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Spatial price transmission under different policy regimes: A case of maize markets in Kenya

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Abstract:

The aftermath of the high energy and unstable market crises globally was the unprecedented volatile and high food prices experienced throughout the Eastern and Southern Africa (ESA) region. Most governments implemented a wide range of policy instruments to mitigate and insulate domestic markets against this price hikes. Despite insulation of the domestic market, high food prices have continued unabated. Raising the question are these policies effective. The success of the policy is dependent on the government ability to implement the specific policy. Implementation of most policies in the ESA region may be described as erratic, highly discretionary, inconsistent, unexpected and sudden hence leading to policy failure and market distortion.

Domestic factors and to some extent, regional factors play an important role in determination of price as opposed to international market as most country within the region are either self-sufficient or almost self-sufficient in staple foods. The aim of this study was to examine the different policy regimes implemented to mitigate against high food crises and their effects on spatial price transmission on domestic markets. .

The results demonstrates evidence of long-run relationship and cointegration between surplus and deficit market under regime with little or no policy intervention. Under this regime, there was higher price transmission, faster correction in price shocks as illustrated by higher speed of adjustment and lower half-life between surplus and deficit markets. Low price transmission, price shocks taking longer to correct as illustrated by low speed of adjustment and higher half-life were observed under different policy regimes.

JEL Classification: C22,D43,L13,R32,Q18

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Introduction

The international markets witnessed food price hikes in 2007/08. This was due to high-energy prices and global market instability since these two factors influences international price formation (Tadesse et al. 2014). Food riots, emergency food aid, increase in the incident of hunger, malnutrition and food insecure population were some of the manifestation of the price hikes witnessed in developing economies. To mitigate and insulate domestic markets against this price hikes most countries implemented a wide range of marketing and trade policy instruments, such as input subsidies, export bans, import tariffs and export quotas among others. These policy instruments were aim at stabilizing domestic prices. The achievement of the policy implementation hinges on the government ability to implement the specific policies. An example is the implementation of the import tariff to stabilize domestic price, it has succeeded in some country and failed in others as noted by D'Hotel et al. (2013). The failure of policy in ESA region can be attributed on nature of implementation. Chapoto and Sitko (2014) have described the implementation as, erratic, highly discretionary, inconsistent, unexpected and sudden. The authors argued when government implement policies in the described manner they do not achieve their intended goals and the policies have ended up distorting the markets.

Despite a decline in the global food prices, most countries in the ESA region have continued to face unabated high and unstable food crises since 2008 as noted by Minot (2014). Reasons advanced for these phenomena is most countries in the region are either self-sufficient or almost self-sufficient in food staples. Domestic factors (supply and demand shocks, macro-economic, policy shocks etc.) and to some extent, regional factors play an important role in determination of price. As a result, these markets are weakly cointegrated to the international food staple markets.

The agricultural sector operated freely with minimal or no government intervention following liberation in early 2000. This situation was reversed following the global food crises and the subsequent unstable and high food prices experienced in the region. Most governments became more involved in the sector through implementation of marketing and trade policy instruments as a measure of stabilizing prices. Studies undertaken to test for spatial market price co-movement has majorly focused on threshold and asymmetrical adjustment. The focus of these two methodologies has been on effects of transfer costs (transport and marketing costs) on price transmissions missing the significant effects of policy on price transmission

The implementation of policy instruments by the Kenyan government to mitigate against high and unstable food price provides an opportunity to study policy effects on spatial price transmission in the past decade and address shortcoming of the threshold and asymmetrical adjustments. The goal of these this paper is to understand the effects of the different policy regimes implemented to mitigate against the high food crises and their effects on spatial price transmission.

The rest of the paper is organized as follows. Section 2 discusses the different policy regimes, section 3 describes the data and the economic framework section 4 presents the findings and section 5 concludes.

2. Policy Regime

To understand how the policy regime affected the price transmission, we split the sample into four-policy regimes. The first regime comprises of the period following liberation. This period was characterized with minimal or no policy interventions from government. The other three policy regimes coincided with different policy instrument implemented by the government to mitigate against high and unstable food prices. The second regime covers the fertilizer subsidy program, the third regime covers the government ban on imports of genetically modified foodstuffs and the final policy regime covers the zero rating of the import tariff on maize.

Regime 1- Liberalization of maize sector (January 2000-November 2008)

Covers the period immediately after liberalization. This era was characterized by minimal or no policy interventions. The National Cereal and Produce Board (NCPB) a state marketing board for grain was restructured and its non-core functions (selling inputs, maize purchases) commercialized while maintaining its core function of maintaining the country strategic grain reserves (SGR). The Board’s role in the purchase of market surplus declined to 25 % compared to over 45% during pre-liberalization era. The era witnessed increase in private sector participation along the maize value chain resulting in low concentration, competition and lower maize price. Real maize prices under this era as shown on Figure 2.1 are generally on a down ward trend. They dip around 2000 and are on an upward trend and peak around 2004 but these prices are lower than pre 2000 period. The prices are on a downward trend towards 2007. Prices appear to co-move together across all markets except for Garissa market. Garissa market did not appear to co-move with the other markets between 2000 and early 2005. Later in 2005 and subsequent months it appeared to co-move with rest.

Regime 2 – Fertilizer subsidy (November 2008-December 2016)

Farmers in Kenya have been faced by high input costs especially fertilizer. The global financial market and high-energy crises of 2007/08 exacerbated the situation as the fertilizer prices recorded the highest they have ever been in the country during this period. The government implemented a fertilizer subsidy program whose aim was to stabilize fertilizer prices, stimulate production and reduce consumer prices. The fertilizer subsidy program has been operating together with the commercial private sector driven value chain. In most cases, when these two distribution channels exists, commercial value chain is affected negatively by public managed distribution (Ricker-Gibert et al. 2013). In Kenya, distribution of the subsidised favours large-scale farmers, as NCPB depots are located in major town (Opiyo et al. 2015). Therefore, the crowding out effect of the private sector is not very clear. Liverpool-Tarsie, 2014 argued that the level of distortion might not be very clear since it’s based on targeting size, timeliness and administrative efficiency. Under this regime, there was co-movement of prices across the different market. Trend on price on price movement volatility as shown on Figure 2.1. The national fertilizer requirements, quantity procured, quantity subsidized and the costs of subsidy are summarized in Table 2.1. The average annual national fertilizer requirement is about 534,000 metric tons of which 74% is procured. The Treasury has increase the amount of money allocated for subsidy by 175% between 2008/09 and 2014/15. Despite the increase in funds, on average only 20% of the procured fertilizer was subsidized.

Table 2.1 Quantity of fertilizer procured by the Government under the fertilizer cost reduction initiative 2008-2014

Year	Total fertilizer requirement (MT)	Fertilizer procured (MT)	Subsidized fertilizer (MT)	% fertilizer procured	% subsidized fertilizer	Treasury allocation (KES Millions)
2008/09	500,000	380,000	45,600	76	12	1,241
2009/10	503,784	384,406	16,624	76	4	758
2010/11	505,489	365,561	96,000	72	26	2,995
2011/12	539,910	387,401	94,155	72	24	3,320
2012/13	542,780	379,946	62,276	70	16	3,150
2013/14	568,600	431,680	171,750	76	40	3,900
2014/15	582,320	442,563	79,661	76	18	3,422

Source Ministry of Agriculture, Livestock and Fisheries 2016

Regime 3 –Genetically Modified Organism (GMO) import bans for all food stuffs (November 2012-December 2016)

Following the finding of the Seralini study released in 2012 by French University that linked cancer in rats to the consumption of GMO food. The Kenyan Medical Research Institute (KEMRI), an Institute under the Ministry of Public Health and Sanitation (MPHS) concurred with the study findings and advocated for the ban of the importation of GMO food into the country. In November 2012, the government through the Department of Public Health (DPH) banned importation of GMO foodstuff.The ban came as a surprise to the National Biosafety Authority (NBA) the regulatory institution that deals with GMO in the country. The authority indicated there was no consultations among stakeholders of which DPH is a member. The ban was counterproductive given the progress Kenya had made in the GMO field. The Department justification of the ban was that it was exercising its mandate of safeguarding consumer health by ensuring products that could harm consumers as shown by the Seralin study were not being imported into the country. The implication of the ban meant that Kenya could not import maize from country that do not label their GM products (USA and South Africa). Under this regime, the real maize prices appear to co-move across all the markets and are on a decline from spikes in 2011/12 when the country experienced drought and had to import maize from overseas as shown on Figure 2..

Regime 4-Zero rating of the import tariffs (November 2008-December 2009 and June-December 2011)

Kenya mainly sources its maize deficit from the region especially Tanzania and Uganda market during normal season. The country turns to the international markets during drought period when imports from the region are not adequate. Import tariff on maize coming from outside the Common Market for Eastern and Southern Africa (COMESA) region attracts an import duty of 50%. Hence, the Treasury with recommendation from the Ministry of Agriculture, Livestock and Fisheries (MOALF) wiaver these duty to allow for importation of maize. Under this regime, maize prices peaked in 2008/09 which started declining and dipped in September 2008 before increasing and then declining towards December 2011 as shown on Figure 2.1.

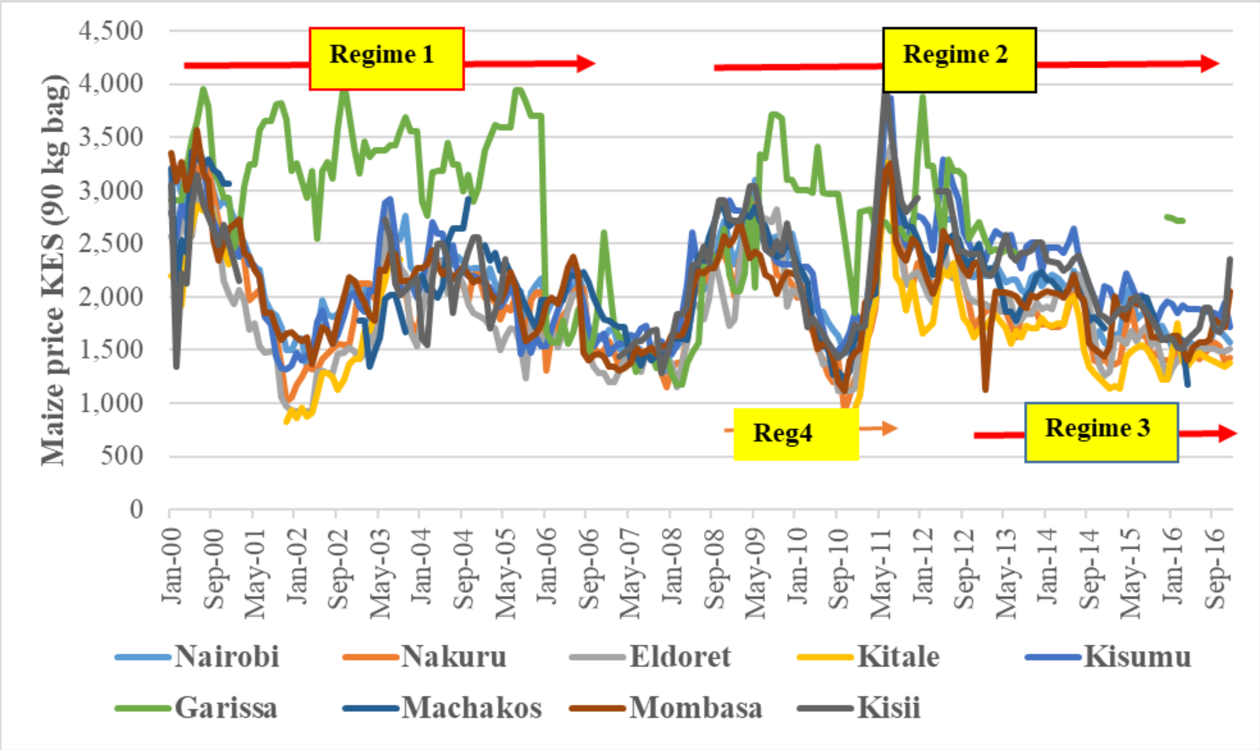

Figure 2.1: Real maize price trends across surplus and deficit markets under different policy regimes

3. Data and econometric framework

The study utilized monthly maize price data from nine domestic markets sourced from the Ministry of Agriculture, Livestock and Fisheries (MOALF). The domestic market comprises of, two surplus market (Eldoret, Kitale) and seven deficit markets (Kisumu, Mombasa, Nakuru, Garissa, Machakos, Kisii and Nairobi). The data covered the period between January 2000 and December 2016. The consumer price index (CPI)[1]was used to deflate nominal price. Investigation of spatial price transmission have mainly focused on asymmetric adjustment and threshold methodological approaches. The assumption in most thresholds approach is arbitrage is triggered when the long-run equilibrium exceed the threshold thus bringing the price back to equilibrium (Balke and Fomby, 1997). For asymmetric adjustment, the main concern is the difference in adjustment parameters that depends on the sign of deviation from the long-run equilibrium. Shortcoming in both approaches is that they do not give policy instruments adequate consideration when analysing spatial price transmission mechanism. Two approaches have been applied when analysing the effects of policy interventions. The first approach has been the use of dummy variable to account for policy changes in cointegration models while the second is splitting the sample into sub-sample

[1] The CPI base year used was February, 2009

based on policy regime (Yang et al. 2015). For this paper, we use the second approach and split the data into four regimes.

In the analysis of time-series data, prices are often non-stationary, implying they will drift randomly rather than return to a mean value. They become stationary when we take the first difference (integrated to degree of order one-I (1)). When we have two prices that are integrated to the order of one-I (1) and the linear combination of one of them is I (0) the said prices are co-integrated. From a standard vector auto-regression (VAR) model, we can derive VECM as follows

$$P_t = A_0 + A_1 P_{t-1} + A_2 P_{t-2} + \quad \dots \dots + A_k P_{t-k} + \varepsilon_t \qquad (3.1)$$

P_t represents a vector of endogenous prices for deficit and surplus market prices, $P_t = \begin{pmatrix} P_t^d \\ P_t^s \end{pmatrix}$, A_t are matrices of unknown parameters while ε_t are error term. Taking the first difference of equation 3.1 it can be rewritten as

$$\Delta P_t = \pi_0 + \pi_1 \Delta P_{t-1} + \qquad + \pi_{k-1} \Delta P_{k-1} + \pi P_k + \varepsilon_t \qquad (3.2)$$

where $\pi_0 = A_0, \pi_i = -\left(1 - \sum_{j=1}^{k=1} A_j\right)$ and $\pi = -\left(1 - \sum_{j=1}^{k} A_j\right)$

The rank of π provides the basis of establishing presence of co-integration. When the rank (π)=0, the prices are not co-integrated and the model is equivalent to a VAR in first difference, if the (π)=2, the prices are stationary and the model is equivalent to a VAR in level, if (π)=1, the prices are co-integrated. The vector π can be decomposed as π=αβ', where α is the matrix of the speed of adjustment coefficient and β is the co-integration vectors. The long-run disequilibrium term for VECM for one lag is expressed as follows:-

$$\Delta P_t = \alpha \beta' P_{t-1} + \sum_{i=1}^{k-1} \pi_i \, \Delta P_{t-1} + \varepsilon_t \qquad (3.3)$$

Our long run relationship will be expressed as follows as P_t has two prices for the deficit and surplus markets

$$\beta' P_{t-1} = [\beta_0 \beta_1 \beta_2] \begin{pmatrix} P_{t-1}^d \\ P_{t-1}^s \end{pmatrix} = \beta_0 + \beta_1 P_{t-1}^d + \beta_2 P_{t-1}^s = Z_{t-1} \qquad (3.4)$$

where the term Z_{t-1} is a stationery process when normalized with respect to β_1. We can express the long-run spatial price relationship as

$$P_t^d = \lambda + \beta P_t^s + \nu_t \qquad (3.5)$$

where $\lambda = \beta_0/\beta_1$ *and* $\beta = \beta_2/\beta_1$. Therefore, β measures the long-run equilibrium relationship. Since our prices are expressed in logarithms, then β in our case represents long-run price transmission elasticity to the deficit market from the surplus markets. When β is close to 1 then markets are well co-integrated and price fluctuation from surplus market is completely transmitted to the deficit markets. The VECM is expressed as follows

$$\Delta P_t^d = \alpha \nu_{t-1} + \sum_{j=1}^{k} \vartheta_{ij} \Delta P_{t-j}^d + \sum_{j=1}^{k} \vartheta_{ij} \Delta P_{t-j}^s + \varepsilon_i \quad (3.6)$$

VECM takes into account that the change in price in the deficit market P_t^d are a factor of changes in P_t^d, P_t^s and disequilibrium in the previous period of the two prices represented by ν_{t-1} in our equation 3.16. Typically -1< α < 0, the negative value of the α usually help to revert the price back to the long-run equibrium. If α is close to -1 we can imply that short-term disturbances can quickly return to equilibrium and the two markets are closely interlinked. The coefficient change in the surplus market ϑ_{ij} is the short –run elasticity of deficit price relative to surplus price. The half-life represents the time required for a given shock to return to half its initial value. This computes as $hl = \ln(0.5) / \log(\alpha)$.

4. Results and discussions

Our price data is non-stationary at level and becomes stationary of first differencing (integrated to degree of order one-I (1)). Thus, pairwise co-integration test was carried out between the surplus and deficit markets using the Johansen's maximum likelihood vector auto-regression approach (Johansen and Juselius, 1990). We use the logged wholesale maize prices for our markets. To determine the lag order for the Johansen co-integration test, we first estimate the unrestricted vector auto-regression model using the two pairwise markets. From the results, we use the lag structure to get the lag order selected by the following criterions, Akaike information criterion (AIC), Schwarz information criterion (SC) and Hanna-Quinn information criterion (HQ). The co-integration test statistics for the surplus and deficit pairwise markets for the full sample and different regimes are summarized on Table 3.1. Eldoret and its respective pairwise markets are cointegrated across all the markets for the full sample. It is cointegrated with most markets across the four regimes with slight differences. Kitale and its respective deficit markets shows cointegration with all market for the full sample, only two under regime one, two under regime three, none in regime four and almost all under regime two.

Table 3.1: Pairwise cointegration tests for surplus and deficit markets across the different policy regimes

Markets	Full sample		Regime 1		Regime 2		Regime 3		Regime 4	
	Obs	**Trace test**	**Obs.**	**Trace test**	**Obs.**	**Trace test**	**Obs.**	**Trace test**	**Obs.**	**Trace test**
Eldoret-Nakuru	204	49.157***	94	20.768***	99	41.485***	50	32.578***	21	25.788***
Kisii	153	52.072***	48	23.533***	96	36.354***	49	16.344**	21	18.233**
Kisumu	204	46.853***	94	20.182***	99	24.705***	50	22.838***	21	14.136
Machakos	167	38.534***	73	20.289***	85	26.767***	35	8.861	21	18.817**
Garissa	170	19.161**	98	7.58	65	15.043	15	16.911**	21	12.666
Nairobi	204	42.320**	94	11.656	99	33.845***	50	18.434**	21	23.197***
Mombasa	204	47.276***	94	17.671**	99	37.669***	50	29.683***	21	12.686
Kitale-Nakuru	108	31.509***	35	20.786***	73	23.592***	49	16.385**		
Kisii	89	22.566***	16	16.871**	70	18.815**	49	9.660		
Kisumu	108	17.724**	35	14.708	73	15.755**	49	13.053		
Machakos	80	22.646***								
Garissa	74	17.300**	35	12.52	39	15.269**	19	11.75491		
Nairobi	108	36.382***	35	11.97	73	26.467***	49	15.67**		
Mombasa	108	33.060***	35	7.028	73	24.064***	49	13.304		

Asterisk ******* and ****** signifies rejection of the null hypothesis (no co-integration vector) at 1% and 5% significant level respectively

To investigate the long-run relationship between our markets, a VECM was applied on the surplus and deficit pairwise markets. The results are illustrated on Table 3.2. For Eldoret and its deficit, pairwise market when there is 1% increase of maize price in Eldoret market. Under regime one, 0.8% of this price will be transferred to Kisii and 1.9% to Machakos with a speed of adjustment of 0.78 and 0.25 respectively. The half-life under this regime is 0.5 and 2.4 months for Kisii and Machakos respectively. Under regime four, when maize price in Eldoret market increased by 1%, 0.1 % of this price will be transferred Kisii and 0.1% to Machakos with a speed of adjustment of 0.11 and 0.09 respectively. The half-life under this regime is 5.9 and 11.2 months respectively. For Kitale and its respective deficit markets, when we increase maize price in Kitale market by 1%, under regime one, 0.1% of this price will be transferred to Garrissa and 0.1% to Nairobi with a speed of adjustment 0.57 and 0.64 respectively. The half-life under this regime is 0.8 months for both Garrissa and Nairobi. There is no long-run relationship for regime two and four respectively. We may attribute this to distortion from policy instruments implemented. Eldoret, Kitale and their respective deficit markets show a higher price transmission in regime three compared to two and four. Regime three coincided with the import ban on GMO foodstuffs. The country relies on imports from the region and occasionally imports from overseas during drought. Under this regime, no imports have been sourced from overseas hence application of the ban. There is evidence of low price transmission, price shocks taking longer to correct as illustrated by low speed of adjustment and higher half-life with policy implementations.

Table 3.2: Spatial price transmission of maize under different policy regime

Sample	Markets	Long-run relationship	Speed of adjustment	Half-life
Full sample	Eldoret-Nakuru	0.95**	-0.18***	3.5
	Kisii	0.97**	-0.16**	3.9
	Machakos	1.95**	-0.16***	4.1
	Nairobi	0.83**	-0.17***	3.8
	Mombasa	0.79**	-0.16***	3.9
	Kitale- Kisii	1.25**	-0.22***	2.3
	Garissa	0.14	-0.29***	2
	Mombasa	0.72**	-0.23**	2.7
Regime 1	Eldoret-Kisii	0.8**	-0.78***	0.5
	Machakos	1.9**	-0.25***	2.4
	Kitale-Kisii	0.17	-0.55**	0.9
	Garissa	0.09**	-0.57***	0.8
	Nairobi	0.06**	-0.64**	0.8
Regime 2	Eldoret-Nakuru	1.06**	-0.30**	1.9
	Garissa	0.12	-0.31**	1.9
	Nairobi	0.90**	-0.20**	2.9
Regime 3	Eldoret-Nakuru	0.8**	-0.74***	0.5
	Mombasa	0.5**	-0.82***	0.4
	Kitale-Nakuru	0.8**	-0.33**	0.6
Regime 4	Eldoret-Kisii	0.1**	-0.11**	5.9
	Machakos	0.09**	-0.06**	11.2
	Mombasa	1.56**	-0.26***	2.3

*** and ** denotes significance at 1% and 5% significant level respectively with the t-values of the speeds of price adjustment given in the brackets and is the estimated adjustment speed in the outer regimes. The half-lives of price adjustment for the producer and consumer markets respectively, are measured in months $hl=\ln(0.5)/\ln(\alpha)$

5.0 Conclusion and policy recommendations

Results from the study indicate policy implemented affects spatial price transmission and market integration. There is evidence of long-run relationship and cointegration between surplus and deficit market under regime with little or no policy intervention. Under this regime, there is higher price transmission, faster correction in price shocks as illustrated by higher speed of adjustment and lower half-life between surplus and deficit markets. Under policy implementation there was low price transmission, price shocks taking longer to correct as illustrated by low speed of adjustment and higher half-life.

Given the effects of policies on spatial market transmission, it is important for the government to be cognisant of the counterproductive nature of the policies it has implemented in addressing the high food price dilemma. Proper consultation and coordination between MOALF and Treasury on the removal of import duty on maize will ensure timely implementation to achieve desired effects. A Review of the GMO ban is suggested so that the country can benefit from cheaper GMO maize from South Africa and other countries , rather than importing expensive non- GMO maize from overseas. The effects of the ban may not have been felt in the period under review as the country relied on imports from neighbouring countries.

The government should consider partnering with commercial distributors to utilize their extensive network for effective and timely distribution subsidized fertilizer to small-scale farmers in remote area.

The aim of the study was to empirically examine the different policy regimes implemented to mitigate against high food crises and their effects on spatial price transmission. The study also addressed the shortcoming of threshold and asymmetrical adjustment approaches where policy effects are omitted.

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