MAIZE IMPORTATION EFFECTS ON KENYAN PRODUCERS AND CONSUMERS' ECONOMIC WELFARE

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A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirement for the Master of Science Degree in Agricultural and Applied Economics of Egerton University

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this university or any other for the award of a degree.

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Recommendation

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DEDICATION

I dedicate this thesis to my husband Jeremiah Ngaji, my son Evan, my mother Wilfrida Abodi, and my siblings Kennedy, Ignatius, Patrick, Irene, and Gerphas.

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ABSTRACT

Whereas maize is a staple food in Kenya, its production has not kept pace with the local demand in the recent past. The ultimate effect of this is reflected in the growing reliance on maize imports. However, much remains unknown about the economic welfare effects of maize importation in Kenya. Even though some studies have attempted to determine the effects of maize importation, they have not directly analysed the distribution of welfare gains and losses from maize imports. Specifically, the studies appear to have neglected the overall effects of maize importation on Kenya's economic welfare, as well as its micro effects on producers and consumers. The study analysed the economic welfare effects of maize importation in Kenya using time-series data for the period between 1963 and 2016. Additionally, it used an error correction version of the Autoregressive Distributed Lag Model (ARDL) and a Partial Equilibrium Model (PEM). The ARDL model results showed that in the long run maize supply responds significantly to the previous period's maize production, producer price, land area under maize cultivation, and fertiliser use. While in the short run, it responds significantly to producer price, fertiliser use, and land area under maize cultivation. On the demand side, maize demand was found to significantly respond to production and substitute prices in the short and long run. Moreover, trade openness, domestic maize prices, and gross domestic product were found to significantly determine maize imports both in the short and long run. PEM results showed that maize importation resulted in ambiguous welfare effects on both maize consumers and producers. Consumer surplus gain only compensated loss in producer surplus in 2 out of 11 points of analysis. On the other hand, producer surplus gain only compensated loss in consumer surplus in 1 out of 11 points of analysis. The resultant total net economic welfare effect of maize importation was negative. This result indicates that importation would leave the maize sector and the economy as a whole worse off. Hence, further maize importation without compensating losers from the maize sector is not feasible. Based on the results, complementary reforms should be put in place to link world prices to consumer prices and to encourage producers to respond to production incentives. Maize trade policy should also be aligned and supported by other macroeconomic policies such as exchange rate policies to eliminate inconsistencies.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADF	Augmented dickey fuller test
ARDL	Autoregressive Distributed Lag
CGE	Computable General Equilibrium
COMESA	Common Market for East and Southern Africa
CPI	Consumer Price Index
CS	Consumer Surplus
DFGLS	Dickey-Fuller Generalised Leased Square
EAC	East African Community
EUT	Expected Utility Theory
FAO	Food and Agricultural Organisation
FAOSTAT	Food and Agricultural Organisation Statistics of the United Nations
GAMS	General Algebraic Modelling System
GDP	Gross Domestic Product
IFPRI	International Food Policy Research Institute
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
MDG	Millennium Development Goal
NCPB	National Cereals and Produce Board
NTB	Non -Tariff Barriers
PEM	Partial Equilibrium Model
PS	Producer Surplus
SBIC	Schwartz Bayesian Information criteria
SDG	Sustainable Development Goal
SSA	Sub-Saharan Africa

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Most countries in the world, especially Sub-Saharan countries, rely on maize as their main staple food. It is one of the essential food crops globally and, together with other cereals, provides at least 30% of food calories to more than a population of 4.5 billion in the world (Ombuki, 2018; Shiferaw *et al.,* 2011). It is a vital ingredient in animal feed and a major raw material in the processing of industrial products (Serna-Saldivar & Carrillo, 2019). According to Food and Agriculture Organisation (FAO), some of the major maize producing countries in the world include China which produces 5 tonnes per hectare, South Africa which produces 3 tonnes per hectare and the United States of America which produces 9 tonnes per hectare, on average (FAO, 2016). Nevertheless, FAO estimates that in 2016, almost 520 million people in Asia, more than 243 million in Africa, and more than 42 million in Latin America and the Caribbean did not have access to this sufficient food energy (FAO, 2017). This implies that in the recent past, demand for this important staple has been on the rise. This is attributed to rapid the population growth rate and production shortfalls in global maize supplies.

To address these challenges and improve maize yield to bridge the supply gap, several measures have been put in place by various world economies. Some of these measures include the introduction of high-yielding varieties of maize and genetically modified seeds. However, despite these advances, maize production in developing countries remains below domestic requirements. To bridge this ever-increasing yield gap, many countries in the world rely on maize imports. According to FAO (2017), world corn imports totaled US$ 32.3 billion in 2016.

Out of the world's 22 countries where maize represents a greater percentage of calorie intakes in the national consumption, 16 of them are African countries (FAO, 2018). In Sub-Saharan Africa, maize production has generally lagged behind the population growth rate despite the vital role it plays in the food supply. This coupled with modest average maize grain output that is still prevalent in farmers' fields presents a greater challenge in fulfilling the projected rise in demand for maize. To satisfy this demand for food, Sub-Saharan African countries increasingly rely on imports. Currently, about 30% of maize consumed in the region is imported compared to 5% in the late sixties (FAO, 2015).

In Kenya, maize is a staple food for most of its citizens. The national food security is often pegged on the availability and adequate supplies of maize to meet domestic food demand (Wambugu *et al.*, 2012). Maize contributes 3% and 12% to Kenya's gross domestic product (GDP) and agricultural GDP, respectively (KNBS, 2019). In addition, it accounts for 36% of caloric food intake and provides at least 72% starch, 10% protein, and 4% fat. It also supplies an energy density of 365kcal/100g (Ranum *et al.*, 2014). The main maize growing areas in Kenya include counties like Trans Nzoia, Nakuru, Uasin Gishu, and other parts of the Western and Nyanza regions.

According to FAOSTAT (2019), the average maize production in Kenya between 2007 and 2017 was approximately 3.2 million metric tons against a backdrop of increasing maize consumption, which is currently at 4.01 million metric tons per year (FAOSTAT, 2019). Therefore, it implies that there is a deficit in maize production. To bridge this increasing gap between maize supply and demand, the country imports maize across the borders from Uganda, Ethiopia, and Tanzania. Moreover, the country also allows large offshore imports from Mexico, South Africa, Malawi, the USA, and other Southern American countries like Brazil and Argentina to fill the maize supply and demand gap (KIPPRA, 2017).

In the recent past, Kenya has been experiencing food supply deficits due to rapid population growth rate which has contributed to a decrease in per capita food production and unmet demand, persistent decline in the natural resource base, lack of access to inputs by a majority of small scale farmers, pest and disease infestation on maize crop, climate variability and post-harvest losses due to insufficient storage facilities (Simiyu, 2014). These challenges have complicated the achievement of food and nutrition security in the country.

To curb these challenges and increase maize production, the government of Kenya has intervened using various policies. These policies include subsidisation of inputs such as fertiliser s and provision of credit for farming households through programs such as Kilimo Biashara. Furthermore, the state-owned National Cereals and Produce Board (NCPB) also influences the purchase of maize from farmers at prices higher than the market prices to provide incentives for increased maize production.

Despite government efforts and inducements to improve maize production, maize output has remained below domestic requirements. The ultimate effect of this is reflected in the growing reliance on maize imports and food aid. According to KNBS (2019), maize imports increased more than eight-fold to 1.328 million metric tonnes from 2016 to 2017. This was necessitated by the 6.3% reduction in maize production from 3.402 million metric tonnes in 2016 to 3.186 million metric tonnes in 2017. Additionally, Kenya increased her maize imports from Uganda as grain prices rose due to the destruction of harvests by *El Nino* rains in 2016. Kenya also received 3,000 tonnes of maize in 2017 from Uganda through its border points. However, in 2016, there was no maize from Tanzania and Uganda due to drought. The remaining option was to import particularly from Mexico which is the largest producer of white maize (KNBS, 2019).

Nonetheless, a policy challenge is how to improve consumer welfare without jeopardizing producer welfare whenever the maize importation window is opened. Essentially, there is a challenge of how to provide production incentives to maize producers by keeping farm prices high enough to motivate them and simultaneously ensure accessibility and affordability of maize to poor consumers by keeping the maize prices as low as possible. In addition to this, a review of the literature indicates that the magnitude of the effects of maize importation in terms of the distribution of welfare gains to the economic agents remains largely unexplored. Specifically, the reviewed studies appear to have neglected a common understanding that although trade may lead to an overall improvement of a country's welfare, it may also negatively affect the micro-level by disadvantaging certain economic agents.

1.2 Statement of the Problem

There have been several interventions by the government to improve maize production in Kenya, given its relative importance in food security. Nonetheless, these efforts have not translated into any significant improvement in maize productivity. Therefore, the country perennially relies on maize imports to bridge the deficit in maize production. However, the effects of maize importation on consumer and producer welfare have not been discerned in Kenya. In particular, there is limited empirical evidence on the effects of maize importation on domestic maize production and producer welfare. In addition, it is not evident in existing literature how maize importation has impacted both producer and consumer welfare. These have made it difficult to determine the overall effects of maize importation on economic welfare. Thus, it is against this problem that the study sought to understand the economic welfare effects of maize importation on maize producers and consumers in Kenya.

1.3 Research Objectives

1.3.1 General Objective

The general objective was to improve the economic welfare of maize producers and consumers in Kenya by enhancing their livelihood.

1.3.2 Specific Objectives

i. To determine supply and demand responsiveness of maize producers and consumers to maize price changes in Kenya.
ii. To ascertain the key determinants of maize imports in Kenya.

iii. To assess the effects of maize importation on consumer and producer welfare in Kenya.

1.4 Research Questions

i. How do maize producers and consumers respond to maize price changes in Kenya?

ii. What are the key determinants of maize imports in Kenya?

iii. What are the effects of maize importation on the welfare of maize producers and consumers in Kenya?

1.5 Justification of the Study

In Kenya, maize is a major contributor to national income and a principal staple food produced and consumed by a vast majority of her population. For this reason, a good understanding of the effects of maize importation on the economic welfare of consumers and producers in Kenya is very important. This will significantly improve policy makers' knowledge on the formulation of policies that can revitalise both maize production and consumption to improve both the welfare of maize producers and consumers. The study was also aimed at generating additional knowledge to scholars and policy makers on important policy implications for designing and developing strategies that can reduce maize imports and at the same time ensure improvement in economic welfare as well as food security. This will ultimately provide important information for achieving vision 2030 and Sustainable Development Goal (SDG) of extreme poverty and hunger eradication. Even though the study was done in Kenya, its findings apply to other developing countries where maize is a staple food.

1.6 Scope and Limitations of the study

The study was conducted using Kenyan data. It focused on aggregate maize producers and consumers. It was limited to the economic welfare of maize producers and consumers in terms of consumer surplus and producer surplus. There are other aspects of economic welfare such as literacy levels, employment, job satisfaction, and health care that were beyond the scope of the study. It centred on time-series secondary data on maize production, acreage, output per acre, imports, prices, and consumption patterns. The secondary data were restricted to the period between 1963 and 2016. The period was considered long enough to allow for accurate prediction of both consumer and producer behaviour and prices before and after the onset of maize market reforms.

1.7 Definition of Terms

Consumer surplus: A measure of consumer welfare. It is the difference between the amount of money consumers are willing to pay for maize and what they pay. It is measured graphically as the area above the price line and below the demand curve. Mathematically it was derived by integrating the demand curve.

Domestic production: Production of maize for use in the home country. It has been used interchangeably to mean domestic maize output.

Economic Welfare: The overall level of financial satisfaction and prosperity experienced by producers and consumers in a country. In the context of the study, it is the welfare of both maize producers and consumers.

Import: Maize commodity bought from a foreign country.

Maize consumers: Are the aggregate maize consumers who form the demand side for the maize market.

Maize producers: Are the aggregate maize producers. They form the supply side for the maize market.

Maize production: General output of maize in metric tonnes in a given season.

Maize productivity: This is the quantity and quality of maize yield per hectare.

Maize yield: Maize output per hectare.

Producer surplus: A measure of producer welfare. It is the benefit a producer receives for selling maize in the market. It can be measured graphically as the area below the expected price line and above the supply curve. Mathematically, it was derived by integrating the supply curve.

Partial Equilibrium Model: A Partial equilibrium model is a type of economic equilibrium where the clearance in the maize market is obtained independently from prices and quantities demanded and supplied in the markets.

Social surplus: The sum of producer surplus and consumer surplus.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter provides literature on past and recent studies on the effects of maize importation on producer and consumer welfare. The chapter begins by giving empirical literature on the supply and demand responsiveness of producers and consumers. Literature on determinants of imports is then provided. The chapter then reviews the empirical literature on the effects of imports on economic welfare. Furthermore, the chapter provides a theoretical framework on which the study was based. The chapter concludes by conceptualizing the relationship between the key factors influencing maize importation, production, consumption, and economic welfare.

2.2 Empirical Literature

2.2.1 Responsiveness of Producers and Consumers to Maize Price Changes

In a study by Yao *et al*. (2013) on consumer response to changes in price and quantity demanded in Australia, it was established that consumers respond to simultaneous decreases in price and quantity more positively than to simultaneous increases. The study further noted that consumers are generally sensitive and averse to price increases. However, to maintain profitability, it may not be easy without increasing the prices of products due to inflation or increased cost. However, this study only dealt with the demand side but ignored the supply responsiveness of producers to price changes. The current study analysed both the aggregate supply and demand responsiveness of maize producers and consumers to maize price changes by deriving both supply and demand elasticities.

Using regression analysis, stationarity and cointegration tests on time-series data, Onono *et al*. (2013) analysed the aggregate response of maize production to both price and non-price incentives. The study aimed at establishing the significance of non-price factors in influencing the production of maize as well as in establishing a balance between price and non-price incentives. Using the autoregressive distributed lag model, they established that maize production positively responds to its output price. Additionally, they found that maize output responds positively to maize sold to marketing boards, liberalization and governance, GDP per capita, and development expenditure in agriculture.

In a study on consumer response to price and package in Chicago, Çakir and Balagtas (2014) used a random utility model of demand to measure consumer responses to price and package size. The findings of the study indicated that consumers were more responsive to price than a package; the elasticity of demand with respect to package size was found to be approximately one-fourth of the magnitude of the elasticity of demand with respect to price. Again the study was partial in that it did not consider the aggregate supply response of producers to price changes. The current study aimed at overcoming this weakness by determining both the aggregate supply and demand responsiveness of producers and consumers to maize price changes in Kenya.

Using descriptive equilibrium output supply functions, cointegration models, and vector autoregressive distributed lags to analyse data, Ayinde *et al*. (2014) conducted a study on price risk and supply response of rice production in Nigeria. They observed a positive and statistically significant supply response to the producer price of rice. They also found that rice output response to acreage was negative and statistically significant with a coefficient of 1.5135. Similarly, imported rice was also negative and statistically significant at a 5% significance level with output changes being responsive to price changes. The findings of Ayinde *et al*. (2014) indicated that rice producers are responsive to price, non-price, price risk, and exchange rate. The study recommended that reducing price risk would play a pivotal role in increasing producer response and in bridging the production gap.

Alia *et al*. (2017) used a partial adjustment model to estimate the response of cotton producers to government price support and its eventual welfare effects in Benin. The results showed that farmers react to price incentives by expanding the land area under cotton. This translated to an increased cotton supply. In addition, price incentives resulted in welfare gains for farmers, with higher gains for farmers in areas with high cotton production potential. Besides price, the study established that rainfall and fertiliser use significantly affected the supply elasticity of cotton production. However, the study focused on the isolated impact of price incentives on producers without the simultaneous impacts on consumers.

To determine the supply response of corn farmers in Quebec province of Canada, Sedghy *et al*. (2016) used a generalised autoregressive conditional heteroscedasticity (GARCH) model. Their empirical results showed that price predictability had a positive effect on producer decisions. Estimation of supply elasticity also illustrated that expected output price was the most important risk factor for corn farmers in Quebec. Farm income stabilisation insurance was also found to be a major contributor to producer responsiveness to effective price changes. However, the study also analysed the supply response of corn farmers to price changes in isolation of consumer responses to price changes.

In an analysis of maize supply response in Nigeria, Ogundari (2018) estimated maize supply response using time-series data in the bounds testing approach. This study revealed a mixture of non-stationarity and stationarity in the time-series data from the ADF test. Bounds test for cointegration also revealed the existence of cointegration between maize supply and explanatory variables. Further, the supply response results showed that maize supply responds positively and significantly to own price, yam price, rainfall, and fertiliser used. He also observed that in the Short-run, supply responds only to the fertiliser use and rainfall which were positive and negative, respectively.

In a similar study on maize supply response in Indonesia, Magfiroh *et al.* (2018) applied an error correction model on the time-series secondary data from 1980 to 2016. The study aimed at assessing the supply response of maize farmers to maize input and output prices in Indonesia. Using maize productivity as the dependent variable, they found that maize supply response is significantly influenced by maize price, soybean price, wages of labour, seed price, fertiliser cost, and maize import price. Due to the positive effect of maize price on maize supply response, the study recommended that to increase maize productivity and support national food security, the maize price floor should be used. However, despite the contribution of this study to the understanding of maize supply response to price changes, it failed to test the time-series properties of the data used in the analysis.

Despite the contribution of the above studies to the growing body of knowledge on supply and demand responsiveness of producers and consumers to price changes, they are not devoid of methodological shortcomings. For instance, a study by Alia *et al*. (2017) used a partial adjustment model which is highly criticized for producing spurious regression results thus limiting a precise observation of consumer and producer responses. Furthermore, most of the reviewed studies have not simultaneously analysed both the aggregate supply and demand responsiveness of producers and consumers. Hence, there is a paucity of reliable information on producer and consumer responsiveness to price changes. This has made it difficult to get reliable elasticity estimates for welfare analysis, thus, making it hard to aggregate the welfare effects. The current study overcame these shortcomings by employing time-series data from 1963 to 2016 to determine both aggregate supply and demand responsiveness of maize producers and consumers to maize price changes.

2.2.2 Determinants of Maize Imports

In an evaluation of import dependency of sectors and major determinants, input-output analysis was used by Ayas (2017). The author found that the main determinants of sectoral import dependency are the intensity of imported input, the share of the sector in output, and the inter-sectoral linkages. The findings of the study further indicated that the Turkish economy had been more import-dependent between 1995 and 2011. Nonetheless, the study relied on a single sector of an economy rather than the whole country therefore the import multipliers exhibiting the total import effect of sectors appeared to be closer to each other. The current study aimed at overcoming this drawback by focusing on major determinants of maize imports in the entire Kenyan economy.

In another study that investigated how supply shocks, both domestic and foreign, impacted imports and consumption in the world rice market between 1960 and 2010, Jha *et al*. (2016) established that domestic shocks have a significant positive influence on the volume of imports. This could be explained by the fact that imports peaked whenever there was a domestic shock. On the other hand, when foreign shocks were positive, imports peaked and consumption failed to stabilize. The author concluded that no matter the nature of foreign shocks, the primary concern should be to stabilize consumption when an economy is faced with negative domestic shocks such as a rise in domestic prices.

In a study that investigated the income elasticity of import demand in Turkey, Lotfi (2016) applied the ordinary least square method to time-series data to determine the income elasticity of import demand from 1980 to 2013. The author selected the amount of import demanded in Turkey from different countries to be the explained variable. Variables that were selected as independent include per capita income, exchange rate, and the inflation rate ratio in Turkey to the inflation rate in the exporting country. He found that the income elasticity of import demand in Turkey was 1.6 suggesting that a 1% increase in per-capita income resulted in a 1.6% increase in import demand.

To ascertain the key determinants of imports in Turkey, Çakmak *et al*. (2016) econometrically used 2003.Q1-2014.Q4 period quarterly data. He established that the explanatory variables that determined imports were real exchange rate returns and growth of the gross domestic product. They specifically demonstrated that a 1% increase in real exchange rate leads to a 0.29% increase in imports. A 1% increase in exports leads to a 0.86% increase in imports, and a 1% rise in real exchange rate leads to a 3.14% increase in imports. The outcomes indicated that structural policies rather than exchange rate policies should be implemented to avert the foreign trade deficit in Turkey. Nevertheless, the study neglected other determinants of imports like population, government stock, and domestic price. This led to specification errors. The current study aimed at overcoming this limitation by using an error correction version of the autoregressive distributed lag approach.

Using double logarithmic model and time-series data spanning from 1961 to 2013, Hyuha *et al.* (2017) analysed the determinants of rice import demand in Uganda. With the study aimed at ascertaining the key parameters influencing rice import demand, the regression results revealed that domestic rice production, population, and own rice consumption significantly influenced rice import demand. The study recommended that for the country to save its foreign exchange, there is a need to reduce the rapid population growth rate and increase domestic production. In a similar study on determinants of aggregate import demand in Sudan, Ibrahim and Ahmed (2017) used data spanning from 1978 to 2014 and cointegration techniques to analyse the data. Their study findings revealed that volume of imports, domestic income, relative prices, and exchange rate were the significant determinants of aggregate import demand. The magnitude of the coefficient of GDP was higher than the coefficients of other determinants hence suggesting that GDP was the most important factor influencing aggregate import demand in Sudan.

In summary, since maize is a food security crop, attention to its imports is very important for policymakers and the government in developing countries like Kenya. Many studies have been done on the determinants of imports. However, there is limited empirical evidence on the determinants of maize imports in Kenya. Therefore, it was important to understand the nature and determinants of maize imports in Kenya.

2.2.3 Effects of Maize Imports on Producer and Consumer Welfare

Trade in agricultural commodities is a much-contested area in free trade negotiations. Much of the contention is about the welfare risk associated with dependency on food imports. Tanaka and Guo (2019) used Computable General Equilibrium Model to quantify the welfare effects of export quota on Japanese rice imports. Anticipated productivity shocks abroad did not make Japanese food security worse-off under free trade. The study also reported that free trade in rice increased Japanese welfare in terms of food security under domestic productivity shocks. Pooled results under the two scenarios suggested that free rice trade resulted in higher welfare outcomes as opposed to the imposition of an export quota. These results were further corroborated by Gao *et al*. (2016), who established that the rice import quota implemented by the government worsened consumer welfare. Gao *et al*. (2016) argued that Japanese consumer welfare would have improved with more free trade.

Chizari *et al*. (2013) used three-stage least squares to estimate supply, demand, imports, and price equations in a study of social welfare impacts of Iranian maize import policies. They found that to maximize social welfare, the government of Iran should impose a tariff rate of about 8%. Furthermore, the study estimated that Iranian policymakers should focus more on tariff rates instead of export taxes imposed by China and Brazil. Nevertheless, despite the contribution of this study to the understanding of social welfare gain, by giving the figure of import tariff that the Iranian government should impose to maximize social welfare gain, the study failed to shed light on the effect of this tariff on the welfare of producers and consumers.

Non-tariff barriers still abound in the face of heightened food safety requirements and campaigns for the promotion of consumption of domestically produced food. In light of this argument, Joseph *et al*. (2014) investigated the effects of various degrees of partial implementation of country-of-origin labelling of seafood products in the US on economic welfare. The model was simulated in four scenarios. The welfare impact of partial implementation of the country-of-origin labelling was compared to a situation of no implementation, voluntary implementation, and total implementation. The study used retail profit, consumer surplus, and domestic producer surplus as components of total welfare. The results of the study indicated that policy had unexpected effects depending on the effects of trade diversion as well as imperfect information and competition. Trade diversion effects on other industries as a result of the policy benefited marketers, especially when consumers were misinformed about the quality of the products. Retailers in the labelled market lost most. The imposition of the regulation had minimal welfare changes on consumers.

A study by Umboh *et al*. (2014) used a simulation method to analyse the impact of tariff changes on household income and consumption in Indonesia. The authors established that import tariff removal had an impact on the production of food crops in Indonesia. It led to a 10.25% increase in the quantity of imported maize, and this also stimulated an increase in the domestic supply of maize and decreased the domestic price of maize from US$ 0.302 to US$ 0.287. Furthermore, the removal of import tariffs also led to increased demand both for consumption and feed. On the contrary, a 10% increase in maize import tariff led to an increase in maize prices which ultimately resulted in a decreased consumption. Additionally, they established that this led to an increase in the agricultural sector income and a decrease in the national sector income. Consequently, farmers responded to less attractive maize prices by reducing the acreage of land under maize and the use of fertiliser input.

Using a linear demand curve and a simple geometrical approach, Todorova and Kalchev (2015) conducted a study on the protective effect of an import quota on welfare in India. The study established that an import quota contributes to substantive welfare losses to the importing economy imposing it. Furthermore, the study found that under the equivalence of a quota and tariff, quota rents substantially exceed tariff revenues to the government. Furthermore, the quota price provided maximum profits to the domestic monopolist compared to the free trade point or that under the tariff. In addition to revenue loss to the government, quota caused a dead weight loss as a result of the monopoly power of the private monopolist.

Mason *et al.* (2015) conducted a study to analyse the trend in wheat consumption and imports and found that staple grain per capita consumption in Sub-Saharan Africa (SSA) rose as the region became more reliant on maize imports. They also found that even though the mounting structural deficit was a primary concern to policy makers in African, it was easier for the SSA governments, including the Kenyan government to raise supplies of food for their increasing population by raising the imports of major staples which include maize, rice, and wheat rather than raising their grain production. Similarly, using global trade data, Megiato *et al.* (2016) applied a computable general equilibrium (CGE) model to analyse the effect of trade between the European Union and Brazil. The study established that Brazil benefited most from imports from the EU. However, these studies were limited in the sense that they failed to provide disaggregated welfare effects of imports, thereby making it difficult to ascertain the distribution of gains or losses among economic agents. The current study focused on overcoming this weakness by establishing the differential effects of maize importation on maize consumers and producers in Kenya.

Diao and Kennedy (2016) used a dynamic computable general equilibrium model to assess the growth and welfare impact of periodic maize export bans in Tanzania. The study was informed by the critical role of maize in Tanzania and the low cost of production compared to the neighbouring countries. The findings of the study indicated that consumers were disproportionately affected by the bans. In particular, whereas urban consumers benefited most from the export bans, the poor rural households and producers were hurt most. The authors attributed the negative impact on the welfare of the poor rural households to a decrease in wage rates for low-skilled labour due to the negative investment effect by producers. Overall, the study concluded by noting that export bans resulted in net welfare losses. Despite the contribution of the study to the understanding of the impact of the export ban on economic welfare, the authors did not include other drivers of economic welfare in the analysis. This suggests model specification problems that may have led to overestimation of the impact of export bans.

Using partial equilibrium and sensitivity analysis, Guei *et al.* (2017) conducted a study about the welfare effect of trade liberalization in South Africa, and they found that when countries embark on free trade, domestic production is substituted by imports from members of the free trade area whose products become inexpensive with the tariff removal. This benefited consumers through net trade creation. More efficient producers from European

Union countries were displaced by less efficient producers. Consumers were therefore found to benefit from reduced prices. Nevertheless, the study failed to shed light on other factors that influence free trade. In particular, the study did not consider the overall effect of free trade on the welfare of consumers and producers. The current study used a partial equilibrium model to analyse the economic welfare effect of maize importation on various economic agents. Specifically, it focused on maize producers and consumers in Kenya.

Iqbal *et al*. (2018) examined agriculture trade liberalization and potential sectoral and welfare gains in Pakistan using a computable general equilibrium model. The study findings revealed that abolition of import tariffs led to the replacement of domestic goods with imported goods. It also led to a rise in exports due to improvement in competitiveness owing to decreased domestic price, resulting in a shift in export production. Consequently, the income of various institutions in the model was estimated to change the structure of production in an economy. These findings implied that the removal of import tariffs negatively affected the welfare of producers. Essentially, this study inferred that import tariff had an influence on the level of income which is a measure of economic welfare. Yet it failed to include the level of consumption and exchange rate, which are also important factors that influence the economic welfare of producers and consumers.

From the empirical literature, there is a wide consensus that trade openness has generated both positive and negative effects on the welfare of both developed and developing economies in the world. However, there is limited empirical evidence on the economic welfare effects of maize importation in Kenya. The current study focussed on the evidence provided from the aforementioned studies to analyse the economic welfare effects of maize importation on maize producers and consumers in Kenya using PEM to simulate the welfare changes.

2.3 Theoretical Framework

Since importation is a trade aspect that affects the welfare of producers and consumers both in the short run and long run, the study was based on a trade policy theory of the second-best, producer behaviour theory under price risk and consumer behaviour theory.

2.3.1 Theory of the Second Best

The theory of the second-best is a type of equilibrium that occurs in the presence of distortions and imperfections in the market. According to Suranovic (2010), the theory of the second-best provides a theoretical foundation for explaining why trade policy can be seen as welfare improving in an economy. It provides a rationale for different types of protections in an economy such as import tariffs. This theory was first applied by Bhagwati (1971) when he provided a framework for understanding the welfare implications of trade policies in the presence of market distortions. Bhagwati (1971) demonstrated in his findings that trade policy has the potential of improving national welfare in the presence of market distortions and if it acts to correct the harmful effects caused by such distortions. This theory is built on a small importing country assumption.

The theory is relevant in the Kenyan context because Kenya is a small importing economy that does not influence the world price of imported maize. Therefore, when Kenya imports maize initially, her domestic policy will affect the quantity of imported maize, the producer prices or consumer prices, producer and consumer welfare, the government, and the nation as a whole. Markets are not perfectly competitive meaning that in most cases there are market imperfections. Trade policies can be used to improve national welfare. For this reason, import tariffs are intended to influence the flow of maize between importing and exporting countries. When there are no import tariffs, the maize consumers in Kenya will pay the world price of maize to consume it and the import volumes will be increased.

Suppose the government of Kenya imposes an import tariff on maize imports, it will increase the maize domestic price by the full value of the tariff. Maize consumers in Kenya will therefore be worse off as a result of the tariff because they will have to pay the world price plus the tariff (Krugman, 2008). The increase in the price of both imported maize and domestic substitute will lead to a reduction in consumer surplus in the market. On the other hand, maize producers in Kenya would be better off as a result of the tariff since the increased maize price will increase producer surplus. The price increase will also prompt a rise in domestic production (Suranovic, 2010). The government, on the other hand, will receive tariff revenue as a result of the imposed tariff but whether the population benefits from the revenue depends on how the government spends it. The aggregate welfare effect will be found by adding the gains and losses to aggregate consumers, producers, and the government. This automatically brings about the use of a partial equilibrium model which can quantify the welfare effects of maize importation in an economic surplus framework. Because the country is small, the import tariff will not affect the price of maize in the rest of the world. Therefore, there will be no welfare changes on producers and consumers there.

2.3.2 Producer Behaviour under Price Risk

Price risk affects both prices of commodities and inputs that farmers produce and buy. The study concentrated much on the effects of maize output price risk and ignored input price fluctuations because output price risk is the most important element of farmers' decision-making processes (Sadoulet & De Janvry, 1995). This supports the idea that at the market level, production and price risks are closely related. Output price risk here was assumed to be fluctuations in maize prices caused by cheap maize imports. The behaviour of maize producers under price risk is based on the theory of expected utility maximization. The commercial maize producers set their output levels to maximize the expected utility of profits. The producers' profit maximization function can be expressed as:

$$Max_{(Y)}E[U(\pi)] = E(P_d).Y - C(Y) - \frac{\Omega}{2}\left(Y^2\sigma^2 P_d\right) \tag{2.1}$$

where E is the expectation operator, $[U(\pi)]$ is the utility of profits, $E(P_d)$ is the expected producer price, Y is output, $C(Y)$ is the total cost of production, Ω is the risk aversion parameter, and $Y^2\sigma^2P_d$ is the variance of profits. If $\Omega>0$ implies risk aversion while if $\Omega<0$ implies risk loving. Given equation (2.1), the optimization function for output level is expressed as:

$$\frac{\partial E[U(\pi)]}{\partial Y} = E(P_d) - C^{'}(Y) - \Omega Y\sigma^2 p_d = 0 \tag{2.2}$$

The first-order condition in equation 2.2 is an implication that the maximum output level under price risk (i.e. when cheap maize imports are available) is expected to be less than output under certainty (i.e. when maize imports are not available). With risk-averse producers, the output level is expected to decrease by an amount equivalent to the marginal cost of risk-bearing $\left(\Omega Y\sigma^2 p_d\right)$, that is, the difference between optimal output level under risk and the corresponding output under certainty. The solution of the first order above to derive output level under risk is given by:

$$E(P_d) = C^{'}(Y) + \Omega\left(Y\sigma^2 p_d\right) \tag{2.3}$$

From equation 2.3, if $\frac{\partial y}{\partial E(P_d)} > 0$ and $\frac{\partial y}{\partial \sigma^2 p_d} < 0$, an increase in the expected price will increase output while an increase in price variability will result in a decrease in output. These interactions were used to show the behaviour of aggregate maize producers in response to maize price changes in the face of maize importation and to quantify the resulting welfare changes. The area below the expected price line and above the supply curve represents producer surplus and can be analytically derived by integrating the supply function with respect to output as shown in equation 2.4:

$$PS = E(P_d).Y^{\circ} - \int_0^{Y^{\circ}}\left[C^{'}(Y) + \Omega\left(Y\sigma^2 P_d\right)\right]dY \tag{2.4}$$

Increasing maize production when cheap maize imports are available is a costly activity that reduces the farmer's profit because it is a risky venture. Maize producers were assumed to be profit maximizers and cost minimizers. In this regard, it was expected that they will consider losses and gains as a point of reference in deciding on whether to increase, reduce or diversify maize production.

2.3.3 Consumer Behaviour Theory

According to Sadoulet and De Janvry (1995), the main objective of consumer behaviour theory is to show how a rational consumer chooses what to consume when faced with a limited income and various prices. Consumers form the demand side of the market and are assumed to maximize the utility function that represents their ordering of preferences. Consider maize consumers with the utility function of *u (q, z),* where *q* is the vector of quantities of maize on which a consumption decision must be made and *z* is the characteristics of the maize consumers. The consumers' income is *y* and a budget constraint is $p^{'}q = y$, where *p* is a row vector of consumer prices, both domestic maize prices and world prices. The consumers' objective function is to maximize utility with respect to *q* subject to a budget constraint above. This can be presented as:

$$Max_{q,\lambda}\, u(q,z) + \lambda\left(y - p^{'}q\right) \tag{2.5}$$

where λ is a langrage multiplier (marginal utility of money). The solution to this maximization equation is a set of n demand equations as shown in equation 2.6.

$$q_i = q_t\left(p, y, z\right),\ \text{i=1,…..n.} \tag{2.6}$$

Equation 2.6 indicates the maximum utility that a consumer derives from the consumption of maize at different prices. The consumers' gain and their responses to price decreases as a result of maize importation can be analysed using consumer surplus. Consumer surplus is the area above the price line and below the demand curve. Mathematically, this can be derived by integrating the demand curve, which is given as:

$$CS = \int_0^q p.\partial q - p.q \tag{2.7}$$

It, therefore, follows that a decrease in maize price as a result of maize importation will make consumers better off thus will improve their welfare. Furthermore, since Kenya is a small open importing economy, it was expected that maize consumers in Kenya will benefit from maize importation resulting in a decrease in aggregate maize supply locally.

2.4 Conceptual Framework

The conceptual framework in Figure 1 illustrates the interrelationships of the key variables identified and how they relate based on the study's specific objectives. The volume of maize imports was hypothesized to be determined by several factors such as domestic production, domestic consumption, price factors (domestic price and world price), trade policy, and macroeconomic factors like gross domestic product (GDP) and exchange rate. On the other hand, domestic production was postulated to be determined by production factors like fertiliser cost, hectares of land under maize cultivation, and rainfall amount.

The study postulated that a fall in domestic maize production (X_3) as a result of production constraints such as pests and diseases, frequent weather shocks, and high cost of farm inputs such as fertiliser , will lead to an increase in the volume of maize imports. It was also expected that the government will respond to this production shortfall by allowing more imports into the country. At the same time, a surplus domestic production discourages maize imports because a surplus means that there is enough food to satisfy the population hence there will be no need for imports. Consequently, an increase in domestic consumption of the staple food (maize) at the expense of domestic production will lead to an increase in the volume of maize imports. However, if domestic production (X_3) is greater than domestic consumption (X_2), there will be no imports, but rather the country will export the surplus or store buffer stock. This relationship between domestic maize production, domestic consumption, and imports can be illustrated as:

$$X_3 - X_2 < 0 \qquad (2.8)$$

$$X_3 - X_2 > 0 \qquad (2.9)$$

Equation 2.8 suggests that domestic maize production is lower than domestic consumption and therefore more will be imported. Equation 2.9 indicates that domestic production is higher than domestic consumption and therefore the country will not import.

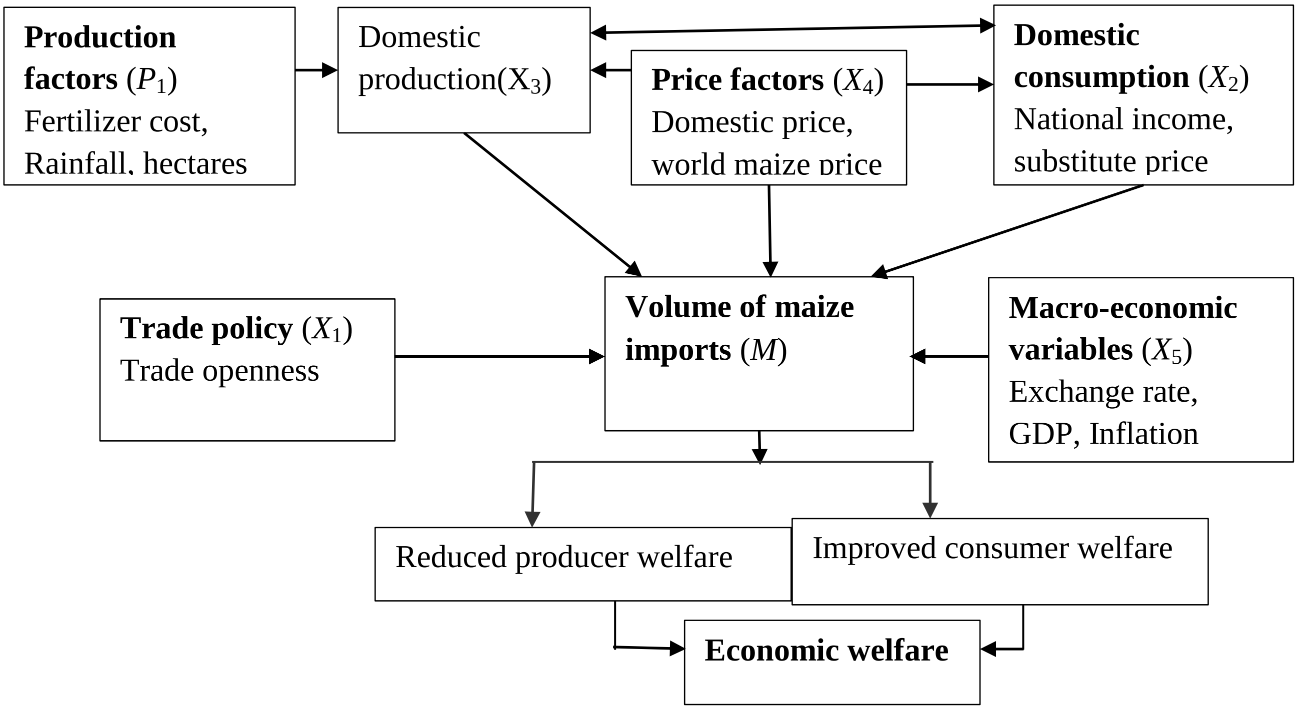

Figure 1: Conceptual framework

The study further assumed that price factors (X_4) will influence the volume of maize imports. Both domestic prices and world prices can determine the volume of maize imports. Therefore, it was assumed that there is a direct inverse relationship between domestic prices and import volumes. For instance, when there is a deficit in domestic supply and the world price is lower than the domestic maize prices, the country will import more. However, the country has little or no influence on the world price of maize since Kenya is a small importing country.

In addition, it was expected that a trade policy (X_1) such as trade openness which was used as a proxy for import tariffs will influence maize import volumes. Therefore, it was postulated that the more the economy opens for trade, the more it imports maize. Hence, lower or zero import tariffs encourages maize imports thus increasing the volume of imports. Conversely, a higher import tariff will discourage maize imports.

The macroeconomic factors such as exchange rate and GDP were anticipated to affect maize import. An increase in the exchange rate, for example, was projected to have an effect of lowering the prices of imported maize. A rise in the inflation rate was also postulated to have an effect of increasing domestic prices relative to international prices. This will prompt the domestic producers to increase domestic production because they have an incentive to do so. On the other hand, the government will import more to cushion maize consumers from the increased prices. Additionally, it was expected that the increased consumption will also lead to an increase in GDP.

Thus, it was expected that maize imports will influence consumer and producer welfare. The effect on the producers and consumers was anticipated to be twofold. Firstly, it was expected to have a direct effect of lowering the domestic price when the imported maize price is relatively cheaper than the domestic maize. Secondly, since maize producers are rational, the decrease in domestic price was expected to indirectly act as a disincentive to them hence they will be demotivated to raise their production. As a result, their income from this enterprise will decrease, resulting in a loss in producer surplus. On the other hand, maize imports were also anticipated to affect consumer welfare. Firstly, it was expected that a reduction in import tariffs will result in increased maize importation. This will in turn result in increased availability and accessibility of maize to consumers. Consequently, imported maize will be priced at a relatively lower price than domestically produced maize. This means that there will be gain in consumer surplus hence, improved welfare of maize consumers.

CHAPTER THREE

SUPPLY AND DEMAND RESPONSIVENESS OF MAIZE PRODUCERS AND CONSUMERS TO OWN PRICE CHANGES IN KENYA

Abstract

Estimating supply and demand response is important for economic growth and poverty reduction. It is also done to determine the role of price in agricultural supply and demand. Using secondary data from FAOSTAT for the period 1963 to 2016 and applying the autoregressive distributed lag (ARDL) model, the price supply and demand responsiveness of Kenya's maize subsector was estimated. The findings revealed that maize supply responds significantly to producer price, the area under maize production, and fertiliser use both in the short and long run. However, the supply elasticity of maize with respect to producer price was inelastic, suggesting that maize supply does not respond well to price incentives and that maize is a Giffen good. On the demand side, maize demand significantly responded to production and price of substitutes both in the long and short run. The findings suggest that support price is a necessary but not a sufficient condition for improving maize productivity. Hence, there is a need for efficient and effective use of the land resource through productivity-enhancing inputs, considering that land expansion is a limited option.

3.1 Introduction

Maize is a major staple in Kenya and its availability is synonymous with food security (Hassan & Karanja, 1997; Nyameino *et al.,* 2003). For this reason, the government of Kenya has over the years intervened in the maize subsector by pursuing policies aimed at improving maize production and marketing (Olwande *et al.,* 2009). Production and marketing of maize in Kenya have also over the years received budgetary support through marketing boards (Nyangito & Kimenye, 1995). However, maize production has not kept pace with consumption (Nyoro *et al*., 2004) and therefore constraining the achievement of the government's stated objective of universal food access, diversity, and nutritional status (The Republic of Kenya, 2007) where the importance of food security was considered in a broader context of regional market integration and globalization (Nyoro *et al*., 2007). Moreover, one of the most important food policy objectives of the government of Kenya is to improve maize supply response (Mose *et al.*, 2007) as a tool for increasing Kenya's food security and income to a vast majority of maize consumers and producers (Mose *et al*., 2007; Nyoro, 2002).

Supply response of maize to price and non-price incentives is one of the major policy concerns in Kenya and other developing countries (Mose *et al*., 2007; Shahzad *et al*., 2018).

Moreover, price incentives in the agricultural sector have also been viewed as major instruments that increase maize supply response (Gabre-Madhin & Haggblade, 2004). Some researchers argue that higher prices are more likely to benefit producers who sell their products and impose losses on the net buying consumers who are unable to respond to price incentives (Alene *et al.,* 2007; Omodho, 2008). Additionally, price incentives are viewed as vital in promoting agricultural growth through market liberalization, which significantly depends on how farmers respond to various price incentives (Jayne *et al*., 2001; Mose *et al*., 2007).

Notwithstanding the significant role that price incentives play in increasing maize supply response, Kenya's maize subsector is still marred with a challenge of how to ensure maize prices are affordable for consumers and at the same time profitable for producers (Jayne & Argwings-Kodhek, 1997; Onono, 2018). In light of this dilemma that is facing Sub-Saharan countries which rely on maize as a staple food, policies that can decrease the cost of transaction can act as alternatives to price policies and increase marketed surplus (Alene *et al*., 2008).

The above sentiments are clear proof that maize supply response should not be studied in isolation since the effect of price increase on the quantity of maize supply and demand relies on how receptive both maize producers and consumers are to price incentives (Jayne & Argwings-Kodhek, 1997). This means that the behaviour of maize producers as the major contributors to food security cannot be studied in isolation of consumer behaviour. By understanding how maize consumers respond to maize price changes in Kenya, policymakers can gain insights into the effects of a policy change on consumer welfare and food security (Jayne & Argwings-Kodhek, 1997).

However, despite there being several studies on the supply responsiveness of maize to its price, much is unknown about the actual responses of maize consumers to price changes. Therefore, a trade-off between maize supply and demand has not yet been achieved. Besides, most of the past empirical studies have only dealt with the supply side ignoring the demand side (Adefemi, 2011; Foster & Mwanaumo, 1995; Heltberg & Tarp, 2002; Liang, 2011; Mose *et al.*, 2007; Omodho, 2008). Additionally, most of the empirical studies on supply response of maize have shown varying results in terms of the magnitude of the elasticities hence difficult to rely on (Mose *et al.*, 2007; Omodho, 2008; Sedghy *et al*., 2016; Shoko *et al*., 2016). Other studies like Jayne and Argwings-Kodhek (1997) and Haggblade *et al*. (2017) only focused on estimating consumer response to maize prices without considering producer responses.

The study adds to this literature by providing empirical evidence on both supply and demand responsiveness of Kenya's maize producers and consumers from an econometric estimation of supply and demand elasticities with respect to maize price. These estimates of supply elasticities will be useful guidelines in policy formulation especially in light of the fluctuations in maize yield per hectare. Even though both price and non-price factors may seem vital in determining maize supply and demand, the study emphasizes the role of maize producers and consumer prices in influencing the supply and demand for maize. The focus is on the aggregate maize sector and therefore the prices used are aggregated across all producer and consumer types. Therefore, only the reported prices for both consumers and producers were considered important in the analysis.

Some of the recent empirical studies have been done either on supply response or demand response to price changes. For instance, Shoko *et al.* (2016) analysed maize supply response in South Africa. Using Nerlovian partial adjustment model of supply response on historical time-series data of area under maize cultivation, their results indicated a Short-run price elasticity of 0.24 and a long-run price elasticity of 0.36 signifying that maize farmers are more responsive to non-price factors than price factors. The study, therefore, recommended programs and policies that focus more on non-price incentives such as technology and infrastructure development, irrigation and research, and extension services. In a similar study aimed at determining factors affecting maize supply in Vietnam, Huong and Yorube (2017) estimated maize supply response using time-series data from 1986 to 2011 in a rational expectation hypothesis model. The findings indicated that maize supply responds positively to expected price, amount of fertiliser used per hectare, maize area, and irrigation.

In another similar study on determinants of maize supply for Dryland farming in Central Java, Ratri *et al.* (2019) used time-series data for 16 years ranging from 2001 to 2016. To analyse the data, they employed linear multiple regression where seven variables were estimated to investigate the key determinants of maize supply. The findings of the study showed that maize output produced in the previous period, harvested area, maize price in the previous year, and fertiliser price had a significant effect on maize supply. Additionally, they observed that the significant variables had varying elasticities, both in the short run and long run. However, supply elasticities in both the short and long run were greater than 1. Further, this study found that maize supply elasticity with respect to maize price and fertiliser was inelastic both in the short and long term while the elasticity of harvested area was elastic in the long and short term. The results of Ratri *et al.* (2019) agree with the findings of Huong and Yorube (2017). One limitation of these two studies is that; they did not test the time-series properties of the data used in the analysis by doing unit root and cointegration tests to rule out the possibility of the existence of unit roots and cointegration in the data. Besides, they failed to employ the most recently developed and effective time-series techniques in their analysis. Hence, there was a possibility of spurious regressions.

In another study on supply response of cassava in Nigeria, Obayelu and Ebute (2017) used a vector error correction model (VECM) to determine factors influencing cassava supply response. The results of their study revealed that cassava prices and land cultivated had a positive influence on cassava supply in the short run. This indicates that price policies were effective in the short-run promotion of cassava supply. However, in the long-run, elasticity of cassava was not significantly responsive to price incentives. This clearly shows that in the long run price incentives were not effective in determining supply response in Nigeria. This was attributed to the volatility of government policies and governance problems.

Haggblade *et al.* (2017) analysed demand for cereals in Addis Ababa, Ethiopia using the Quadratic Almost Ideal Demand System model (QUAIDS). Their results showed that when only substitution effects are considered, all cereals' demand became elastic as was expected for normal goods. However, demand for millet was found to be the least responsive to changes in own price in the urban area. Rice demand was less responsive to changes in its price when compared to maize and sorghum. Further, the authors discovered that own-price elasticities for maize and sorghum demand were highly elastic for lower-income households as compared to higher-income households. Additionally, they found higher elasticities for sorghum and millet suggesting strong future growth in demand.

Using a heterogeneous agent modelling approach to simulate production and consumption responsiveness of households producing maize, beans, and bananas in Uganda, Musumba and Zhang (2016) observed the existence of a degree of substitution between maize and other cereals. The authors also observed that higher prices lower the household maize consumption and increase household income implying that the higher the prices, the higher the household income. Additionally, the findings indicated that maize price increase lowers the poverty rate for households who are net sellers.

With an exception of the study by Musumba and Zhang (2016) which analysed both supply and demand responses, the selected empirical studies analysed isolated responses of either supply or demand. Secondly, there is evidence of varying elasticity estimates of both supply and demand hence cannot be relied on. Finally, some of the reviewed studies like the study by Shoko *et al.* (2016) used the Nerlovian Partial Adjustment model which may have led to spurious regressions. The current study aimed at overcoming this weakness by using an error correction version of the Autoregressive Distributed Lag Approach to analyse both supply and demand response.

3.2 Methodology

3.2.1 Study Area

The study was confined to the Republic of Kenya which is located in East Africa. Kenya is situated on the equator and is bordered by five countries namely Uganda to the West, South Sudan to the Northwest, Ethiopia to the North, Somalia to the Northeast, and Tanzania to the South. Kenya has a wide range of topographical features from the fertile Plateaus of the West and The Great Rift Valley which is home to many lakes in the region. Kenya covers an area of approximately 586,600 Km sq. of which 10,700 Km sq. is covered by water bodies. It is found in latitude and longitude lines of 1°00'N and 38° 00'E (KNBS, 2019). Kenya also has mountains like Mount Kenya, Mount Elgon, and volcanic landforms with areas of active hot springs and the highland areas of Central Kenya which provide fertile farming grounds. For this reason, Kenya is one of the most agriculturally productive countries in Africa. Kenya enjoys a tropical climate. Its Coastal region is warm and humid, the central highland has a temperate climate and the North and North Eastern regions experience hot and dry climates (KNBS, 2019).

According to the Kenya National Bureau of Statistics, Kenya has approximately 47.6 million people (KNBS, 2019). It is one of the top agricultural producers in Africa because of the rich fertile soils in the highlands. Main cash crops grown in the region include coffee and tea. Other crops grown in most parts of the country include maize which is the primary staple food, cassava, beans, potatoes among others. The main maize growing regions in Kenya include Trans-Nzoia, Uasin Gishu, Nakuru, Laikipia, Kisii, Narok, Bungoma, Kakamega, Nandi, Kericho, Tea zones of central Kenya, Nyahururu, Mt. Elgon slopes, slopes of Mt. Kenya, Bomet, Nyeri, Kiambu, and Meru tea zones. Maize is cultivated both on a small and large scale. Small scale production accounts for about 70% of the overall production while 30% of output is from large-scale commercial producers (Onono, 2018).

3.2.2 Data Sources

The study utilized time-series secondary sources of data to generate 54-year aggregate annual time-series data on maize producer prices, the area under maize cultivation, fertiliser cost, rainfall amount, maize production quantity, consumption quantity, domestic prices, national income, price of substitutes, exchange rate, gross domestic product, border prices, import volumes and export volumes for the period 1963 to 2016. The sources of the time-series data included both international and domestic sources. International sources included FAOSTAT, World Bank, and World Trade Organization (WTO) online databases, from which data on the area under maize cultivation, fertiliser cost, maize production, national income, border prices, exchange rate, gross domestic product, and maize import volumes were obtained. On the other hand, domestic sources consisted of publications from Kenya National Bureau of Statistics (statistical abstracts and economic survey documents), Ministry of Agriculture, and NCPB from which data on producer prices and domestic prices were obtained. Producer prices were compiled as annual averages from all the 8 major maize producing regions in Kenya to generate aggregate producer prices. Consumer prices were also compiled from retail maize prices as annual averages from all the 8 regions of Kenya to arrive at the aggregate consumer prices. Maize producers were assumed to use previous period prices to predict prices for the next subsequent periods. Finally, data on the amount of rainfall was obtained from the meteorological department of the Ministry of Agriculture. The long-run elasticities of both supply and demand were generated from short-run estimates by dividing the short-run estimates by the absolute values of the error correction term. It was important to estimate both short and long-run elasticities because, in the long run, all factors of production can be utilised unlike in the short-run where some factors are fixed while others are constant.

3.2.3 Research Design

The study applied a quantitative research design to statistically answer the research questions. This method was appropriate because the study determined statistical relationships between socioeconomic factors that influence the welfare of maize producers and consumers in Kenya.

3.2.4 Description of Variables for Analysis of Supply and Demand Response

Table 1 shows a description of variables that were used in the analysis of the supply and demand response of maize producers and consumers to maize price changes. The choice of independent variables was based on the findings from the literature review. A detailed description of these variables has been done with specific variables hypothesized to influence either maize supply or demand.

The *Production* variable was used as a dependent variable on the supply responsiveness equation. Based on the evidence from Omodho (2008), production was used as a proxy for aggregate supply which was postulated to be explained by producer price, the area under maize cultivation, fertiliser use, and rainfall. Production has been a dominant measure of the supply response in many of the supply response studies (Huong & Yorube, 2017; Kuwornu *et al.*, 2011; Obayelu & Ebute, 2017; Ozkan *et al.*, 2011; Ratri *et al.*, 2019).

Qconsumed (maize quantity consumed) was used as a proxy for aggregate maize demand on the demand responsiveness equation following the recent works of Musumba and Zhang (2016) and Haggblade *et al*. (2017). This was justified by the fact that maize consumers are rational and therefore they demand only what they need for consumption (Chapoto *et al*., 2010). It was postulated that maize demand would be influenced by maize domestic price, price of substitutes, maize production or output, and national income. The assumption here was that demand for maize follows either static or non-static expectations. The use of this variable as an outcome variable in the demand response was further justified by past empirical literature (Haggblade *et al*., 2017)

Price (producer price) was the primary independent variable on the supply equation. It was deemed an important factor in determining farmers' decisions on whether or not to increase their maize production. Several empirical studies confirmed the use of the price variable as the main independent variable in the supply response analysis (Adefemi, 2011; Liang, 2011; Shoko *et al*., 2016). It was anticipated that maize producers will respond to a positive price change by increasing their maize production and to a negative price change by reducing their maize production. Hence, maize producer price was expected to be positively or negatively associated with maize supply. Since there is a time lag involved in the production, the output is obtained several months after planting (Omodho, 2008; Seay *et al*., 2004). Therefore, maize producers do not know the actual price of maize at the time of planting. Maize producers were thus assumed to be guided by the previous period prices in making production decisions. Nominal prices were adjusted using the consumer price index (CPI) to derive the real maize producer prices.

Hectare was used as a proxy for the land area under maize cultivation. It was used as one of the explanatory variables in the supply response equation. It was expected that the larger the area under maize cultivation, the higher the supply of maize. A study by Kuwornu *et al.* (2011) confirmed the use of the area under maize cultivation as an explanatory variable in the supply response equation.

Rainfall (amount of rainfall) was used as an independent variable in the supply response equation. It was expected that the amount of rainfall would have either a positive or negative effect on maize supply. The use of this variable as an explanatory variable was justified by past empirical studies (Kuwornu *et al.,* 2011; Muchapondwa, 2009; Olwande *et al*., 2009)

Fertcost (fertiliser cost) was also used as an explanatory variable in the supply equation. Due to the unavailability of reliable time-series data on the amount of fertiliser used on maize, fertiliser cost was used as a proxy for fertiliser use on maize production. It was anticipated that the higher the spending on fertiliser used on maize production, the higher the amount of fertiliser used. Hence, the higher the maize supply. Therefore, this variable was deemed to be the best measure of the amount of fertiliser used in the production of maize.

Table 1: Description of variables for analysis of supply and demand response

Variable	Description	Measurement	Expected Sign
Dependent Variables			
Production	Maize production in (Tonnes)	Continuous	
Qconsumed	Maize quantity consumed (Tonnes)	Continuous	
Independent Variables			
Price	Producer price (KES/Tonne)	Continuous	+-
Hectares	Land area under maize (Hectares)	Continuous	+-
Rainfall	Amount of rainfall (ml)	Continuous	+-
Fertcost	Fertiliser cost (KES)	Continuous	+-
Maizedomprice	Maize domestic price (KES/Tonne)	Continuous	+-
Whtdomprice	Domestic wheat price (KES/Tonne)	Continuous	+-
Gdppercapita	Gross domestic product (KES)	Continuous	+-

Maizedomprice (maize domestic price) was the primary independent variable that was assumed to influence aggregate maize demand. However, it was expected that any change in maize domestic price would not have a significant effect on maize aggregate demand since maize is a primary staple for most urban and rural consumers in Kenya.

Whtdomprice (wheat domestic price) was used as a proxy for the price of substitutes of maize due to the unavailability of data on prices of other substitutes. It was anticipated that any change in this variable would positively or negatively affect aggregate maize demand.

Gdpercapita (per capita gross domestic product) was used as a proxy for national income. Normally, it can be used to depict the per capita income of consumers. Taking into consideration the entire Kenyan economy as the unit of analysis and the aggregate maize consumers, this variable was deemed important for the study.

3.2.5 Modelling Strategy

The time-series data obtained from the secondary sources were organised and managed using Microsoft Excel and STATA software to obtain both descriptive and inferential statistics. Data were then analysed using the distributed lag approach proposed by Nerlove (1958). According to Nerlove, the distributed lag estimation can be handled by developing an explicit dynamic model of producer and consumer behaviour which accounts for distributed lags of both supply and demand. Therefore, following Narayan (2005) and Pesaran *et al.* (2001), an error correction version of the autoregressive distributed lag model (ARDL) was used in the analysis of both supply and demand response to maize price changes.

The error correction version of the ARDL model was preferred for the analysis over other approaches such as the Nerlovian partial adjustment model and Engle-Granger two-step procedure since it gives more efficient and reliable results in small and finite samples. Given a sample size of 54 that the study used, the model was deemed to produce consistent and reliable results both on theoretical and empirical grounds. Secondly, it can produce feasible results when the data set in question contains both exogenous and endogenous variables which are integrated of different orders (Obayelu & Ebute, 2017). Finally, the model can capture both long and short-run dynamics of both supply and demand when testing for cointegration, thereby producing unbiased long-run estimates (Muchapondwa, 2009).

Three steps were followed in the application of the error correction version of the ARDL modelling approach. Firstly, the order of integration for each variable was determined using unit root tests to confirm whether or not the variables are stationary. A stationary series has a constant mean and variance (Mackinnon, 1996). The Augmented Dickey-Fuller (ADF) test which takes care of possible autocorrelation in the error terms was used to test for stationarity in the data (Nkoro & Uko, 2016). The results were further confirmed by performing the Dickey-Fuller Generalised Least Squares (DFGLS) test which is a more powerful test for stationarity that delineates the presence of unit roots in situations where there exist structural breaks in the time-series (Gujarati, 2004). These tests were performed using the following functional form:

$$\Delta Z_t = \beta_1 + \beta_{2t} + \delta Z_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta Z_{t-1} + \varepsilon_t \tag{3.1}$$

where Δ is the change operator, Z_t is variable in the series to be checked for stationarity, Z_{t-1} represents one period lagged values, ΔZ_{t-1} shows the first difference. To ensure that the error term is serially uncorrelated so that unbiased estimates of δ can be obtained, the number of lagged difference terms were determined empirically (Gujarati & Porter, 2009). n is the lagged value of ΔZ to control for the higher order of correlation and ε_t indicates white noise error term.

Secondly, the presence of a unique or long-run cointegrating relationship was tested using the ARDL bounds test approach which is represented by equation 3.2.

$$\Delta Y_t = \gamma + \sum_{i=1}^{p} \delta_i Y_{t-i} + \sum_{i=0}^{q} \beta_i^{'} X_{t-i} + \varepsilon_t \tag{3.2}$$

where Y_t is a vector representing maize quantity supplied or maize quantity demanded in time *t*, which was allowed to be integrated of order zero or order one, that is, I(0) or I(1) and is a function of its own lagged values, the current and lagged values of other exogenous variables in the model. *t* is period in years, δ and β are coefficients to be estimated and they represent elasticities of supply or demand with respect to various explanatory variables. γ is a constant, i =1,…*k; p, q* are optimal lag orders, which were chosen based on Schwartz Bayesian information criterion (SBIC); *p* lags were used for the dependent variables and *q* lags were used for the exogenous variables. *i* is the optimal lag structure for all the variables, *t-i* is the optimal number of lags and e_t is a vector of the error terms.

Following Narayan (2005), the direction of the relationship between domestic maize supply or demand and other explanatory variables was determined through a joint significance test of the coefficient of the lagged dependent variables under the null hypothesis of no long-run relationship or no cointegration. This was represented by $H_0 : \delta_{1i} = \delta_{2i} = \delta_{3i} =$ *0* (where *i* = 1, 2, 3) and an alternative hypothesis of the presence of cointegration or long-run relationship which was represented by $H_1 : \delta_{1i} \neq \delta_{2i} \neq \delta_{3i} \neq 0$ which was tested during estimation.

Finally, following Pesaran *et al*. (2001), an error correction term was added to the ARDL model to incorporate both long and short-run dynamics of the variables and was specified as presented in equation 3.3 to obtain both short and long-run elasticities of supply and demand. The re-parameterization of ARDL into an error correction model by adding an error correction term was possible since the ARDL model is a single equation model which is of the same form as the error correction model (Nkoro & Uko, 2016).

$$\Delta Y_t = \gamma + \sum_{i=1}^{p} \delta_1 \Delta Y_{t-i} + \sum_{i=0}^{q} \beta_i^{'} \Delta X_{t-i} + \lambda ECT_{t-1} + \varepsilon_t \tag{3.3}$$

where,

$$\lambda = (1 - \sum_{t=1}^{p} \delta_1) \tag{3.4}$$

is the speed of adjustment with a negative sign

The error correction term was defined as presented in equation 3.5. ECT is the residual from the regression of the long-run equation and it captures short and long-run dynamics as well as the forward-looking behaviour of both maize producers and consumers (Mackinnon, 1991). Additionally, it shows how much of the disequilibrium in the previous period is corrected in the current period Y_t

$$ECT_{t-1} = \ln Y_{t-1} - \theta X_t \tag{3.5}$$

where,

$\theta = \frac{\sum_{t=0}^{q} \gamma_i}{Y_{0i}}$ is the long-run parameter which incorporates short and long-run dynamics to give both short-run and long-run elasticities.

3.3 Results and Discussion

3.3.1 Descriptive Results on Supply and Demand Responsiveness

Table 2 presents descriptive statistics used in the analysis of supply and demand responsiveness to price. The descriptive statistics were analysed decade-wise except for the 2013-2016 periods. Both production and consumption recorded an upward trend throughout the entire period of analysis. This is evidenced by the average production increase from 1,426 thousand to 3,491 thousand metric tonnes between 1963-1972 and 2013- 2016 and an average consumption increase from 76 thousand to 9,034 thousand metric tonnes during the same period. However, the level of production from 1963 to 1992 was higher than the level of consumption during the same period. That is, the average production increased from 1,426 to 2,398 thousand metric tonnes for the period 1963-1972 and 1983-1992 respectively while consumption increased from an average of 76 thousand to 1,207 thousand metric tonnes in the same period. The sharp increase in production compared to consumption from 1963 to

1992 could be attributed to the fact that during the better part of this period, the country was self-sufficient in maize production (Wangia *et al.,* 2002). This coupled with the use of purchased inputs in the early 1970s promoted by the government through cooperative societies and maize control boards resulted in a breakthrough in maize production, hence, the reason for increasing production (Omodho, 2008).

Consequently, although there was an increasing trend in the level of production and consumption in the entire period of analysis, the increase in consumption was higher than the increase in production from 1993 to 2016. This is evidenced by the sharp increase in average consumption from 3,348 thousand to 9,031 thousand metric tonnes and a steady increase in production from an average of 2,437 to 3,491 thousand metric tonnes. The sharp increase in consumption compared to production during this period confirms the widening gap between maize supply and demand due to rapid population growth. Secondly, it also portrays increased access to maize imports and reduced consumer prices due to tariff reductions and duty-free access to maize imports from COMESA and EAC countries. This was occasioned by the maize market reforms and Kenyan membership in World Trade Organisation (Wangia *et al.,* 2002).

Additionally, as the producer price of maize increased, the area of land under maize cultivation (hectares) and maize production also increased. This is evidenced by the increasing trend in average producer price, hectares, and production from 1963 to 2016. This indicates that both land and price are important factors that contribute to maize supply. The average amount of rainfall has not been constant over the years. This is evidenced by the fluctuating trend in the average amount of rainfall in all the decades beginning with 1963-1972 which recorded a higher mean amount of rainfall of 1,265 millimetres to 2013-2016 which recorded a mean amount of rainfall of 731 millimetres. The fluctuating trend in the amount of rainfall underscores the need to quit from overreliance on rain-fed agriculture. There was a tremendous increase in the use of fertiliser s in maize production from 1993 to 2016.

Both domestic prices of maize and maize consumption quantity show an increasing trend in average price and average consumption over the years. However, the increase in domestic price did not lead to a corresponding decrease in domestic maize consumption in almost all the decades. This lends support to the fact that maize is a staple food for most maize consumers in Kenya.

Table 2: Descriptive statistics for supply and demand response to maize price changes

Variable	1963-1972		1973-1982		1983-1992		1993-2002		2003-2012		2013-2016	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Production('000)	1,426	216	2,084	358	2,398	396	2,437	320	2,980	465	3,491	244
Producer price	309	78	497	140	1,229	117	1,527	306	4,416	1,569	5,254	1,584
Hectares ('000)	1,185	135	1,403	149	1,350	137	1,505	83	1,818	249	2,154	104
Rainfall	1,265	520	1,063	208	870	137	894	247	777	299	731	299
Fertcost (000)	23	37	247	59	805	336	1,615	812	5,236	2,134	12,890	3,201
Qconsumed (000)	76	35	318	154	1,207	217	3,348	1,155	7,296	2,850	9,031	1,015
Maizedomprice	479	44	1,144	354	3,095	575	13,460	2,504	21,984	7,956	36,771	2,685
Whtdomprice	666	32	1,644	536	4,318	1,021	17,107	3,964	27,559	3,958	36,300	1,209
Gdppercapita	619	82	839	40	874	33	836	14	904	62	1,079	42

On the same note, the average wheat domestic price also exhibited an increasing trend from 1963 to 2016 as evidenced by the increasing average wheat domestic prices from KES 666 per tonne between 1963-1972 to KES 36,300 per tonne from 2013- 2016. Finally, the average per capita GDP also shows an increasing trend over the years. An implication that as maize production increases over the years, per capita GDP also increases. This lends support to the fact that maize supply is an important factor that contributes to GDP growth in Kenya. Additionally, both producer and consumer price trends of maize were graphically presented as shown in Figure 2.

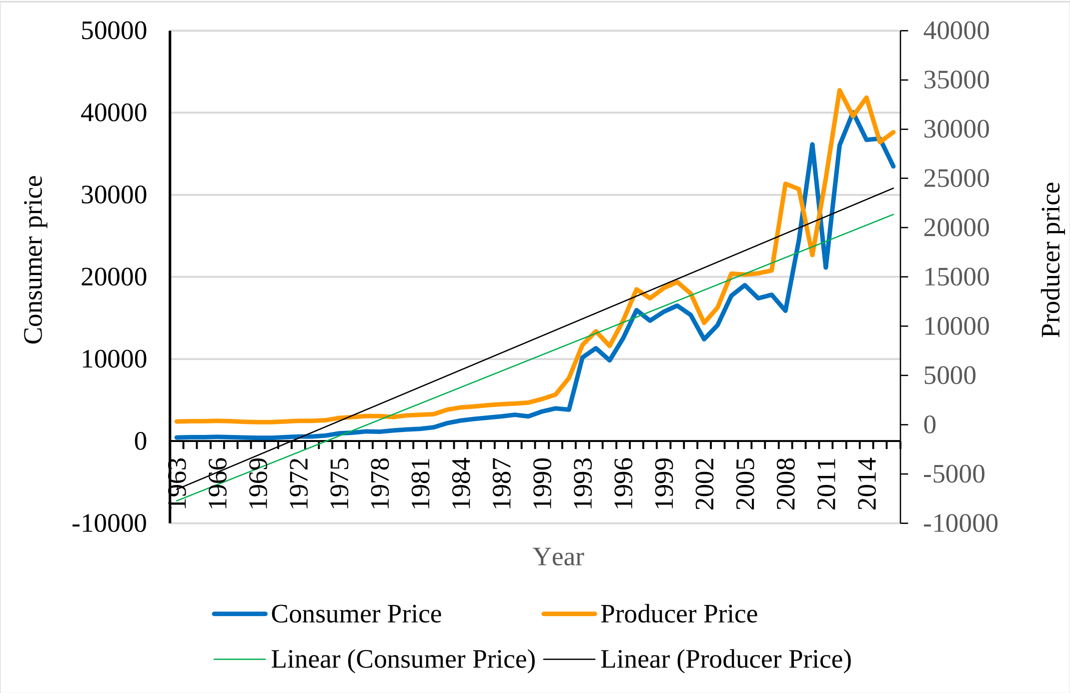

Figure 2: Producer and consumer price trend from 1963 to 2016

Source: Statistical Abstracts and Economic Survey documents

The period between 1963 and 1978 reveals that both producer and consumer prices were stable. This is concurrent with the period of strict controls of maize prices and movement under the Maize Marketing and Produce Board (MMPB). Consequently, the period from 1981 to 2016, portrays a fluctuating and increasing trend in both producer and consumer prices. This trend indicates that although maize market reforms led to the elimination of maize price and movement controls which consequently culminated in full liberalization in 1995, it was accompanied by price variability which led to unstable producer and consumer incomes.

3.3.2 Empirical Results for Maize Supply Response to Price Changes

3.3.2.1 Diagnostic Test Results

It was essential to test the important time-series assumptions before estimating the error correction version of the ARDL model. Using SBIC to account for model selection uncertainty in choosing optimal lag length, both ADF and DFGLS tests were performed on all the variables in their level form to establish the presence of unit roots. Table 3 presents the ADF and DFGLS test results for level variables.

Table 3: Unit root test results for supply response level variables

Variable	**ADF**		**DFGLS**		**Inference**
	Test statistics	**Critical value**	**Test statistics**	**Critical value**	
lnproduction	-2.255	-2.929	-2.625	-3.108	Non stationary
lnprice	-0.924	-2.928	-3.123	-3.202	Non stationary
lnhectares	-0.656	-2.928	-1.988	-3.159	Non stationary
lnrainfall	-4.78	-2.928	-5.437	-3.202	Stationary
lnfertcost	-2.688	-2.928	-2.007	-3.202	Non stationary

The null hypothesis for a unit root test is that the time-series is non-stationary. This hypothesis is rejected if the test statistic is greater than the critical value in absolute terms. All the variables were transformed into logarithms to allow supply to respond proportionately to a rise or fall in each explanatory variable. This prevents changes in the elasticities as supply quantities change. This hypothesis was tested at a 5% significance level. According to Table 3, it is evident that production, producer price, hectares (area under maize cultivation) and fertiliser cost have unit roots in their level form. Therefore, the variables are non-stationary. However, the results indicate that rainfall has no unit root, hence, it is stationary. The DFGLS statistics also validate the results of the ADF test statistics. Therefore, the null hypothesis that production, producer price, hectares, and fertiliser cost are non-stationary in their level form was accepted. However, the null hypothesis that rainfall is non-stationary was rejected. This test result is similar to the findings of Huq and Arshad (2010), Mose *et al.* (2007), Muchapondwa (2009), and Shahzad *et al.* (2018) who also found that rainfall was stationary in level form. However, these results are contrary to the findings of a study done by Ogazi (2009) who found that domestic maize prices were stationary in level form.

Table 4: Unit root test results for supply response differenced variables

Variable	ADF		DFGLS		
	Test statistic	**Critical value**	**Test statistic**	**Critical value**	**Inference**
lnproduction	-5.486	-2.93	-4.905	-3.112	Stationary
lnprice	-6.076	-2.928	-5.368	-3.209	Stationary
lnhectares	-5.18	-2.929	-3.747	-3.164	Stationary
lnfertcost	-5.274	-2.928	-5.623	-3.209	Stationary

Since all the variables were non-stationary in their level form except rainfall, there was a need to establish their order of integration to aid in guiding the selection of an appropriate estimation model. Hence, the first difference of each series was tested to establish their order of integration. Again, the null hypothesis for the unit root test here was that the time-series is non-stationary. This hypothesis is rejected if the test statistic is greater than the critical value in absolute terms. Table 4 presents the ADF and DFGLS test results for the first difference of each level variable. Both the ADF and DFGLS test results of the first differenced variables revealed that production, producer price, hectares, and fertiliser cost are stationary in their first differenced form. Hence, they are integrated of order one (I (1)) except rainfall which is integrated of order zero (I (0)). These findings are in line with Mose *et al.* (2007), Muchapondwa (2009), and Omodho (2008) who analysed supply responsiveness of maize and found stationarity in data after the first differencing.

The unit root test results above confirmed that the series had mixed regressors. To this end, a bounds test of cointegration was performed to establish whether or not the time-series are cointegrated. The bounds test was performed under the null hypothesis that the time-series are not cointegrated. This hypothesis is rejected when the calculated F statistic is greater than the upper bound critical value (I (1)) or if the t statistic is less than the upper bound critical value (I (1)). The results of this test are given in Table 5.

Table 5: Bounds test for cointegration for supply response variables

Test statistic	Lower bound I(0)	Upper bound I(1)
F-statistic 13.981	2.86	4.01
t-statistic -7.677	-2.86	-3.99

Following Narayan (2005) and Pesaran *et al*. (2001), the calculated F value of 13.981 which is greater than the critical value (4.01) for the upper bound at a 5% significance level was obtained. Similarly, the t value of -7.677 which is less than the upper bound critical value (-3.99) at 5% significance level was obtained. Based on these tests, the null hypothesis of no cointegration or existence of a long-run relationship was rejected. Consequently, the alternative hypothesis that the variables have a long-run relationship or are cointegrated at a 5% significance level was accepted. These results are consistent with the findings of Muchapondwa (2009) and Shoko *et al.* (2016), who analysed supply responsiveness and found a long-run relationship between supply and other explanatory variables. The cointegration results suggest that the ARDL model alone is not appropriate for analysing the supply response of maize. To this end, an error correction term was incorporated in the ARDL model and was used to estimate supply responsiveness to price changes.

3.3.2.2 Long-run Supply Response Results

Table 6 shows the long-run supply response results. The first lag of production (lnproduction (-1)) was positive and significant at a 1% significance level with an elasticity of 0.427 implying that a 1% increase in maize production in the previous period, leads to a 0.427% increase in maize production in the current period. This could be attributed to the asset fixity problem once capital is devoted to maize production since maize constitutes a large percentage of agricultural production in Kenya. Therefore, the moment a production increase occurs, it is likely to persist to the near future. Secondly, this reinforces the fact that maize producers use adaptive expectations in forecasting the next period’s trend in maize production based on the previous period’s maize supply and prices. This result is correspondent with the findings of a study by Shahzad *et al*. (2018) which also found that previous period production influenced the current period supply.

Table 6: Long-run supply response results

Variable	Coefficient	Std. Error	Probability
lnproduction (-1)	0.427	0.134	0.003***
lnprice	-0.098	0.052	0.08*
lnprice (-1)	0.102	0.053	0.061*
lnhectares	0.892	0.164	0.000***
lnhectares (-1)	-0.486	0.197	0.018**
lnrainfall	0.017	0.051	0.741
lnfertcost	0.016	0.006	0.007***

Note: ***, **, and * represent significance at 1%, 5% and 10% respectively

The long-run elasticity of current producer price (lnprice) was -0.098% which was inelastic and significant at a 10% significance level. This indicates that a 1% increase in producer price of maize leads to a 0.098% decrease in maize supply other factors held constant. This implies that maize supply does not respond well to price incentives. However, it was negative, a result similar to the findings of Muchapondwa (2009) and Shoko *et al.* (2016). This could be attributed to several factors. Firstly, the negative price elasticity of supply could be attributed to the fact that price is endogenous and is determined after the supply has been observed which explains why there are low prices when harvests are plenty and high prices when supply is low. This result is consistent with post-planting price announcements which Kenya tends to use. This further validates the use of the error correction version of the ARDL model which takes this endogeneity aspect into account. Secondly, the negative response with respect to price could be attributed to the fact that most maize producers are small-scale farmers who depend on maize both for revenue generation and for food. Therefore, apart from being maize producers, they are also net buyers of maize, hence, an increase in maize price may not warrant a corresponding increase in maize supply. Finally, the negative elasticity could be attributed to the forecasting error made in predicting maize prices that will prevail in the current period due to stochastic shocks. Thus, maize producers may be unable to correctly forecast maize supply and prices even if production and prices experience no further shocks.

The first lag of producer price of maize (lnprice (-1)) was positive and significant at a 10% significance level in the long run with an elasticity of 0.102 indicating that a 1% increase in maize price in the previous period leads to 0.102% increase in maize supply in the current period, other factors held constant. This implies that maize producers base their expected price formation on the previous period's available set of information. Thus, at the beginning of each year's planting season, farmers are influenced by the price prevailing in the last year's planting season. The significance of the lagged price of maize further lends support to the fact that farmers use adaptive expectations in making their production decisions. Thus, their production decisions are based on prices they expect to prevail several months after harvest. Although the magnitude of elasticity of lagged price was higher than that of the current price in the long-run, it was still inelastic. A fact that could be attributed to several factors. Firstly, maize producers form their expected prices based on calculations from previous price records which may be erratic and inaccurate. Secondly, other factors like natural calamities such as floods, drought, and famine are unpredictable but can result in detrimental effects which can spontaneously negatively affect maize supply. This result agrees with the findings of previous studies (Muchapondwa, 2009; Obayelu & Ebute, 2017; Ratri *et al.*, 2019).

Similarly, the coefficient of lnhectares was positive and significant at a 1% significance level. A percentage increase in the area of land under maize cultivation leads to a 0.892% increase in maize supply, all other factors held constant. This means that bringing more land under maize production is a way of increasing maize supply. This is an indication that land area contributes the most to the increase in maize supply. This could be attributed to motivation from increased derived economic benefits from the maize crop as a result of the availability of the necessary market information at the disposal of maize producers. This result agrees with the findings of previous studies (Huong &Yorube, 2017; Shahzad *et al*., 2018). Furthermore, the first lag of hectares (lnhectares (-1)) was negative and significant at a 5% significance level. A percentage increase in the area of land allocated to maize production in the previous period leads to a 0.486% decrease in maize supply in the current period, other factors held constant. This negative elasticity could be attributed to diminishing returns from the same parcel of land which progressively yields diminishing output, hence, decreased supply.

The coefficient of fertiliser cost (lnfertcost) was positive and significant at a 1% significance level in the long run. An indication that the higher the fertiliser use per hectare, the higher the maize supply, other factors held constant. However, the fact that the coefficient was inelastic indicates that fertiliser use alone is not a sufficient condition for improving maize productivity. Therefore, the current fertiliser subsidy program should be integrated with appropriate soil management practices to determine appropriate fertiliser requirements for different soil types and dissemination of such information to farmers. These findings agree with the result of Mose *et al*. (2007) who established that fertiliser is the most significant input in maize production in the long-run.

3.3.2.3 Short-run Supply Response Results

Table 7 presents short-run supply elasticities. The speed of adjustment had an expected sign and was significant at a 1% significance level. Its value was -1.104, which implies that about 110% of the deviations in maize supply from long-run equilibrium are corrected in the current period. The fact that the speed of adjustment was different from zero shows that the feedback mechanism was effective in converging maize supply towards long-run equilibrium.

Table 7: Short-run supply response results

Variable	Coefficient	Std. error	Probability
Speed of adjustment	-1.104	0.144	0.000***
Dlnprice	0.096	0.026	0.001***
Dlnhectares	0.590	0.133	0.000***
Dlnrainfall	0.035	0.047	0.460
Dlnfertcost	0.019	0.004	0.000***
Constant	5.500	2.332	0.023

R^2 = 0.6303 Adjusted R^2 = 0.5728

Note: *** represents significance at a 1% significance level

The results also show significant and inelastic short-run supply response to current producer price (Dlnprice). A percentage increase in maize price leads to a 0.096% increase in maize supply, all other factors held constant. This result indicates that price incentives are a necessary but not sufficient condition for improving maize supply. This result is similar to the findings of Olwande (2009) and Ratri *et al.* (2019) who also found that maize supply elasticities with respect to producer price were inelastic in the short run.

The coefficient of hectares of land (Dlnhectares) was 0.590 which was positive and significant at a 1% significance level. A percentage increase in land area under maize cultivation leads to a 0.590% increase in maize supply, *ceteris paribus*. This implies that land is the most important fixed factor contributing to maize supply. Increasing the size of land allocation to maize production through land consolidation would be desirable and imply economies of scale. However, in Kenya population increase has led to the subdivision of land into uneconomical parcels. Therefore, increasing land size may not be realistic and efficient.

This necessitates more efficient and effective use of available units of land. In correspondence to this study, Olwande *et al*. (2009) found that as the land area under maize expanded in the short run, maize output increased.

Fertiliser cost also had a positive and significant effect on maize supply in the short run as was expected. A percentage increase in fertiliser use leads to a 0.019% increase in maize supply. This result is consistent with the findings of Ratri *et al.* (2019) who also found that fertiliser use had a positive and significant effect on maize supply.

3.3.2.4 Post Estimation Diagnostics for Supply Response

The regression analysis revealed an adjusted R^2 of 0.5728. This indicates that 57.28% of the variations in maize supply are explained by the estimated explanatory variables. Therefore, the model best fits the data. Post estimation diagnostic tests were done to establish the conformity of the time-series variables to the assumptions of homoscedasticity, normality multicollinearity, and serial correlation and to indicate the appropriateness of the error correction version of the ARDL model. The results of these tests are given in Appendix A through D. Jarque-Bera's normality test (p = 0.8876) was statistically insignificant (Appendix A). Therefore, the null hypothesis of normality was accepted. A multicollinearity test was also performed on the series to verify the existence of a perfect linear relationship among the variables. To this effect, a mean VIF of 3.12, which was less than 10, was obtained (Appendix B). This suggests that there was no multicollinearity in the series. Breusch-Godfrey LM test which is suitable for testing serial correlation in data with lagged dependent variable was used to test for serial correlation and a p-value of 0.1019 was obtained, which shows that there was no serial correlation in the data series (Appendix C). A heteroscedasticity test was also performed using the Breusch-Pagan test and a probability chi-square value of 0.2710 was obtained which confirmed that the data was homoscedastic (Appendix D).

3.3.3 Empirical Results for Demand Responsiveness to Price Changes

3.3.3.1 Diagnostic Test Results for Demand Response

As mentioned earlier on the estimation of a supply response, the primary step in time-series analysis is to check the unit root problem. Both the ADF and DFGLS tests were again used to check the unit root problem in all the variables in their level form. Hence, the null hypothesis that the series is non-stationary was accepted for both ADF and DFGLS test statistics. Therefore, maize quantity consumed (lnQconsumed), production, maize domestic price, wheat domestic price, and GDP per capita were non-stationary in their level form. Table 8 presents the ADF and DFGLS test results for unit root for level variables.

Table 8: Unit root test results for demand response level variables

Variable	ADF		DFGLS		
	Test statistic	Critical value	Test statistic	Critical value	Inference
lnQconsumed	-1.655	-2.928	-2.919	-3.209	Non stationary
lnproduction	-2.16	-2.93	-2.572	-3.112	Non stationary
lnmaizedomprice	-0.461	-2.928	-2.533	-3.209	Non stationary
lnwhtdomprice	-0.706	-2.928	-1.839	-3.209	Non stationary
lngdppercapita	-1.882	-2.928	-2.623	-3.209	Non stationary

Since all the variables were non-stationary in their level form, the ADF and DFGLS tests were performed on the first differences of all the variables under the null hypothesis that the series is non-stationary. At a 5% significance level, this hypothesis was rejected, meaning that the series became stationary after first differencing. Therefore, all the variables were found to be integrated of order one (I(1)). Hence, the error correction version of the ARDL model was still appropriate for the estimation of demand responsiveness to price. Table 9 reports the ADF and DFGLS unit root test results for the first differenced variables which were used in the estimation of demand responsiveness to price changes.

Table 9: Unit root test results for demand response differenced variables

Variable	ADF		DFGLS		
	Test statistic	Critical value	Test statistic	Critical value	Inference
lnQconsumed	-6.661	-2.929	-4.815	-3.216	Stationary
lnproduction	-5.475	-2.933	-4.69	-3.116	Stationary
lnmaizedomprice	-6.705	-2.929	-6.429	-3.216	Stationary
lnwhtdomprice	-4.697	-2.929	-4.348	-3.216	Stationary
lngdppercapita	-4.803	-2.929	-3.527	-3.216	Stationary

Bounds test for cointegration was done to investigate the existence of a long-run relationship in the data series. Table 10 shows that the calculated F value of 6.451 which is greater than the critical value (4.376) for the upper bound at a 5% significance level was obtained. The t value of -5.521 which is less than the upper bound critical value (-4.044) at a 5% significance level was also obtained. Based on these tests, the null hypothesis of no cointegration or existence of a long-run relationship was rejected. The alternative hypothesis that the variables have a long-run relationship was accepted at a 5% significance level.

Table 10: Bounds test for cointegration for demand response

Test statistic	Lower bound I(0)	Upper bound I(1)
F-statistic 6.451	3.104	4.376
t-statistic -5.521	-2.890	-4.044

3.3.3.2 Long-run Demand Response Results

Table 11 presents long-run elasticities of demand with respect to maize domestic price, production, substitute price (lnwhtdomprice), and national income (lngdppercapita). The estimated elasticity of the first lag of quantity of maize consumed (lnQconsumed (-1)), which was used as a proxy for maize demand, was 0.541 which was significant at a 1% significance level in the long-run. This suggests that the current year's maize demand is positively and significantly influenced by the previous year's maize demand. Therefore, a 1% increase in the previous year's maize demand will increase the current year's maize demand by 0.541%. This can be possibly explained by the fact that maize consumers use static expectations. This lends support to the fact that both maize producers and consumers have a belief that current prices or income and consumption patterns tend to persist shortly due to uncertainty.

Table 11: Long-run demand response results

Variable	Coefficient	Std. Err.	Probability
lnQconsumed (-1)	0.541	0.146	0.001***
lnproduction	0.791	0.280	0.027**
lnmaizedomprice	-0.114	0.254	0.684
lnwhtdomprice	1.045	0.319	0.013**
lngdppercapita	0.621	0.493	0.214

Note: ***, **, * represents significance at 1%, 5%, and 10% respectively

Production (lnproduction) was positive and significant at a 5% significance level, which implies that a 1% increase in maize supply leads to a 0.791% increase in maize demand, other factors held constant. Even though the coefficient shows that the elasticity of maize demand with respect to maize output was inelastic, its magnitude was high, a clear indication that maize supply plays a very crucial role in determining maize demand. Most maize consumers will demand more during bumper harvests to caution them during times of shortage when prices are high. This underscores the need for change in the consumption behaviour of maize consumers to minimize wastage of this staple during periods of bumper harvests when supply is high. This is in line with Chapoto *et al.* (2010).

Similarly, the elasticity of wheat domestic price was 1.045 which was both elastic and significant implying that a 1% change in wheat domestic price is associated with a 1.045% point increase in demand for maize. The positive sign signifies that a degree of substitution exists. The relatively high cross elasticity shows that the degree of substitution is high. This may mean that richer maize consumers have more options than poorer consumers since they have a wide range of varieties to choose from. This result is similar to the findings of a study done by Musumba and Zhang (2016) who found significant cross-price elasticity of demand. This result contrasts the findings of Van Zyl (1986) who estimated the cross elasticity of demand for maize was low and portrayed that the degree of substitution between maize and other commodities was small. However, this result also agrees that a degree of substitution does exist. This can be attributed to the fact that maize is a food security crop and therefore consumers tend to shift to its consumption whenever the prices of other substitutes increase.

3.3.3.3 Short-run Demand Response Results

Table 12 reports short-run elasticities of demand with respect to various explanatory variables. The coefficient of the error correction term which represents the speed of adjustment had an expected sign and was significant at a 1% significance level. Its value was -0.789, which implies that about 78.9% of the deviations in the quantity of maize demanded from long-run equilibrium are corrected in the current period. This also indicates that any shock on maize quantity demanded is restored by 78.9% in the current period.

Maize production (Dlnproduction) had a positive and significant effect on maize demand with the elasticity of 0.638, which was significant at a 5% significance level. This suggests that a 1% increase in maize production is associated with a 0.638% increase in maize demand in the short run, other factors held constant. This could be attributed to the fact that high production represents the high availability of maize for consumption in the market at relatively cheap prices. Therefore, consumers can access it at relatively low prices, hence, increasing demand. This result is consistent with the findings of Chapoto *et al.* (2010); De Groote and Kimenju (2012) regarding food staples.

Table 12: Short-run demand response results

Variable	Coefficient	Std. Err	Probability
Speed of adjustment	-0.789	0.143	0.000***
Dlnproduction	0.638	0.343	0.026**
Dlnmaizedomprice	-0.104	0.328	0.73
Dlnwhtdomprice	0.829	0.339	0.004***
Dlngdppercapita	0.761	0.617	0.224
Constant	-4.315	0.224	0.001

R^2 =0.9730, Adjusted R^2 =*0.*9693

Note: ***, **, * represents significance at 1%, 5%, and 10% respectively

Similarly, the wheat domestic price was also positive and significant at a 5% significance level with a coefficient of 0.829. A 1% increase in wheat domestic price is associated with a 0.829% increase in demand for maize in the short run, holding other factors constant. The positive coefficient emphasizes the importance of maize as a staple and a food security crop compared to other possible substitutes. The finding is consistent with the results by Musumba and Zhang (2016) who established the existence of a degree of substitution between maize and other cereals when market prices increased for other cereals

The domestic price elasticity of maize demand was negative and insignificant as was expected both in the short and long run. This indicates that a price change does not have any significant effect on the quantity of maize demanded. This reinforces the fact that maize is a major staple and a food security crop. However, the coefficient of domestic maize price was negative. An indication that the corresponding demand curve is downward sloping, hence, the law of demand was satisfied. This lends support to the findings of a study done by Caracciolo *et al.* (2014) who also established that demand for other cereals, tubers, and roots are relatively sensitive to price variation than that of basic household food-stuff such as maize and cassava. Furthermore, the study corroborates the findings of Van Zyl (1986) in his study in South Africa who discovered that the price elasticity of demand for maize was -0.149 which was relatively inelastic. In all cases, the long-run supply and demand elasticities were greater than the short-run supply and demand elasticities. Hence, the Lechatelier principle was satisfied (Milgrom & Roberts, 1996).

3.3.3.4 Post Estimation Diagnostic Test Results for Demand Response

Post estimation diagnostic tests were done to indicate the appropriateness of the error correction version of the ARDL model to the assumptions of heteroscedasticity, multicollinearity, normality, and serial correlation. The results of these tests are shown in Appendix E through H. The value of Adjusted R^2 was 0.9693 which suggests that 96.93% of the variations in the maize demand were explained by the explanatory variables. Jarque-Bera normality test value ($p = 0.2863$) was statistically insignificant (Appendix E). Therefore, the null hypothesis that the residuals are normally distributed was accepted. Further, the Breusch-Godfrey LM test was used to test for serial correlation, and a p-value of 0.5182 was obtained which shows that there was no serial correlation in the series (Appendix F). White's test was also used to test heteroscedasticity and a probability chi-square value of 0.3615 was obtained. Therefore, the null hypothesis of homoscedasticity was accepted (Appendix G). Finally, a multicollinearity test was performed to verify the existence of an exact linear relationship among the explanatory variables. To this effect, a mean VIF of 5.64 which was less than 10 was obtained (Appendix H). This suggests that there was no multicollinearity in the series.

3.4 Conclusion

Using time-series data from 1963-2016, the supply and demand responsiveness of maize producers and consumers was analysed using an error correction version of the ARDL model. The findings showed a significant response of maize supply to its first period lagged value, producer price, hectares, and fertiliser use in the long run. Similarly, in the short run, the findings showed that maize supply responds positively to producer price, hectares, and fertiliser use. However, maize demand was found to respond positively to production and wheat domestic price in the short run, while in the long run, maize demand responded significantly to its first period lagged value, wheat domestic price, and production.

The findings suggest that to ensure sustainability and development in the maize sector, there is a need to encourage structural change in domestic maize production through the use of productivity-enhancing inputs such as fertilisers. The bottlenecks in procuring the subsidized fertiliser should therefore be removed to ensure universal access of the subsidized fertiliser by both small-scale and large-scale producers. Another strategy is waiving import duties on fertiliser imports and provision of information on cheap sources of fertilisers. This will not only reduce the cost of fertiliser but will also lower the transaction cost of information search to the farmer. The operations of the NCPB should also be re-examined and redefined so that the benefits of centralized marketing accrue to the majority of small-scale farmers, given that majority of maize producers are small-scale farmers.

The fact that wheat domestic price was significant and highly elastic in the long run suggests that maize has possible substitutes. Therefore, there is a need for change in the consumption behaviour of maize to include the consumption of wheat as a staple food. Additionally, there is a need to increase local production of wheat and other possible substitutes of maize to curb over-reliance on maize imports whenever there is a deficit in maize production locally. Wheat prices should also be subsidized as much as possible to enable poor consumers to purchase it at reduced prices whenever there is a deficit in maize supply.

A package of changes should therefore be initiated by the government and policymakers in the maize subsector to ensure a better response from both maize producers and consumers. These include but are not limited to the removal of bottlenecks in maize pricing through the promotion of effective maize market reforms. Once the Kenyan market channels and prices are freed, private producers will then bid up formally depressed maize prices. Under positive price elasticity of supply, higher prices will induce higher production which, will further stimulate demand for purchased inputs that include hired labour. This will, in turn, have a positive effect of enabling maize producers to get higher incomes. This will consequently have a significant multiplier effect on the maize consumers due to the relatively high marginal propensity to consume for poor farmers and consumers.

CHAPTER FOUR

DETERMINANTS OF MAIZE IMPORTS

Abstract

The purpose of this objective was to investigate the key factors that determine maize imports in Kenya. To achieve this, time-series secondary data from FAOSTAT, World Bank, and World Trade Organization (WTO) for the period 1963 to 2016 were used. The econometric analysis of the time-series data using an error correction version of the Autoregressive distributed lag model revealed that maize imports are determined by trade openness, the domestic price of maize, and gross domestic product in the long run. In the short run, the results showed that maize imports are determined by the exchange rate, one period lag of exchange rate, one-period lag of maize import volume and production. The findings suggest that to reduce overreliance on maize imports, effective management of the macroeconomic environment should be stimulated to create a favourable environment for improving domestic maize production to discourage a surge in maize imports and at the same time improve the country's food security.

4.1 Introduction

The importance of international trade in the process of development has for a long time been a topic of interest to international economists in developed and developing economies (Fatukasi & Awomuse, 2011). Specifically, the study on determinants of imports has attracted the attention of many researchers in most developed and some developing economies (Abidin *et al*., 2016; Pablo & Yomar, 2019; Yue & Constant, 2010). As in many African countries, the economic development of Kenya is closely tied to the behaviour of international trade. In regards to this, the attractiveness of globalization, liberalization, and interdependence between countries has also increased a great deal. This is evidenced by the rapid pace at which every country strives to achieve economic growth and development by attaining as much benefit from international trade as possible (Dao, 2016).

The reduction of global trade restrictions through globalization and World Trade Organization (WTO) commitments has also seen many developing countries import both agricultural and non-agricultural commodities from other parts of the world (Khan & Hussain, 2011). The Kenyan economy is not an exception as it relies on many international economies for imports to boost its food security. Besides importing electronics and other intermediate commodities, Kenya relies on other world economies to increase its strategic grain reserves (Gallagher, 2005). The increase in maize imports in Kenya in the recent past has been experienced with the removal of price and quantity barriers on imports (Chapoto &

Jayne, 2009). However, before the structural adjustment program (SAP) era, Kenya's maize import volume followed a downward trend since the country was self-sufficient in the production of maize (Swamy, 1994). In fact, in the 1960s and 1970s, Kenya was nearly a net exporter of maize (Byerlee & Eicher, 1997).

Figure 2 shows the trend in maize production and imports from 1963 to 2016. The Figure shows that maize production peaked during the mid-1970s and early 1980s due to the existence of an enabling environment for private producer participation in farming after independence (Argwings-Kodhek *et al.*, 1993). Consequently, there was a slight decline in production between 1978 and 1980 a situation which could be attributed to inefficiencies in maize marketing and limited use of new technologies which was a disincentive to maize producers. Additionally, even though there was modest growth in maize production in the period between 1993 and 1995, this was followed by a steady decline in maize production from 1995 to 2005 due to abating terms of trade between agricultural exports and imports and poor implementation of policies of trade (Jayne *et al*., 2008). This paved way for a sharp increase in maize imports between 1993 and 2001, primarily due to maize market reforms and liberalization of the maize marketing system (Nyoro *et al*., 1999).

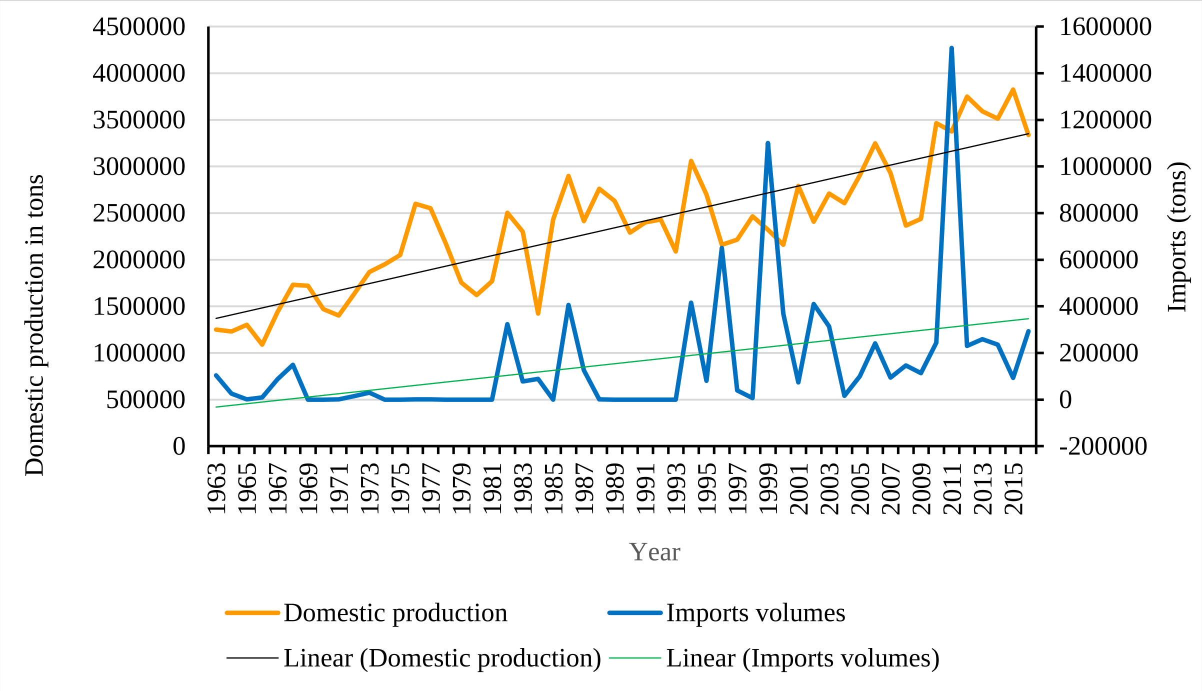

Figure 3: Trend in domestic production and maize imports

Source: FAOSTAT (2019)

The decline in maize production from 2007 to 2009 came as a result of political instability caused by post-election violence during this period. This saw a tremendous increase in maize imports from 2008 to 2012 to remedy the situation created by decreased maize production. However, the value of import is highly understated due to large informal imports which have not yet been documented. The trend in domestic maize production and maize imports confirms that over the years, Kenya has been pursuing a policy of self-reliance on maize imports instead of self-sufficiency in maize production. Besides, the Figure shows that Kenya was only self-sufficient for a short period, that is, from 1963 to 1982.

The above trend in maize imports and production reveals that it is vital to know the macroeconomic and microeconomic factors that determine maize import volumes in Kenya. This will inform policy decisions on strategies that the country should use to reduce its over-reliance on maize imports and at the same time ensure food security in the country is guaranteed. However, although studies on determinants of import have been done in many developed and developing countries, there is limited empirical evidence of such studies in Kenya. Therefore, the current study is a fresh attempt to model the determinants of aggregate maize import volumes in Kenya based on time-series secondary data from 1963 to 2016. The study also aimed to propose policy options based on its findings for the control of maize imports in Kenya.

Many recent and past studies have been done on determinants of imports in various countries using different types of variables and models. In a study done by Dao (2016) on analysis of the determinants of the share of imports in an economy based on data from the World Bank, linear regression was performed on various samples from both developed and developing economies. A statistical model of the share of imports in the GDP was specified as being nonlinear and dependent on the gross national income and its square. The findings of the study revealed that empirical results vary depending on the period under consideration and the level of economic development in a country. However, one limitation of this study is that it did not take into account the unit root properties of the data series. Further, it did not test the existence of a long-run relationship in the data. The absence of this information and the estimation based on level variables led to a high possibility of inconsistent results based on spurious regressions.

In another study by Yue and Constant (2010) that aimed at ascertaining the key determinants of disaggregated import demand in Cote d'Ivoire, time-series data ranging from 1970 to 2007 were used in an ARDL modelling process to capture the effect of final consumption expenditure, export expenditure, investment expenditure and relative prices on import demand. The study found a long-run relationship among the variables. Additionally, inelastic import demand for all expenditure components and relative prices was found.

However, in the short run, the study found other expenditure components to be major determinants of import demand.

In a similar study on determinants of demand functions for imports in Nigeria, Fatukasi and Awomuse (2011) used real GDP, external reserves, real exchange rates, and index of openness as explanatory variables. The error correction model results revealed that the error correction term was statistically significant indicating the existence of a long-run relationship between the quantity of import demanded and its determinants over the sample period between 1970 and 2008. The study also established that real gross domestic product was a chief determinant of import demand in Nigeria in the short run. These findings corroborate the results of Egwaikhide (1999) who examined the determinants of imports in Nigeria using dynamic specification and error correction modelling and discovered relative prices, foreign exchange earnings, and real output were the significant determinants of the growth of total imports during the period under investigation.

In another study in Latin America that aimed at determining the behaviour of imports in Colombia for the period between 2000 and 2016, Pablo and Yomar (2019) established the existence of a long-run relationship between the demand for imports with the real gross domestic product and real exchange rate using error correction model. The findings indicated that Colombian imports are determined by the gross domestic product and real exchange rate. Similar to this study, Keum and Lee (2017) employed the first difference model and simultaneous equation model with GMM estimation technique to estimate the determinants of intermediate goods imports and raw material goods imports respectively, they observed that the imports of final goods are determined by importing country's income while the raw material goods imports are determined by an increase in exports in Korea. These results were corroborated by Fedoseeva and Zeidan (2018) who also did a study on determinants of imports and observed that income was a major determinant of import demand in Europe.

From the empirical studies above, it is evident that there exists a wide variation in determinants of imports with several studies identifying income and exchange rate as the major determinants of imports. In addition to income and exchange rate, the current study aimed at adding domestic price, openness index, and consumption as determinants of imports Following the works of Fedoseeva and Zeidan (2018), Keum and Lee (2017), Narayan and Narayan (2005), and Pablo and Yomar (2019), the study used an error correction version of ARDL model which captures time-series properties of unit roots and existence of long-run relationship to analyse the determinants of maize import volumes in Kenya. The exchange rate and GDP were included in this model to capture the effect of macroeconomic variables on international maize trade and to eliminate the aggregation bias. This differs from traditional import models which use only import and relative prices as components of the import function, hence, the study extends the works of Dao (2016) and Egwaikhide (1999). A basic assumption is that maize importers are always on their demand schedules in such a way that demand equals the actual volume of imports.

4.2 Methodology

4.2.1 Description of Variables for the Determinants of Maize Imports

Import (Maize import volume) was used as a dependent variable on the determinants of the import equation. It was assumed to be determined by trade openness, domestic production of maize, domestic consumption of maize, domestic price, gross domestic product, and exchange rate. It was used as a continuous variable and its unit of measurement was considered to be tonnes. The use of import volume as a dependent variable was justified by past empirical studies (Fatukasi & Awomuse, 2011; Yue & Constant, 2010).

Opens (openness index) was used as a proxy for trade openness. It is the sum of imports and exports, normalised by GDP. It measures a country's exposure to international trade. This variable was measured as the sum of exports plus imports, divided by GDP. It was anticipated that the more a country opens up for trade, the more it imports. It was used as a continuous variable and its expected sign was positive. The use of this variable as an explanatory variable was justified by past empirical studies (Fatukasi & Awomuse, 2011).

Prod and *Cons* were used as proxies for domestic production and domestic consumption, respectively. It was postulated that the lower the domestic maize production, the higher the demand for maize for consumption to meet the deficit created by the low domestic maize output. Hence, the need for maize imports. These two variables were continuous and were measured in tonnes. The inclusion of these two variables as explanatory variables was justified by past empirical studies (Khan & Hussain, 2011)

Dp and *Gdp* represented the domestic price of maize and gross domestic product respectively. Domestic price was expected to have a positive effect on maize imports because it was postulated that the higher the maize domestic prices, the higher the maize imports. Consequently, the gross domestic product was used to assess the effect of the macroeconomic environment on maize imports. The relationship between gross domestic product and maize imports was expected to be negative. A study by Abidin *et al*. (2016) confirmed the use of these variables as explanatory variables in the analysis of this objective.

Finally, *Exr* (exchange rate) was also used to assess the effect of the macroeconomic environment on maize imports. An unfavourable exchange rate (when the local currency is weaker than the US dollar) was anticipated to hurt maize imports. Additionally, an appreciation of Kenya shillings against a dollar was expected to have a positive impact on maize imports. Table 13 reports the description of variables that were used in the analysis of determinants of imports.

Table 13: Description of variables for determinants of maize imports

Variable	**Description**	**Measurement**	**Expected sign**
Imports	Maize import volume (Tonne)	Continuous	
Prod	Domestic production (Tonne)	Continuous	-+
Cons	Domestic consumption (KES)	Continuous	-+
Dp	Domestic price (KES)	Continuous	-+
Opens	Openness index (Ratio)	Continuous	-+
Gdp	Gross domestic product (KES)	Continuous	-+
Exr	Exchange rate (US $)	Continuous	-+

4.2.2 Modelling Strategy

Similar to chapter three, the ADF test was used to test the unit root problem and the order of integration of the series. As stated earlier, a stationary series is a series with constant variance and mean in its level form denoted by I (0) while a non-stationary series is a series with a mean and a variance that are time-variant (Wooldridge, 2013). A non-stationary series can be made stationary by taking the first or second difference of the series denoted by I (1) and I (2) (Gujarati, 2003). Therefore, following Wooldridge (2013), the ADF test was performed using the functional form 4.1.

$$\Delta Z_t = \alpha_1 + \alpha_{2t} + \beta Z_{t-1} + \sum_{t-1}^{n} \delta \Delta Z_{t-1} + e_t \qquad (4.1)$$

where Δ is the change operator, Z_t is variable in the series to be checked for stationarity, Z_{t-1} is one period lagged values, ΔZ_{t-1} shows the first difference, and e_t indicates white noise error term. The decision rule remains that if the ADF test statistic is higher than the critical value in absolute terms at a 5% significance level, then the series is stationary. On the other hand, if the ADF test statistic is lower than the critical value in absolute terms at a 5%

significance level, then the series is non-stationary or it has a unit root problem in which case it should be differenced to make it stationary (Gujarati, 2003).

Secondly, the bounds test for cointegration was used to check the existence of long-run relationships among the variables. The decision rule was that if the F statistic value is greater than the upper bound value at a 5% significance level, then there exists a long-run relationship among the variables. On the other hand, if the F statistic is lower than the upper bound value then there is no long-run relationship among the variables. The existence of the long-run relationship was tested under the null hypothesis of no cointegration stated as: $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$.

Thirdly, the existence of a long-run relationship (cointegration) confirmed the estimation of both short-run and long-run elasticities using an error correction version of the ARDL model. Following Pesaran and Shin (1999), this model was chosen due to its ability to provide more choices for the selection of the optimal number of lags (Yeshineh, 2017). Therefore, due to the evidence of a long-run relationship, the ARDL model equation was specified as seen in equation 4.2.

$$\begin{aligned} \ln imports \; &= \alpha_1 + \sum_{j=1}^{n} \theta_1 open_{t-1} + \sum_{j=1}^{n} \theta_2 \ln prod_{t-1} + \sum_{j=1}^{n} \theta_3 \ln cons_{t-1} + \\ &\sum_{j=1}^{n} \theta_4 \ln gdp_{t-1} + \sum_{j=1}^{n} \theta_5 \ln dp_{t-1} + \sum_{j-1}^{n} \theta_6 exr_{t-1} + u_t \end{aligned} \tag{4.2}$$

where t is the period, θ represents the long-run elasticities, α_1 is a constant and u_t is the white noise error term.

Finally, the error correction version of the ARDL model was specified to facilitate the analysis of the short-run and long-run effects of explanatory variables on import volume and to suggest the speed of adjustment to long-run equilibrium (Yeshineh, 2017).

$$\begin{aligned} \ln import_t &= \alpha_1 + \sum_{j=1}^{n} \beta_1 \Delta opens_{t-1} + \sum_{j=1}^{n} \beta_2 \Delta \ln prod_{t-1} + \sum_{j=1}^{n} \beta_3 \Delta \ln cons_{t-1} \\ &+ \sum_{j=1}^{n} \beta_4 \Delta \ln dp_{t-1} + \sum_{j=1}^{n} \beta_5 \Delta \ln gdp_{t-1} + \sum_{j=1}^{n} \beta_6 \Delta exr_{t-1} + \gamma ECT_{t-1} + e_t \end{aligned} \tag{4.3}$$

where β shows short-run elasticities and ECT_{t-1} is the error correction term which measures the speed of adjustment towards long-run equilibrium after a shock and ranges from -1 to 0. The error correction term is the most consistent determinant of imports (Fedoseeva & Zeidan, 2018). It ensures that the series is non-explosive and that the long-run equilibrium is achieved by correcting errors in one period by the next (Pablo &Yomar, 2019). Zero indicates that there is no convergence to equilibrium while the negative value shows that any shock in the system is perfectly adjusted to equilibrium in the next period. γ is the parameter of the speed of adjustment.

4.3 Results and Discussion

4.3.1 Descriptive Results for the Determinants of Maize Imports

Table 14 presents the descriptive statistics for the variables that were used in the analysis of the determinants of maize imports. The rest of the descriptive statistics for production, consumption, domestic prices, and GDP have already been given in chapter three. It is evident that import volumes exhibited fluctuating trends from 1963 to 2016. However, the standard deviations for import volumes were greater than the average import volumes in all the decades except for the 2013-2016 period due to fluctuations in the international markets caused by the inconsistent trade policies and large volumes of informal maize imports which have not yet been documented. Consequently, there was an upward trend in both trade openness and exchange rate. The ratio of trade openness index increased from an average of 0.380 in 1963-1972 to 0.800 from 2013-2016, respectively. Similarly, the exchange rate increased from an average of US $7.141 in 1963-1972 to US$ 93.432 in 2013 to 2016.

Table 14: Descriptive results on determinants of maize imports

Variable	1963-1972		1973-1982		1983-1992		1993-2002		2003-2012		2013-2016	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Imports ('000)	39.217	54.313	35.438	101.752	69.805	127.068	314.516	355.212	300.905	433.707	220.268	87.728
Openness index	0.380	0.141	0.361	0.111	0.449	0.091	0.630	0.128	0.729	0.088	0.800	0.059
Exchange rate	7.141	0.001	8.074	1.184	19.780	6.097	64.551	10.330	76.918	6.567	93.432	7.560

4.3.2 Diagnostic Test Results for the Determinants of Maize Imports

Table 15 presents the ADF test results for level variables. The results indicate that maize import (lnimports) has no unit roots, meaning that it is stationary. On the other hand, the openness index, production, consumption, domestic price, GDP, and exchange rate were found to be non-stationary in level form. Hence, the need to perform the ADF tests for the first differences of the remaining variables.

Table 15: ADF test results for level variables for determinants of imports

Series	Test statistic	Critical value	Inference
lnimports	-3.044	-2.928	Stationary
Openness index	-0.917	-2.929	Non stationary
lnproduction	-2.160	-2.930	Non stationary
lnconsumption	-1.655	-2.928	Non stationary
lndomestic price	-0.461	-2.928	Non stationary
lnGDP	-1.623	-2.928	Non stationary
Exchange rate	0.578	-2.928	Non stationary

Table 16 presents the ADF test results for the first differenced variables. The results show that openness index, production, consumption, domestic price, GDP, and exchange rate become stationary after first differencing. This implies that they are all integrated of order I (1). The ADF test results for level and differenced variables suggest a mixture of stationarity among the variables, therefore, justifying the suitability of the error correction version of the ARDL model in this analysis. The ADF test results are in corroboration with the findings of Abidin *et al.* (2016), Egwaikhide (1999), and Pablo and Yomar (2019) who found a mixture of I(0) and I(1) in an analysis of determinants of import in different countries.

However, it is worth noting that the population was omitted in this analysis since it was highly collinear. Similarly, other variables such as import duties, political cycles, and government policies were also not included in the model because of the unavailability of reliable time-series data on these variables. Hence, the variables violated the stationarity assumption of time-series data even after second differencing.

Table 16: ADF test for differenced variables for the determinants of maize imports

Series	Test statistic	Critical value	Inference
Openness index	-6.484	-2.930	Stationary
lnproduction	-5.475	-2.933	Stationary
lnconsumption	-6.661	-2.929	Stationary
Lndomestic price	-6.705	-2.929	Stationary
lngdp	-4.714	-2.929	Stationary
Exchange rate	-4.688	-2.929	Stationary

ARDL bounds test was also performed to investigate the presence of long-run relationships among the variables. Table 17 presents bounds test results. It reveals the existence of a long-run relationship among the variables since the F statistic value was greater than the upper bound value at a 5% significance level. This result was further confirmed by the t-statistic value which was less than the upper bound value at 5% significance level. This is in line with the findings of Narayan and Narayan (2005), Pablo and Yomar (2019), Razafimahefa and Hamori (2005), Tang and Nair (2002), and Tang (2003), who also found a long-run relationship between the import and its determinants.

Table 17: Bounds test for long-run relationship

Test statistic	Lower bound I(0)	Upper bound I(1)
F-statistic 4.409	2.714	4.125
t-statistic -4.621	-2.857	-4.413

4.3.3 Long-run Results on Determinants of Maize Imports

Table 18 is a presentation of the long-run results on the determinants of maize imports. The results reveal that the openness index was positive and significant at a 10% significance level as was expected. This suggests that a 1 unit increase in trade openness is associated with a 23.364% point increase in maize import volumes, holding other factors constant. A possible reason for this is that the more the economy opens for trade, the more the influence of trade on her domestic activities and the more it imports. This is consistent with the findings of Fatukasi and Awomuse (2011) who found a positive relationship between import demand and openness index.

Table 18: Long-run results on determinants of maize imports

Series	**Coefficient**	**Std. Err.**	**Probability**
Openness index	23.364	13.499	0.093*
lnproduction	-3.581	6.596	0.591
lnconsumption	0.346	1.535	0.823
lndomestic price	4.242	2.427	0.090*
lnGDP	-10.515	5.577	0.068*
Exchange rate	-0.038	0.077	0.629

Note: *represents significance at 10% significance level

The coefficient of maize domestic price was 4.242% which was elastic and significant at a 10% significance level signifying that a 1% increase in domestic maize price results in a 4.242% increase in the volume of maize imports. This could be attributed to the fact that Kenya does not produce many viable alternatives to her imported maize. Therefore, Kenya is heavily reliant on imported maize which has a few domestic substitutes. This suggests that exchange rate policy can be used to influence maize import volumes in Kenya. This result is similar to the findings of Egwailkide (1999) who in his analysis of import demand determinants in Nigeria, established that import demand is price elastic. However, this result is contrary to the findings of Sinha (1997) and Yue and Constant (2010) who established that aggregate import demand is price inelastic in the long-run and is not sensitive to price changes. Additionally, the result is different from the findings of Khan and Hussain (2011) who established a negative relationship between domestic price and imports. Unlike the study which indicates that maize imports in Kenya can be significantly controlled using domestic price, the study by Khan and Hussain (2011) showed that tea imports in Pakistan cannot be significantly controlled by adjusting the domestic price. This was so because Pakistan is the largest importer of tea and only a negligible part of tea consumed in the country is produced locally. Therefore, the country has to import tea regardless of changes in local tea prices. Hence, changes in domestic prices are not likely to affect tea imports.

The coefficient of GDP was negative and significant at a 10% significance level implying that a 1% increase in GDP leads to a 10.515% decrease in the volume of maize imports, other factors held constant. Therefore, this result implies that an improvement in maize domestic production would lead to a decrease in the volume of maize imports. This could be attributed to the fact that the purchase of domestic goods and services increases

GDP and therefore an increase in GDP means an increase in domestic production. Secondly, this could be attributed to GDP increase shifting demand away from maize as a staple food to more luxurious foodstuff like wheat. Thirdly, since GDP is a development indicator, this may also indicate that the more a country develops, the more it diversifies its domestic production by producing other commodities or products through research and extension services which may act as substitutes for maize, thereby decreasing maize imports.

Finally, another implication of the negative coefficient of GDP is the fact that international trade is a large and growing component of GDP. Nevertheless, this does not mean that trade reduces domestic output and growth but rather that import variable corrects imports that are already in consumption, private investment, and government expenditure hence the negative elasticity. This result confirms the findings of Pablo and Yomar (2019) who established that imports are determined by GDP and exchange rate in Colombia. However, imports are a measure of foreign production, and therefore it does not have a direct impact on GDP but GDP plays an important role in increasing international trade between Kenya and other countries. This is in line with Abidin *et al*. (2016) and Khan and Hussain (2011) who found that GDP, GDP per capita, and trade to GDP positively contribute to bilateral trade. These results also validate the findings of Agbola and Damoense (2005) who found that GDP, relative prices, and urbanisation are the key determinants of import demand for pulses in India in the long run. However, this result is contrary to the findings of Fatukasi and Awomuse (2011) who established a positive relationship between import demand and real GDP.

4.3.4 Short-run Results on Determinants of Maize Imports

Table 19 presents the short-run results on determinants of imports. In the short run, all variables were significant according to priori expectations except the openness index. However, domestic price and consumption did not have any effect on import volume in the short run. The coefficient of the error correction term which represents the speed of adjustment was -0.704 which was negative and significant at a 1% significance level validating the error correction version of the ARDL model. It implies that about 70.4% of the deviations in maize import volumes from long-run equilibrium are corrected in the current period. The speed of adjustment measures the speed at which import volume adjusts to changes in its determinants before converging to its normal equilibrium level. It also broadly reflects the relative importance attached to the various import policies by authorities. These results are in corroboration with the previous findings of Narayan and Narayan (2005) who found a speed of adjustment of -0.76 which was negative and significant. The speed of adjustment of -0.704 is very close to that of -0.72 which was found by Frimpong and Oteng-Abayie (2006) in an investigation of aggregate import demand for maize and expenditure components in Ghana. However, the result supersedes the findings of Fatukasi and Awomuse (2011) who found a significant but very low speed of adjustment of -0.07. Therefore, the model used in the study performed very well, both on a theoretical and empirical basis.

Table 19: Short-run results on determinants of maize imports

Variable	**Coefficient**	**Std. error**	**Probability**
Speed of adjustment	-0.704	0.148	0.000***
Dlnimports(-1)	0.411	0.144	0.007***
Dopenness	-11.102	8.358	0.193
Dlnopenness(-1)	-9.107	6.657	0.181
Dlnproduction	1.323	3.524	0.710
Dlnproduction (-1)	7.838	2.753	0.008***
Dexchange rate	-0.175	0.078	0.032**
Dexchange rate (-1)	0.173	0.087	0.057*
Constant	4.504	0.348	0.002

R^2 = 0.8232, Adjusted R^2 = 0.7293

Note: ***, **, * represents significance at 1%, 5%, and 10% respectively

The first lag of imports (Dlnimports(-1)) was positive and significant at a 1% significance level with a coefficient of 0.411 implying that a 1% increase in maize imports in the previous period leads to a 0.411% increase in the volume of maize imports in the current period, holding other factors constant. This finding suggests that initially, the increase in imports remains steady in the short term since the contract for the importation of maize has already been signed in the previous period and it has to be fulfilled. Secondly, this could be attributed to the fact that maize importers and the government have forward-looking behaviour. Hence, their previous period's decision on the volume of maize imports may influence the volume of maize imports in the current period. For instance, when domestic maize price increase persists, maize importers may decide to increase the volume of maize imports in the current period to take advantage of the available market opportunity since maize imports normally come at a relatively cheaper price than the domestically produced maize and that maize importers are rational. Therefore they will import more.

The first lag of domestic production (lnproduction (-1)) was positive and significant at a 1% significance level in the short run. This implies that a 1% increase in maize production in the previous period leads to a 7.838% increase in maize imports in the current period, other factors held constant. A basic reason for this is that importers are normally on their demand schedules, in such a way that demand always matches actual import volumes or levels. However, on several occasions, imports do not instantly adjust to long-run equilibrium levels following any change in its determinants or explanatory variables. Numerous factors may contribute to this. Key among these factors is the adjustment costs, inertia and lags or habit in observing the changes. Hence, an increase in maize production in the previous period may not warrant a corresponding instant decrease in maize imports in the current period. This finding agrees with the results of Narayan and Narayan (2005).

Similarly, the current exchange rate and first lag of exchange rate (Dexchange rate (-1)) were significant at 5% and 10% significance level respectively. The coefficient of the current exchange rate was negative and significant an indication that the higher the exchange rate, the lower the volume of maize imports. This could be ascribed to the period when a dollar strengthened against the Kenya shilling thus making it more expensive to import than to export. Another reason could be that, in the short term, depreciation may not be able to improve the current account of the balance of payment. However, the first lag of exchange rate was positive and significant indicating that a 1 unit increase in the exchange rate in the previous period, leads to a 0.173% increase in the volume of maize imports in the current period, holding other factors constant. This could be accredited to the appreciation or strengthening of Kenya shilling against a dollar in the previous period which lowers the prices of imported staples and other durables in the current period. The reduced import prices thus lower importation cost and inflation rate hence enabling the Kenyan government and private traders to import more. Consequently, this shows that depreciation of the US dollar results in a significant and proportionate increase in Kenyan imports. This confirms the vulnerability of the Kenyan economy to exogenous shocks. This agrees with the findings of Bensafta (2018) in an Algerian study.

4.3.5 Post Estimation Diagnostic Test Results for Determinants of Imports

Residual analysis was carried out on the estimated regressions to ensure the validity of the results for policy suggestions. This was followed by post estimation diagnostic tests to establish the conformity of the time-series variables to assumptions of homoscedasticity, normality, serial correlation, and multicollinearity. The Breusch-Godfrey LM test was used to test for serial correlation. A probability value of 0.8716 was obtained which shows that there was no serial correlation in the data series (Appendix I). White's test was used to test for heteroscedasticity. A probability value of 0.4334 was obtained which shows that we accept the null hypothesis that the errors are homoscedastic (Appendix J). This was further confirmed by Cameron and Trivedi's decomposition of the IM-test for heteroscedasticity which showed a probability value of 0.4263 (Appendix K). Jarque-Bera normality test ($p = 0.3335$) was statistically insignificant. Therefore, the null hypothesis of normality was accepted (Appendix L). Additionally, a multicollinearity test was performed on the series to verify the existence of a perfect linear relationship among the explanatory variables. To this effect, a mean VIF of 6.20 which was less than 10 was obtained (Appendix M). This shows that there was no multicollinearity in the data series. Finally, the adjusted R^2 value of 0.7293 indicates that 72.93% of the variations in import volumes were explained by the variables in the model. Hence based on this, it is reasonable to conclude that the model best fits the data and is well behaved.

4.4 Conclusion

The study used a recently developed bounds testing approach to test for the long-run relationship between imports, trade openness, production, consumption, the domestic price of maize, GDP growth, and exchange rate. Evidence of cointegration relationship was confirmed among the variables in the import equation when import volume was used as a dependent variable. This did not only allow for the estimation of long-run elasticities but also short-run elasticities of maize import equation using an error correction version of the ARDL model. The key long-run and short-run results were that: trade openness, domestic production, maize domestic price, GDP, and exchange rate were the key determinants of maize import volumes in Kenya. These results had plausible magnitude and were consistent both theoretically and empirically. Therefore, on this basis, policy implications can be derived.

Firstly, it is very clear that prices play a very crucial role in the determination of maize import volumes. Therefore, inflation should be kept at auspicious levels through a sensible monetary policy of ensuring low and stable inflation to bring about price stability in the economy. This will ensure money supply in the economy is consistent with the growth and price objectives set by the government.

Secondly, GDP was negative and significant suggesting that even though GDP growth promotes international trade in the long run, increased GDP cannot always be a source of financing imports. Import growth can imply a multiplier effect on public expenditure which would be financed through external flows such as emigrant remittances and external aid through donor activities in Kenya. Therefore, economic strengthening should be encouraged to attract funds for investment from other countries without economic and political risk. Effective management of the macroeconomic environment leading to economic growth should therefore be stimulated to create a favourable environment for improved maize production to discourage maize imports.

The exchange rate was also a significant determinant of import volume in Kenya. It, therefore, follows that the terms of trade should be put in check to ensure a balance of payments and to rectify both internal and external imbalances. This will go hand in hand in reducing the trade deficit once the exchange rate is favourable. Hence, the earnings from exports will be sufficient enough to compensate for higher spending on imports. This will contribute to improvement in foreign exchange earnings and ultimately to productivity improvement as a result of a reduction in import bill.

In conclusion, a recipe to constraint overreliance on maize imports is not to lower production or curtail demand. At the heart of the solution lies the need for acceleration of structural change in production. Therefore, the problem that the Kenyan economy needs to solve first is to improve or accelerate domestic production. In particular, the Kenyan government should encourage improvement in domestic production of maize and other staples like cassava, millet, wheat, and rice to diversify consumption of the staple and improve the food security status of the economy. In doing so, the Kenyan economy needs to enhance advanced technological production and boost its domestic production to internally compete with maize imports to reduce the surge in maize imports.

Further to enhance the beneficial effect of the improved production technology, investment in research and development projects should be highly encouraged. Low production technology will only lead to overdependence on maize imports and encourage foreign trade deficit which is not safe for the economy. These results also point out that structural policies and exchange rate policies should be implemented to solve chronic foreign trade deficit problems in Kenya. In addition, policies designed to influence imports, in particular, must involve substantial domestic and adjustment efforts. The government’s fiscal discipline must also be heartened to take care of the extensiveness in an increase in maize importation to decrease the maize import bill.

CHAPTER FIVE

WELFARE EFFECTS OF MAIZE IMPORTATION IN KENYA

Abstract

Maize imports bridge the maize supply-demand gap in Kenya. However, this does not automatically lead to a conclusion that maize imports have positive or negative effects on the economic welfare of producers and consumers. Despite this realization, there is limited literature that has focused on the implication of maize imports on economic welfare in Kenya. The study aimed at providing empirical evidence on the economic welfare effects of maize imports on producers and consumers in Kenya. The study used time-series secondary data from FAOSTAT, World Bank, and Kenya National Bureau of Statistics for the period 1963 to 2016. The Partial equilibrium model which is suitable for measuring the effects of pricing policies on specific sectors and also allows perfect substitutability between domestically produced goods and imported goods was used to analyse this objective. The study found that maize importation results in ambiguous welfare effects on both maize consumers and producers. From the findings, consumer surplus gain only compensated loss in producer surplus in 2 out of 11 points of analysis. On the other hand, producer surplus gain only compensated loss in consumer surplus in 1 out of 11 points of analysis. The resultant net economic welfare effect of maize importation was negative. These results indicate that maize importation would leave the maize sector and the economy as a whole worse off, hence further maize importation without compensating losers from the maize sector is not feasible. Therefore, the study recommends that complementary reforms should be put in place to link world prices to consumer prices and to encourage producers to respond to production incentives.

5.1. Introduction

The role of maize in the Kenyan food system and economy cannot be overstated. Maize is a staple food and the most grown crop in the country (Abate *et al*., 2015; KALRO, 2019; Muyanga *et al.,* 2005). The average land area under maize production rose steadily between the 1960s and 2000s. For instance, approximately 1 million hectares of land were under maize production in the first decade of Kenyan independence (FAOSTAT, 2019). The average land area under maize production rose to about 1.6 million hectares between 2000 and 2010. Recent estimates from FAOSTAT (2019) indicate that approximately 2.1 million hectares of land were under maize production from 2011 to 2017. Despite the increases in land area under maize production, maize yields have almost stagnated in recent decades. FAOSTAT (2019) estimates indicate that the average yield in the 1980s was about 1.7 tonnes per hectare. Nevertheless, the yields have stagnated at almost 1.6 tonnes per hectare since the 1990s (FAOSTAT, 2019; Olwande, 2012).

The stagnation in maize productivity has seen the country descend from being a maize sufficient and exporter to a net importer in the recent decade. For instance, Kenyan maize exports averaged 85,000 tonnes in the 1960s compared to about 41,000 tonnes of imports in the same period (FAOSTAT, 2019). Furthermore, the average maize exports and imports were approximately 67,000 and 4000 tonnes in 1970 and 99,000 and 100,000 tonnes in the 1980s, respectively. According to Abate *et al*. (2015), Kenya became a net maize importer in the 2000s and the country's net maize imports were estimated at 292,000 tonnes between 2000 and 2011. On average, Kenya imported about 350,000 tonnes of maize between 2011 and 2015 and registered about 5500 tonnes of maize exports (FAOSTAT, 2019). These statistics indicate that Kenya has moved from being maize sufficient to a maize deficit country in the last five decades.

Kenya has witnessed rapid population growth in the last five decades, which has translated into increasing demand for food. Maize being a staple food commodity in the country has recorded a rise in demand. The per capita maize consumption was estimated at 98 kg per annum by 2004 (Nyoro *et al*., 2004). However, recent estimates indicate that per capita maize consumption stands at 108 kg per year (Kariuki *et al*., 2016). A focus on this statistic indicates that the demand for maize outstrips production, which forces the country to rely on imports to meet the increasing domestic demand for maize. Therefore, it can be concluded that trade plays an instrumental role in enabling the availability of staple food in Kenya.

In Kenya, trade dates back to before independence when tea and coffee were the main exports. However, Kenyan participation in international trade has increased since the 1960s due to the continued wave of global economic integration. Trade liberalization in the agricultural sector in Kenya, just like most of the other countries in Sub-Saharan Africa, can be traced back to 1980 (Nyairo, 2011). The introduction of agricultural reforms in the 1980s was supported by international development organizations and agencies. The reforms were aimed at eliminating production bottlenecks in the agricultural sector as well as exposing the sector to market forces (Sheahan *et al.*, 2016). The reforms involved the reduction of government involvement in the agricultural sector and the creation of incentives for farmer participation in the sector (Nagarajan *et al*., 2019; Nyairo, 2011).

Before the structural adjustment programs of the 1980s, the government-controlled the maize sub-sector (Nzuma, 2007). The government-controlled territorial and pan-territorial price and monopolized maize marketing through the NCPB (Nzuma & Sarker, 2010). The intensification of the structural adjustment programs led to the elimination of government control of the movement of maize and pricing. Prices were also deregulated and subsidies to maize millers were eliminated. In 1993, NPCB ceased to be the sole buyer and seller of maize in the country. Territorial and pan-territorial pricing was also deregulated (Kirimi, 2012). However, these policies did not adequately eliminate government controls in the maize sub-sector.

The accession of Kenya to the World Trade Organization (WTO) and ratification of several bilateral and multilateral trade agreements opened Kenyan borders to international trade. The endorsement of the Uruguay Round of Agreement on Agriculture (URAA) saw Kenya commit to market access requirements, including tariffs (David, 2018). Additionally, Kenya is also committed to the East African Community (EAC) and Common Market for East and Southern Africa (COMESA) trade agreements. According to Vitale *et al*. (2013), Kenya applies the EAC's common external tariff (CET) on cereals, with temporary adjustments depending on the level of deficit. Maize imports from countries that are non-EAC or non-COMESA member states are subjected to a tariff of close to 50%. However, the tariff is either waived, reviewed, or re-imposed from time to time (d'Hôtel *et al*., 2013). Maize imports from COMESA and EAC are tariff-free. According to Mulinge *et al*. (2015), Kenya imports mostly from Zambia, Malawi, and Tanzania. However, d'Hôtel *et al*. (2013) noted that tariff inconsistencies may result in undesired results from a policy change.

Consequently, the number of studies investigating the effects of international trade on economic welfare is increasing. This underscores the importance of trade liberalisation on the welfare of both consumers and producers in a country. For instance, Biswas and Sengupta (2015) used the Partial Equilibrium Model to compare the implication of tariff changes on welfare in developing countries. Additionally, they analysed the welfare effects of the implementation of quantitative restrictions. The study established that import tariffs and quotas resulted in a reduction in volumes of imports. The implication of the tariffs and quota was a reduction in producer profits and importer profits. However, domestic production did not completely offset the fall in imports which resulted in price hikes that impacted consumer welfare. Overall, the trade policy effects led to welfare losses that defeated the original purpose of the policy change. However, Biswas and Sengupta (2015) noted that impacts depended on currency devaluation and exchange regimes implemented by the developing countries.

Schmitz and Lewis (2015) investigated the effects of the North American Free Trade Agreement on producer and consumer welfare using time-series data for the period 2008-2013. Estimates from the Partial Equilibrium trade model showed that trade agreements between Mexico, Canada, and the United States had a disproportionate ex-post impact on sugar economic welfare. While Mexican producers gained an average of $405 million to $833 annually, sugar producers in the United States significantly lost from the trade agreement. Mexican consumers suffered between $376 million and $766 million loss in welfare. Nevertheless, the total welfare loss for Mexico averaged between $29 million and $67 million per annum. In contrast to the policy effect in Mexico, the United States producer surplus reduced by about $654 million and $1.6 billion per annum, but increased consumer welfare by between $612 million and $1.7 billion in the same period. United States' total welfare increased by between $405 and $833 million in the same period.

Parajuli and Zhang (2016) used monthly imports of Canadian softwood into the United States to analyse consumer and producer welfare. Similar to Schmitz and Lewis (2015), Parajuli and Zhang (2016) used the Partial Equilibrium trade model to estimate the welfare impacts of the softwood lumber agreement. The trade agreement restricted the volumes of Canadian softwood imports to the United States. The import restriction resulted in negative consumer surplus and positive producer surplus in the United States. The tax revenues for the United States were positive. Overall, import restrictions resulted in a total economic loss. However, the trade policy resulted in negative producer welfare in Canada, but a positive net economic welfare.

Sabala and Devadoss (2019) used a partial equilibrium trade model to estimate the welfare impact of the trade on China and the United States. The study established that the 25% import tariff increased consumer prices resulting in a $3.03 billion decrease in consumer surplus. In contrast, producer welfare increased by $370 million. The net welfare loss was $2.66 billion. The United States responded to Chinese tariff hikes by expanding its exports to Mexico, Canada, Brazil, Argentina, and Paraguay. Nevertheless, trade diversion did not offset producer losses due to a decrease in consumer and producer prices. The Chinese tariff on the United States soybean resulted in $5.52 billion and $2.80 billion in producer loss and consumer gain, respectively. This translated into a net economic loss of $2.72 billion.

The reviewed literature draws links between trade and economic welfare. However, most of the literature focused on the welfare effects of trade in developed countries. There are no specific studies on the welfare effects of maize imports in Kenya. Besides, the majority of existing literature focused on the productivity effects of trade liberalisation on maize production, producer responsiveness to price, and food security (d'Hôtel *et al*., 2013; Kassim, 2015; McCorriston *et al*., 2013; Sumathi *et al.*, 2019). Additionally, the generalization of the reviewed literature is weak in that trade gains and losses may be disproportionate, depending on the level of economic development of trading nations. The current study focused on overcoming the mentioned weaknesses by analysing the economic welfare effects of maize importation in Kenya. Specifically, it simulated the effects of maize imports on producer and consumer welfare in Kenya from 1963 and 2016 using the Partial equilibrium model.

5.2 Methodology

5.2.1 Modelling Strategy

To achieve this objective, data were subjected to analysis using a Partial equilibrium model (PEM). The model was constructed based on a small country importer assumption because Kenya is a small importing country that does not have control over the world prices of maize (Lutz & Scandizzo, 2015). The PEM is commonly used in literature to estimate the welfare effects of trade policy (Biswa & Sengupta, 2015; Nzuma & Sarker, 2010; Parajuli & Zhang, 2016; Schmitz & Lewis, 2015). The model focuses on estimating the effects of a policy change on a single sector as opposed to multi-sector effects that are analysed using the general equilibrium model. It has the capability of assessing indirect effects that result from trade policy changes such as import and export losses or welfare gains and losses. It also allows perfect substitutability between domestic and imported commodities (Lutz & Scandizzo, 2015).

The effects of maize importation on the economic welfare of maize producers and consumers in Kenya were simulated in PEM using price elasticity estimates of maize demand and domestic supply. The elasticity of supply and demand resulting from trade policy changes were specified as follows:

$$Ess = \frac{\Delta \ln(Mqs)}{\Delta \ln(Ps)} \tag{5.1}$$

$$Edd = \frac{\Delta \ln(Mqd)}{\Delta \ln(Pd)} \tag{5.2}$$

where Ess and Edd denote price elasticities of supply and demand, respectively, *Mqs* is maize quantity supplied to the market, *Mqd* is the maize quantity demanded in the market, *Ps* is producer price, *Pd* is maize domestic price, and Δ is the change operator.

The elasticities derived from equations 5.1 and 5.2 were entered into the demand and supply sides of the PEM. Following Naanwaab and Yeboah (2014), the maize import demand function was specified as presented in equation 5.3.

$$Q_m(P,Y) = Q_d(P,Y(P)) - Q_s(P) = Q_m(P,Y) \quad (5.3)$$

where $Q_m(.)$ denotes quantity of imported maize, P is the domestic price, Y is income, $Q_d(.)$ is the quantity of domestic maize demand, and $Q_s(P)$ is the quantity of maize supplied to the domestic market at each price level P. On the other hand, Naanwaab and Yeboah (2014) specified import supply function as:

$$Q_x(P) = Q_s(P) - Q_d(P) \quad (5.4)$$

where $Q_x(P)$ denotes the quantity of maize imports supplied to the market. The quantity of imports supplied to the market is a function of the price of maize P . Q_s is the quantity of maize supplied by the domestic market and Q_d is the quantity of maize demanded in the domestic market.

Empirically, equations 5.3 and 5.4 were fitted using specifications 5.5 and 5.6 respectively (Naanwaab & Yeboah, 2014).

$$M_t^* = f(Y_t P_{mt} / P_{dt}) \quad (5.5)$$

$$M_t^* = \alpha_0 + \alpha_1 Y_t + \alpha_2 P_t + e_t \quad (5.6)$$

Equation 5.5 is the empirical estimation equation for the import demand function while 5.6 is the empirical estimation of the import supply equation 5.4. M_t^* is the desired quantity of imports at time *t*, P_{mt} and P_{dt} denote import price and the domestic price at time *t*, respectively. Y_t is the income at time *t*, P_t is the relative price, P_{mt} / P_{dt} is a ratio of import price to the domestic price at time *t*, and e_t is the stochastic error term.

A partial adjustment mechanism was then introduced into the model and the PEM equation was then specified as:

$$\Delta M_t = M_t - M_{t-1} = \delta(M_t - M_{t-1}) \quad (5.7)$$

where M_t represents the actual quantity of maize imported at a time t, M_{t-1} denotes the actual quantity of maize imported at a time $t-1$, while δ is the coefficient of adjustment. Substituting equation 5.6 into 5.7 yields the dynamic import equation 5.8.

$$M_t = \delta\alpha_0 + \delta\alpha_1 Y_t + \delta\alpha_1 P_t + (1-\delta)M_{t-1} + \delta e_t \tag{5.8}$$

The PEM focuses on establishing the effects of a price change resulting from imports, a tariff, or an import quota changes on volumes of trade and welfare. Therefore, since the interest of the study is about consumer and producer responses to price, income was excluded from import functions. Therefore, it was postulated that a policy change will trigger changes in import volumes because of the differences between the world and domestic prices of maize. This was represented by the import demand (5.9) and supply (5.10) equations as follows:

$$M_t = Q_d - Q_s = M(P/P_t{*}, Edd_t, M_{t-1}) \tag{5.9}$$

$$S_t = Q_S - Q_d = S(P/P_t{*}, Ess_t, S_{t-1,}) \tag{5.10}$$

where s_t is the actual quantity of maize imports supply at time *t*, $P/P_t{*}$ is the relative price, Ess and Edd are elasticities of supply and demand respectively, s_{t-1} is the actual quantity of maize imports supplied at time *t*-1.

5.2.2 Description of Variables for Economic Welfare Analysis

Shehata and Mickaiel (2015) posit that welfare gains or losses from trade as specified in equations 5.9 and 5.10 can be derived following model variables and derivations in Table 20 through Table 22. *Pd* and *Pw* are domestic price and border price of maize respectively. They are continuous variables measured in Kenya shillings (KES). Between 1963 and 1986 domestic maize prices were strictly controlled by the government through the maize marketing and produce boards. After 1995, domestic maize policy dramatically changed and the role of the NCPB reduced to a buyer of the last resort (Nzuma, 2007). Border price of maize was used as the price at which maize across the international borders is sold at the Kenyan borders. *QPd* and *QCd* represent maize production and consumption quantity at domestic prices respectively. *QPw* and *QCw* represent maize production and consumption quantities at border prices respectively. *Ess* and *Edd* are the supply price elasticity and demand price elasticity at domestic prices, respectively. *Esw* and *Edw* are the supply price elasticity and demand price elasticity at border prices respectively.

Table 20: Private Price

Variable	Description	Measurement	Derivation
Pd	Domestic Price	KES	
Tmd	Import Tariff Rate	Percentage	*(NPC-1)/NPC*
Ess	Supply Price Elasticity	Percentage	
Edd	Demand Price Elasticity	Percentage	
QPd	Production Quantity	Tonne	
QCd	Consumption Quantity	Tonne	

Table 21: Social Price

Variable	Description	Measurement	Derivation
Pw	Border Price	KES	
NPC	Nominal Protection Coefficient	Ratio	*Pd/Pw*
Tmw	No Import Tariff Rate	Percentage	*NPC-1*
Esw	Supply Price Elasticity	Percentage	*Ess*(Pw*QPd)/(Pd*QPw)*
Edw	Demand Price Elasticity	Percentage	*Edd*(Pw*QCd)/(Pd*QCw)*
QPw	Production Quantity	Tonne	*QPd-(Ess*(Pd-Pw)*QPd/Pd)*
QCw	Consumption Quantity	Tonne	*QCd-(Edd*(Pd-Pw)*QCd/Pd)*

Table 22: Derivation of Economic Welfare

Variable	Description	Measurement	Derivation
NELp	Net Economic Loss in Production	KES	*0.5*(QPw-QPd)*(PwPd)*
NELc	Net Economic Loss in Consumption	KES	*0.5*(QCw-QCd)*(PdPw)*
PS	Change in Producer Surplus	KES	*QPd*(Pd-Pw)-NELp*
CS	Change in Consumer Surplus	KES	*QCd*(Pw-Pd)-NELc*
GR	Change in Government Revenue	KES	*-NELp-NELc-PS-CS*
NET	Net Economic Loss in Export/Import	KES	*PS+CS+GR* = -*(NELp+NELc)*

5.3. Results and Discussion

Table 23 presents the average price elasticity of supply and demand for maize between 1963 and 2016. The private price elasticity of maize supply was 1.53%. On the other hand, the private price elasticity of demand was -1.05%. On social price elasticities, supply elasticity was averagely 0.24% while demand price elasticity was -0.02%.

Table 23: Supply and demand elasticities between 1963 and 2016

Elasticity	Private	Social
Supply	1.53	0.24
Demand	-1.05	-0.02

Table 24 presents the results of the PEM analysis of the effects of maize imports on the economic welfare of maize producers and consumers in Kenya for the period 1963 to 2016. The welfare effects are a five-year impact of maize imports, except for the period 2013 to 2016.

Table 24: Maize import effects on the economic welfare of maize producers and consumers

Period	PS (million KES)	CS (million KES)	Net effect (million KES)
1963 – 1967	-40.48	.-9.08	-49.6
1968 – 1972	-430.5	-63.03	-493.5
1973 – 1977	-901.8	46.11	-855.7
1978 – 1982	-6,934	1,562	-5372
1983 – 1987	773.9	-144.8	629.1
1988 – 1992	-5,962	-104,100	-110,062
1993 – 1997	-3,505	3,613	108
1998 – 2002	1,019	-7,012	-5,993
2003 – 2007	-2,910	5,627	2,717
2008 – 2012	29,550	-58,540	-28,990
2013 – 2016	88,180	-492,800	-404,620

In 7 out of the 11 periods under review, maize producers suffered economic losses due to maize importation. Simulation results show that Kenyan producers lost about KES 40 million between 1963 and 1967. On average, during this period, producer welfare decreased under a negative producer surplus of KES 8 million per annum. This could be attributed to a decline in marketed surplus during this period which was occasioned by land transfers and the resettlement program initiated by the government right after independence (Karanja, 1996). In the 1968-1972 and 1973-1977 periods, the producer surplus reduced by about KES 431 million and 902 million, respectively, which translates to an average annual loss of KES 86.2 million and 180.2 million, respectively. This loss could be attributed to an 80% decline in the overall food production due to the exodus of settlers from large farms and the transition to African farming after independence (Heyer *et al.,* 1976; Karanja, 1996).

In the 1963-1967 and 1968-1972 periods, consumer surplus reduced by KES 9 million and 63 million, respectively. This implies that on average, maize consumers lost KES 1.8 million and 12.6 million per annum, respectively. However, consumers gained KES 46 million between 1973 and 1977 which indicates that annually, consumer surplus increased by KES 9.2 million in the same period. The decrease in consumer surplus between 1963 and 1972 could be attributed to the trade imbalance. During this period, Kenyan maize export volumes were greater than import volumes (FAOSTAT, 2019). The net economic losses for periods 1963-1967, 1968-1972, and 1973-1977 were about KES 50 million, KES 494 million, and KES 856 million, respectively. These losses could not be entirely attributed to maize imports but rather to the declining economic performance of the country elicited by the adjustments from the colonial rule which led to declining per capita food production and the global oil crisis (Karanja, 1996).

The periods coinciding with the commencement of the structural adjustment policies registered producer gains and losses. Producers lost KES 6,934 million from 1978 to 1982 and gained about KES 774 million between 1983 and 1987. This implies that on average, producers lost KES 1386.8 and gained KES 154.8 million per year for the periods 1978 to 1982 and 1983 to 1987, respectively. The loss in producer surplus from 1978 to 1982 could be attributed to drought in 1980 as well as inefficiencies in marketing boards (Kirimi, 2012). Similarly, consumers lost about KES 145 million between 1983 and 1987 and gained KES 1,562 million from 1978 to 1982. This translates to a loss of KES 29 million per annum and a gain of KES 312.4 million per annum respectively. The high increase in consumer surplus from 1978 to 1982 could be attributed to subsidized sifted maize meal prices and food security status of the country during this period which came as a result of strict control of maize prices by NCPB (Nzuma, 2007). The resultant net effect of maize importation was a loss of KES 5,372 million from 1978 to 1982 and a gain of about KES 629 million from 1983 to 1987. The gain in producer surplus and the resultant net gain from maize importation from 1983 to 1987 could be attributed to stable producer incomes as a result of stable pan territorial and pan seasonal maize prices in the entire country during this period. Secondly, this could be attributed to the commencement of structural adjustment programs that reduced government involvement in maize marketing and deregulation of maize prices (Kirimi, 2012; Nyairo, 2011). The structural adjustment programs possibly created incentives for investment in the maize sub-sector, which resulted in positive productivity effects. According to FAOSTAT estimates (2019), the volume of Kenyan maize imports and exports almost balanced in the mid-1980s. Therefore, the gains from maize exports could have possibly offset potential losses from importation.

Despite the gains from trade liberalization policies which commenced from the mid-1980s, producers lost about KES 5,962 and KES 3,505 million for the period 1988-1992 and 1993-1997, respectively as a result of continued trade openness. This translates to a loss of KES 1192.4 and KES 701 million per year, respectively. Similarly, consumers lost KES 104,100 million between 1988 and 1992 but gained only KES 3,613 million from 1993-1997 which suggests a loss of KES 20, 820 million per annum between 1988 and 1992 and a gain of KES 722.6 million per annum between 1993 and 1997. The net social effects of maize importation were losses of KES 110,062 million and gains of KES 108 million for the 1988-1992 and 1993-1997 periods, respectively. The immense losses in consumer and producer surplus which resulted in a net economic loss between 1988 and 1997 could be attributed to the elimination of intra-regional trading of maize in Kenya in 1993 (Kirimi, 2012). Kenya also ratified the Uruguay Round of Agreement on Agriculture (URAA) and acceded with WTO (Ndirangu, 2017). This trigged increased importation of maize, which was possibly a disincentive for investment in maize production for most commercial maize producers. Estimated maize imports to Kenya rose from 100 thousand tonnes in the 1980s to almost 270 thousand tonnes in the 1990s (FAOSTAT, 2019).

Producer surplus increased by KES 1,019 million between 1998 and 2002 and decreased by KES 2,910 million between 2003 and 2007 which translates to a gain of KES 203.8 million per annum between 1998 and 2002 and a loss of KES 580 million per annum for 2003-2007 periods. The decrease in producer surplus from 2003-2007 could be attributed to duty-free access to maize imports from COMESA and EAC countries. On the other hand, consumer surplus reduced by KES 7,012 million for the 1998-2002 period, before increasing by KES 5,627 million between 2003-2007. The changes in prices and quantities resulted in a net loss of KES 5,993 million and a net gain of KES 2,717 million for periods 1998-2002 and 2003-2007, respectively. The consumer loss and the net economic loss for the periods between 1998 and 2002 corroborate findings by Jayne *et al*. (2006), who indicated that import tariff imposed frequently within the period resulted in higher domestic prices by as much as 10% which could have been a disincentive for maize consumers.

Maize producers gained KES 29,550 million while maize consumers lost KES 58,540 million between 2008 and 2012. During this period, producer welfare improved due to a positive producer surplus of KES 5,910 million per annum while consumer surplus decreased by KES 11,708 million per annum. This could be explained by the general increase in food prices globally, which was occasioned by the global financial crisis of 2007-2008. The global food price spikes of basic food crops alongside oil prices hit the population in developing countries (Sundaram, 2010). The liberalization of agricultural trade regulations also allowed the transmission of high food prices which possibly resulted in higher producer and consumer prices. The quantity changes may have been caused by high input costs triggered by rising oil prices, making maize imports have less impact on consumer prices. Consequently, producer surplus improved because of higher producer prices while consumer surplus decreased due to higher consumer prices. Additionally, the loss in consumer surplus suggests the need for an increase in strategic grain reserves to cushion maize consumers from persistent global price spikes.

Consumer prices in Kenya did not ease after the aftermath of the 2008 global food crisis. This could be attributed to artificial shortages of the food staple in Kenya during this period, created by inconsistent policies in recent years. As a result, consumer surplus decreased by about KES 492,800 million between 2013 and 2016 which translates to a reduction in consumer welfare by KES 98,560 million per annum. However, producer surplus increased by KES 88,180 million. This implies that on average, producer surplus increased by KES 17,636 million per annum. The economic loss in the same period was KES 404,620 million. The net economic loss for the period 2013-2016 was the largest since the 1960s. The largest loss in consumer surplus coupled with the overall economic welfare loss during this period is a clear indication that the money lost during this period as a result of maize importation could have been channelled to increase government allocation to input subsidy, which was allocated an average of KES 3.45 billion only for the 2013/2014, 2014/2015 and 2015/2016 financial years (GOK, 2014; GOK, 2015; GOK, 2016).

The results provide evidence of the ambiguous effects of maize imports on the economic welfare of maize producers and consumers in Kenya. Price appears to play a secondary role in determining the outcomes of post-trade reforms undertaken in Kenya. The inconsistencies in the timing and implementation of trade policies could be attributed to the ambiguous effects of maize imports in Kenya. Imports play a crucial role in improving the competitiveness of domestic industries. The inconsistency in the implementation of the trade policies could be attributed to the lack of capacity of the Kenyan government to regulate and stabilize maize production and prices through imports. This could be due to governance problems or failure (d'Hôtel *et al*., 2013; Jayne & Tschirley, 2009; Poultion *et al*., 2006). The empirical evidence provided by the study suggests that government interventions in the market may fail to provide production or consumption incentives of a balance due to policy inconsistency or ineffective implementation of the policy reforms.

The ambiguous effects or rather the unintended outcomes could also be attributed to ad hoc and discretionary trade policies implemented by the government (d'Hôtel *et al*., 2013). The discretionary policies create uncertainty for local maize traders and importers. Import tariffs are frequently implemented and unannounced changes made sporadically. Furthermore, the government implements maize export bans. These events deprive both producers and consumers of gains that would have possibly accrued from trade. Additionally, the NCPB sets the official producer and consumer pricing structure, which, in turn, influences market prices. The maize imports are subjected to the same price regime as domestic maize. Thus, the imports have little impact on maize prices (Ariga & Jayne, 2010; Mulinge *et al*., 2014).

Maize in Kenya is dominantly produced by smallholder farmers. However, Ariga and Jayne (2010) posit that the imposition of import tariffs or bans only benefits large-scale farmers who market their surplus at higher market prices. The import restriction through prices or bans for most of the periods of the analysis could be possibly attributed to the argument of Ariga and Jayne (2010). The distributional effects of import restriction could have hurt maize buying rural and urban households. It is crucial to note that smallholder farmers also retain large proportions of maize output during shortages, which usually coincide with hasty government interventions in the market. Retention of maize output raises market prices which hurts consumers because maize imports rarely offset the effect of maize supply deficits.

Nevertheless, the ambiguous policy effects of imports on welfare may not be entirely attributed to trade policy. McCorriston (2013) opines that liberalization of the agricultural sector in developing countries does not operate in a policy vacuum. Other macroeconomic policy reforms occur alongside trade policies which impact the intended effects of trade policy change. According to McCorriston (2013), isolating the effects of macroeconomic policies from trade policy is a daunting task in the developing countries, Kenya included. In some circumstances, the effect of trade liberalization may be outweighed by other macroeconomic policies. This argument implies that the effect of trade policy on economic welfare is influenced by other policies implemented elsewhere in the economy. For instance, Biswas and Sengupta (2015) cite exchange rate policies as important in explaining the effect of trade policies in developing countries. This is further supported by the fact that exchange rate is an important determinant of maize import volume as shown by the results of the analysis of objective two.

5.4. Conclusion

The study simulated the effects of maize imports on producer and consumer welfare in Kenya from 1963 to 2016. The results show that maize imports have ambiguous effects on economic welfare. In 4 out of 11 points of analysis, maize imports resulted in net consumer gains and producer gains. No gains were recorded within the same period. This implies that trade benefits producers or consumers differently. For consumers to gain from a trade policy, producers have to lose or vice versa. Additionally, the results show that the net gain in economic welfare from trade policy was registered in only 3 out of 11 periods under review. The remaining 8 periods under review registered net economic losses. This is a clear indication that the resultant effect of maize importation would be a net societal loss and a loss in government revenue. It can therefore be concluded that trade policy intervention in the maize subsector does not always result in the intended outcomes. However, it should be noted that the effects of imports on economic welfare cannot be entirely linked to trade policy but rather also to other macroeconomic policies.

The study, therefore, recommends that maize trade policy outcomes should be aligned and supported by other macroeconomic policies to eliminate inconsistencies. Secondly, the maize trade policy should align domestic prices with world prices to provide producer incentives. The alignment of domestic prices to international prices will also allow efficient allocation of production resources, which, in turn, will improve the competitiveness of the domestic maize sub-sector. This will ensure that both maize producers and consumers benefit from the sector. This will go a long way in ensuring sustainability and development in the maize subsector. These recommendations can be achieved by NCPB which should set maize purchase prices that are based on import parity prices. The government should avoid implementing discretionary policies to eliminate market uncertainty. The government should also enhance consumer surplus by implementing food safety nets, by building strategic grain reserves that would be used to stabilize prices. This can be achieved by rechanneling part of the annual budgetary allocation for maize imports to irrigation and water projects such as the Galana Kulalu irrigation project to reduce overreliance on rain-fed production of maize.

CHAPTER SIX

GENERAL DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides a summary of the study. Additionally, it provides conclusions based on the findings of the study. It also provides policy recommendations and areas for further research.

6.2 Discussion

The study first analysed the supply and demand responsiveness of maize producers and consumers. The ADF stationarity test results for the supply response equation revealed that apart from rainfall that was stationary in level form, all the other variables became stationary after first differencing. The results from the error correction version of the ARDL model showed that maize supply responds significantly to the previous period's maize production, producer price, the area under maize cultivation, and fertiliser use in the long run. Consequently, in the short run, the results revealed that maize supply responds positively and significantly to producer price, fertiliser use, and area under maize cultivation. However, the elasticity of maize supply with respect to price was inelastic both in the short and long run. However, long-run results indicated that maize supply negatively responds to current producer price. This fact could be attributed to the endogeneity aspect of price. The study further found that land area under maize cultivation and fertiliser use are important factors that can contribute to an improvement in maize supply.

Consequently, on the demand side, the results revealed that maize demand significantly responds to the previous period's quantity demanded, production, and price of substitutes (wheat domestic price) in the long run. Additionally, in the short run, the results showed that maize demand responds significantly to production and the price of substitutes. The significance of the first lag of maize demand highlights the need to diversify maize consumption to include consumption of other possible substitutes such as cassava, wheat, millet, and rice. This is further reinforced by the elastic response of maize demand to wheat domestic price both in the short and long run. Additionally, the study adds that wheat can be a possible substitute for maize. The significance of production also emphasizes the important role that maize supply plays in determining maize demand.

From the analysis of determinants of imports, the stationarity test results revealed that import was stationary in level form while trade openness, production, consumption, domestic price, GDP, and exchange rate became stationary after first differencing. The results from the error correction version of the ARDL model revealed that trade openness, maize domestic price, and GDP significantly determine maize import volumes in the long run. While in the short run, the results revealed that the first lag of maize imports, first lag of production, exchange rate, and its first lag significantly determine maize import in Kenya.

The third objective simulated the effects of maize imports on producer and consumer welfare in Kenya for the period 1963-2016 using a partial equilibrium model. The results revealed that maize imports result in ambiguous welfare effects on both maize producers and consumers. Specifically, gain in consumer surplus only compensated loss in producer surplus in two points of analysis out of eleven, that is, 1993 – 1997 and 2003 – 2007 while the gain in producer surplus only compensated loss in consumer surplus in one point of analysis, that is, between 1983 and 1987. Despite the increase in the volume of maize imports between 2013 and 2016, producers gained KES 88,180 million during this period while maize consumers lost KES 492,800 million due to continued increase in maize prices. The net economic welfare effect of maize importation was negative. In general, the gains in consumer surplus did not compensate for the losses in producer surplus and vice versa. Therefore, the implementation of Uruguay Round market access commitments without compensating both maize consumers and producers would still leave the maize sector worse off.

6.3 Conclusions

i. The study established that support price is a necessary but not sufficient condition for improving the productivity of maize. More efficient and effective use of land should be encouraged through the use of productivity-enhancing inputs such as fertilisers. Adoption of this should be encouraged through intensification of extension services to enhance technical efficiency in the use of available land considering that land expansion is a limited option. Therefore, aggregate maize supply response should be encouraged through technical progress and mechanization in the use of land instead of just pricing incentives alone.

ii. Besides domestic prices and domestic maize production, exchange rate and GDP growth are important determinants of maize import volumes. The findings suggest that both micro and macroeconomic factors play a significant role in international maize trade.

iii. The effect of maize importation would be a net loss to both maize producers and consumers and a resultant net economic loss, hence, a loss in government revenue. These findings suggest that a decline or an increase in maize prices does not warrant the desired consumption and production increases. It can therefore be concluded that trade policy intervention in the maize subsector does not always result in the intended outcomes.

6.4 Policy Recommendations

Based on the foregoing findings, the following policy recommendations can be made:

i. To curb over-reliance on maize imports and ensure that both maize producers and consumers benefit from the maize subsector, effective market reforms should be formulated and implemented to free maize market channels and prices. Secondly, the bottlenecks in procuring subsidized fertiliser should be removed so that its benefits accrue to all maize producers in terms of reduced cost of production and to consumers in terms of reduced maize prices. Finally, the Kenyan government should encourage improvement in domestic production of other staples like cassava, millet, wheat, and rice to diversify consumption of the staple and improve the food security status of the economy.

ii. Government policies should be geared towards effective management of the macroeconomic environment (exchange rate and GDP growth) and domestic price stability. This will create a favourable environment for improving maize production instead of encouraging further tariff reductions. The inflation rate should therefore be kept as favourable as possible through a sensible monetary policy of ensuring low and stable inflation to bring price stability in the economy. This will then give maize producers an incentive to invest more in maize production hence resulting in positive productivity and welfare improvements.

iii. Trade policy outcomes should be aligned and supported by other macroeconomic policies such as exchange rate policies for the benefit of both maize producers and consumers. The maize trade reforms should also align domestic prices to world maize prices to provide producer incentives and to simultaneously allow maize producers to respond to price incentives and price shocks. Additionally, complementary reforms should be put in place to allow world prices to transmit to maize consumers. The alignment of domestic prices to international prices will allow efficient allocation of production resources, which, in turn, will improve the competitiveness of the domestic maize sub-sector and consumer welfare. Therefore, maize purchase prices should be set based on import parity prices.

6.5 Areas of Further Research

In the study, only macroeconomic and microeconomic factors were considered as important factors that determine maize imports because of the unreliable data available on import duties, availability of maize in the international markets and government policy, and relative prices of other staples like wheat, rice, sorghum and cassava. Future research should consider these factors to improve the validity of the results. Secondly, it was not possible to explore the distribution of welfare gains and losses on maize producers and consumers to the fullest because of lack of data differentiated by household type, for example, data on small scale and large scale producers as well as data on rural and urban maize consumers, because this requires survey data. Future research should consider doing this analysis using survey data.

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APPENDICES

Appendix A: Jarque-Bera normality test for supply response

```
Jarque-Bera normality test:  .2386 Chi(2)  .8876

Jarque-Bera test for Ho: normality:
```

Appendix B: VIF test for multicollinearity for supply response

Variable	VIF	1/VIF
lnproduction		
L1.	7.01	0.142578
lnprice1	4.78	0.209016
lnfertmaize	2.89	0.345697
lnhectares	2.81	0.356170
lnproduction		
LD.	1.79	0.559405
lnrainfall	1.31	0.765266
lnprice1		
D1.	1.23	0.811213
Mean VIF	3.12	

Appendix C: Breusch- Godfrey LM test for autocorrelation for supply response

lags(p)	F	df	Prob > F
1	2.790	(1, 44)	0.1019

H0: no serial correlation

Appendix D: Breusch- Pagan test for Heteroskedasticity for supply response

```
Ho: Constant variance

Variables: fitted values of D.lnproduction

chi2(1)      =     1.40
```

```
Prob > chi2  =   0.2366
```

Appendix E: Normality test for demand response

```
Jarque-Bera normality test:  2.501 Chi(2)  .2863

Jarque-Bera test for Ho: normality:
```

Appendix F: Breusch-Godfrey LM test for autocorrelation for demand response

```
---------------------------------------------------------------------------

    lags(p)  |          chi2               df                 Prob > chi2

-------------+-------------------------------------------------------------

       3     |          2.271               3                   0.5182

---------------------------------------------------------------------------

                        H0: no serial correlation
```

Appendix G. White's test for Heteroskedasticity for demand reponse

```
White's test for Ho: homoskedasticity

         against Ha: unrestricted heteroskedasticity



         chi2(27)     =     28.99

         Prob > chi2  =    0.3615
```

Appendix H: Multicollinearity test for demand reponse

```
Variable |       VIF       1/VIF

-------------+----------------------

lnwhtdompr~d |    3.49      0.317491

        lnPd |    7.13      0.110295

       lnQCd |

         L1. |     7.71    0.126516

         L2. |     9.09    0.034380

      lnprod |     3.71    0.269788

lngdpperca~a |     2.71    0.368505

-------------+----------------------

    Mean VIF |     5.64
```

Appendix I: Breusch-Godfrey LM test for serial correlation

lags(p)	chi2	df	Prob > chi2
3	0.707	3	0.8716

H0: no serial correlation

Appendix J: White's test for Heteroskedasticity

```
Ho: homoskedasticity

against Ha: unrestricted heteroskedasticity


        chi2(49)     =     50.00

        Prob > chi2  =    0.4334
```

Appendix K: Cameron & Trivedi's decomposition of IM-test for Heteroskedasticity

Source	chi2	df	p
Heteroskedasticity	50.00	49	0.4334
Skewness	18.49	17	0.3587
Kurtosis	0.01	1	0.9382
Total	68.49	67	0.4263

Appendix L: Jaque Bera normality test for determinants of imports

```
. jb resid

Jarque-Bera normality test:  2.196 Chi(2)  .3335

Jarque-Bera test for Ho: normality:
```

Appendix M: Multicollinearity test for determinants of maize imports

```
Variable |       VIF       1/VIF

-------------+----------------------

exchangerate |

         L1. |     9.58     0.107164

         --. |     8.55     0.112263

        lnPd |     6.52     0.214595

       lngdp |     7.19     0.147485

       lnQCd |     3.35     0.332948

    openness |

         --. |      9.20    0.108648

      lnprod |

         L1. |      7.82    0.127813

    openness |

         L1. |      7.07    0.141521

      lnprod |

         L2. |      6.50    0.153931

         --. |      5.68    0.175964

   lnimports |

         L1. |      4.66    0.214483

    openness |

         L2. |      4.56    0.219483

   lnimports |

         L2. |      4.48    0.223201

-------------+----------------------

    Mean VIF |    6.20
```

Appendix N: Publication abstract

Scientific Research Publishing

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An Analysis of the Determinants of Maize Import Volumes in Kenya

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Abstract

The objective of our study is to investigate the key factors that determine maize import volumes in Kenya. To achieve this objective, we used time series secondary data from FAOSTAT, World Bank and World Trade Organization (WTO) for the period 1963 to 2016. We consider this period to be long enough to allow us to accurately capture the domestic maize price patterns before and after the onset of maize market reforms in Kenya. Our econometric analysis of the time series data using an error correction version of Autoregressive distributed lag model shows that maize import volume is determined by trade openness, domestic price of maize and gross domestic product in the long run. In the short run, the results show that maize import volume is determined by exchange rate, lag of exchange rate, lag of maize import volume and production. The findings suggest that to reduce overreliance on maize imports, effective management of macroeconomic environment should be stimulated to create a favourable environment for improving domestic maize production so as to discourage a surge in maize imports and at the same time improve the country's food security.

Keywords

Import, Maize, Autoregressive Distributed Lag Model, Kenya

Appendix O: Research permit

THIS IS TO CERTIFY THAT:
MS. MAURINE ADHIAMBO ABODI
of EGRTON UNIVERSITY, 0-20115
NJORO,has been permitted to conduct
research in *Nairobi County*

on the topic: *EFFECTS OF MAIZE IMPORTATION ON THE ECONOMIC WELFARE OF ITS PRODUCERS AND CONSUMERS IN KENYA*

for the period ending:
2nd May,2020

Permit No : NACOSTI/P/19/33930/29045
Date Of Issue : 2nd May,2019
Fee Recieved :Ksh 1000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation