Asymmetric price transmission in food markets in the highlands of central Kenya

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Abstract

This paper investigates the non-linear adjustments between maize and beans markets in the highlands of central Kenya. Results are based on bi-weekly retail price data collected from ten markets in Mbeere and Meru south districts. The error correction model extended by the incorporation of asymmetric adjustment terms was used to study asymmetry in price transmission between the markets. Cointegration technique was used to determine the existence of a long-run price relationship between the maize and beans markets. The findings indicate that the markets are integrated. Retail price transmission process between the markets is asymmetric. The observed prices adjust more rapidly to increases in prices than to decreases. The speed of price response between market pairs was higher for markets that are far apart.

Key words: Asymmetric adjustments, spatial food price transmission, error correction models

1. Introduction

In the agriculture based countries, which include most of sub-Saharan Africa, agriculture and its associated industries are essential to growth and to reducing mass poverty and food insecurity. Maize is the main staple food in Kenya and accounts for 28% of gross farm output from the small scale producers (Jayne et al, 2001). The common bean is the second to maize as a food crop (Katungi et al, 2010) and a relatively inexpensive alternative source of protein for many households (FAO, 2008). Despite their high importance, production in some parts of the country has not kept pace with demand due to a number of biotic, abiotic and socioeconomic constraints.

Policy makers in Kenya are continuously under pressure to ensure that producers receive adequate incentives to produce and sell, while keeping prices tolerable for buyers. An efficient and organized agricultural marketing system is therefore necessary to enable producers to realize a just price for their produce and to reduce their exploitation by traders. Markets promote the stability of food supply since price adjustment between the markets occur as a result of movement of food between spatially separated markets. Thus markets ensure food distribution from surplus to deficit areas (Jaleta and Gebermedhin, 2009). Markets also play an important role in economic development because they promote competition, which motivates more efficient use of resources and encourages innovation. The profit motive that drives market activity is therefore responsible for improvement in the quality of life.

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Agricultural markets have assumed increased importance after the launch of new economic policy and consequent opening up of agricultural markets to competition. To enable Kenyans to derive the full benefits from the new liberalized trade regime, it is necessary to remove various constraints and deficiencies in the existing domestic markets and marketing practices. Market liberalization led to the emergence of small grain traders in response to increased market opportunities (Nyoro et al, 1999; Omamo and Mose, 2001). Since the transfer of distribution and marketing roles to the private sector, markets have grown in importance as key factor influencing the success or failure of efforts to improve food production and consumption in Kenya.

A key premise in economics is that markets allow for price signals to be transmitted both spatially and vertically. The efficient market hypothesis states that at any given time, prices fully reflect all available information. This implies that for a market to be efficient, information must be transmitted fairly to all players in the market such that abnormal profits cannot be earned by exploiting this information set (Ogutate and Folayan, 2006). The concept of market efficiency derives from the idea of perfectly competitive markets. If a marketing system is efficient, consumer preferences are transferred without distortion to producers who will use such price information to make production decisions which are allocatively efficient in turn (Harris-White, 1995). Thus for a market to be efficient, prices must incorporate all available information in order to maximize welfare gains and secondly, marketing costs must exclude rent. When a market is efficient, a single price will prevail in all spatially separated markets. An efficient market would not allow price differences to persist in the long run; price movements in one market would result in adjustments to regain the equilibrium relationship among the prices observed in geographically separated markets.

Markets are said to be integrated if they are connected by the process of arbitrage which will be reflected in price series of commodities in spatially separated markets. Price integration could be short run or instantaneous or long term. Short run market integration implies that a price increase in one market is immediately and fully reflected in the price level of the other market while long term market integration is obtained when short run price adjustments converge to equilibrium in the long run (Ravaillon, 1986). Campenhout (2006) outlines some of the benefits of a well integrated market system for developing countries as reduction of rural poverty and localized food scarcity. There is also a relationship between ease of implementation of stabilization policies and market integration (Alderman, 1993).

This study analyses those processes that are referred to as asymmetric i.e. for which transmission differs according to whether prices are increasing or decreasing. It is commonly asserted that traders use market power to employ pricing strategies which result in complete and rapid pass through of cost increases but slower and less complete transmission of cost savings (Kinnucan and Forker, 1987). It is sometimes claimed that only price increases are transmitted to buyers, whereas traders are the main beneficiaries of price decreases. If the market system were well integrated, then the price increases should be transmitted to the same extent as price decreases (Goletti and Christina-Tsigas, 1995). According to Kinnucan and Forker (1987) Asymmetric price transmission (APT) exists because of: (a) normal inertia in the food marketing system associated with storing, transporting and processing the farm product; (b) costliness of repricing items at retail; (c) market imperfections such as diversity in market structure and differences in information transmissions and assimilation at vertical exchange points; (d) the nature of price reporting and collection methods.

This paper employs an error correction model suggested by von Cramon-Taubadel and Loy (1996) to determine the relationship between retail prices of maize and beans in the highlands of central Kenya. The main objective of this study is therefore to determine whether price transmission in markets in the highlands of central Kenya are symmetric or asymmetric. APT implies that some group is not benefitting from a price reduction or increase that would, under conditions of symmetry, have taken place sooner and/or the size of the welfare change have been of a greater magnitude than observed. Hence APT implies a different distribution of welfare than would obtain under symmetry, because it alters the timing and/or the size of the welfare changes that are associated with price changes. Furthermore, if APT is, as is commonly hypothesized, a manifestation of market failure (for example the exercise of market power by monopolists), then it will also signal, in addition to welfare redistribution, the associated net welfare loss.

2. Methodology

2.1 Study area and data sources

The highlands of central Kenya which comprises districts in central and eastern provinces are very diverse in terms of agro ecological zones, soils, potential for agricultural production and farming systems. This study focuses on Meru South district, representative of the densely populated high-potential area and Mbeere district, a representative of the low-potential area; similar agro ecological diversity also exists within individual districts. The diversity in climate and soils provides opportunities for agricultural production and trade. Maize and beans are among the main staple food crops grown for subsistence and sale. The data used in this study consisted of bi-weekly maize and beans retail prices from ten markets (Karaba, Makima, Ishiara, Siakago, Kiritiri, Chuka, Kaanwa, Itugururu, Kathwana and Magutuni) in the highlands of central Kenya.

2.2 Modeling APT

The model is based on linear relationship among price series commodity prices:

$$P_{i,t} = \alpha_0 + \alpha_1 P_{j,t} + \mu_t \qquad (1)$$

Where $P_{i.t}$ denotes the retail commodity price at time t and market i, $P_{j,t}$ denotes the commodity price at time t and market j, α_0, α_1, are parameters to be estimated and μ_t is the error term. Commodity prices are usually non-stationary. However, this does not pose a problem as the error term μ_t is stationary for this implies that price changes in a market i do not drift far apart in the long run from another market j, or are cointegrated.

Tweeten and Quance (1969) used a dummy variable technique to estimate irreversible supply functions. Translating equation (1) for supply analysis into the context of APT:

$$P_{i,t} = \alpha + \beta^+ D^+ P_{j,t} + \beta^- D^- P_{j,t} + \gamma_t \qquad (2)$$

Where D^+ and D^- are dummy variables with: $D^+=1$ if $P_{j,t} \geq P_{j,t-1}$ and $D^+=0$ otherwise; $D^-=1$ if $P_{j,t} \leq P_{j,t-1}$ and $D^-=0$ otherwise. Two price adjustment coefficients are estimated; these are β^+ for increasing price phases and β^- for the decreasing price phases. In this case asymmetry means that $\beta^+ \neq \beta^-$.

Houck (1977) proposed a variable splitting technique that includes first differences of the increasing and decreasing phases of $P_{j,t}$:

$$\Delta P_{i,t} = \alpha + \beta^+ \Delta P^+_{j,t} + \beta^- \Delta P^-_{j,t} + \gamma_t \qquad (3)$$

Ward (1982) extended Houck's specifications by including lags of the exogenous variables:

$$\Delta P_{i,t} = \alpha + \sum_{k=1}^{k=m} \left(\beta^+ \Delta P^+_{j,t-k+1} \right) + \sum_{k=1}^{k=n} \left(\beta^- \Delta P^-_{j,t-k+1} \right) + \gamma_t \qquad (4)$$

Where m and n are the lag lengths. Based on comparisons of individual β-coefficients in (4) they analyse the speed of price transmission in specific periods, and based on the sums of these coefficients they analyse its magnitude.

According to Von Cramon-Taubadel and Loy (1996) the $\Delta P_{j,t}$ in (4) can also be split into positive and negative components to allow for positive and negative deviations from the long-term equilibrium (ECT^+ and ECT^-) to test for APT. The Error correction Model (ECM), including lagged changes in $P_{i,t}$ takes the following form:

$$\Delta P_{i,t} = \alpha + \sum_{k=1}^{k=m} \left(\beta^+ D^+ \Delta P_{j,t-k+1} \right) + \sum_{k=1}^{k-n} \left(\beta^- D^- \Delta P_{j,t-k+1} \right) + \varphi^+ ECT^+_{t-1} + \varphi^- ECT^-_{t-1} + \gamma_t \qquad (5)$$

Asymmetric transmission implies that $\varphi^+ \neq \varphi^-$

Testing of asymmetric price transmission between markets will follow three steps. In the first step, using augmented Dick-Fuller (ADF) test, the series of commodity prices in the different markets are tested for stationarity. Once stationarity is confirmed, the second step involves testing the error term in (1) between two price series for stationarity and if tests prove that (1) is not a spurious regression, then P_{it} and P_{jt} are referred to as being cointegrated and (1) can be considered an estimate of the long-term equilibrium relationship between them. In the third step, an ECM that relates changes in P_{it} to changes in P_{jt} as well as the error correction term (ECT) (the lagged residuals from the estimation of (1)) is estimated. The ECT measures deviations from the long run equilibrium between P_{it} and P_{jt}, so including it in the ECM allows P_{it} not only to respond to changes in P_{jt} but also to 'correct' any deviations from the long run equilibrium that may be left over from previous periods.

Cointegration and error correction models which utilize time series econometric analysis have been criticized as being unreliable. Recent research has focused on the application of threshold auto-regression and cointegration method developed by Balke and Fomby (1997) and Enders and Granger (1998) to address both transaction costs and price asymmetry across regional markets. Conceptually, threshold models are analogous to more conventional switching regime models, such as the parity bound models, which incorporates data on prices, volumes trades and transaction costs to distinguish autarky, arbitrage failure and efficient arbitrage among markets. In the threshold models, regime switch is triggered when a forcing variable crosses a predefined threshold between a pair of markets. Enders and Granger showed that in addition to transaction costs, these models can also address asymmetry in price adjustment.

Although this is an important improvement to market integration and price transmission analysis, these models have to rely on very restrictive assumptions that transaction costs remain constant over a certain period of time. According to Barrett (1996) transaction costs may not be constant in the long run and even be non-stationary. However, unavailability of time series data on transaction costs continues to be a serious constraint in market integration analysis. Time series models provide useful insights into market integration and price transmission while relying only on price series which is more available in developing countries. Its application therefore continues to be useful in signaling potential failures in food markets in developing countries.

2.3 Sources of Asymmetric Price Transmission

The response of prices to changes in prices in other markets is generally not instantaneous but instead is distributed over time. Perfect transmission of movement in agricultural commodity markets simply implies that price in one market is fully transmitted to price in the other market, assuming that the two markets are integrated. The idea in symmetric response is that a price decrease or increase in a markets leads to the same price change in another market. The premise of full price transmission corresponds to those of standard competition model, where the law of one price is supposed to regulate spatial price relations.

The existence of asymmetries may be related to special features of the market under consideration. According to Scherer and Ross (1990), the common source of asymmetric response is market power. In rural agricultural markets, imperfect competition allows oligopolists react collusively more quickly to shocks that squeeze their marketing margins than to shocks that raise them, resulting in asymmetric short-run transmission. Prices are expected to adjust more frequently if there is more competition. Other factors such as information asymmetry may make some market agents to behave as price makers while others remain price takers. Although only a few studies have empirically tested the link between market power and asymmetry (Meyer and von Cramon-Taubadel, 2004), there have been a variety of hypotheses to link the two.

According to Conforti (2004), transport and transaction costs often act as wedges between prices in different markets. Inadequate rural infrastructure may result in higher price differences between markets than can be attributed to the cost of moving commodities between them. Delays in transport is expected to cause asymmetries in price transmission.

3 Results

3.1 Stationarity test

Stationarity tests were applied using the model with a constant and no linear trend using Augmented Dick-Fuller (ADF) test. Tables 1 presents the results for testing for unit roots in maize and beans price series. The null hypothesis is that prices for all markets are mean non-stationary. The number of lags included in the test was selected using the Akaike's information Criterion (AIC).

Table 1 shows that ADF unit root tests for all maize and beans price levels had coefficients that were smaller than the critical value (in absolute terms). Thus the results from unit root test may not reject the hypothesis of unit roots at 5% critical level. When the price series are differenced once, they all become stationary and the null hypothesis of unit roots is rejected. Thus, the maize and beans price series for the markets under consideration are integrated of order one. This means that each of the variables is a random walk and integrated of the same order. This is a necessary but not sufficient condition for cointegration (Granger, 1986), thus the need to carry out cointegration analyses for the variables.

In the second step, cointegration regression, all the series were tested, since they all had the same order of integration, I(1). The main purpose of the cointegration analysis was to test whether the non-stationary time series price data were cointegrated or not. This test determines whether a long run relationship exists between the price series. The null hypothesis is that the markets are not cointegrated.

The test results in table 2 show that all the markets were integrated. This is not surprising since, based on economic theory one would expect commodities to move from high production (Meru south) to low production (Mbeere) regions. Maize and beans are the major staple crops grown in the region for both food and income. The importance of maize and beans to the households means that the commodity is traded across the markets in the region thus the prices tend to converge in the long run.

To test whether there were any asymmetries in price adjustment, the error correction model was differentiated among positive and negative values of the error correction term (ECT). A positive value of the error correction term implies that the observed price in a market is higher than the equilibrium price that is determined by the prices in the other markets. Therefore, a positive value of the error correction term means that the price in the market would be expected to adjust downwards. A negative value of the error correction term has the opposite interpretation.

Table 4 presents estimates for the coefficient of price adjustments between maize market pairs. The results indicate that prices in the markets respond asymmetrically to price changes in the other markets. Analysing overall price adjustment without taking the level of significance into account, most of the markets adjust their price faster to price increase than to price decreases in the other markets. The difference in upward and downward price adjustments was lower for markets that are closer to each other than those that are farther apart.

In the case of makima, asymmetric price changes occur when the actual price is below equilibrium as determined by the price in Siakago and Kathwana and above equilibrium for Itugururu. The prices would therefore be expected to exhibit an upward adjustment in the following week for siakago and kathwana and a downward adjustment for Itugururu. The price of maize in Makima market being lower than expected with respect to kathwana is the most responsive relationship with a 35% upper adjustment of the error correction term. The coefficients for the other price adjustment are not significant.

At Ishiara, Karaba and kiritiri markets, prices adjust faster to price increase than decrease. Responding to changes in prices at Kathwana market, the price in ishiara adjusts upwards by 19% and downwards by 13% of the ECT in one week respectively. The prices in Kiritiri adjusted downwards by 20% in the following week as predicted by Itugururu market and upwards by 30%. The lower difference between upward and downward adjustments between Kathwana and Ishiara could be due to the relatively shorter distance between the two markets.

Asymmetric price changes did occur within the beans prices. Results in table 5 indicate that analyzing overall price adjustments without taking significance into account, retail beans prices in most market pairs adjusted faster to price increases than to price decreases in the adjusting markets.

Karaba and Itugururu markets had all their upward price adjustments being faster than downward price adjustments. At Karaba market, the upward retail price of beans adjustment is most responsive relationship with respect to changes in Kaanwa prices at 12% which almost doubles the 7% of ECT that it adjusts downwards in one week. This relationship is reversed for the case of Kiritiri, Kaanwa and Magutuni, where beans markets adjust their prices faster with respect to price decreases in other markets than to price increases.

Makima, Ishiara, Kathwana and Chuka markets had mixed price adjustments depending on the adjusting markets. As table 5 shows, beans retail prices in Ishiara adjust upwards by 10% and downward by 11% in response to price changes in Kaanwa. At the same time, Ishiara prices adjust upwards by 19% and downwards by 9% in response to changes in Magutuni prices. The mixed price adjustments for beans may be attributed to increased competition from other legumes produced in the area.

4. Conclusion and Implications

A fundamental issue when analyzing reforms in the agricultural markets is the extent to which agricultural commodity markets respond to changes in prices. This study sought to analyze the extent of efficiency of food markets by considering long term price movements between markets in the highlands of central Kenya. Price transmission between markets is central in understanding the extent of integrating economic agents into the marketing process.

The study sought to explore the non-linearity in the price transmission in the maize and beans markets. An ECM differentiated among positive and negative values of the ECT was used to support the hypothesis of sticky prices in the sense that food markets show greater response to rising prices than to falling prices between them. The study addresses major concern of policy makers: ensuring income for food producers and food availability for deficit producers and urban consumers.

Time series analysis of price data was used to establish comovement of prices between markets. The results show incidences of market efficiency measured through market integration. ADF tests indicated non-stationarity for the maize and beans price series. Cointegration tests showed cointegration between all the maize and beans markets in the highlands of central Kenya.

The evidence presented in the study, using bi weekly retail maize and beans prices strongly supports the asymmetric price responses hypothesis. The results also show that different speeds in price responses between market pairs was much higher for markets that are far apart than those that are closer to each other. Comparing the two commodities, mixed price responses were observed mostly for beans. This may be due to the fact that the region produces other legumes such as cowpeas and greengrams which substitute beans in consumption thus increasing competition. Policy options should therefore ensure that participation of both the government and private sector is enhanced in order to develop efficient rural food markets and enhance their integration.

Given the growing number of traders, the findings imply that an enabling environment for traders may enhance their ability to carry out market activities more efficiently. Policies aimed at building local institutions e.g. banks, information points etc, to facilitate access credit and information will play an important role. Access to credit may encourage new entrants thereby increasing competition. Provision of credit could also assist existing traders to expand the transaction volumes and geographical coverage. This when augmented with an efficient market information system will facilitate spatial distribution of commodities from production to demand zones thereby stabilizing prices.

Even with reduced involvement in markets, the government has the responsibility of providing adequate infrastructure to support market activities and reduce transaction costs e.g. transport and communication infrastructure, storage and market facilities, weights and measures equipment. The strategic plan for agriculture should focus primarily on improving efficiency through the whole value chain so that it can become a competitive consumer driven sector.

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Table 1 unit root test for maize and beans price series

Market	Test statistic (levels)		Test statistic (differences)		I(d)
	Maize	Beans	Maize	Beans	
Makima	-0.073	-1.871	-5.227	-6.673	1
Kathwana	-0.217	-2.864	-5.851	-6.412	1
Karaba	-1.257	-1.615	-5.437	-7.011	1
Siakago	0.075	-2.137	-4.075	-6.409	1
Kaanwa	-2.584	-3.077	-7.283	-5.79	1
Kiritiri	-1.064	-1.492	-6.677	-6.349	1
Magutuni	-1.781	-2.269	-5.522	-6.722	1
Itugururu	-1.309	-2.141	-5.061	-6.809	1
Chuka	0.176	-2.858	-5.51	-5.617	1
Ishiara	-0.133	-1.262	-6.278	-6.017	1
5 % Critical levels	-2.904		-2.905		

Source: Author's computations

Table 2: Unit root tests for OLS residuals for maize

	siakago	karaba	makima	ishiara	kiritiri	kathwana	magutuni	chuka	kaanwa	itugururu
siakago	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
karaba	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
makima	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
ishiara	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
kirtiri	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
kathwana	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
magutuni	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
chuka	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
kaanwa	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
Itugururu	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject

Source: Author's computations

Table 3: Unit root tests for OLS residuals for beans

	siakago	karaba	makima	ishiara	kiritiri	kathwana	magutuni	chuka	kaanwa	itugururu
siakago	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
karaba	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
makima	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
ishiara	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
kirtiri	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
kathwana	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
magutuni	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
chuka	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
kaanwa	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject
Itugururu	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Reject

Source: Author's computations

Table 4: Asymmetric price transmission in the maize market

Significance of positive and negative values of ECT determining asymmetric price relationship: Dependent variable is change in price										
	Makima	Ishiara	Karaba	Kiritiri	Siakago	Kathwana	Kaanwa	Magutuni	Itugururu	Chuka
Makima ECT +		-0.072**	-0.06	-0.079		-0.111	0.061*	0.026	-0.176**	-0.147
Makima ECT -		-0.005	0.047	-0.097**		0.993***	-0.007	0.077	-0.21**	-0.051
Ishiara ECT+			-0.024	0.044		-0.043	0.009	-0.015	0.024	
Ishiara ECT-			-0.059	-0.048		0.009	-0.003	0.116***	-0.06	
Karaba ECT +	-0.014	-0.06			0.068**	0.009	0.014	0.01	0.084*	0.012
Karaba ECT -	0.075	0.098**			-0.048	0.04	-0.021	0.003	0.016	0.019
Kiritiri ECT +	0.076	-0.072*	-0.031		0.118*	0.08	0.058*	0.044	-0.005	0.068
Kiritiri ECT -	0.026	0.035	0.07		-0.089	-0.059	0.03	0.025	0.046	-0.051
Siakago ECT +	-0.15	-0.067	0.018	-0.057		-0.235*	0.011	-0.071	-0.06	-0.066
Siakago ECT -	0.337*	0.027	-0.1***	-0.059		0.244	0.009	0.185***	-0.32***	-0.034
Kathwana ECT+	-0.104	-0.127**	-0.011	0.083	0.096		0.034	-0.024	-0.047	0.272
Kathwana ECT-	0.349**	0.186*	-0.082**	-0.185**	-0.105		-0.005	0.109**	-0.251***	0.107
Kaanwa ECT +	-0.02	-0.015	-0.009	-0.008	-0.113**	-0.054		0.403***	0.081*	-0.098**
Kaanwa ECT -	0.037	0.021	-0.01	-0.024	0.073	0.074		-0.211**	-0.167**	0.12*
Magutuni ECT +	0.014	-0.029	0.002		-0.073	-0.023	0.133		0.025	-0.042
Magutuni ECT -	-0.057	0.033	-0.025*		-0.003	-0.02	-0.22***		-0.221***	0.003
Itugururu ECT +	0.192***	-0.027		0.197*	0.391***	0.029	0.011	0.074**		0.036***
Itugururu ECT -	0.068	-0.017		-0.3***	-0.116	-0.047	0.089**	0.084**		0.314**
Chuka ECT +	-0.241	-0.094			-0.05	-0.549***	0.014	-0.014	0.128	
Chuka ECT -	0.192	0.043			-0.016	0.197	-0.006	0.103**	-0.351***	

***1% significance, **5% significance, *10% significance

Source: Author's computations

Table 5: Asymmetric price transmission in the beans market

Significance of positive and negative values of ECT determining asymmetric price relationship: Dependent variable is change in price										
	Makima	Karaba	Siakago	Kiritiri	Ishiara	Kathwana	Kaanwa	Magutuni	Itugururu	Chuka
Makima ECT +		-0.022	0.06	-	-0.202***	-0.046	-	-0.002	-0.051	0.033**
Makima ECT -		-0.03	-0.223*	-	0.07	-0.008	-	-0.013	-0.036	-0.062**
Karaba ECT +	-0.215***		-0.074	0.01	0.085	0.015	0.125***	0.007	-0.044	-0.024
Karaba ECT -	0.186***		-0.02	-0.014	-0.165**	-0.053*	-0.013	-0.03	-0.032	0.035
Siakago ECT +	-0.1	-0.054		0.021	-0.061	-0.1	0.105***	-0.044*	-0.048	0.08***
Siakago ECT -	-0.039	0.085		-0.012*	0.003	-0.039	-0.016**	0.044	0.03	-0.137**
Kiritiri ECT +	0.004	0.011	0.01		-	-0.154**	-	0.073*	0.005**	0.11***
Kiritiri ECT -	0.006	0.008	-0.008		-	0.096*	-	-0.042	-0.013***	-0.089*
Ishiara ECT+	0.139***	0.07	0.079*	-0.061**		0.014	0.043*	0.031	0.051**	-0.006
Ishiara ECT-	0.003	0.044	-0.015	-0.004		0.007	-0.035**	-0.047	-0.059**	0.007
Kathwana ECT+	-0.004	-0.061	0.045	0.009	0.032		-	0.023*	0.013	0.035**
Kathwana ECT-	0.051	0.115**	0.045	-0.001	-0.05		-	-0.009	-0.034	-0.018
Kaanwa ECT +	-0.012	-0.07**	-0.007	0.002	0.115***	0.582***		0.004	-0.014	-0.01
Kaanwa ECT -	0.024***	0.124***	0.017*	-0.003	-0.104*	-0.132**		-0.003	0.045	0.035
Magutuni ECT +	-0.039	0.024	0.009	-0.094	-0.093**	0.009	-		0.019	-0.05
Magutuni ECT -	0.018	-0.005	0.014	0.057	0.194***	-0.012	-		-0.042	0.107*
Itugururu ECT +	0.041	-0.032	0.046	-0.004	-0.033	0.029	0.136***	-0-046		-
Itugururu ECT -	-0.031	0.048	-0.055	0.003	0.031	-0.032	-0.011	0.059		-
Chuka ECT +	-0.016	-0.011	-0.001	-0.11*	-0.005	-0.057***	0.242***	0.018	-0.014	
Chuka ECT -	0.009	0.0003	0.026	-0.011	0.008	0.005	-0.023*	-0.045	0.016	

***1% significance, **5% significance, *10% significance

Source: Author's computations