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The Effect of Fuel Prices on Food Prices in Kenya

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ABSTRACT

High food prices are one of the major risks facing households from developing countries. Food prices have attracted renewed interest among policy experts in identifying appropriate policy instruments to counter the effect of price vulnerability. This paper evaluates the effect of fuel prices on food prices by testing for Granger causality and cointegration applied to diesel, maize, beans, cabbage, and potatoes price data for the period 2010-2018. The results revealed a unidirectional Granger causality running from diesel prices to cabbage and potatoes prices but there was no causal relationship with maize and beans prices. The findings suggest that there is a long-run price relationship between perishable foods and fuel prices with an increase in the price of diesel resulting in a significant increase in the price of cabbages and potatoes. The study recommends a policy of cushioning an increase in food prices by introducing a tax relief once the fuel price hits a certain level.

Keywords: Food Prices, Fuel prices, Cointegration, Granger Causality
JEL Classifications: Q48, Q43, Q13

1. INTRODUCTION

Households in developing countries are increasingly facing high food prices. This has a negative effect on their consumption and investment patterns. Poor urban consumers suffer more as they have to spend a large share of their income on food, yet an unusual price increase forces them to resort to negative coping strategies like reducing variety and quality, or, in extreme cases, simply to starve (Kimani-Murage et al., 2014). Lagi et al. (2011) reported that food prices are the precipitating condition for social unrest in North Africa and the Middle East in the year 2011 as well as earlier riots in 2008 which coincided with large peaks in global food prices. Rashid (2007), Gilbert (2010), and Torero (2016) have identified the most common causes of food price volatility as climatic factors, infrastructure, policy shocks, and exchange rate uncertainty.

Co-movement between oil prices and agricultural commodity prices is widely believed to occur in many circumstances. The worldwide surge in food crop prices occurred at about the same time as a similar surge in the price of crude oil, raising the suspicion that oil and food crop prices have become more closely linked in recent years (Tyner, 2010, Nazlioglu and Soytas, 2012). High oil prices can increase market demand for corn that can be converted to biofuel for use in industrialized economies. Oil is one of the most important inputs used in the food production sector. Oil is used to produce fuel for agricultural machines such as tractors and pumps. Furthermore, post-production, changes in oil prices, and eventually fuel prices can lead to changes in the prices of food products due to the changes in transport costs. This has raised the suspicion that an increase in oil prices will lead to changes in production and transport costs and this will trickle down to the farm output and overall profitability of an agricultural venture (Dillon and Barrett, 2016). However, the effects are often mitigated through subsidies and other policies that help cut down some of the costs (Gardebroek and Hernandez, 2013, Nzuma, 2013).

Before the liberalization of the oil sector in Kenya in 1994, the petroleum sector was marked by relatively high direct governmental participation and a low-level private sector involvement (Mecheo and Omiti, 2003). Though more players gained entry into the sector after liberalization, the domestic market still had characteristics that foster the rise and sustenance of a cartel-like behavior. Activities by independent petroleum dealers were still limited (Indetie, 2003) to the extent that four of the major petroleum market players controlled about 80% of the market (Republic of Kenya, 2006, Kojima et al., 2010). Since their operations and investment in the petroleum industry had an impact on the whole economy, directly and indirectly, the government saw the need to have a controlling hand in the sector.

The Energy Act enacted in 2006 laid the foundations of regulations of the petroleum sector in Kenya by putting together all laws relating to energy policies under one regulatory body, the Energy Regulatory Commission (now known as the Energy and Petroleum Regulatory Authority - EPRA). Given that the market structure of the petroleum industry could facilitate cartelization, this spurred the enactment of Price regulation in December 2010 to control the petroleum sector. The EPRA publishes monthly, maximum pump prices of petroleum products in the country. The said prices are set based on c.i.f. (cost insurance and freight), crude oil price, and transportation costs within the country, retailers' and wholesalers' margins, and refining fees. The final retail prices also include various government taxes and levies which constitute about 40% of the total retail price.

In Kenya, the transport sector is the largest consumer of petroleum products accounting for approximately 68.7% of the total volume of petroleum fuels followed by aviation and power generation while agriculture accounts for 1.05% (KNBS, 2017). Thus a significant increase in fuel prices will crucially affect the price of the transported food. Evidence shows that food prices in Kenya have been rising consistently (Nzuma, 2013). This steady rise can be attributed to unfavourable weather patterns and the increasing cost of agricultural production. Where fuel-dependent inputs are involved, this places the agricultural sector at a position that is dependent on fuel. According to a study conducted in East Africa, a 1% increase in oil prices globally has the potential to cause a 0.26% increase in the price of maize (Dillon and Barrett, 2016).

An increase in oil prices would result in an increase in all the associated costs of production, processing, and transportation of food products. To offset the increased cost, prices of the products will be raised. However, this price change is limited to the extent to which fuels are used in agriculture. This means that a farm that is not fuel-intensive could have a minimal production cost that is directly affected by the changes in oil prices. With this in mind, Baumeister and Kilian (2014) suggested that although oil prices and food prices are somehow correlated, the transmission of oil price changes to the changes in food prices is limited. Mueller et al. (2011) assert that the high grain prices in 2008 were not caused by increased biofuel production, but as a result of a speculative bubble related to high petroleum prices, a weak US dollar, and increased volatility due to commodity index fund investments.

While input and transportation costs continue to affect the prices of food, the potential impact of the price relationship between the latter and oil has already proven to be great in many circumstances. Changes in oil prices have been shown to lead to changes in commodity prices, food included (Aghalith, 2010; Chen et al., 2010; Gardebroek and Hernandez, 2013; Dillon and Barrett, 2016). This means that price transmissions between fuel and agricultural produce prices require more investigation in order to fully comprehend the underlying mechanisms and make guided policy. This study aims to investigate the link from diesel to food prices in Kenya and to examine the transmission of petroleum price shocks to food prices after the introduction of price controls in 2010.

2. METHODOLOGY

2.1. Data and Data Sources

The study utilized time series price data and literature review from relevant documents. The estimation of price transmission made use of average monthly retail price data in Nairobi for diesel, maize, beans, potatoes, and cabbages covering the period 2010-2018. Food prices were obtained from the Kenya National Bureau of Statistics (KNBS) while diesel (automotive gas oil) prices were obtained from the Energy and Petroleum Regulatory Authority (EPRA). The analysis focused on maize and beans since they are by far the most important staple foods in Kenya; potatoes are the second most important food and cash crop after maize; cabbages which constitute one of the most common families of vegetables in terms of daily use in the country and diesel because it's the petroleum product that is mainly used in transportation and operating farm machinery. Nairobi was selected because it is the capital city of Kenya where most households primarily rely fully on purchases for their food.

2.2. Data Analysis

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

$$P_{i,t} = \alpha_0 + \alpha_1 P_{j,t} + \mu_t \tag{1}$$

Where $P_{i,t}$ denotes the retail price at time t and commodity i, $P_{j,t}$ denotes the price at time t and commodity 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 commodity i do not drift far apart in the long run from another commodity j, or are cointegrated.

Before the specification and estimation of the ECM, it is required to examine the stationarity of the variables. Augmented Dickey-Fuller (ADF) test was employed to test the non-stationarity of the price series. Stationarity means that the mean and the variance of a series are constant through time and the autocovariance of the series is not time-varying (Enders, 2008). Since the wrong transformation of data gives biased results, a stationarity test is important to set up the specification and estimation of the correct model (Engle and Granger, 1991)

2.2.1. Testing for causality

Several tests have been developed and used to test for causality among economic time series including Granger causality test and

Sims' test (Madalla, 2005). The Granger causality test assumes that the past is key to the present. Considering two series, Y_t and X_t, the series X_t fails to Granger cause Y_t if a regression of Y_t on lagged X's and lagged Y's, the coefficients of the latter are zero (Madalla, 2005). The Sim's test assumes that the future cannot cause the present so that regressing Y on lagged, current and lead values of X, if X is to cause Y, then the sum of coefficients of the lead X terms must be statistically equal to zero (Gujarati and Sangeetha, 2007). The Sim's test assumes that X_t fails to cause Y_t in the Granger sense if in a regression of Y_t on lagged, current, and future X's, the latter coefficients are zero (Madalla, 2005).

The error correction mechanisms are more stringent as compared to Granger and Sim's test because they include the use of longer lags to capture the dynamics of short-run adjustment towards long-run equilibrium. According to Engle and Granger (1991), the following modified Error Correction Model (ECM) can be used to represent two series that are cointegrated.

$$\Delta P_{i,t} = \beta_0^i + \beta_1^i P_{i,t-1} + \beta_2^i P_{j,t-1} + \sum_{k=1}^{k=m_i} \gamma_k^i \Delta P_{i,t-k} + \sum_{h=0}^{h=n_i} \delta_h^i \Delta P_{j,t-h} + \mu_t \tag{2}$$

Where Δ is the difference operator; m_i and n_i are the number of lags; the β's, δ and γ are parameters to be estimated and μ_t is the error term. The error correction mechanism is provided by the sum of the third and fourth terms with their joint coefficient representing the error correction term (Engle and Granger, 1991). The length of the lags is chosen using the Akaike Information Criteria (AIC). Following Goletti and Babu (1994), the null hypothesis of causality from diesel to food prices can be tested as follows:

$$H_0 : \beta_2^i \neq 0 \; \delta_h^i = 0 \quad h = 0,1,......., n$$

The hypothesis is conducted to determine whether a cointegrated price variable drives or leads the other prices in the cointegration space.

2.2.2. Testing for cointegration

Cointegration tests whether there is a statistically linear relationship between different data series (Asche et al., 2004) and tests for a more general notion of equilibrium. To investigate whether diesel and food prices are cointegrated this study uses a multivariate approach, based on the Maximum Likelihood Estimation (MLE) of the error correction model developed by Johansen (1988) and Johansen and Juselius (1990)

$$\Delta P_t = \sum_{i=1}^{p-1} \Gamma_i \Delta P_{t-1} + \Pi P_{t-1} + \mu + \varepsilon_t \tag{3}$$

Where P denotes the vector of endogenous variables, Γ_i the matrix of short-run coefficients, and Π the matrix of long-run coefficients, ε_t is the vector of independently normally distributed errors. The matrix Π contains the cointegrating vectors and a set of loading vectors that determine the weight of the cointegrating vectors in every single equation. Through normalization, the cointegrating vectors can be identified from the estimated Π matrix. To determine the number of cointegrating relationships r, the Johansen's procedure provides two likelihood ratio tests: the trace statistic (TR) and maximum eigenvalue (MAX) test (Johansen and Juselius, 1990). The Trace statistic tests the null hypothesis of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of endogenous variables for r=0, 1.... n−1. The maximum eigenvalue statistic tests the null hypothesis of r cointegrating vectors against the alternative of n + 1 cointegrating vectors.

3. RESULTS

3.1. Testing for Stationarity

Table 1 presents the results for testing for unit roots in the food and diesel price series. The number of lags included in the test was selected using the Akaike's Information Criterion (AIC). The Augmented Dick-Fuller test (ADF) was used to test for stationarity.

The Augmented Dickey-Fuller (ADF) test shows non-stationary at levels for all the five price series data. However, stationarity was reached after the first difference. This means all the data is integrated of order one, I (1), a requirement for Johansen's cointegration analysis. It is sufficient to conclude that each of these commodity prices shared a common trend with the other commodity prices. Therefore, all the commodities are included in the subsequent cointegration analysis.

3.2. Testing for Causality

Pairwise Granger causality tests were conducted between diesel and food prices and the results presented in Table 2.

From the results, we cannot reject the hypothesis that diesel does not Granger cause maize and beans but we do reject the hypothesis that diesel does not Granger cause cabbage and potatoes. Therefore, it appears that Granger causality runs one-way from diesel to potatoes and from diesel to cabbages and not the other way. Unidirectional causality means that diesel price changes spread to cabbages and potatoes. Thus diesel price movements can be used to predict potato and cabbage prices. There is no causality between diesel and maize and beans price series in both directions. This means diesel prices cannot be used to predict maize and beans price changes.

Maize and beans are both storable commodities and their lack of response to changes in diesel prices may be attributed to the fact that the sellers are given more options in terms of when and

Table 1: Unit root test for price series

	Levels series	First Differences	Lags	I (d)
Diesel	−1.645445	−7.283792	11	1
Maize	−1.711190	−9.783888	12	1
Beans	−1.103493	−10.27851	12	1
Potatoes	−1.581369	−10.80425	11	1
Cabbages	−0.341507	−9.999694	12	1
	Test critical values:	1% level	−3.499910	
		5% level	−2.891871	
		10% level	−2.583017	

under what conditions to sell their products. Price changes at any point along the chain can result in shifts to alternate transport modes or routes as grain marketers search for the lowest-cost method of moving grain between buyer and seller. In Kenya, vegetable production is highly dependent on irrigation and thus fuel may account for part of cabbage production cost. Besides, the perishable nature of cabbages and potatoes can lead to highly unstable prices of the commodities since it is one of the factors that help middlemen to determine the price to their advantage.

Post-harvest losses during handling, transport, storage, and distribution are the major problems, especially in perishable commodities. In horticultural marketing, transportation firms are the most common intermediaries**.** Warehousing firms are scarcely found because of the perishability of the commodities and relatively high costs of cold storage. Also, vegetables and tubers are not regarded as strategic commodities so direct intervention is absent. Thus, diesel prices are important for policy targeting in order to send price signals to perishable food commodities that are directly affected by fuel price variations. If diesel prices are transmitted to food prices, then food prices can be determined by investigating the price determination process of diesel.

3.3. Cointegration Between Food and Diesel Prices

Cointegration implies that there is a linear long-run relationship between the price series. Johansen's MLE was conducted to examine whether a long-run cointegration relationship exists between the price series and to reveal by statistical evidence if the selected commodities conform to a common market and the results presented in Table 3.

The trace test indicates 1 cointegrating equation at the 0.05 level and the Max-eigenvalue test indicates 1 cointegrating equation at the 0.05 level. This cointegrating equation means that one linear combination exists between the variables that force the prices to have a relationship over the time period, despite potential deviation from equilibrium levels in the short-term. Since the long-run cointegration relation was found among the food and diesel price series, the estimation of cointegration vectors was undertaken,

Analyzing the normalized cointegrating coefficient in the Vector Error Correction Model (VECM) allows us to understand how the prices adjust during the period under consideration. Estimation of the adjustment parameters in the VECM specification shows how food prices adjust to the long-run equilibrium when diesel retail price changes. The results are normalized on the diesel prices as presented in Table 4. Due to the normalization process, the signs are reversed to enable proper interpretation.

Potatoes and cabbages have the expected sign and are statistically significant. The adjustment coefficients were negative and significant for cabbages and potatoes meaning that the prices responded to high diesel prices. A 1% increase in the price of diesel leads to a 13.9% increase in the price of potatoes in the long run. A 1% increase in the price of diesel leads to a 7.9% increase in the price of cabbages in the long run. Maize prices have a positive relationship while beans prices have a negative relationship with diesel prices. However, the values were not significant at the

Table 2: Pairwise Granger causality for Food and Diesel Prices

Null Hypothesis	F Statistic	Prob	Decision
Beans do not granger cause diesel	0.01123	0.9888	Do not reject
Diesel does not granger cause beans	1.43409	0.2437	Do not reject
Maize does not granger cause diesel	0.11617	0.8905	Do not reject
Diesel does not granger cause maize	0.39813	0.6727	Do not reject
Cabbage does not granger cause diesel	1.24743	0.2928	Do not reject
Diesel does not granger cause cabbage	10.4251	0.0001	Reject
Potatoes do not granger cause diesel	0.94419	0.3933	Do not reject
Diesel does not granger cause potatoes	4.86832	0.0101	Reject

Table 3: Cointegration test results

Hypothesized no. of CE (s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
None *	0.597392	110.4451	69.81889	0.0000
At most 1	0.190181	36.75199	47.85613	0.3593
At most 2	0.138742	19.66549	29.79707	0.4458
At most 3	0.066596	7.567264	15.49471	0.5128
At most 4	0.024208	1.984972	3.841466	0.1589

*denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) P values

Table 4: Diesel response model for food prices

LNDIESEL	LNBEANS	LNMAIZE	LNCABBAGE	LNPOTATOES
Normalized cointegrating coefficients (standard error in parentheses)				
1.000000	6.719508	−3.771492	−7.894056	−13.87954
	(6.58983)	(3.12251)	(1.66320)	(2.93078)
Adjustment coefficients (standard error in parentheses)				
0.001359	−0.00119	−0.01608	−0.03276	−0.00995
(0.00142)	(0.00351)	(0.00273)	(0.00355)	(0.00325)

5% level in the cointegrating equation. While proper storage is important due to the highly perishable nature of vegetables and tubers, there are no cold storage facilities in the farms and markets resulting in rapid loss of product quality. The observed elasticities are likely to be as a result of the importance of transportation as the main physical function in fresh vegetables and tubers marketing.

4. CONCLUSION AND POLICY RECOMMENDATIONS

This article analyses the possible relationships between fuel and food prices in Kenya. The main objective was to examine price transmission between fuel and food commodities. Based on the findings from the granger causality test, the study concluded that diesel prices have a significant pass-through effect on perishable food prices. Results from the Johansen tests reveal a long-run relationship between diesel and food prices. An increase in diesel prices resulted in an increase in cabbage and potato price by 13.9% and 7.9% respectively. However, diesel prices did not affect maize and beans prices implying that different commodities responded differently to fuel price changes.

Transport constitutes a major cost in marketing therefore important for policy targeting during times of high and increasing food prices. Further research should focus on disentangling the different factors leading to high and increasing food prices by providing a precise quantification of their contributions. Since the highest contributor to the diesel pump price is taxation, the Kenyan government should consider coming up with a policy of cushioning increase in food prices by introducing a tax relief once the fuel price hits a certain level to ensure fuel prices do not adversely cause food prices to abnormally increase.

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