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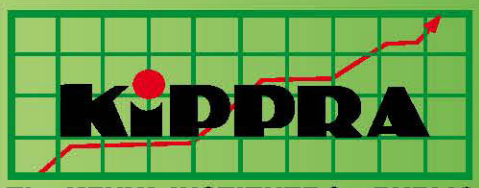

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POLICY RESEARCH and ANALYSIS

Determinants of Maize Prices in Kenya

Grace Waweru and Matilda Owino

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THE KENYA INSTITUTE FOR PUBLIC POLICY
RESEARCH AND ANALYSIS (KIPPRA)

YOUNG PROFESSIONALS (YPs) TRAINING
PROGRAMME

Determinants of Maize Prices in Kenya

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Kenya Institute for Public Policy Research and Analysis

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Abstract

White maize is the main staple food in the diet of over 85 per cent of the population in Kenya. It is the cheapest source of calories among the cereal grains, making up about 65 per cent of the total food calories consumed by households in Kenya. Therefore, maize availability and affordability are very important for food security. Using annual data from 1990 to 2020, this paper undertakes an analysis of the key determinants of maize prices to inform policy actions in improving the maize market. The key findings show that the average retail maize prices increase even as the quantities produced increase, implying that the produce is not adequate to meet demand. The value of fertilizer and seeds is positive, implying that the cost of production has an effect on maize prices. Further, even when there are imports, this does not ease pressure on maize prices. As such, it is recommended that the government supports farmers to increase their yield by adopting appropriate technology and utilize the unused arable land by increasing farming areas; subsidizing farm inputs to reduce the cost of production; provide support on effective use of fertilizers in crop production; and encourage and promote modernization of maize production through public private partnerships.

Abbreviations and Acronyms

ADF	Augmented Dickey-Fuller
ARDL	Autoregressive Distributive Lag
CPI	Consumer Price Index
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Statistics
GDP	Gross Domestic Product
GM	Genetically Modified
KNBS	Kenya National Bureau of Statistics
KSH	Kenyan Shilling
SDG	Sustainable Development Goals

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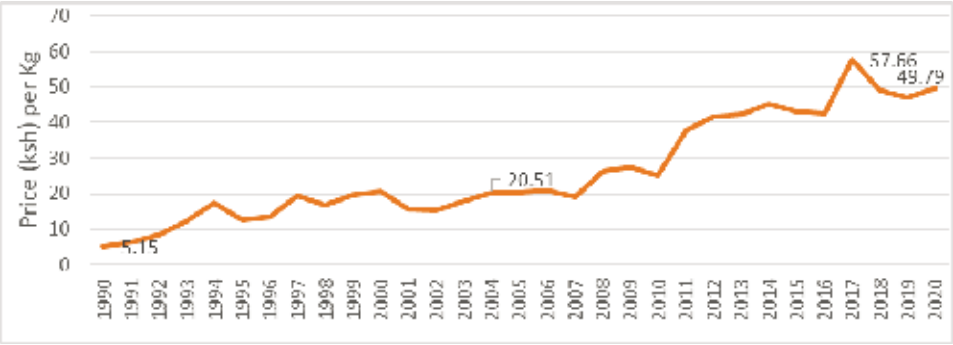
1. Introduction

Globally, white maize is a very important cereal for human and animal consumption and raw material for production (Nyangena and Juma, 2014). It is majorly grown for human consumption and is crucial for food security in developing countries, especially in Africa. According to the Food and Agriculture Statistics (FAOSTAT) 2021, in 2019, the top three largest producers of maize globally were the United States of America, China and Brazil producing about 31.8 per cent, 23.0 per cent and 9.6 per cent, respectively. In Africa, the largest corn producers in 2019 were South Africa followed by Nigeria and Ethiopia. Africa mainly grows non-genetically modified maize except for South Africa, Egypt, Burkina Faso and Sudan. White maize is one of the main crops produced in Kenya, and it makes up only about 0.3 per cent of the world production. This is because production is undertaken by smallholder producers on about 40 per cent of the total crop area in Kenya (Ministry of Agriculture, Livestock and Fisheries - MoAL&F, 2015).

In Kenya, maize availability is very important for food security as most families obtain their daily caloric intake from maize and its products. Cereals contribute 45.4 per cent of the total daily supply of calories, with maize providing most of the calories at 56 per cent (KNBS, 2019). In 2017, the Food and Agriculture Organization (FAO) projected that staple cereals will continue to be critical for food security until 2050 in low and middle-income countries. However, maize prices have been increasing drastically over the years as shown in Figure 1.1. The price of white dry maize has been on an increasing trend since 2008, reaching an all-time high of Ksh 57.6 per kg in 2017. The price has increased by almost 50 per cent between 2010 and 2020 (KNBS, 2021).

Figure 1.1: Annual average retail prices of maize in Kenya



Data source: KNBS data (various reports)

The rising price of white maize and other food commodities has been pushing the inflation rate in Kenya. The annual inflation rate in Kenya as measured by the Consumer Price Index (CPI) increased to 5.4 per cent in 2020 from 5.3 per cent in 2019. The price of food and non-alcoholic beverages increased at a rate of 9.07 per cent (KNBS, 2021). Overall, the high prices of staple foods continue to limit household purchasing power and access to food (FEWS, 2022).

In Sub-Saharan Africa, Wodon and Zaman (2008) note that the poor are more likely to be adversely affected by higher food prices as they spend most of their income on food. A study by Tegemeo Institute showed that low-income groups are spending a high proportion of their income on food, and the proportions are increasing (Kamau et al., 2010). According to a World Bank report on poverty, a typical person in a low-income country spends about two-thirds of their income on food (World Bank, 2022).

As white maize is the main staple food in the diet in over 85 per cent of the population in Kenya and the cheapest source of calories among the cereal grains, it makes up a considerable portion of the total expenditure on food consumed by households in Kenya (Mohajan, 2014). At the same time, the low-income population may not be able to reorganize their expenditure to offset the price rises. The high maize prices are, therefore, a burden to the poor who are the net purchasers of maize.

Although some development economists argue that higher food prices in developing countries can be used as incentives to produce more food, the net effect of higher prices is a rise in the number of the poor (Alene et al., 2008; Omodho, 2009). The rise in maize prices impairs the efforts to achieve SDG two (2) and objectives of the Kenya Vision 2030 to achieve zero hunger; and the government's agenda on food security. Globally, it is estimated that about 192 million people are acutely food insecure (WHO, 2022). Thus, there is need to investigate the factors contributing to the rise in maize prices in Kenya so as to come up with meaningful policy recommendations. The study, therefore, sought to assess the factors affecting the price of white maize in Kenya.

The rest of this paper is organized as follows: section two discusses sector development and policy environment related to maize markets; section three gives an overview of theoretical and empirical literature; section four provides an overview of the methodology used in the study; section five explains the findings and discussions from the study; and section six gives a conclusion and provides policy recommendations.

2. Sector Development and Policy Framework

2.1 Policy Framework

It is the responsibility of any government to look after the welfare and well-being of its citizens. To ensure achievement of this goal globally, the United Nations, through the stakeholders involved, developed the Sustainable Development Goals (SGDs). The 17 SDGs are aimed at ensuring: no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, promoting decent work and economic growth, industry, innovation and infrastructure, reducing inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice and strong institutions, and partnerships for the goals.

Different governments have put country level policies to ensure achievement of these SDGs. Under the second SDG – the zero hunger – that is focused on ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture, a number of policies have been formulated at the continental, regional and national levels. At the continental level, the African Union (AU) has domesticated the second SDG through implementation of the AU Agenda 2063. The priority area of focus include reduction of poverty, inequality and hunger, a high standard of living and attainment of a quality of life and well-being for all citizens. Also, another AU 2063 goal, under the same second SDG goal, is the modern agriculture for increased productivity and production, which is under the area of focus of agricultural productivity and production.

At the regional level, the East African Community established through a treaty on 30th November 1999 and took effected on 1st July 2000. The EAC mission is to "widen and deepen economic, political, social and cultural integration to improve the quality of life of the people of East Africa through increased competitiveness, value added production, trade and investments." The mission outlines the trade relationship among the partner countries, which shows how there is coexistence among the countries even in terms of commodities for sustainability of staple foods in the East African countries.

Kenya, in line with the domestication of the second SDG, the AU Agenda 2063, and the East African Community mission, adopted the Kenya Vision 2030 on 10th June 2008 towards transforming Kenya into a "newly industrializing, middle-income country providing a high quality of life to all its citizens by 2030 in a clean and secure environment". Implementation of this Vision is anchored on three key pillars, namely: economic, social and political. In agriculture, which falls under the economic pillar, the cost of fertilizer was seen as an area of concern since it

posed a potential threat to the achievement of the overall SDG of food security. The effect of the cost of fertilizer is felt at the market where price fluctuations of commodities are determined by the quantity of a commodity supplied in the market at the point of production. To address this, three fertilizer cost reduction strategies were established, among them being bulk procurement of fertilizer, local processing of fertilizer by blending and packaging, and supporting of manufacturing plant for national/regional fertilizer requirements. One fertilizer plant, called the Fertiplant East Africa was built and launched in 2021. This was to address issues of accessibility and affordability of fertilizer in the Kenyan market to Kenyan farmers. Potential fertilizer plant investors were identified and shortlisted. This was done to increase use of fertilizer among all farmers. The implementation of the consolidated agricultural reform legislations, which were to be prepared to actualize the implementation of the Acts and setting up of institutions such as the Agriculture, Fisheries and Food Authority (AFFA); Kenya Agricultural and Livestock Research Organization (KALRO) proposed in the new Acts. Additionally, efforts were made to fast-track passing of the Livestock and Fisheries Bills in Parliament. Policies and regulations to guide the agricultural sector were also established.

2.2 Sector Development

Maize is a staple food in most of the East African countries, including Kenya. Currently, the cost of maize flour in the country has increased as previously mentioned. Despite the Fertiplant East Africa plant being built, the rate of fertilizer imports is still on the rise. This has been shown clearly in the statistics for the fertilizer trends for the production, importation, exportation, and consumption for the periods 2017 and 2018 as shown in Annex 1 and Annex 2. Maize flour prices have risen by about 30 per cent since the beginning of 2022. This followed the previous 80 per cent surge. These prices have been influenced by several factors, among them fertilizer production inputs, and the Russia - Ukraine war as a result of the economic impact felt on the disruptions in Black Sea trading routes as Russia exports about 16, 12 and 12 per cent of urea, DAP and MAP globally. This has had an effect on the fertilizer prices in the Kenyan market.

3. Literature Review

3.1 Theoretical Literature

Markets are a very important part of the economy of a country. This has made numerous researchers to invest in this area of research. Most researchers have come up with different theories explaining market behaviours in different areas and a few of them are discussed below.

3.1.1 The Theory of Price

The theory of price postulates that the price of a good or service is set by the forces of demand and supply. Prices ought to go up at the point where supply is exceeded by demand. This economic theory was defined by Hammond et al. (2013) as the analysis of price-taking behaviour in partial equilibrium. Weyl (2014) defines the theory of pricing as a "methodological approach that derives a small collection of 'prices' sufficient to characterize low-dimensional allocative problems in rich aggregate economies". From the two definitions, among other literature, the authors brought out clearly how the optimal market price comes about when the commodities available in the market are consumed in total by potential clients. Also, the theory clearly illustrates how the supply may also be affected by factors such as the presence and reliability of raw materials and also how demand may vary depending on competitor goods or services, or its affordability to the consumer.

3.1.2 Demand and Supply Theory

The theory brings together two key aspects of the market; that is, the supply of commodities or services after they have been demanded by the consumers. The theory explains the interactions between the owner of a resource and the buyer of a resource under different situations of their availability in both cases. This theory was popularized by Adam Smith in 1776 and was first published by Steuart in 1958. The principles of this theory have been shown to be very effective in the prediction of market behaviour. This theory explains how market prices are determined. It states that, in a competitive market, the price per unit of a commodity or service will always tend to fluctuate until a point of equilibrium between quantity supplied and quantity demanded is reached at current market prices. Jenkin (1870) explained the theory using graphics showing the relationship between supply and demand.

3.1.3 The Cobweb Theory

This is an economic model that explains periodic fluctuations in prices in certain types of perfectly competitive markets such as the maize market. Here, the focus is on the price increment in the maize market, which is a commodity market sector. Secondly, maize price is one of the commodity prices from the demand side of the market. The Cobweb theory was initially conceptualized and written by a British economist (Kaldor, 1934) and another American Agrarian economist (Ezekiel, 1938). The theory is conceptualized on a time lag between supply and demand and assumes that:

i. Farmers must decide their production volume a year in advance;
ii. Previous year prices determine the supply;
iii. Low prices discourage farmers from planting in the next year; and
iv. Demand for agricultural goods is usually price inelastic.

Based on these assumptions, suppliers' response to past prices lead to a fluctuation between high and low prices in the market. The model describes a cyclic supply and demand in a market where the amount produced must be chosen before prices are observed. The Cobweb model is generally based on a time lag between supply and demand decisions. Agricultural markets such as the maize market are contexts where the theory applies. Suppose, for example, that as a result of low application of fertilizer, farmers go to the market with unusually small produce of maize. This shortage, equivalent to a left shift in the market supply curve, results in high prices. If farmers expect these high prices conditions to continue, then in the following year, they will increase their maize production. Therefore, when they go to the market, the supply will be high, resulting in low prices. If they then expect low prices to continue, the maize production decreases, hence the maize production will decrease in the next year, resulting in high prices at the market again. This paper is based on the Cobweb Theory to explain the determinants of maize prices in the agricultural market.

3.2 Empirical Literature

Several factors have been attributed to the rise in maize prices over the past few years, including disruptions in maize supply caused by reduced supply from the local and regional markets, poor climatic conditions, high input costs, high fuel prices, pest infestations, hoarding of maize by farmers and the trade impacts of Russian invasion into Ukraine.

A simulation analysis of the impact of production shocks on the maize markets in Ethiopia found that a 20 per cent increase in maize yield could reduce maize

prices by 81 per cent (Yami, Meyer and Hassan, 2020). A correlation analysis of the effect of maize production and consumption on prices in Romania found that price was not greatly influenced by production (Petre, 2017). The World Food Programme (WFP) estimated that cereal production would decrease by 16 per cent in 2022 owing to high fuel and fertilizer prices. Ombuki (2018) carried out a study on the factors influencing maize production in rural Kenya using a multiple linear regression model. The study indicates that lack of use of high-yielding maize varieties and size of land under cultivation were the key factors affecting maize production. Kilwake (2021) established that domestic maize prices in Kenya is determined by the quantity of maize produced, quantity imported and GDP growth.

Using the Autoregressive Distributive Lag (ARDL) model, Abodi, Kariuki and Obare (2021) in their study on the determinants of maize import volumes in Kenya found that maize import volumes is influenced by domestic prices of maize in the long-run. In another study, Baffes, Kshirsaga and Mitchell (2015) examined the drivers of monthly changes in maize prices in Tanzanian markets. The study found that trade policies and weather shocks explained variations in domestic prices. Another study reported that increase in maize import led to a decrease in price while, interestingly, maize exports had a similar effect on price (Petre, 2017).

Production of cereals is closely associated with fertilizer consumption due to the role of fertilizer as an input in maize production (IFA, 2007; FAOSTAT, 2008). A study by Gnutzmanna and Spiewanowskib (2016) on fertilizer and food prices estimated the cost share of fertilizer in food commodity prices in the long-run. The study found that the likely key to understanding food prices in 'normal' and 'crisis' times is fertilizer, since the results of the study showed that when fertilizer prices double, it leads to a 44 per cent increase in food price in the long-run. In Kenya, studies show that application of fertilizer is the most important factor in maize production (Kinyanjui, 2019; Otieno, 2019). Using the Vector Autoregressive (VAR) model and Granger causality test, Ott (2012) investigated the interaction between fertilizers, food and energy. The study found that the price of food commodities influenced the fertilizer market and not vice versa. According to the study, this is due to high food prices inducing a higher demand for fertilizer, hence pushing fertilizer prices even higher. The study also found that an increase in prices of oil and natural gas triggered an increase in fertilizer prices.

Several studies have also linked the rise in food prices, including maize, to the Russia-Ukraine war. Both countries are major producers of farm inputs such as fertilizers. In addition, Russian exports of natural gas account for about 20 per cent of the global trade. This has contributed to disruptions in the supply chain, leading to an increase in food prices (Glauber and Laborde, 2022; Breisinger et al., 2022).

Rudolf (2019) analyzed the effects of maize price shocks on household food security and reported that a 50 per cent increase in maize prices decreased rural households' caloric intake by 5.4 per cent and for rural landless households by 12.6 per cent. The World Bank (2022) reported that there would be a 4.4 per cent rise in poverty if there was a 50 per cent rise in the price of cereals in West and Central Africa.

3.3 Overview of Literature

The theoretical and empirical literature have put forward the factors that determine the rise in maize prices. The reviewed literature suggests that maize yield/production, import volumes, trade policies, fertilizer and energy prices, and weather shocks were important determinants of white maize prices.

However, most country level studies have looked at the determinants of maize production without a clear link to the maize prices. Therefore, this study sought to fill in this gap by analyzing the determinants of maize prices in Kenya and come up with policy recommendations based on the findings.

4. Methodology

4.1 Theoretical Framework

This study adopted the Cobweb Theory due to price fluctuations and the aspect of time lags as illustrated in the theoretical literature. The model focuses on the price adjustments where it is applied in flexible price-perfect competitive markets, within the primary sectors such as the markets where the adjustments of prices are mainly obtained by combining both the supply and demand side of the markets. The model tends to express the supply and demand into functions that can be solved to get the prices of the commodity at the markets.

To explain the changes in the prices at the market, the supply and demand functions can be expressed linearly as shown below:

$$Q_d = \alpha + \beta P_t \tag{4.1}$$

$$Q_s = \pi + \delta P_{t-1} \tag{4.2}$$

Where:

Q_d and Q_s are the quantities demanded and supplied respectively

α and π are the constants

P_t is price in the current period

P_{t-1} is the prices in the previous period

Making price the outcome variable in both cases:

$$Pt = \frac{Qd}{\beta} - \frac{\alpha}{\beta} \tag{3.3}$$

$$P_{t-1} = \frac{Qs}{\delta} - \frac{\pi}{\delta} \tag{3.4}$$

Subtracting Equation 3.4 from Equation 4.4, we get:

$$P_t - P_{t-1} = \frac{Qd}{\beta} - \frac{\alpha}{\beta} - \frac{Qs}{\delta} + \frac{\pi}{\delta} \tag{3.5}$$

Assumption: Quantity demanded is equal to quantity supplied, that is, Qd = Qs

$$P_t - P_{t-1} = \frac{Q}{\beta+\delta} - \frac{\alpha}{\beta} - \frac{\pi}{\delta} \tag{3.6}$$

$$P_t - P_{t-1} = \beta 1 Q + \beta o$$

Where:

$$\beta 1 = \frac{1}{\beta+\delta}$$

$$\beta 0 = \frac{\alpha}{\beta} - \frac{\pi}{\delta}$$

From Equation 4.6, maize prices is a function of quantity of maize demanded or supplied and other exogeneous factors.

Therefore:

$$P_t - P_{t-1} = \beta 0 + \beta 1 Q + \beta 2 Z \quad (4.7)$$

$$P^*t = \beta 0 + \beta 1 Q + \beta 2 Z \quad (4.8)$$

Where Z is a vector of all exogenous factors such as fertilizer value, seeds value and import quantity.

Therefore, the economic model specification is as follows:

$$P_t = \beta 0 + \beta 1 \text{ (Quantity of maize produced (Q))} + \beta 2 \text{ (fertilizer value (Ft))} + \beta 3 \text{ (seeds value (Sv))} + \beta 4 \text{ (imports quantity (Iq))} + ut \text{ (error term)} \quad (4.9)$$

4.2 Analytical Framework

4.2.1 Model specification

Under this part, we outline and illustrate how the Autoregressive Distributive Lag model is utilized in this analytical process. We did this by following the steps by Kleanthis Natsiopoulos and Nickolaos G. Tzeremes (2022), where they utilized the ARDL modelling approach and the bounds test for cointegration by Pesaran et al. (2001). From this, the ARDL model is specified with the average retail prices as outlined below:

$$P_t = \beta 0 + \Sigma\beta_1 Q_{t-1} + \Sigma\beta_2 Fv_{t-1} + \Sigma\beta_3 Sv_{t-1} + \Sigma\beta_4 Iq_{t-1} + ut \quad (4.10)$$

Where:

P_t = Price at time t

β_o = Constant

$\beta_1 - \beta_4$ = Coefficients of the estimates

$t - 1$ = Lagged values of residuals

ut = error term

4.3 Data Sources and Description of Variables

4.3.1 Data sources

The study utilized annual time series data covering the period from 1990 to 2020. The data was sourced from the economic survey reports and statistical abstracts from Kenya National Bureau of Statistics.

The dependent variable was:

Maize retail prices – The average retail prices of white loose dry maize per kilogram in Kenya shilling.

While the independent variables were:

Maize quantity – Quantity of maize produced in million bags

Fertilizer value – Value of fertilizer in million Kenya shillings

Seeds value – Value of maize in million Kenya Shillings

Imports quantity – Quantity of maize imports in tonnes

The expectation was that there would be a positive relationship between the average retail maize prices and the fertilizer and seeds value, while imports quantity and quantity produced is expected to have a negative relationship with maize retail prices.

4.3.2 Descriptive statistics

Descriptive statistics are presented in Table 4.1, which includes 31 observations. The minimum price of maize was Ksh 5.15 per kilogramme with a maximum of Ksh 57.66 kilogramme and a mean of Ksh 26.38 per kilogramme. The quantity of maize imported had a high standard deviation as the minimum quantity imported was zero tonnes and the maximum imported was 1,508,414. This shows that there are periods when Kenya had sufficient production of maize to cater for its demands and in other periods there were deficits in the production, resulting to high import quantity to cater for the increasing demand. In terms of skewness, seeds value was negatively skewed while maize prices, quantity of maize produced, fertilizer value and quantity of maize imported were positively skewed. The quantity of maize produced and seed value were fairly distributed symmetrically, maize prices per kilogramme (Ksh) and fertilizer value were moderately skewed, hence moderately asymmetrical, while quantity of maize imported was highly skewed and highly asymmetrically distributed.

Table 4.1: Descriptive statistics

	Maize prices per kg (KSh)	Quantity of maize produced (million bags)	Fertilizer value (million Ksh)	Seeds value (million Ksh)	Quantity of maize imported (tonnes)
Mean	26.386	31.65	5915.5	2492.571	327798.8
Minimum	5.150	18.87	769.6	541.8	0
Maximum	57.660	44.6	17612.1	4483.1	1,508,414
Standard deviation	14.708	7.215	5383.8	1328.929	375768.7
Skewness	0.523	0.322	0.859	-.0103	1.828
Kurtosis	-1.100	1.936	-0.753	1.561	5.875
Observations	31	31	31	31	31

Data source: Author's computation using Kenya National Bureau of Statistics data

5. Results and Discussions

5.1 Diagnostic Tests

5.1.1 Stationarity Test

Unit root test was done on the variables for determination of stationarity using the Augumented Dickey-Fuller (ADF) unit root test and to understand the order of integration. Quantity of maize produced, quantity imported, and seeds value were to be stationary at levels I (0) while average retail maize prices and fertilizer value were proven to be stationary at first difference I (1). Based on this, the time series data under use qualified to be analyzed using the autoregressive distributive lag model since the data are stationary at levels or at first difference.

Table 5. 1: Augmented Dickey-Fuller test for stationarity

	ADF at level, I (0)		ADF at 1st difference, I (1)	
Variable	**Test statistic**	**Order of integration**	**Test statistic**	**Order of integration**
Retail price of maize	-2.642	I (0)	-6.858*	I (1)
Quantity of maize produced	-4.689*	I (1)	-7.579*	I (1)
Quantity of maize imported	-5.935*	I (1)	-8.721*	I (1)
Seed value	-4.400*	I (1)	-9.946*	I (1)
Fertilizer value	-1.955	I (0)	-7.722*	I (1)

Data source: Kenya National Bureau of Statistics (1990; 2020), Economic Survey

5.1.2 Optimal lag selection

The determination of the lag length used in cointegration analysis allows adequate number of lags to be employed to avoid overestimation in model analysis. Based on the results shown in Table 5.2, the optimum lag chosen by most of the criteria is three.

Table 5.2: Optimal lag

Lag	LL	LR	Df	p	FPE	AIC	HQIC	SBIC
0	-598.962				5.0e+15	50.330	50.395	50.576
1	-539.821	118.28	25	0.000	3.0e+14	47.485	47.876	48.958
2	-494.103	91.435	25	0.000	7.4e+13	45.759	46.475	48.458*
3	-456.216	75.776*	25	0.000	7.0e+13	44.685*	45.726*	48.612
4	.	.	25		-9.1e-19*	.	.	.

Data source: Authors' computation

5.1.3 Cointegration Tests

We did the bounds test for cointegration to determine whether the data has long-run relationship. Table 5.3 demonstrates that, at the 5 per cent level of significance, the t-value (-4.798) is less than the upper bound critical value (-4.60) and the F-statistic (5.081) is greater than the critical value (5.06) for the upper bound. We rejected the null hypothesis of no cointegration and concluded that there is cointegration between the price of maize and independent variables at the 5 per cent level of significance.

Table 5.3: Bounds test for cointegration

Test statistic	Lower bound I (0)	Upper bound I (1)
F-statistic 5.081	2.45	5.06
t-statistic -4.798	-2.57	-4.60

Data source: Authors' computation

5.2 Regression Results

Table 5.4 shows the long-run and short-run results of the determinants of white maize retail prices.

From the regression results, in the long-run, the quantity of maize produced, fertilizer value and imports quantity have a significant impact on white maize retail prices. The quantity of maize produced has a significant positive relationship with retail maize prices. This means that a one unit increase in quantity of maize produced leads to 0.57 per cent increase in the retail price of white maize. A logical explanation to this maybe as a result of increase in demand, as a result of

increase in population and the reduction in production per person in the country (FAO, 2020). Since demand is inelastic, the change in quantity demanded due to a change in price is small. Therefore, the production volume has not been able to keep up with the increasing demand and consumption.

Table 5.4: Regression results for the determinants of retail maize prices

	(ARDL 1) **D.Maize Price**	**(ARDL 2)** **D.Maize Price**
ADJ		
Error correction term (ect)	-0.932*** (-5.30)	-0.956*** (-5.90)
Long run quantity of maize produced	0.572* (2.25)	0.595* (2.61)
Fertilizer value	0.002*** (6.36)	0.002*** (6.87)
Seeds value	-0.002 (-1.62)	-0.002 (-2.17)
Log imports quantity	3.458** (3.15)	2.532* (2.76)
Mean exchange rates		-0.006 (-0.08)
SR		
LD. Pt	0.845***	0.917***
	(5.23)	(5.91)
D. Quantity of maize produced (-2.14)	-0.479	-0.411 (-2.09)
LD. Quantity of maize produced	0.200 (1.12)	0.187 (1.19)
D. Fertilizer value	0.001* (2.53)	0.001* (2.69)
D. Seeds value	0.002* (2.31)	0.003* (2.67)
D. Log imports quantity	-1.389 (-1.87)	-1.177 (-1.67)
LD. Log imports quantity	-1.711** (-3.87)	-1.537** (-3.91)

D. Mean exchange rates			0.188* (2.67)
N	25	27	
R^2	0.925	0.942	
adj. R^2	0.850	0.874	

t statistics in parentheses
* p < 0.05, ** p < 0.01, *** p < 0.001

Data source: Authors' computation using 1990 to 2020 Economic survey data from Kenya National Bureau of Statistics

From the results, a one unit increase in the fertilizer value results to a 0.002 per cent rise in the retail price of maize. An increase in fertilizer value increases the cost of production, which ultimately leads to an increase in food prices. Higher fertilizer prices reduce its access especially in the developing countries, leading to reduced crop yield. The low supply coupled with high demands due to increasing population drives food prices higher. A similar study obtained similar results of positive significant relationship between fertilizer prices and food prices in the long run (Gnutzmanna and Spiewanowskib, 2016).

Regarding the quantity of imports, a one unit increase in import quantity is seen to lead to a 34.5 per cent increase in maize price. This could be as a result of imported inflation, since the cost of imported dry maize and other raw materials has been on the rise. At the same time, the rapid increase in Kenyan population contributes to the reduced production per capita of maize in the country (FAO, 2020). This means that the supply from own production and import has not been able to keep up with the increasing demand.

In the short-run, lagged maize prices has a positive and significant effect on current maize prices. Also, the current quantity of maize produced has a negative relationship with the average retail maize price, unlike the lagged quantity of maize produced that has a positive relationship with average retail maize prices. These are, however, not significant at five per cent level of significance. Similarly, the results show that fertilizer value has a significant positive relationship with retail maize prices at five per cent significance level. This means that a one unit increase in fertilizer value leads to 0.001 per cent increase in maize price in the current period. The implication of high fertilizer prices is an increase in the cost of production, which drives food prices high.

Quantity of maize imported was found to have a negative significant relationship with maize price in the first lag. According to this study, a one unit increase in import quantity resulted to 17.1 per cent decrease in the retail price of maize. These results are consistent with a study by Kilwake (2021), whose results indicated a positive and significant relationship between import quantities and maize prices.

When mean exchange rate was added to the ARDL model, the effect of the independent variables (except import quantity) on maize prices did not change significantly. The effect of import quantity on maize prices seemed to be more reliant on mean exchange rate. This is because the relative strength of a country's currency affects the costs of imported food items. The results also show that mean exchange rate has a significant positive relationship with retail maize prices in the short-run, where a one unit increase in mean exchange rate results to 0.188 per cent increase in retail maize prices.

The addition of mean exchange rate in the model also improves its reliability as the adjusted R squared increases from 85.0 per cent to 87.4 per cent. This means that the first and second models explain the changes in maize prices by 85 per cent and 87.4 percent, respectively.

6. Conclusion and Recommendations

White maize and its products such as maize flour form an important part of the diet of millions of Kenya, and therefore their availability is vital in improving food security in a country that is highly vulnerable to food insecurity and poverty. The following is a summary of the key findings:

i. Average retail maize prices rise with increasing quantity produced. As seen earlier from the computation, in the short-run, the quantity of maize produced is inversely proportional to the average retail maize prices as would be expected in the study, though not significant. However, in the long-run, the average retail maize prices seem to be directly proportional to the quantity of maize produced, and this is unexpected. This is mainly as a result of the high rapidly growing population that maize production is not able to keep up with and due to reduction in the production of maize per person in the country. The existing arable land is also under-utilized.
ii. Prices of white maize increase with rising price of fertilizers. These, just as expected, have a positive relationship. The government has always tried to intervene through provision of fertilizer subsidies to reduce input cost. This intervention has, however, proven to be unreliable as the subsidies are always unsustainable and they are issued only occasionally. Also, the price of fertilizers is controlled by the global market, as most of the fertilizers utilized by farmers are always imported. This has led to a continued rise of white maize prices.
iii. Maize imports have not eased the increase in the price of white maize. The expectation would be that the two variables are inversely proportional as brought out in the short-run. However, some underlying issues such as the importation cost and rapid increase in population growth has led to drastic decrease in production of maize per capita as explained in the long-run. This shows how both the locally produced maize and the imports are still not enough for the Kenyan population. Most of the efforts have been made to improve maize production, for example, supporting farmers on various methods of farming, and sensitization and teaching them the smart and modern ways of farming. The support has always been done to the people who are prone to farming and in the favourable geographical areas, where rains are mostly available. However, the problem still persists.
iv. The value of seeds and the average retail maize prices are directly proportional in the short-run, as expected. However, they are inversely proportional in the long-run. The availability of seeds can sometimes vary, hence maize farmers could opt to use their previously harvested maize as seeds, which could be

cheaper, and still produce maize. Also, the government, through the National Cereals and Produce Board, makes seeds available to farmers, hence there is little effect on the overall production as shown by results where the seeds value was not significant in relation to maize retail prices.

v. The mean exchange rate has been proven to be important in the model as it increases the percentage of the adjusted R-squared, implying that it also explains more about the variation in the model. Also, there is a negative relationship between the mean exchange rate and the average retail maize price in the long-run while the opposite is experienced in the short-run. The mean exchange rate is affected by the strength of a country's currency value. It influences the maize imports value, which in turn influences maize prices as indicated in the results. A high mean exchange rate implies strength in the Kenyan currency, hence the quantity of maize imported increases, and the maize price at the market reduces as proven in both the long-run and short-run results.

With these results, the study recommends the following:

i. Through public-private partnership (PPP), there is need for targeted support to farmers to increase maize yield so that the supply in the market is adequate to meet the demand. This can be done by increasing the capacity of producers to use modern food production technologies such as farm mechanization, use of high yielding maize seeds and irrigation.

ii. The government should subsidize farm input, including fertilizer and seeds to reduce the cost of production. To improve the effectiveness of fertilizer subsidies, there is need for policies that focus on support services that can allow the dissemination of information on effective fertilizer use to maize producers.

iii. There is need to increase the area under maize production in the country. This can be done through targeted investment in irrigated agriculture, thus making use of the arid and semi-arid lands. This will lead to increased production thus increasing availability of maize commodities in the market.

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