affects prices of cereals in the long-run, provided that there is no supply shock of cereals.

4. CONCLUDING REMARKS

In Ethiopia, recent statistical reports show that higher rate of food inflation is a common phenomenon which intends to adversely affect the livelihood of especially the majority poor group. Bread and other prepared foods are among the commodities experiencing continuous rise of prices even if the magnitude is relatively lower compared to other commodities. As bread and other prepared foods are expected to be purchased by majority of the people, instability or continuous rise of their prices can significantly affect the living condition of specially the poor households.

In cognizant of the adverse impact of the food inflation on the livelihood of especially the poor, the government is taking different measures. These measures usually focus on stability of prices of grains (such as cereals). If there is efficient market co-ordination, price stability in the grains/cereals market is expected to stabilize prices of processed products such as bread and other prepared foods. Taking this into consideration, this study was undertaken to figure out whether the market for cereals and bread and other prepared foods are efficiently coordinated there by price stability in cereals market can also stabilize prices of bread and other prepared foods, in Addis Ababa. To this end, both descriptive and time series quantitative analyses were carried out.

Result of the descriptive analysis shows that price series of these commodities are moving together showing the possibility of co-integration between prices of these two categories of commodities, as indicated by the graphical presentation. However, the graphical presentation also indicates that there seems to be great association between prices of these commodities for the rising segment of price of cereals than that of the fall in price of cereals. Test of equality of variation between the two price series, using F-statistic and coefficients of variation, also indicates that the variation in price of cereals is significantly higher than that of price of bread and other prepared foods. Given this, we may suspect that much of the variations in price of bread and other prepared foods are brought about for the rising segment of price of cereals than for the fall in prices of cereals.

In order to confirm this precisely, time series quantitative analysis was undertaken using test of co-integration and VECM. Result of the quantitative analysis shows that there is co-integration between the two price series, as indicated by Johansen's and Juselius test of co-integration. Given this, the VECM indicates that there is simultaneous causality between the

two prices, implying that price of cereals cause price of bread and other prepared foods as well as price of bread and other prepared foods causes price of cereals.

Taking this into consideration, test of symmetry/asymmetry price transmission was carried out for both cases (when price of cereals cause prices of bread and other prepared foods, and when price of bread and other prepared foods causes price of cereals) using Threshold Error Correction Model that decomposes the data into two for positive and negative shocks in the independent variable. Result of test of the F-statistic (Wald test) reveals that there is asymmetric price transmission between the two categories of commodities in the short-run, for both cases. The result indicates that there is more reaction for a rise in price than for a fall in price, for both cases. The implication is that price stability measures targeted on grains (cereals) market may not have anything to do with prices of processed commodities (bread and other prepared foods) in the short-run. The same holds true when causality goes in the other way round.

On the other hand, the study indicates that there is symmetric price transmission based on long-run adjustments, for both cases, implying that pricing policy enacted in grains (cereals) market has meaningful effect on prices of processed commodities (bread and other prepared foods) in the long-run. Similarly, pricing policy for processed foods has implication on prices of grains unless there exists supply shock in grains market.

Therefore, price stability measures based on perception of the link of the two markets should take into account the period of adjustment of the prices. If it is urgent or immediate price stability in all markets that we are looking for, separate measures are required for both markets. However, if we need the prices to be stabilized slowly, price stability in grains (cereals) market can stabilize prices of processed foods (bread and other prepared foods) without policy replication in the market of processed commodities, thereby resources that would be lost if we make separate measures in the two markets can be saved, only in the long-run.

Competing Interests

The authors declare that there is no competing interest.

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