ANALYSIS OF WHEAT IMPORTATION AND ITS ASSOCIATED EFFECTS ON DOMESTIC WHEAT PRODUCTION IN KENYA

TOO HENRY KIPSANG

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

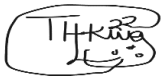
EGERTON UNIVERSITY

SEPTEMBER, 2022

DECLARATION AND RECOMMENDATION

Declaration

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

Signature  Date ……4/11/2022…….

Too Henry Kipsang

KM17/17538/17

Recommendation

This thesis has been submitted with our approval as university supervisors.

Signature……  …….. Date……6-11-2022……

Prof. Hillary Kiplangat Bett, PhD

Department of Agricultural Economics and Agribusiness Management,

Egerton University.

Signature……  …… Date……5th November 2022……

Dr. Raphael Gitau, PhD

Department of Agricultural Economics and Agribusiness Management,

Egerton University.

COPYRIGHT

DEDICATION

I dedicate this thesis to my son, Ethan Kiprop and my wife, Lilian Chelimo who showed support during my studies. Also, I wish to dedicate this work to all my siblings and friends who supported me throughout the entire process.

ACKNOWLEDGEMENTS

I thank Almighty God for the grace of life, good health, perseverance and confidence throughout my study period. I wish to thank Egerton University for allowing me to pursue a Master's degree in the institution.

I acknowledge the African Economic Research Consortium (AERC) in collaboration with the Government of Kenya (GoK) for the scholarship to pursue a Collaborative Master's degree in Agricultural and Applied Economics (CMAAE) and funding this research project through a research grant. Furthermore, sponsoring me to attend an exchange program at the University of Pretoria in South Africa which was a great experience.

Special thanks go to my supervisors, Prof. Hillary Kiplangat Bett and Dr. Raphael Gitau for their tireless efforts, guidance and invaluable input throughout the research process. I also wish to take this opportunity to thank Prof. Job K. Lagat and Prof. Patience Mshenga for their encouragement, advice and support during my studies at Egerton University. I want to acknowledge other staff members in the Agricultural Economics and Agribusiness Management department for their continued support during my studies.

Additionally, I wish to pass my gratitude to my parents Benjamin Cheruiyot and Christine Kimaiyo for their encouragement and financial support throughout my study period. I would also like to thank my uncles, Wilson Arusei, Jonah Kogo and James Sirtui for their encouragement and moral support during my studies.

Lastly, I wish to thank my colleagues and course mates for their input and encouragement during the research process. I will forever be grateful.

ABSTRACT

Grains are presently the foremost necessary contributor to human food provided globally. In Africa, wheat economies are often characterized by a growing gap between domestic wheat supply and consumption. This is clearly indicated by the increase in wheat import bills in Africa. According to New trade theory imports are imperfect substitutes for domestic goods and services. As a result, changes in import dynamics are associated with changes in relative prices and income. In Kenya, government policy on wheat has been inadequate by focusing on production rather than being cognizant of the fact that Kenya has a structural deficit and will rely on wheat imports to fulfil its wheat requirements. Therefore, this study seeks to contribute towards a policy formulation framework for food security through analysis of wheat importation in Kenya. To achieve the objective, secondary time-series data from 2000 to 2019 was analyzed using the Auto-Regressive Distribution Lag-Error Correction Model (ARDL-ECM), Generalized Least Squares (GLS) method and Granger causality model. After data transformation, all variables were normally distributed indicated by the Jarque Bera test statistics. Unit root tests show with robustness that all variables tested were stationary either at level or first difference. The results of the bound test show that there is long run cointegration because the F-test statistic (10.596) was greater than the I (1) upper bound (3.990). The results of Granger causality exhibited three types of causality bidirectional, unidirectional, and independent. This reinforced the finding of existence of cointegration in wheat imports. The estimated import demand function captures 98.2% of total wheat imports in Kenya and this can be used to forecast and estimate the quantity of wheat imports in Kenya. In the ARDL-ECM model, the adjustment coefficient of 1.59 indicates how wheat imports are over-adjusted in Kenya. The findings of the study further reveal an inelastic response for relative prices, ending stock of wheat and government tariff on wheat, which have long run effects on wheat importation in Kenya. In the short run relative price was inelastic and the only variable that affects wheat importation in Kenya. To ensure that Kenya can feed its population wheat imports are only necessary for the short term but leads to growing import bills in the long run. Hence, the government should strive to come up with policies that promote competitive wheat production as it will create a multiplier effect on the economy in the long run. For instance, planting varieties that are in high demand in the Kenyan market.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ADF - Augmented Dickey-Fuller

AERC - Africa Economic Research Consortium

AIC - Akaike Information Criterion

ARDL -Autoregressive Distribution Lag

CMAAE - Collaborative Master's degree in Agricultural and Applied Economics

COMESA - Common Market for Eastern and Southern Africa

CUSUMSQ - Cumulative Sum of Squares

EAC - East Africa Community

ECM - Error Correction Mechanism

EU - European Union

FAO - Food and Agriculture Organization of the United Nations

FAOSTAT- Food and Agriculture Organization Corporate Statistical Database

GDP - Gross Domestic Product

GLS - Generalized Least Squares

GNP - Gross National Product

GoK – Government of Kenya

GRETL – GNU Regression, Econometrics Time-series Library

HO - Heckscher Ohlin theory

IMF - International Monetary Fund

KALRO - Kenya Agriculture Livestock Research Organization

KES - Kenya Shillings

KNBS - Kenya National Bureau of Statistics

KPSS - Kwiatkowski–Phillips–Schmidt–Shin

MENA - Middle East and North Africa

MoALFC - The Ministry of Agriculture, Livestock, Fisheries and Co-operatives

MT- Metric Tonnes

OLS - Ordinary Least Squares

PP - Phillips–Perron

SBC - Schwarz Bayesian Information Criterion

SDGs - Sustainable Development Goals

SSA - Sub-Saharan Africa

STATA - Statistical software package

UECM - Unrestricted Error Correction Model

UN COMTRADE - United Nations Commodity Trade Statistics Database

UNCTAD - United Nations Conference on Trade and Development

URAA - Uruguay Round Agreement on Agriculture

US$ - United States of America dollars

USA - United States of America

USDA - United States Department of Agriculture

VIF - Variance Inflation Factors

WB - World Bank

WITS - World Integrated Trade Solution

WTO - World Trade Organization

CHAPTER ONE
INTRODUCTION

1.1 Background of the study

Grains are presently the foremost necessary contributor to human food provided globally. Approximately 21% of food in the world depends on the annual wheat crop harvests (Enghiad *et al*., 2017). According to FAO (2015), cereals represent the highest number of commodities imported to Africa, accounting for 43% of total imports, whereby wheat leads followed by rice. In Africa, the wheat economy is characterized by an increasing gap between domestic wheat supply and consumption. The widening gap is progressively making Africa be dependent on imports for staple grains, especially wheat and rice. This is supported by the evidence of an increase in the wheat import bill in Africa which has been further exacerbated by high and volatile wheat prices, climate change and export restrictions by the world's major producers such as Russia (Enghiad *et al*., 2017; Mason *et al*., 2012; Negassa *et al*., 2013). The trade imbalance is severe in Sub-Saharan Africa (SSA) because most of the countries are net importers of food and agricultural commodities (Kipruto, 2019). In 2017, Africa produced 25000 metric tonnes (MT) of wheat on 10 million hectares out of the total demand of 61000 MT, creating a food deficit of approximately 36000 MT (59%) of wheat that was imported. On average, over the past decade, SSA has produced 7500 MT on a total area of 2.9 million hectares and imported 12700 MT (Negassa *et al*., 2013; Tadesse *et al*., 2019).

Wheat consumption in Africa increased by 55% over the last two decades. The expansion was attributed to rising income levels, an increase in population and the convenience associated with wheat products, which have made it more popular (Meyer *et al*., 2016). The rapid change in SSA wheat consumption has been reported as part of changing food preferences linked to urbanization (Morris & Byerlee, 1993). Despite the increase in demand, most African countries have continued to import wheat instead of increasing their domestic production. They mainly import the hard wheat variety to be blended with soft wheat to produce a composite wheat flour that meets its domestic requirements. Low wheat supply in African countries necessitates import of wheat to bridge the deficit. As observed by Enghiad *et al*. (2017) consumption by developing countries contributes 77% of total global wheat production and majority being net importers are at the mercy of global wheat prices.

Wheat in Kenya is an important cereal crop and ranks second after maize in its cereal crop priority. In Kenya, wheat production contributes significantly to food security, poverty reduction and job creation in agriculture (Kamwaga *et al*., 2016). The domestic production of wheat in Kenya is highly volatile and deficit in meeting demand, whereas consumption has been increasing at an average rate of 109.7% in the last two decades and shows no sign of slowing down as shown in appendix I and appendix II. The average production of main staples in Kenya gradually increased between 2000-2019 with 143%, 35.4% and 3.87% for rice, maize, and wheat respectively. Average consumption over the last two decades for these staples are 230%, 27.2% and 109.7% for rice, maize and wheat respectively as indicated in appendix II. From the statistics, we can conclude that there is stagnation in the wheat sector as average production and average consumption diverge over the two decades.

It is estimated that by 2024, Kenya annual consumption of wheat will be 2700 MT against 400 MT that will be produced and Kenya will have to import approximately 2300 MT (Elsheikh *et al*., 2015; Meyer *et al*., 2016; Monroy *et al*., 2013). In the short term, imports of wheat to fill domestic supply shortages would be inevitable (Negassa *et al*., 2013). This is because it benefits consumers by lowering the market price of wheat products. Hence, importing wheat to Kenya benefits consumers more than domestic producers. According to Vos (2015), agricultural trade based on rules and regulations for protecting human health and encouraging fair trade policies supports imports as part of food security measures. Hence, importing wheat to Kenya does pose a challenge to the domestic production sector as well as providing room for improvement through improving competitiveness.

Kenya has developed a series of economic reforms and policies since 1990s to address the wheat sector and agriculture in general. These reforms aimed at promoting the involvement of the private sector in the production, marketing, processing and trading of agricultural commodities. Reforms such as liberalization of trade in Kenya have supported the rising imports of foodstuffs in the case of maize, rice, wheat, sugar and dairy products (Gertz, 2008). As a result, most agricultural prices are now dictated by market forces, with import and export parity prices being the key determinants of domestic prices. According to Zahonogo (2017), trade openness on long term economic growth varies depending on the level of economic development. The impact of trade openness on developed countries is positive and negative for developing countries.

In Kenya, wheat farming faces many challenges. According to Nyangito *et al*. (2002), the constraints faced by wheat farmers in Kenya are high cost of production, low productivity, inadequate infrastructure and inappropriate production technologies. These factors have escalated to a level where wheat farmers substitute production of wheat for other high value enterprises. This is noted as farmers shift to other more competitive enterprises such as barley, horticulture and dairy (Gitonga, 2019). Foreign Agricultural Service a global agricultural information network predicted a decrease in Kenya wheat production in 2019/2020 due to a reduction in the area planted as a result of low prices of wheat. This has exacerbated the use of imports by millers as an alternative plan when farmers are reluctant to invest in wheat production. This is because domestic producers of wheat, supply only 30% to millers of the total national demand in Kenya (Meyer et al., 2016).

Kenya wheat productivity over the past three decades has been low at approximately 1.7 tonnes/hectare on average which is nearly below 50% world average (Macauley & Ramadjita, 2015). This is majorly due to the biophysical and socio-economic obstacles experienced. For instance, more devastating epidemics of stem rust disease have been damaging wheat crops since 1906 when for the first-time commercial wheat crop was sown. Kenya is the epicentre of a severe wheat rust strain that is affecting wheat and a threat to global wheat production (Macharia, 2018). According to Gitonga (2019), Kenya's wheat yields are also constrained by soil degradation and the use of recycled seeds by wheat farmers. In farming, decision-making gets difficult when farmers are faced with challenges and price instability. This makes them risk-averse and in return opt out to an enterprise with higher returns in the production processes (Enghiad *et al*., 2017). More so, continuous land subdivision of farms for inheritance purposes undermines the long-term viability of wheat farming in Kenya and this in future will escalate the level of wheat imports (Gitonga, 2019).

While imports exert pressure on trade balance from the trade theory point of view. If imports displace domestic production, then it will involve a fall in that sector's output, employment and value-added. The level of imports has a strong influence on price, quality and quantity levels of domestic production. Economists argue that trade brings overall benefits to the economies. However, trading creates losers and winners. This is because during trading most economic changes occur. Hence the challenge of international trade is that losers are not compensated and

those who gain do not realize that (Gasiorek *et al*., 2019). In accordance with the new trade theory and growth theory, trade influences growth rate as it increases efficacy by reducing redundancy and reallocation of resources across sectors (Zahonogo, 2017). Considering the Kenyan wheat industry, importation of wheat may have far-reaching implications on domestic wheat production, posing a significant threat to its survival and food security, because the cereal is consumed as a food crop. There is very little up-to-date empirical knowledge of how wheat imports affect the production of wheat domestically. As a result, policy debates about trade in wheat and the impacts it is causing on the domestic sector are often based on conventional wisdom and believes that have not been empirically tested. Therefore, this study analyzed the effect of wheat imports in Kenya to reveal the impact it is causing to the domestic sector using annual time series data for the period 2000-2019. This time period of analysis was purposively selected because this is the time wheat importation in Kenya surged.

1.2 Statement of the problem

The quantity of wheat imported in Kenya has increased in the last two decades, while consumption has followed the same trend but production during this period remained stagnant. It is predicted that the area under wheat is expected to decline thus Kenya may continue to depend on imports. Kenya has been using different strategies to improve production of wheat, through improving efficiency by employing modern production techniques for example, adopting improved wheat varieties, and practising proper agronomical practices. This is done to compete with the rest of the world in wheat farming and improve wheat production levels in the country. However, capacity of wheat farmers in Kenya to meet wheat demand is clearly limited due to lack of competitive advantage compared to other wheat producing countries thus exposing consumers to high wheat prices. This has increased dependence on wheat imports from time to time. In Kenya, government policy concerning wheat has been deficit by focusing on production rather than being cognizant of the fact that Kenya has structural shortages and will rely on imports to fulfil its wheat requirements. The available body of knowledge has focused more on domestic perspectives of the wheat sector for instance efficient use of resources in wheat production and risk mitigation strategies in wheat farming, but little attention on empirical studies have been put forward to understand how wheat imports is affecting the domestic wheat sector, therefore this study sort to fill the gap.

1.3 General objective

To contribute towards food security in Kenya through a policy formulation framework for wheat importation.

1.3.1 Specific objectives

i. To determine characteristics of drivers of wheat importation in Kenya.
ii. To determine the import demand function of wheat in Kenya.
iii. To determine cointegration of variables in the import demand function in Kenya.
iv. To determine Granger causality in wheat importation model in Kenya.

1.3.2 Research questions

i. What are the characteristics of drivers of wheat importation in Kenya?
ii. What is the import demand function of wheat in Kenya?
iii. What variables are cointegrated in the import demand function in Kenya?
iv. What variables have Granger causality with wheat imports?

1.4 Justification of the study

The reason behind this study is that policies of wheat in Kenya has mainly focused on increasing domestic wheat production leaning towards the old theory of trade of being self-sufficient developed by the mercantilists. Hence there is a paucity of studies done on the impact of wheat imports on domestic production. However, wheat production can be affected by various factors such as; agro-ecological conditions, institutional factors, technical factors, and socio-economic factors like investments in the wheat sector. Wheat importation is likely to be one key factor. Historically, Kenya has produced less than 30% of its domestic wheat requirements and it is relying on imports to fill the deficit (Meyer *et al*., 2016). This necessitates a need to relook at how import is affecting domestic production in Kenya. The study was aligned to new trade theory where we must balance between domestic wheat production and wheat importation because they are not substitutes for each other (imperfect substitutes model). This will help policy makers to have a better focused food security agenda in Kenya and be able to address policies in the wheat sector as opposed to the current situation. The study determined if the import spikes are systemic or dependent on short-term fluctuations. Also, the study provided an understanding of long-term trends in macro-economic factors for the increase in wheat imports. Therefore, help policymakers, government actors and other stakeholders in defining possible programs and policies for the wheat

sector. This study was in line with "agenda four" of food security to all Kenyans and Sustainable Development Goals (SDGs) number 1 (zero hunger), 2 (no poverty), 8 (decent work and economic growth) and 12 (responsible consumption and production). The study will benefit researchers and the academic world because it builds on existing knowledge.

1.5 The scope and Limitation of the study

The study focused majorly on how wheat importation to Kenya is affecting the domestic wheat sector at the national level, excluding analysis at the firm level. This is because available data is not disaggregated. The target period of the study is from 2000 to 2019 because this is the time wheat importation skyrocketed.

Data problem is one of the major impediments to the accuracy of the analysis. Because the study relies on secondary information from different national (Kenya National Bureau of Statistics (KNBS) and Kenya national statistical abstracts) and international sources (World Bank (WB) and World Integrated Trade Solutions (WITS)). Again, the study did not analyze farmers' preferences for other enterprises based on comparative advantage.

1.6 Operational definition of terms

Granger causality- a concept that shows the direction of relationship existence between two or more variables. It states which event preceded the other.

Cess- this is a form of tax that is charged on agricultural products when they are being moved from one region to another.

Compensation variation- represents an increased quantity of money that must be taken away from the consumer arising from an increased amount of goods and services that leaves the consumer just as well off as before the change.

De-minimis provision- relates to something that has minor importance.

Dutch disease- is a resource reallocation to the booming sectors leaving the lagging sectors to suffer resource scarcity.

Emerging economy- is an economy of a developing nation that is becoming more engaged with global markets as it grows.

Gluten – a mixture of two proteins in cereal grains especially wheat which is responsible for the elastic properties.

Paucity – a small amount of something.

Trade liberalization- is the removal and reduction of barriers to trade to ease the movement of goods and services from one country to another.

Wheat economy- entails the production, trading, marketing and consumption of wheat crop in the world.

Wheat sector- this is a group of actors involved in the wheat crop, in this case they include wheat producers, traders and consumers.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter discusses relevant literature on wheat importation and domestic wheat production. It provides some insights into what has been said and documented by various authors and experts in the field of the study. It gives a review of issues surrounding wheat trade and agriculture at large.

2.2 Global trade of imports

Trade is known to promote economic growth. According to Krugman and Obstfeld (2008), trade gains emerge from the specialization and exchange of products and services. In Kenya, there is a need to provide a long-lasting solution to the structural deficit and have a focused wheat importation. This is by targeting efficient farmers to produce wheat (large scale farmers), as the inefficient farmers produce other crops that they are efficient in (Gitau *et al*., 2011). It has been reported that agricultural trade has increased, led by demand in emerging economies. Since there is a strong connection between food security and food trade (import and export). Economists in support of liberalization argue that trade is a transmission belt of food from surplus regions to deficit areas. The opponents point out that due to differences in competition capacities, trade liberalization harms domestic producers by suppressing their revenues (Clapp, 2015). On contrary, the unique situation of Kenya in wheat production shows that most of our farmers despite producing do not produce enough for their consumption and have to rely on the market for the wheat grain and its products. Therefore, low food prices are beneficial to smallholder farmers in the short-run but disadvantageous in the long-run. Thus, trade growth is expected to continue in bringing both positive and negative consequences in low-income food-insecure countries (Sharma *et al*., 2005).

The trade liberalization strategies were expected to foster growth and ensure food is always available to all people. However, the intended result was not attained because the state of liberalization was rapid, broad and far-reaching, poorly aligned and not synchronized with other policies in place. Observers and experts have related rise in imports to the World Trade Organization (WTO) agreement on trade liberalization. The Agreement of the WTO specifies that when a commodity is imported into a country in such an increased quantity, absolute or relative to

domestic production under such conditions, it may trigger or threaten the domestic industry which produces the same competitive goods (Iloh *et al*., 2020; Sharma *et al*., 2005). Import surges and their associated effects on domestic producers and consumers is a sensitive matter that needs to be relooked especially in developing countries such as Kenya.

The agreement for the agricultural sector is a matter of great debate in the African continent (Sharma *et al*., 2005). Agreement on Agriculture distinguishes programs that directly stimulate production from those that do not. Then they try to remove those that do not stimulate domestic production (Wang & Hu, 2018). Uruguay Round Agreement on Agriculture (URAA) separated domestic support policies into various categories (coloured boxes). This was according to their effect on production and trade. Green box policies are those that are minimally trade-distorting and are not subject to any WTO limitation for example government funding on agricultural research and extension. Blue box policies are those which are little trade-distorting example is a production crisis that restrains farmers from increasing output in response to government payment. Amber boxes include domestic support like subsidies that distort market prices and trade. Red box policies have support programs that must be discontinued, it is an empty box because no policies were prohibited by the URAA (Knutson *et al*., 2007). Support interventions are not included in the right boxes in all situations. Under the agreement on agriculture, the de-minimis provision allows developed nations to provide up to 5% of the value of production in product and non-product-specific trade-distorting support without counting this as part of their current total aggregate measurement of support. In this case, subsidies that fall in the amber box are treated as minimally trade-distorting under the green box by developed nations (Hart & Babcock, 2001). Therefore, putting pressure to African countries through development aid not to implement some of its policies.

In literature, import surges are generally associated with unfair trade practices in particular export subsidies. The Food and Agriculture Organization of the United Nations (FAO) analysis to measure import surges showed that the impacts differ depending on products. Although the negative effect of Senegal's broiler industry was apparent, import spikes in dairy goods were not a major issue due to the gradual rise in dairy imports in Tanzania. Moreover, the study revealed that government and other stakeholders are necessarily not open-minded about resolving import surges and strong import trends (Sharma *et al*., 2005). Hence a large degree of resource reallocation

across firms within an industry due to trade liberalization to the sector of more growth. This in future will create Dutch disease in the economy (Kasahara & Lapham, 2013). This will contribute to policy uncertainty by reducing investor confidence, as well as poor harmonization and coordination in the implementation of the other policies.

To achieve long term food sufficiency is possible through the liberalization of trade, but it undermines domestic food security through commercial marketing (FAO, 2015). Thus, the role of the government is to try to regulate food trade and balance between the structural deficit and import bill to come up with policies and programs that address this in a coordinated and harmonized manner to ensure the food (wheat) sector continues to thrive without collapsing.

In Kenya, the foremost challenge of free trade in wheat is competition with low priced and high-quality imports. Therefore, there is a need to reconsider and reshape the planning model and policy-making of agricultural development and food security strategies (Gitu, 2012). Previous studies have approached wheat production with a focus on technical issues such as increasing wheat yields leaving out the effect of wheat which is being imported yearly. Policy problems include defining the reasons driving import spikes and deciding whether the triggers are systemic or dependent on short-term demand fluctuations caused by changes in domestic production or international market determinants and shocks.

2.3 Kenya wheat production

2.3.1 Wheat production overview in Kenya

Wheat production in Kenya is rain-fed and dominated by large and medium scale farmers, who account for approximately 75% of the area planted and 83 % of total production (Meyer *et al*., 2016; Monroy *et al*., 2013; Nyangito *et al*., 2002). In Kenya, wheat production is input-intensive and highly mechanized making it uncompetitive for small scale producers. The area for wheat has slightly gone up since independence and it is estimated to be 120,000 hectares for the last decade as shown in Figure 1 (Monroy *et al*., 2013). To meet the production deficit over the next decade, a large rise in imports will be required, exacerbating the negative net trading position that is set to hit 2300 MT by 2024 from 1400 MT in 2014 (Meyer *et al*., 2016).

Wheat is the second most essential agricultural product in Kenya from a food security point of view both in terms of calories and quantities consumed. In Kenya wheat accounts for about 24% and 13% of total cereal and calorie intake respectively (Sahoo *et al*., 2016). Wheat has a unique

policy context due to its importance in food security and trade (Monroy *et al*., 2013). Because most African countries are net importers and have structural deficits, wheat must be imported from outside Africa at world international prices. Other food security commodities like maize and beans are imported in large quantities from East African countries. Kenya wheat farmers produce wheat varieties in the relative ratio of 3:1 for low-quality soft wheat variety and high-quality hard wheat variety respectively. On the other hand, milling companies blend imported wheat which is the hard wheat to soft wheat in the ratio of 2:3 to produce composite flour that meets the needs of the Kenyan market. This implies that Kenya wheat requires quality and price adjustments in the market (Monroy *et al*., 2013).

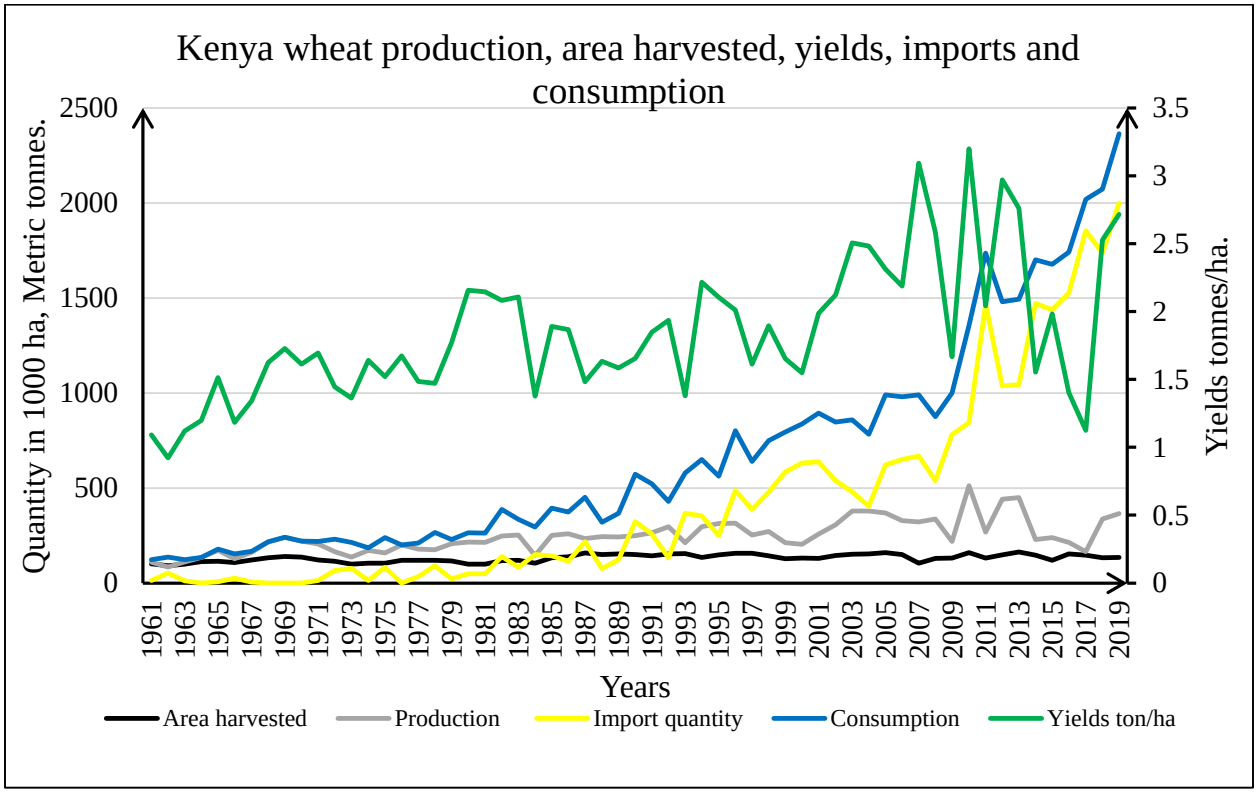


Figure 1: Graph showing Kenya wheat production, area harvested, yields, imports and consumption from 1961 to 2019.

Source: Monroy *et al*. (2013) and extended from 2010 to 2019 using data from FAOSTAT by the author.

In Figure 1 and Table 1 the average production between 1961-1979 and 1980-1999 increased by 49%. For 1980-1999 and 2000-2018 average production increased by 26% showing that there

was a decline over the previous period. Wheat yields increased at an average rate of about 27% between 1961 and 1999. Since then, yields have trended downward at an average rate of approximately 21% in the last two decades. The average area harvested between 1961-1979 and 1980-1999 increased by 20%. For 1980-1999 and 2000-2018 area harvested slightly increased by 3%. From the statistics, we can see a declining trend in the wheat sector over the last six decades except for wheat imports and consumption.

Table 1: Average production, area harvested, yields, import and consumption of wheat in Kenya over the past six decades between 1961-2018

Average				% Δ over the two periods	
	1961-1979	1980-1999	2001-2018	1961-1999%Δ	1980-2018%Δ
Area harvested(ha)	114531.3	137174.7	141552.5	19.77043	3.191423
Yields(hg/ha)	14419.89	18320.95	22137.37	27.05329	20.8309
Production(MT)	167.29	249.439	313.63	49.10619	25.7339
Import(MT)	26.82	238.23	967.23	788.2955	306.0133
Consumption(MT)	194.11	487.67	1280.87	151.2343	162.6515

Source: Author computation using data from FAOSTAT

2.3.2 Wheat production ecological requirements and challenges in Kenya

Wheat in Kenya is predominantly grown in areas above 1,500 meters above sea level. These places are; Narok, Uasin Gishu, Nakuru, Trans-Nzoia, parts of Laikipia and Meru. These regions have cool and wet climatic conditions and it is suitable for the wheat crop based on the ecological department (D'Alessandro *et al*., 2015; FAO, 2015). Majority of the growing regions compete with maize and dairy farming practices making wheat production challenging. The Kenyan government has tried to carry out research on wheat production by breeding varieties that are suitable for various regions based on Kenya Agriculture Livestock Research Organization (KALRO) Njoro research centre in Nakuru county. Although it is true that weather patterns, such as drought, are significant in explaining Kenya's agricultural production, the key culprits may be policy-related factors (Gitu, 2012). Since the impact of wheat which is being imported is not factored out.

Wheat production in Kenya faces the following challenges; land subdivision and population pressures, inadequate machinery, inappropriate technology for smallholder farmers, limited access

to credit, soil acidity, land degradation, land tenure insecurity, poor infrastructure (roads), low producer prices, inadequate research and extension services and inadequate implementation of wheat policies. Some measures undertaken so far include; credit creation, research and extension services, storage and appropriate technology application (Birch, 2018; Gitu, 2012).

2.3.3 Kenya wheat competitiveness

The idea of competitive advantage is used to describe the ability of countries to produce goods more effectively compared to their trading partners. This implies that countries will tend to export those commodities that they produce at the lowest cost and import what they do not possess competitiveness. If this concept is followed, it can be beneficial because it can allow countries to specialize, resulting in more effective use of limited resources. The use of competitiveness to inform producers and agro-processors is good to ensure they operate at a low cost of production (Sukati, 2016). It is also believed that farmers are willing to grow crops that bring more income, therefore choosing to plant a higher-yielding crop (Shavanov & Shigapov, 2020).

Russia and USA are among the major countries in the world producing wheat amounting to 72100 MT and 51300 MT respectively in 2018. Over the last two decades, Russia has managed to switch from a net importer of wheat to a net exporter, displacing the EU to become the biggest exporter in the 2016/2017 marketing season. The high level of wheat output and low production costs as well as quality has helped propel Russia to the top position among wheat exporters. However, the average yearly production of the USA from 1992 to 2018 is higher, a total of 59000 MT, while the Russian average for the same duration is just 48500 MT (Shavanov & Shigapov, 2020). This shows that the comparative advantage of agriculture evolves depending on the circumstances and policies put in place.

Poor performance in the agricultural industry discourages private sector investment and value chain development for certain crops, for instance, Kenyan wheat production. Because of low agricultural productivity in wheat, Kenya relies on wheat imports, limiting the scope for agribusiness development for the wheat value chain (Babu & Shishodia, 2017). Kenya wheat production inefficiencies occur from high input costs (fertilizers, chemicals, seeds and high cost of machinery operation), high maintenance costs and low yields. Transporters face inefficiencies through high maintenance costs, high fuel prices, poor infrastructure (feeder roads connecting production areas and the markets) and roadblocks. Wheat traders face multiple layers of taxation

(cess) levied by local authorities, especially when wheat crosses several municipalities (Gitau *et al*., 2011). All these make Kenya wheat production uncompetitive when compared to other nations.

2.3.4 Wheat policy decisions and measures in Kenya

Policy is a guiding principle to a given course of action conducted by the government. Policy affects the actions and decisions of the government in regard to programs (Knutson *et al*., 2007). The Ministry of Agriculture, Livestock, Fisheries and Co-operatives (MoALFC) of Kenya develops and implements agricultural policies. The objective of agricultural policies in Kenya is mainly to increase income and productivity. Various policies have been prepared and implemented to introduce stability in agricultural output levels and to commercialize and intensify production (Boulanger *et al*., 2018). Agricultural price policies favouring producers include government control through setting input and producer prices. Kenya budget allocation to agricultural sector has been rising in response to the Maputo declaration to increase funds for agriculture investment to at least 10% of the government budget. In Kenya vision 2030 mid-term plans agriculture is recognized as the main sector to promote economic growth by the transformation of agriculture from low productivity subsistence activities to innovative, competitive agriculture sector with acknowledgement of climate risk (Amwata, 2020). The food security crisis of 2007/2008 pushed the government to support consumers through social protection policies in Kenya hence social protection gained importance in the country's agenda. After social protection government policy attention was given to trade measures. Since more regional cooperation has led to free movement of goods (GoK, 2008).

The government of Kenya supports wheat farmers through a memorandum of understanding with the Cereal Millers Association. This is a key industry player and their members must provide a mop-up plan for domestic production in order for them to be granted import licenses (Gitonga, 2019). Kenya has been protecting domestic wheat producers with a tariff of 25 - 35 % range, although tariffs of up to 50% appear to have been levied in 2000. Import duties within the East African Community (EAC) are zero-rated for the entry of raw materials for its members, 10% on semi-processed goods and a levy of 25% on finished goods (Shinyekwa *et al*., 2016). Common Market for Eastern and Southern Africa (COMESA) applies reduced import duty rates on goods from member states on a reciprocal basis. Ethiopia for instance applies an import duty rate reduced by 10% on goods originating from COMESA (Omondi *et al*., 2018). While imports from the rest

of the world are subject to a duty of 35%. Consequently, the Kenyan government appealed for a moratorium from COMESA on the 35% ad valorem import duty on wheat grain from 2002-2005, to give them time to resolve challenges facing the wheat sector to make it more competitive (Binfield *et al*., 2019). Because with the duty, imported wheat to Kenya was still priced more competitively than domestically produced wheat. This was extended up to 2010 and from July 2011 wheat importations were fully liberalized.

In COMESA, Kenya tariffs were harmonized with those of other states at 35% for wheat grain and 60% for wheat flour. The East African Community (EAC) integrated these rates in its regulations in 2004. However, members of COMESA and EAC have agreed to a layout framework to change these rates as situations will deem. Therefore, Kenya reduced its wheat tariff from 35% to 25% in reaction to the wheat price increase of the 2007/2008 food crisis. Also, Tanzania and Uganda lowered their tariffs on wheat to 10% and zero per cent, respectively in 2010 (Meyer *et al*., 2016; Monroy *et al*., 2013). However, wheat farmers are lobbying for an increase in import duty to make their wheat locally competitive. On the other side, millers are advocating wheat to be zero-rated. This is because wheat grain accounts for 55-65% of the cost of milled flour (Binfield *et al*., 2019). Under the new agreement, registered millers were allowed to import wheat duty-free if they adhere to EAC and COMESA rules of origin (Meyer *et al*., 2016; Monroy *et al*., 2013). Because of trade liberalization of wheat in Kenya, private sector imports and domestic marketing are no longer pre-stated. However, large-scale wheat farmers have persistently influenced pricing and other aspects of wheat marketing. Also, miller's quality requirements occasionally, have had a direct influence on the price of wheat (Monroy *et al*., 2013).

2.4 Drivers of wheat consumption and wheat imports

In a study on SSA wheat consumption, the results show that the key drivers of rising wheat imports and consumption are; a rise in household incomes, growing populations, increasing opportunity costs of women's participation in the labour force and a change in dietary patterns and preferences. This is in addition to low yields and productivity, limited access to essential inputs and infrastructure, oil shocks, low fertilizer uses and difficulty in controlling pests and diseases. ("Agriculture in Sub-Saharan Africa," 2016; Mason *et al*., 2012; Rakotoarisoa *et al*., 2011). Wheat products are known to save time because bread and other wheat products can be prepared in one place and distributed in a form that is easily consumed with little additional preparation

(D'Alessandro *et al*., 2015; Mason *et al*., 2012). Hence, consumers are buying more convenient and processed products, reflecting urbanization (Mason *et al*., 2012). Therefore, wheat consumption is closely associated with urbanization and higher incomes, hence increasing component in the Kenyan diets. On the other hand, proportions of the rural household taking wheat flour in Kenya increased among households with low income, remained constant for middle income and declined among highest income households between 2013 and 2015. The decline in consumption for high-income households could be in relation to health awareness of gluten content in wheat which is linked to certain health risks (Onyango *et al*., 2016). The rise in consumer demand for wheat is largely fueled by burgeoning urban consumers who prefer convenience food. In return, cheap imports will shift demand towards themselves and over time, tastes and preferences change as people get used to imported foods (Morris & Byerlee, 1993).

In the coming decade, wheat consumption in the SSA is expected to grow at a faster rate from 770,000 MT a year to 1.28 million MT between 2020 and 2030 due to population growth only. The increase in the income and involvement of women in the workplace is likely to increase the use of wheat in SSA further. In many SSA countries, wheat consumption and expenses are systematically higher in urban centres than in rural areas, which is why urbanization in the region is a key driver for the increase in demand of wheat. Due to global trends, the price of wheat relative to maize, rice and other staples has declined recently in several wheat consuming countries in SSA, making wheat relatively more affordable to domestic consumers. Therefore, the affordability of wheat is another important driver for the increase in demand of wheat in Kenya and Nigeria (Mason *et al*., 2012).

There are two key dilemmas in SSA regarding the growing dependence on imports of staple foodstuffs. The first one is occurring when world prices for these goods are rising as well as the availability of these products is likely to be more unpredictable because of climate change. The Second is that SSA consumption of wheat is generally greater in urban than in rural areas, with wheat imports and domestic production on large-scale commercial farms meeting currently most of its urban demand for wheat. Apart from Ethiopia, very little wheat from small-scale farmers is produced in SSA. Hence, growing wheat demand entails limited urban-rural synergies and negligible expectations for structural changes to contribute to broad-based economic growth (Mason *et al*., 2012).

Kenya increasing dependence on food imports has resulted in a decline in domestic production. In this case, Kenya food security is endangered because the country has a weak resource base for importing food products due to its reliance on agricultural exports for foreign exchange (Nyangito *et al*., 2004). Hence, in the short-run trade affects direct food production, employment, food prices and government revenues. In the long-run, trade affects competitiveness, distribution networks and infrastructure development. These effects translate into changes in food security indicators through the total food supply, household income level and government services (FAO, 2017).

Conventionally low domestic production and low competitiveness have been known as the main reasons for wheat importation. Imports now have to do with economic factors (crisis in the agricultural sector, import capacity, re-export trade and food security policies) and non-economic factors for example urban bias in protecting the standards of living of the urban population for social and political reasons (Nishiwaki, 2017).

2.5 Food importation

2.5.1 Food import bills in Kenya

Kenya has total imports of 17.4 billion United States of America dollars (US$) and total export of US$ 6.05 billion which is partially used to pay for the imports as per the statistics of 2020. This leads to a deficit balance of trade of US$ 11.3 billion. Kenya imports of goods and services as a percentage of GDP is 23% in 2020 (WITS, 2020). Kenya dependence on international markets to feed its citizens has increased more than $4^{1}/_{2}$ times in the last decade as food imports were valued at KES 15.09 billion in 2008 to KES 68.63 billion in 2018 (Africa, 2020). Food imports and aid at times serve to fulfil temporary food security needs for vulnerable groups during calamities such as drought and floods. However, in return, it reduces domestic food prices, suppresses domestic food production and reduces food production in importing countries (Mason *et al*., 2012).

The reliance on food imports is viewed differently by different countries. This is according to the way they pay for the food import bills. For example, in certain oil or mineral-rich countries, importing specific food products tend to be more beneficial than producing them at home because they have enough foreign currency reserves to pay for the food import bills. However, for cash-strapped countries, persistent food imports become an issue, as large and

growing food import bills suck resources away from other development agendas without addressing long-term food insecurity (Iloh *et al*., 2020).

In Kenya, the wheat import bill has been growing reaching approximately US$355 million in 2018 (KNBS, 2019). According to United States Department of Agriculture (USDA) estimates wheat is the main imported agricultural product in Kenya for domestic consumption, draining the foreign exchange (USDA, 2020). A study by Wanjau (2014), found that imports are sensitive to adjustments in import and export prices. He added that there is a high demand for imports and consequently a relatively lower demand for exports in Kenya. This will in turn intensify the import bill of Kenya as more products are imported in relation to the level of exports. The ratio of Kenya import to export is on the general rise an indication that the country is spending more of its foreign exchange in incurring high import bills. This affects the government to finance other socio-economic development activities (Nyangito *et al*., 2004). In the case of wheat, Kenya fails to recognize the increasing importance of wheat in the diets of Kenyans, especially in urban areas and there is silence on more than KES 30 billion lost in foreign exchange to import wheat on yearly basis (Macharia, 2018).

Market access for imports in Kenya has improved since reforms of trade liberalization, thus a tremendous growth in imports (Nyangito *et al*., 2004). The most significant quantities of food imports come from developed countries (European Union (EU), United States of America (USA) and Australia). These are nations where food production is highly subsidized, thus posing a threat to the domestic production of food commodities in developing countries (Gitu, 2012). The bulkiness of Kenya wheat imports is from Russia, Ukraine, Canada, Argentina and Latvia as shown in Table 2. United States of America (USA) wheat export to Kenya is hampered by Kenya's long-standing restriction from lack of certification protocol for flag smut between USA and Kenya. Recently Kenyan government granted USA tender to import wheat in Kenya this is according to the smart farm report February 2020. Research done by Monroy *et al*. (2013) found that imports of wheat in Kenya appear pro-cyclical with the highest level occurring in the same years with the highest production. As he noted, there is a positive correlation of 0.29 between imports and domestic production over the period 1960 – 2010. This however should not be the case, as it is known for domestic production to reduce imports. Therefore, fluctuations in domestic production reflect changes in import levels (Gitu, 2012; Nyangito *et al*., 2004).

Table 2: Key countries exporting wheat to Kenya

Country (units in MT)	2016	2017	2018
Russia	454(29%)	439(26%)	838(41%)
Argentina	-	394(23%)	371(18%)
Ukraine	150(10%)	213(12%)	191(9%)
Canada	910(6%)	160(9%)	140(7%)
Latvia	211(13%)	-	131(6%)

Source: USDA Foreign Agricultural Service (Global Agricultural Information Network)

As noted by Mukhamadeev *et al*. (2019), import substitution is a long term development strategy of the state and a measure aimed at the individual sector to improve the production level and quality life of people. Due to the global crisis on food security, Kenya developed an aggressive plan to boost domestic wheat production using the Agriculture Sector Development Strategy 2010-2020. This was an import substitution strategy that requires an increase in investments in the agricultural sector, reforming agricultural research and information dissemination systems and improving access to credit in order to increase technological innovation of major cereals including wheat (Mburu *et al*., 2014).

2.5.2 The impact of Russia vs Ukraine war and coronavirus disease on food security

The conflict between Russia and Ukraine has led to negative socioeconomic consequences internationally. This has been felt greatly in the food security and energy sector (oil). This is because Russia and Ukraine are among the world's leading producers and exporters of wheat and oil internationally (Ben Hassen & El Bilali, 2022). The war is adding to the existing shocks which are crumbling the world economy. This include; the coronavirus pandemic and climate change like drought and flooding. This has accelerated supply pressures leading to high demand caused by shortages in the supply sectors (Hellegers, 2022). Hence leading to high inflation rates on commodities globally. The results of the war and coronavirus pandemic has led to cascading effects both direct and indirect on the agricultural sector. The impact of the war on other nations depends on coping mechanisms. Those countries with limited coping mechanisms are highly hit because they are import-dependent nations. This is due to sanctions affecting food markets and international trade leading to unprecedented consequences caused by the restriction of imports and exports in inputs (fertilizers) and outputs (grains) (Ben Hassen & El Bilali, 2022; Hellegers, 2022).

This includes Middle East and North Africa (MENA) and SSA more so countries in the horn of Africa for which Kenya is included. Therefore, it is key to develop systems and ways to adapt to shocks associated with the global food security and energy sector (Hellegers, 2022).

2.6 Review of the import demand functions

In literature, most determinants of import demand functions include real income, relative price and dummy variables to account for unusual circumstances such as devaluation and policy changes. Furthermore, much of the research on import demand is based on the imperfect substitutes model developed by Goldstein and Khan (1985), with the critical assumption that imports are not perfect substitutes for domestic goods. Therefore, the principle behind international trade is the need to improve economic efficiency by promoting specialization (Nguyen & Jolly, 2013).

A study in South Africa (SA) to estimate import demand of wheat using time series data from 1971 to 2007. Found that wheat consumption increased more than production thus South Africa remained a net importer of wheat. Also, they noted that urbanization cause consumers to require ready-to-eat food for instance bread. In addition, there are macroeconomic variables that influence production as well as importation and consumption. Among these variables are; real rate of interest, foreign exchange and inflation. Adjustments in these variables can have a positive or negative effect on the amount of imported wheat, based on their impact on real income and real prices. The high cost of production explains the move towards importing wheat in developing countries, as world trade is driven by the comparative advantage possessed by different countries in wheat production (Baiyegunhi & Sikhosana, 2012). As a result, the policy emphasis should be on balancing the development of domestic production while providing an enabling environment for wheat imports under appropriate long-term goals of increasing domestic output to a competitive level with imported wheat.

According to Goldstein and Khan (1985), import demand function of imported goods to a country is determined by income, price of domestic goods and price of the imported goods. A study by Çulha *et al*. (2019) in their findings suggested that changes in imports are mainly explained by both income and relative price changes. A study by Uzunoz and Akcay (2009), analyzed factors affecting import demand for wheat in Turkey and found real prices of wheat,

Gross National Product (GNP), exchange rate, production value of wheat, domestic demand and trend factor to be statistically significant.

A study in Ghana to understand crude oil import demand behaviour in Africa tried to estimate the short-run and long-run import demand model over the period 1980-2012. The study used the Auto-Regressive Distribution Lag (ARDL) approach. Results show that demand for crude oil is price inelastic in the short-run but elastic in the long run (Marbuah, 2018). Also, a study to examine an import demand function for Cambodia employed the ARDL model and time series data from 1993 to 2015. The findings of the study show that relative prices and exchange rates have a negative effect on import demand in Cambodia for both the long and short-run. While export volume has a positive effect on import demand. But Foreign Direct Investment (FDI), final consumption expenditure and foreign exchange reserve have an insignificant impact on import demand in Cambodia (Hor *et al*., 2018). To estimate Jordanian aggregate import demand, a bounds testing approach was employed to test cointegration, while the ARDL approach was used to analyze long-run elasticities. The results show a cointegration among variables when import volume is a dependent variable. Estimated long-run elasticity for income and relative prices were elastic, thus stable foreign exchange market because elasticities are greater than one in absolute terms. The understanding of import demand behaviour is crucial for significant import forecasts, international trade planning and exchange rate policy designing (Mugableh, 2017). Due to the importance of trade in the economy monitoring imports is key in controlling the trade deficit.

In a study to examine the role of the import demand function for Tunisia from 1990 to 2009 utilized the ADRL bound testing approach for cointegration. The results show that a long-run relationship exists between import demand, exports and household consumption in Tunisia. More so, the import demand of Tunisia is highly elastic for the final consumption of households and exports of Tunisia, but it is inelastic with investment and relative prices in the long run. In the short run, import demand reveals inelastic behaviour with the final consumption of a household, exports, domestic investment and relative prices in Tunisia (Mehmood *et al*., 2013).

A study by Kang *et al*. (2009), examining the import demand model and welfare effects in rice importing countries used Ordinary Least Squares (OLS), instrumental variables with generalized method of moments and seemingly unrelated regression to specify world rice import demand function. Social welfare effects were obtained using consumer surplus and compensation variation.

The outcome suggests that FDI, economic growth and importing countries' population positively affect national income (GDP as a proxy variable) hence, positively affecting rice consumption. The oil price has a strong effect on the domestic rice prices in importing countries because oil prices influence the transport costs of rice. Price elasticity of demand and income elasticity are inelastic in regard to rice imports.

From the literature reviewed, it can be summarized that import demand factors include; income, prices and other country-specific factors. This was extended to this study on wheat imports in Kenya. The study hypothesized that wheat imports in Kenya are determined by GDP per capita, tariff, yields, ending stock, relative price, foreign exchange rate and lagged wheat imports. Due to the lagged component in the hypothesized variables, ARDL modelling was preferred because of its advantages over other models in handling lagged values.

2.7 Review of Granger causality model

Wiener-Granger causality model is a linear model that is built on the idea that the future cannot cause the present or the past, popularly known as the Granger causality model (Gujarati, 1995). Causality tries simply to identify which event precedes the other. Since the two events are observable phenomena, the main task is just to identify which of the two precedes the other or if they occur at the same time (Maddala, 1992). The advantage of Granger's causality model, there is no attempt to incorporate economic theory in order to impose any restriction on the relationship between the variables of interest (Granger, 1969).

In Granger (1969), causality is achieved by regressing a variable on lagged values of itself and another variable. Looking at two-time series data, Y_t and X_t. The Series X_t fails to Granger cause Y_t if in a regression of Y on lagged Y_t's and lagged X_t's, the coefficient of X is not statistically significant (Mabeta, 2015). The Granger causality model is specified as follows;

$Y_t = \alpha_0 Y_{t-1} + \alpha_1 X_{t-1} + u_{it}$……..……..…….i

$X_t = \alpha_0 X_{t-1} + \alpha_1 Y_{t-1} + u_{jt}$……ii

2.8 New trade theory and growth theory

Classical and neo-classical theories of international trade (traditional trade theories) are the major international trade theories. The most prominent model is the neoclassical theory of Heckscher Ohlin (HO) (van Berkum & van Meijl, 2000). Despite its theoretical dominance in the field for more than 50 years some of the implications were not supported by the empirical evidence.

For instance, the Leontief paradox presented by Wassily Leontief in 1951 found that USA (the most capital-abundant country in the world) exported labour-intensive goods and imported capital-intensive goods, which contradicts the HO theorem (Los, 2017). These necessitated economists to research more appropriate theories to explain trade. This theoretical framework incorporates modern trade theories developed by Krugman in the late 1970s. In the late 1980s, the new growth theory emerged from progress in the fields of industrial organization and economic dynamics, initially occupied by macroeconomic theories (Roland, 2004). The growth theories shed light upon the evolution of comparative advantage (van Berkum & van Meijl, 2000). An important factor in differentiating various approaches is whether technology differs between countries. However, starting with HO including the new trade theories focused on economies of scale and imperfect information and assumed similar technologies across countries. Like neo technological theories, the new growth theories emphasize the role of technological change. Trade implications of the new growth theories are that trade and trade policy can influence the long-run growth of the country (van Berkum & van Meijl, 2000). Therefore, opening of trade influence the growth rate in terms of the redundancy effect by eliminating duplication of innovation as trade increases the efficiency of research and development. Second, there is an integration effect and reallocation effect of resources across sectors (Rivera-Batiz & Romer, 1991; van Berkum & van Meijl, 2000).

According to the new trade theory developed by Krugman (1979), imports are not perfect substitutes for domestic goods and services. Therefore, changing import trends are related to changes in relative prices and incomes. The sensitivity of imports to these two essential variables is generally stated in form of elasticities. This generates a substitution between domestically produced and imported products. In the end, the level of imports' price elasticity will reflect both the quality preferences and availability of domestic substitutes. Since imports are either directly consumed or enter domestic production processes through inter-industry trade (Orsini, 2017).

The frequently used form of the regression model in modelling imports is the double logarithmic-linear model stated in the following two cases;

$\ln Y_t = \beta_0 + \Sigma_t \beta_t \ln X + \varepsilon_t$ ……...iii

or

$\ln Y_t = \alpha_1 + \alpha_2 \ln X_{t2} + \alpha_3 \ln X_{t3} + \cdots + \alpha_k \ln X_{tk} + \varepsilon_t$ ……..…iv

The slope parameters (β_t, $\alpha_{2,3\ldots k}$) measure the elasticity of Y with respect to X. Whereby Y is the dependent variable, X independent variable, β_0 &α_1 are constants and ε_t is the error term.

2.9 Conceptual framework

Consumers of wheat in Kenya are linked by processors in the wheat industry (National Cereal and Produce Board and miller's association) who are responsible for stocking, monitoring and controlling the wheat grain. In Kenya, demand for wheat is met through wheat imports and domestic wheat production. This study hypothesized that wheat imports affect domestic wheat production indirectly by lowering wheat prices, thus reducing the wheat area planted. Hence yields of wheat production become low. Government intervenes in the wheat sector through tariffs on wheat imports and research and development on wheat varieties for domestic wheat producers. In summary, these variables and their relationships are presented diagrammatically in Figure 2.

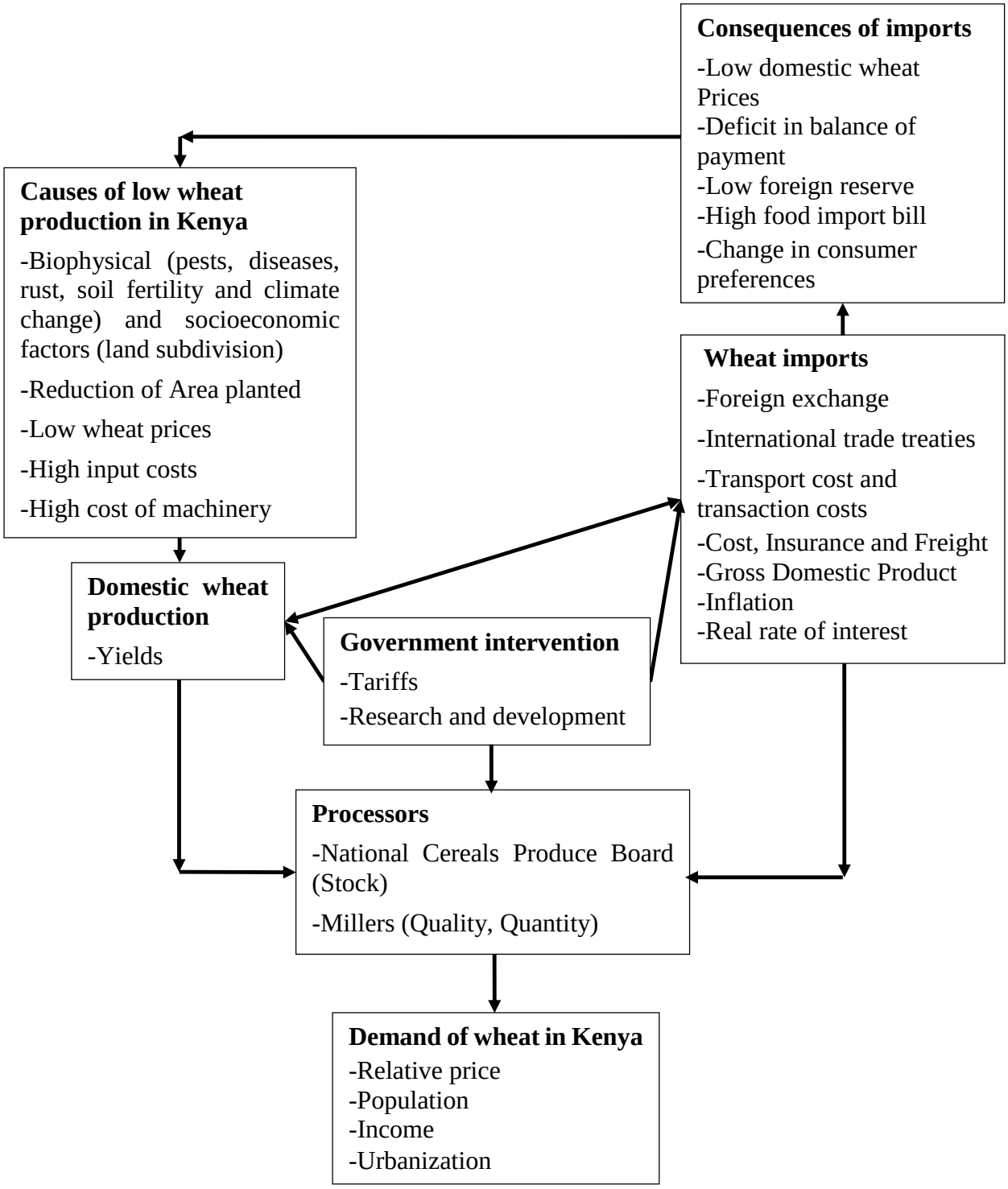


Figure 2: Conceptual framework.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

The study surveyed the literature on wheat imports and domestic wheat production in Kenya based on the available secondary data. For this research, secondary data was sourced from website materials and other related published documents. Detailed analysis of statistical data and policy documents was done.

3.2 Data collection

The study used secondary annual time series statistical data from 2000 to 2019. This time frame was selected due to the burgeoning of wheat imports in Kenya over this period. The data was collected from both national and international sources, such as the statistical abstracts of Kenya, Kenya National Bureau of Statistics(KNBS), Ministry of Agriculture, Livestock, Fisheries and Co-operatives (MoALFC), World Integrated Trade Solution (WITS), World Bank database (WB), United Nations Conference on Trade and Development (UNCTAD), United Nations Commodity Trade Statistics Database (UN COMTRADE), Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), International Monetary Fund (IMF) and United States Department of Agriculture (USDA).

3.3 Data analysis and diagnostic tests

3.3.1 The concept of stationarity

Most time-series data are non-stationary. This indicates that their mean, variance and covariance are not constant over time. The regression of non-stationary time series data may produce spurious regression results. A random process Y_t is labelled stationary if it is time-invariant in the first and second moments (mean and variance). The first condition implies that for a stationary stochastic process, all members have the same constant mean. Hence, a time series of a stationary random process should fluctuate around its mean value. The second condition means that the variance is independent of the time factor (Engle & Granger, 1987; Mabeta, 2015).

The Augmented Dickey-Fuller (ADF) and Phillips–Perron (PP) tests are the most used in testing stationarity. They are becoming more criticized for their often-problematic application especially in the case of the ADF test. This test requires carrying out embedded tests on both sides (dependent and independent) and constitutes a framework that is not well-suited to series with the

trend. Therefore, in this study, the two tests were combined with the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) because it considers the deterministic trend and the existence of residue autocorrelations. In contrast with the others, it tests the null hypothesis of level stationarity or around a tendency against the alternative hypothesis of a unit root. Kwiatkowski–Phillips–Schmidt–Shin tests are intended to complement unit root tests that is why this study combines it with the two unit root tests (Nishiwaki, 2017).

3.3.2 The concept of co-integration

If two-time series data Y_t and X_t are integrated of the same order, that is, $Y_t \sim I(1)$ and $X_t \sim I(1)$, then Y_t and X_t are said to be cointegrated if there exists a relationship by β such that $Y_t - \beta X_t$ is I (0). This is denoted by saying Y_t and X_t are co-integrated by order CI (1, 1). This means that Y_t and X_t in the regression do not drift too far apart from each other over time. This shows that there is a long-run equilibrium relationship between the two variables and the series move together overtime or I (0). Any two series which are individually I (1) generate a linear combination which is I (0) because by subtracting the independent from the dependent, the stochastic trend which makes the series individually I(1) will be eliminated thus their linear combination will become stationary (Mabeta, 2015). On the other hand, if Y_t and X_t are not cointegrated, that is, $Y_t - \beta X_t = e_t$ is also I (1), they can drift apart from each other over time in a regression. This means, there is no long-run equilibrium relationship between them. Therefore, regressing Y_t on X_t will yield spurious results as indicated earlier (Engle & Granger, 1987).

3.3.3 Diagnostic tests and post estimation tests.

Before running the regression, the study performed stationarity and cointegration tests to minimize the occurrence of spurious results. Various diagnostic tests and post estimation tests were done; the Durbin Watson test and Lagrange Multiplier test was used to test for serial correlation of the error terms while the White test and Breusch Pagan test was used for testing heteroscedasticity in the model. Multicollinearity check was done by use of variance inflation factors (VIF), if the VIF is between 1-10 there is no multicollinearity and the study can proceed with study dynamics but for values greater than 10 the study ascertained the existence of multicollinearity (Franke, 2010). If there is multicollinearity the precision, coefficients and probability (P) values in the model are affected, hence potential solutions like the principal component analysis can be employed (Frost, 2017). The study calculated the central tendency and

dispersion characteristics of the various variables. In addition, the Jarque-Bera method was used to check for normality distribution. Also, to ensure there is parameter stability in the model cumulative sum of squares on recursive residuals (CUSUMSQ) was run. The conclusions allowed the study to proceed with the analysis of the dynamic properties of time series data. Data was entered using Microsoft excel while the analyses were run using Statistical software package (STATA) and GRETL software.

3.4 Analytical framework

3.4.1 To determine and characterize the drivers of wheat importation in Kenya.

The study adopted the descriptive statistics technique in analyzing this objective. First, the study identified the drivers of wheat imports in Kenya by use of literature review and then mean, standard deviations, maximum and minimum were calculated.

3.4.2 To determine the import demand function of wheat in Kenya.

Theoretical model

Hemphill (1974), established the theoretical basis of the import demand model used in this analysis. This model is based on the desire to minimize fluctuations of current imports in presence of foreign exchange constraints from the long run equilibrium import level. The policy makers are assumed to grant import licenses in a flexible way to minimize the costs of deviating from both the long-run and short-run desired levels (Moran, 1989). Following Hemphill (1974), the explicit quadratic function is used to capture the costs of imports.

$$C_t = \alpha_1(M_t - M^*)^2 + \alpha_2(R_t - R^*)^2 + \alpha_3(M_t - M_{t-1})^2 + \alpha_4(M_t - M_t^d)^2 \quad \text{.....v}$$

Where; C_t -cost of imports. M_t -current level of imports.

M* -imports' long-term equilibrium. R_t -current level of exchange reserves.

R* -desired level of exchange reserves. M_{t-1}-lagged imports in period t.

M_t^d -desired level of import volumes. $\alpha_1, \alpha_2, \alpha_3$ and α_4 are all expected to be positive.

In the import decision-making process economic agents minimize the costs of adjustment to the long-run import level (M*) by using reserves to smoothen imports (Moran, 1989). The argument raised in the literature is that foreign exchange is not used exclusively to pay the import bills. Under this context, the currency reserves will remain at a point that will sustain the imports over

time. Nevertheless, it was assumed that the amount of exchange reserves needed is directly linked to the level of foreign currency received from abroad (Nishiwaki, 2017).

$R_t^* = \beta_0 + \beta_1 F_t^*$ $0 \leq \beta_1 \leq 1$……...vi

R_t^* - desired level of exchange reserves. F^* - level of foreign currency at equilibrium.

In the long-run, $F^* = M^*$; in the short run, the two variables are linked by their identical existence in the balance of payments accounting. This identical nature is written as follows:

$\Delta R = F_t - M_t$……...vii

It is presumed in general that F^* can be estimated from its current point. This proposition arises from the assumption that the future can be viewed as the product of previous innovations. Consequently, if the short-term exchange assets stay stable over time, their long-term variability can be assumed to be negligible. Therefore, in the long-run, those balances remain unchanged. The short-term changes in foreign currency influence the view of decision-makers as reflected in the foreign currency acquired in the long-run (Moran, 1989). These shifts often influence their decision as to whether foreign exchange variations are transient or permanent. Given what precedes, it can be assumed that;

$F_t^* = F_t - \lambda \Delta F_t$ ……viii

In this relation, λ represents how decision-makers perceive the exchange reserve fluctuations. A positive value of λ means that they consider the fluctuation to be temporary. While a negative value of λ means that decision-makers perceive the fluctuation to be permanent. To simplify matters, and following Moran (1989), the current level of exchange reserves is assumed to be identical in the short and long term; this implies that λ =0.

This argument is also used in relation to the demand for imported goods. Thus, the demand for imported goods by a consumer or country is influenced by income, import prices and domestic prices. Formulated in an equation as follows;

$M_t = \beta_0 + \beta_1 F + \beta_2 R_{t-1} + \beta_3 M_{t-1} + \beta_4 \left(\frac{Pm}{P}\right) + \beta_5 Y_t + \varepsilon_t$……ix

$\beta_1, \beta_5 > 0$; $0 \leq \beta_2, \beta_3 \leq 1$; $\beta_4 \leq 0$

The log-linear formation of the model is;

$lnM_t = \beta_0 + \beta_1 lnF + \beta_2 lnR_{t-1} + \beta_3 lnM_{t-1} + \beta_4 ln\left(\frac{Pm}{P}\right) + \beta_5 lnY_t + \varepsilon_t$ ……x

where; β_0 -constant term. $\beta_{1\ldots} \beta_5$ -variable parameters. F_t - level of foreign currency.

P_m -import price that considers tariff and non-tariff measures.

P-domestic price index. ε_t - random error term. *ln* -natural log.

Empirical model

The study used the empirical model stated below to determine wheat import demand function in Kenya;

$$logM_t = \beta_0 + \beta_1 logGDPTA_t + \beta_2 logTAR_t + \beta_3 logFOREX_t + \beta_4 logYLDS_t + \beta_5 logRP_t + \beta_6 logSTK_t + \beta_7 logM_{t-1} + \varepsilon_t \quad \text{.....xi}$$

Where; β_0 -constant, $\beta_1 \ldots \beta_7$ -variable parameters, t -time period (t=1,2…20) and ε_t - stochastic error term.

Table 3: Description of variables.

Variable	Symbol	Source	Definitions	Expected Sign
Wheat import	Mt	WITS and FAOSTAT	Quantity of wheat imported in Kenya in MT	+
GDP per capita	GDPTAt	WB	Proxy for the real income measured in US$	+
Foreign exchange rate	FOREXt	IMF	Represents the foreign exchange rate in US$	-/+
Yield of wheat production	YLDS	FAOSTAT	Domestic wheat yields measured in Hg/Ha proxy for wheat production	-
Relative price of wheat imports	RPt	UN COMTRADE UNCTAD	Price of wheat imports divided by the price of domestic wheat in US$	-
Ending stock of wheat	STKt	FAOSTAT and USDA	Wheat reserve at the end of the year in MT	-/+
Tariff on wheat import	TARt	Statistical abstracts of Kenya, KNBS and MoALFC	Represents tariff on wheat imports in Kenya captured as a dummy variable	-
Lagged wheat import	LMt	Generated	Lagged quantity of wheat imports in Kenya in MT	-/+

3.4.3 To determine cointegration of variables in the import demand function in Kenya.

ARDL bound testing approach for cointegration

The study employed ARDL bound testing approach in testing cointegration developed by Pesaran *et al*. (2001). This procedure has advantages over other classical cointegration tests. First, the model approach can be used irrespective of whether the time series data is stationary or not (I (0) or I (1)) or mixed. Second, Unrestricted Error Correction Model (UECM) can be derived from it through simple linear transformation and this model has both short-run and long-run dynamics in a single equation form. Lastly, the empirical results of the approach provide superior and consistent results for a small sample size.

The ARDL bound test approach is based on the OLS estimation of conditional UECM for cointegration analysis (Thao & Hua, 2016). Denis Sargan in 1924-1996 pioneered the ECM approach on the analysis of wages and prices. His contributions to macro-econometric modelling distinguished the long-run from the short-run when formulating dynamic relationships among economic variables (Teräsvirta & Eliasson, 2001). According to Granger's representation model, if the variables are in a long-term equilibrium relationship, then the best short-term representation of the long-term relationship is the error correction model (ECM) (Engle & Granger, 1987).

The Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (SBC) was used to determine the appropriate number of lag periods, this is because the number of lags influences the causality credibility in regression analysis (Gujarati, 1995; Wanjau, 2014).

The generalized ARDL model is specified as follows;

$$Y_t = \gamma_{0j} + \Sigma_{i=1}^{p}\delta_j Y_{t-1} + \Sigma_{i=0}^{q}\beta_k' X_{t-1} + \varepsilon_{jt} \quad \text{xii}$$

Where Y_t is vector and variables in X_t are allowed to be purely I (0) or I (1) or mixed. β and δ are coefficients, γ is constant j = (1…. k); p and q are optimal lag orders and ε_{jt} is a vector of error terms (serially uncorrelated).

The empirical model for ARDL bound test for cointegrations is specified as follows;

$$\Delta logM_t = \alpha_0 + \Sigma_1^{20}\alpha_1\Delta logM_{t-1} + \Sigma_1^{20}\alpha_2\Delta logGDPTA_{t-1} + \Sigma_1^{20}\alpha_3\Delta TAR_{t-1} + \Sigma_1^{20}\alpha_4\Delta logFOREX_{t-1} + \Sigma_1^{20}\alpha_5\Delta logYLDS_{t-1} + \Sigma_1^{20}\alpha_6\Delta logRP_{t-1} + \Sigma_1^{20}\alpha_7\Delta logSTK_{t-1} + \beta_1 logM_{t-1} + \beta_2 logGDPTA_{t-1} + \beta_3 logTAR_{t-1} + \beta_4 logFOREX_{t-1} + \beta_5 logYLDS_{t-1} + \beta_6 logRP_{t-1} + \beta_7 logSTK_{t-1} + \varepsilon_{it} \quad \text{xiii}$$

If the result of the ARDL bound test is greater than the upper bound, the null hypothesis of no levels relationship is rejected following the t and F test statistics. Hence, the presence of a long run relationship. But if it is less than the lower bound there is no cointegration.

After testing for bound cointegration in the model. If there is no cointegration short-run function is only estimated and specified as follows;

$\Delta Y_t = \alpha_0 + \Sigma_i^t \alpha_1 \Delta Y_{t-1} + \Sigma_i^t \alpha_1 \Delta X_{t-1} + \varepsilon_{it}$ ……..……xiv

If there is cointegration both the long-run and short-run model are estimated specified as follows;

$\Delta Y_t = \alpha_0 + \Sigma_i^t \alpha_1 \Delta Y_{t-1} + \Sigma_i^t \alpha_2 \Delta X_{t-1} + \alpha_3 Y_{t-1} + \alpha_4 X_{t-1} + \varepsilon_{it}$ ……..…...…xv

Equation xv can be re-written as;

$\Delta Y_t = \alpha_0 + \Sigma_i^t \alpha_1 \Delta Y_{t-1} + \Sigma_i^t \alpha_2 \Delta X_{t-1} + \lambda ECM_{t-1} + \varepsilon_{it}$ ……...……xvi

The ECM model is empirically stated as follows;

$\Delta \log M_t = \alpha_0 + \Sigma_1^{20} \alpha_1 \Delta log M_{t-1} + \Sigma_1^{20} \alpha_2 \Delta log GDPTA_{t-1} + \Sigma_1^{20} \alpha_3 \Delta TAR_{t-1} +$

$\Sigma_1^{20} \alpha_4 \Delta \log FOREX_{t-1} + \Sigma_1^{20} \alpha_5 \Delta \log YLDS_{t-1} + \Sigma_1^{20} \alpha_6 \Delta \log RP_{t-1} + \Sigma_1^{20} \alpha_7 \Delta \log STK_{t-1} +$

$\lambda ECM_{t-1} + \varepsilon_{it}$ ……..……..……xvii

Where; ECM (Error Correction Model) shows long-run model estimation.

λ extent of the adjustment of $\Delta Y_t/\Delta M_t$ to the preceding period explained by residuals.

α_3 and α_4 individual impact of long-term elasticity for equation (xv). Δ - first difference operator.

α_0 is constant $\alpha_1, \alpha_2 \ldots \alpha_7$ are the impact of short-term elasticity ε_{it} error term.

The extent of the adjustment increases when λ becomes more negative. A negative sign of λ (-λ) confirms the existence of a long-term equilibrium relationship between variables (Engle & Granger, 1987). In this study, the ARDL bound test was used to test for cointegrations, estimate the short-run model and generate ECM for the long-run model used to test for long-term equilibrium.

3.4.4 To determine Granger causality in wheat importation model in Kenya.

Granger causality model.

In this study, the Granger causality model was used to test for pairwise causality between wheat imports and various exogenous variables, such as domestic production (yields as proxy). The directional causality was evaluated and the expected causality levels were; unidirectional, bilateral and no causality.

The study used these models for estimating pairwise Granger causality.

$logM_t = \alpha_0 logM_{t-1} + \alpha_1 logGDPTA_{t-1} + u_{it}$ ……..……..……...xviii

$logGDPTA_t = \alpha_0 logGDPTA_{t-1} + \alpha_1 logM_{t-1} + u_{jt}$ ……...…..……...xix

$logM_t = \alpha_0 logM_{t-1} + \alpha_1 TAR_{t-1} + u_{it}$ ……...……..……..……..…xx

$TAR_t = \alpha_0 TAR_{t-1} + \alpha_1 logM_{t-1} + u_{jt}$ ……..……...…..….xxi

$logM_t = \alpha_0 logM_{t-1} + \alpha_1 logFOREX_{t-1} + u_{it}$ ……..……..……...…..…..xxii

$logFOREX_t = \alpha_0 logFOREX_{t-1} + \alpha_1 logM_{t-1} + u_{jt}$ ……..……..……xxiii

$logM_t = \alpha_0 logM_{t-1} + \alpha_1 logYLDS_{t-1} + u_{it}$ ……..……...……..…..xxiv

$logYLDS_t = \alpha_0 logYLDS_{t-1} + \alpha_1 logM_{t-1} + u_{jt}$ ……..…...……..…xxv

$logM_t = \alpha_0 logM_{t-1} + \alpha_1 logRP_{t-1} + u_{it}$ ……..……..…...……..…xxvi

$logRP_t = \alpha_0 logRP_{t-1} + \alpha_1 logM_{t-1} + u_{jt}$ ……..……..……..…..xxvii

$logM_t = \alpha_0 logM_{t-1} + \alpha_1 logSTK_{t-1} + u_{it}$ ……..……...…..……xxviii

$logSTK_t = \alpha_0 logSTK_{t-1} + \alpha_1 logM_{t-1} + u_{jt}$ ……..……..……..…xxix

Where u_{it} and u_{ij} are the error terms of the paired Granger models and are uncorrelated to each other, α_0 and α_1 are the parameters. In the models, α_1 was used to test if there is statistical significance in the models.

$H_0: \alpha_1 = 0$ null hypothesis (no statistical Granger causality) ……..…xxx

$H_1: \alpha_1 \neq 0$ alternative hypothesis (there is statistical Granger causality)..……xxxi

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This section presents descriptive statistics, followed by unit root tests, cointegration test, estimated import demand function and ARDL-ECM analysis. Lastly, the post estimation diagnostic tests and Granger causality are discussed.

4.2 Descriptive statistics

The study compared the data collected through the data triangulation process, in other words comparing data from more than one source. This is key in determining data reliability, consistency and validity (Nightingale, 2009). The data collected converged and complement each other indicating that the data was accurate. The data used in the analysis included seven quantitative time series data with one qualitative variable (dummy). Their descriptive statistics are captured in Table 4 and Table 5.

Table 4: Descriptive of quantitative statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Mt (000') (MT)	20	1018.81	510.05	404.06	1998.80
FOREXt (US$)	20	84.155	11.55	67.318	103.411
YLDS (000') (Hg/Ha)	20	22.46	5.69	12.58	31.00
STKt (MT)	20	174.3	106.433	43	449
GDPTAt (US$)	20	966.246	460.772	389.543	1816.547
RPt (US$)	20	1.503	.266	1.063	2.184
LMt(000') (MT)	19	967.23	467.38	404.07	1854.95

The results in Table 4 show the descriptive quantitative statistics of the variables used in modelling wheat imports (Mt) in Kenya. The variables used for wheat imports in Kenya followed the works of Hor *et al*. (2018) and Musyoka (2009). From the data in the last two decades our dependent variable which is wheat imports to Kenya had an average of 1018.81 MT with the highest value of 1998.80 MT while the minimum value of imports was 404.06 MT (units are in thousands). Gross Domestic Product per capita (GDPTAt) was 966.25 US$ on average in the last two decades with the highest value of 1816.55 US$ and a minimum value of 460.77 US$. The foreign exchange rate had an average value of 84.155 with a standard deviation of 11.55 and a

range lying between 67.32 and 103.41. The yields had an average value of 22.46 hectogram per hectare (Hg/Ha) and the values deviate by 5.69 from its mean with a minimum value of 12.58 Hg/Ha and the highest figure being 31.00 Hg/Ha (units are in thousands). The average ending stock was 174.3 MT with a standard deviation of 106.4MT as well as a minimum value of 43MT and 449MT being the highest ending stock. The relative price of wheat in Kenya had an average value of 1.50 and deviated by 0.266 from the mean and with a range of between 1.063 and 2.184. The lagged wheat imports figures were closely related to those of wheat imports and there were slight differences in their values. This was attributed to variation in the number of observations between the two variables, with 20 for wheat imports and 19 for lagged wheat imports.

Wheat imports had the highest standard deviation followed by lagged wheat imports, GDP per capita, ending stock, foreign exchange rate, yields and relative price. This shows that there is more variation in wheat imports in Kenya in the last two decades compared to the other variables in the study for a similar period. Therefore, it can be deduced that wheat imports are highly volatile compared to other variables in the study.

A tariff dummy representing government policy was used with 0 representing the period with tariff in place and 1 representing the time in which the government does not impose any tariff on wheat imports in Kenya. From the results, in the two decades' tariff imposed on wheat had a frequency of 12 while the period without tariff had a frequency of 8. This translated to 60 per cent and 40 per cent respectively as noted in Table 5.

Table 5: Descriptive of qualitative statistics

TARt	Frequency	Per cent	Cumulative percentages
No tariff (1)	8	40.00	40.00
Tariff (0)	12	60.00	100.00
Total	20	100.00	

4.3 Normality test for the variables

The data was transformed into logarithms (log to base 10). According to Pek *et al*. (2017), the applicability of data transformation helps to address non-normality issues usually associated with small sample sizes. The transformation addressed non-normality and serial correlation problems that could arise since the sample size was small (20 observations). Table 6 shows the central tendency and dispersion characteristics of the various variables calculated. After transformation,

the results of all the variables were normally distributed as captured by the Jarque Bera test statistics. This is because the Jarque Bera p-values are greater than 0.05 and therefore the null hypothesis cannot be rejected implying the is normality in the time series data.

Table 6: Description of transformed data

Variable	Obs	Mean	Std. Dev.	Min	Max	S	K	Jb statistic	Jb chi^2 p-value
logMt	20	5.956	.218	5.606	6.301	.1554	1.6444	1.612	.4467
logGDPTAt	20	2.932	.229	2.591	3.259	-.2840	1.7116	1.652	.4378
TARt	20	.4	.503	0	1	.4082	1.1667	3.356	.1867
logFOREXt	20	-1.921	.058	-2.015	-1.828	.3187	1.9395	1.276	.5284
logYLDSt	20	4.337	.117	4.1	4.505	-.4718	2.2199	1.249	.5355
logRPt	20	.171	.076	.027	.339	.0875	3.0807	.0309	.9846
logSTKt	20	2.161	.282	1.633	2.652	-.3327	2.4991	.578	.749
logLMt	19	5.938	.208	5.606	6.268	.1986	1.6842	1.496	.4734
DlogMt	19	.026	.102	-.15	.24	.4614	2.5886	.808	.6676

Note: Jb - Jarque Bera, S -Skewness and K -Kurtosis

4.4 Unit root tests

Before running any test on stationarity, graphs of each variable were drawn as captured in appendix III. This helps to identify if there are any trends, breaks or cycles in order to address them accordingly. In performing the unit root tests, ADF, PP and KPSS were used and the results are presented in Table 7, Table 8 and Table 9 respectively.

The stationarity test of variables using the ADF test is captured in Table 7 with the null hypothesis being non stationary. The findings indicate that the log of ending stock and log of relative price was stationary around the intercept at original level. The log of wheat imports and log of lagged wheat imports were stationary around intercept and trend at original level. At first difference tariff, log of yields and log of GDP per capita were stationary around intercept. The log of foreign exchange rate was neither stationary at level nor first difference, therefore other testing techniques were applied to ensure robustness in the unit root results.

Table 7: ADF stationarity results

Variable	Level				First difference				Summary
	Intercept(constant)		Intercept and trend		Intercept(constant)		Intercept and trend		
	t- test	p-value	t- test	p-value	t- test	p-value	t- test	p-value	
logMt	-0.075	0.9519	-3.60	0.0299*	-3.593	0.0059*	-3.585	0.0311*	I(0)
TARt	-0.728	0.8395	-2.09	0.5516	-2.915	0.0436*	-2.814	0.1919	I(1)
logFOREXt	-0.398	0.9105	-2.04	0.5795	-2.245	0.1903	-2.334	0.4155	Not I(0/1)
logYLDSt	-2.582	0.0968	-2.80	0.1981	-4.154	0.0008*	-3.904	0.0120*	I(1)
logSTKt	-3.435	0.0098*	-3.83	0.0150*	-4.730	0.0001*	-4.641	0.0009*	I(0)
logLMt	-0.155	0.9437	-3.45	0.0446*	-3.466	0.0089*	-3.438	0.0465*	I(0)
logGDPTAt	-1.015	0.7478	-2.40	0.3808	-2.921	0.0430*	-3.016	0.1278	I(1)
logRPt	-5.832	0.0000*	-5.65	0.0000*	-6.710	0.0000*	-6.427	0.0000*	I(0)

In the PP test, the null hypothesis is stated as non-stationary while the alternative is stationary. The outcome of the PP test in Table 8 shows that log of yields, log of ending stock and log of relative price are stationary around the intercept at original level. The log of wheat imports, tariff dummy, log of foreign exchange and log of lagged wheat imports were stationary around intercept at first difference. The log of GDP per capita was neither stationary at level nor first difference in PP but stationary in ADF at the first difference, therefore further testing was done to ensure robustness in the unit root results.

Table 8: PP stationarity results

Variable	Level				First difference				Summary
	Intercept(constant)		Intercept and trend		Intercept(constant)		Intercept and trend		
	t- test	p-value	t- test	p-value	t- test	p-value	t- test	p-value	
logMt	-0.154	0.9438	-3.393	0.0523	-5.713	0.0000*	-5.889	0.0000*	I(1)
TARt	-0.742	0.8356	-2.122	0.5340	-4.245	0.0006*	-4.126	0.0058*	I(1)
logFOREXt	-0.470	0.8977	-1.734	0.7357	-3.723	0.0038*	-3.807	0.0162*	I(1)
logYLDSt	-3.665	0.0046*	-3.709	0.0218*	-6.805	0.0000*	-6.555	0.0000*	I(0)
logSTKt	-5.602	0.0000*	-6.121	0.0000*	-10.357	0.0000*	-10.122	0.0000*	I(0)
logLMt	-0.368	0.9153	-3.283	0.0691	-5.462	0.0000*	-5.620	0.0000*	I(1)
logGDPTAt	-0.413	0.9079	-1.939	0.6344	-2.859	0.0504	-2.763	0.2110	Not I(0/1)
logRPt	-7.544	0.0000*	-7.182	0.0000*	-10.043	0.0000*	-9.550	0.0000*	I(0)

In the KPSS test, the null hypothesis signifies the existence of stationary of the time series while the alternative hypothesis shows the presence of unit root in the data being tested. Testing hypothesis was accomplished using t-test statistics and critical value in Table 9. The findings of unit root tests show that log of yields, log of ending stock and log of relative prices are stationary around the intercept at original level. While the log of wheat imports, tariff, log of lagged wheat imports and log of GDP per capita are all stationary around intercept and trend at original level. Log of foreign exchange is the only variable that was stationary around intercept at the first difference in the analysis of root tests. The results are captured and summarized in Table 9.

Table 9: KPSS stationarity results

Variable	Level		First difference		Summary
	C @5%=0.463	C and T @5%=0.146	C @5%=0.463	C and T @5%=0.146	
LogMt	.7	.126*	.177*	.088*	I(0)
TARt	.624	.119*	.113*	.0921*	I(0)
logFOREXt	.585	.157	.155*	.0757*	I(1)
logYLDSt	.13*	.109*	.123*	.117*	I(0)
logSTKt	.215*	.0617*	.0779*	.0682*	I(0)
logLMt	.659	.129*	.165*	.094*	I(0)
logGDPTAt	.742	.12*	.0835*	.0815*	I(0)
logRPt	.17*	.0758*	.173*	.102*	I(0)

Note, C=Constant, T=Trend, I (0) is stationary at level and I (1) stationary at first difference.

The outcome of ADF, PP and KPPS tests on unit roots shows with robustness that none of the variables tested was integrated of order two I (2) as recorded in Table 10. Therefore, the results of variables being either stationary at level or first difference meets the requirement of ARDL modelling. Hence the long run cointegration of the variables was tested using ARDL bound test.

Table 10: Results summary of the three unit root tests.

Variable	Test			Conclusion
	ADF	PP	KPSS	
logMt	I (0)	I (1)	I (0)	I (0)
TARt	I (1)	I (1)	I (0)	I (1)
logFOREXt	I (0/1)	I (1)	I (1)	I (1)
logYLDSt	I (1)	I (0)	I (0)	I (0)
logSTKt	I (0)	I (0)	I (0)	I (0)
logLMt	I (0)	I (1)	I (0)	I (0)
logGDPTAt	I (1)	I (0/1)	I (0)	I (1)
logRPt	I (0)	I (0)	I (0)	I (0)

Note, I (0) =stationary at level, I (1) =stationary at the first difference and I (0/1) =Not stationary at level or first difference

4.5 ARDL bounds test for cointegration

To estimate ARDL bound test, the lag selection is necessary and this was carried out using AIC and SBC, in both the maximum lag level selected was 1 and the number of observations after adjustment was 18 as stated in Table 11.

Table 11: Lag selection-order criteria

Sample: 2002 - 2019 Number of observations = 18

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBC
0	1.95707	-	-	-	052649	-.10634	-.099521	-.056876
1	15.7266	27.539*	1	0.000	012751*	-1.52518*	-1.51154*	1.42625*
2	16.4964	1.5395	1	0.215	.013111	-1.4996	-1.47914	-1.3512

LR: Likelihood Ratio FPE: Final Predictor Error HQ: Hannan-Quinn criterion * optimal lag length

The results of the bound test in Table 12 show that there is long run cointegration because the F test statistic (10.596) is greater than the I(1) upper bound (3.990). Therefore, the null hypothesis is rejected in favour of the alternative hypothesis of existence of the long run relationship. This is confirmed by the t-test statistic (-5.976) being absolutely greater than I (1) upper bound (-4.660). The confirmation of the cointegration in the time series data makes it possible to estimate both the short run and the long run estimates of the ARDL model by estimating the ECM together with the ARDL model in the single equation form.

Table 12: ARDL bounds test results for cointegration when wheat import is the dependent variable

	Test statistic	Lower bound [I_0]	Upper bound [I_1]
F-statistic	10.596	2.750	3.990
t-statistic	-5.976	-3.130	-4.660

4.6 Estimated Import Demand Function

The OLS regression results in appendix IV violate the assumptions of no serial correlation and the existence of heteroscedasticity as captured by the p-values of 0.079 and 0.0496 for Breusch-Godfrey and Breusch-Pagan tests respectively. Therefore, to correct the violations, Cochrane Orcutt regression analysis was applied. The import demand function was estimated using Generalized Least Squares (GLS)/Cochrane Orcutt regression analysis to address heteroscedasticity and serial correlation violations. The findings are captured in Table 13.

Table 13: Estimated import demand function using GLS (Cochrane Orcutt) regression analysis

logMt	Coeffient.	Std.Err.	t-value	p-value	[95% Conf	Interval]	Sig
logGDPTAt D1	.894	.555	1.61	.138	-.342	2.13	
TARt	-.031	.052	-0.60	.559	-.147	.084	
logFOREXt D1	-1.317	.953	-1.38	.197	-3.44	.806	
logYLDSt	-.358	.144	-2.49	.032	-.678	-.038	**
logRPt	-1.001	.274	-3.66	.004	-1.612	-.391	***
logSTKt	.168	.059	2.84	.017	.036	.299	**
logLMt	.996	.13	7.69	0	.707	1.284	***
Constant	1.398	.86	1.62	.135	-.519	3.315	
Mean dependent var		5.973	SD dependent var			0.223	
R-squared		0.982	Number of obs			18	
F-test		76.181	Prob > F			0.000	
Akaike crit. (AIC)		-41.782	Bayesian crit. (SBC)			-34.659	

Note, *** is p<0.01 and ** is p<0.05.

The results in Table 13 indicate that the variables in the import demand function jointly explain 98.2% of the total variation in wheat imports in Kenya. The statistically significant variables are yields and ending stock at 5% significance level. At the same time, relative price and lagged wheat imports are significant at 1% level. The statistically significant variables are inelastic to the wheat imports except for relative prices which was elastic in the estimated import demand function.

In Kenya, the wheat import demand function estimated was found to be inelastic and significant with a negative relationship with yields as captured in Table 13. This implies that when yields increase by one per cent wheat imports decline by 0.358% at *ceteris paribus* conditions. According to Sandström *et al*. (2018) when a country produces more of a commodity which it consumes, it helps to reduce outsourcing of that product. Hence, addressing factors that cause a decline in the country's yield trends should be a priority to ensure profitable domestic production. Due to inelastic property, wheat imports are less responsive when yields change. Thus, the government should not only rely on increasing yields but also incorporate other mechanisms to be effective in reducing wheat imports.

Stock is usually used to buffer the changes in the supply of a commodity and in return, this helps in price stabilization and food security (Boansi & Favour, 2015; Sandström *et al*., 2018). From the results ending stock was significant, implying that when ending stock increases by one per cent wheat imports increase by 0.168% at *ceteris paribus* conditions. Therefore, Kenya being a wheat deficit country utilizes its stock when there are shortages of wheat grain. Thus, for each wheat import procured by the country, ending stock increases the volume of imports demanded because it is factored in when importing. In inventory management, the challenge of having more stock increases the handling costs and puts the capital in idle condition. Even though having more stock of wheat is necessary for Kenya it has cost implications. Therefore, the stock should be kept at economically efficient levels to avoid losses and wastage in the system. This can be done by applying economic order quantity theory to address issues of when to order, how to make an order to maintain overall stock and quantity to order (Agarwal, 2014).

Relative price was elastic and statistically significant at 1% significant level. This implies when relative prices increase by one per cent wheat imports decline by 1.001% holding all the other factors constant. Since the relative price was elastic in the analysis it implies that wheat import in Kenya is more responsive to relative price (this indicates that when the relative price change by small per cent wheat import changes by a large quantity). This may suggest that due to increase in prices wheat imports have been affected in Kenya tremendously. The finding conforms to demand theory and corroborates with the works of Musyoka (2009), that when relative price increases it leads to a decline in imports. This has led to policy implications in Kenya ranging from the need to be more competitive to compete globally to the need for government to provide support measures for wheat producers such as training farmers and researching on wheat varieties that are of high yield.

In time series analysis the effect of a variable may not necessarily be instantaneous because of the delayed response. Hence this effect is felt gradually over time (Mukherjee *et al*., 2017). In the model analyzed, lagged wheat import was statistically significant at one per cent significance level with its value being less than one. This implies when lagged wheat imports increase by one per cent wheat imports increase by 0.996% holding other factors constant. This is because for Kenya wheat import and consumption have been reported to be changing food preferences for most of the urban consumers in the long term. This contradicts with works of Baiyegunhi and Sikhosana

(2012), with a negative sign in the coefficient. Perhaps this may be possible for lagged wheat imports to be related to wheat stock used as buffers because Kenya is not a wheat sufficient country.

Moreover, an interesting scenario for many SSA countries, they are deficient in most agricultural products yet they have large parcels of land resources not being utilized. However, the easiest solution they seek to this problem is importation, which adds to the deficit already existing in their trading systems. This may explain why there are high import bills by the wheat importers in Africa and Kenya is not exceptional. This has been found in the long run to pull away resources from other social-economics activities without solving the problem of food insecurity (Iloh *et al.*, 2020).

The estimated import demand function in equation xxxii captures 98.2% of total wheat imports in Kenya and this can be used to forecast and estimate the amount of wheat imports in Kenya. This will help in planning and strategizing on policies that are optimal for the economy (Mugableh, 2017). Since the relative price, lagged wheat imports, ending stock and yields are statistically significant in the wheat import demand. Therefore, policies that are targeted at the wheat sector should emanate from these variables.

$$\widehat{logM_t} = \widehat{1.398} + \widehat{0.894}\ logGDPTA_t - \widehat{0.031}\ logTAR_t - \widehat{1.317}\ logFOREX_t - \widehat{0.358} logYLDS_t - \widehat{1.001} logRP_t + \widehat{0.168}\ logSTK_t + \widehat{0.996}\ logM_{t-1} \quad \text{.....xxxii}$$

4.7 ARDL-ECM Analysis

To run the model, optimal lag length is required because it influences the credibility of the results. The optimal lag selection structure was carried out using SBC. This information criterion was preferred to ensure that the lag level could handle the serial correlation occurrence and its ability to choose a more parsimonious model in the lag structure. This is because too many lag levels lead to loss of degrees of freedom which can cause multicollinearity, misspecification of error terms and serial correlation in the model being analyzed. Since annual time series data was utilized, the maximum lag length preferred is usually 2 (Narayan & Smyth, 2006). With help of SBC and a maximum lag length set to 2 for the annual data, the following ARDL (1,1,0,0,0,1,1) optimal lag lengths were obtained.

The ARDL (1,1,0,0,0,1,1) model was used to explain the surging wheat importation in Kenya for both the short run and the long run. The null hypothesis of the ARDL-ECM model shows that

there is no statistical significance level over the alternative hypothesis of existence of statistical significance level. When the probability value (p-value) is less than the significance level, we reject the null hypothesis and accept the alternative hypothesis. However, when the p-value is greater than the significance level we do not reject the null hypothesis. Following the works of Hor *et al*. (2018) the significance levels adopted for the study entails 1%, 5% and 10% in testing the hypotheses.

The results of the ARDL-ECM model analysis are captured in Table 14. The model variables jointly explain 82.48% of the total variation in wheat imports as captured by the Adjusted R^2. The goodness of fit from this study is close to those of Narayan and Narayan, (2010) in estimating import demand elasticities of South Africa with the value of 83.31%. The finding is also close to the results of Musyoka (2009) whereby the R-squared are 85.15% and 85.24% when dynamic instrumental variable two-stage least squares and OLS regression methods were used respectively. This confirms that our model estimation performed quite well.

Table 14: ARDL-ECM model showing long run and short run results for wheat imports in Kenya for ARDL (1,1,0,0,0,1,1) regression, with logMt as the dependent variable.

Independent variables	Coef.	Std.Err.	t-statistic	P>t	[95%Conf	Interval]	sign
Long run effects							
logGDPTAt	0.078	0.110	0.710	0.503	-0.183	0.338	
TARt	-0.112	0.053	-2.130	0.070	-0.237	0.012	*
logFOREXt	-0.728	0.433	-1.680	0.137	-1.752	0.297	
logYLDSt	-0.202	0.131	-1.540	0.167	-0.512	0.108	
logRPt	-0.987	0.356	-2.770	0.028	-1.829	-0.145	**
logSTKt	0.163	0.082	1.980	0.088	-0.032	0.358	*
Short run effects							
ECM_{t-1}	-1.593	0.281	-5.660	0.001	-2.259	-0.927	***
D1.logGDPTAt	1.097	0.776	1.410	0.200	-0.738	2.932	
D1. logRPt	0.794	0.359	2.210	0.062	-0.054	1.643	*
D1. logSTKt	-0.149	0.099	-1.500	0.177	-0.385	0.086	
Constant	-1.397	1.951	-0.720	0.497	-6.010	3.216	
R-squared							0.9279
Adjusted R-squared							0.8248
Jarque-Bera normality test probability value							0.5196
Ramsey RESET test for omitted variables probability value							0.2359
Serial correlation							
Durbin Watson statistic							2.1927
Durbin’s alternative test for autocorrelation probability value							0.3360
Breusch-Godfrey LM test for autocorrelation probability value							0.1719
Heteroscedasticity							
White’s test probability value							0.3888
Cameron and Trivedi's decomposition of IM-test probability value							0.3425
Breusch-Pagan / Cook-Weisberg test for heteroscedasticity probability value							0.6538
LM test for autoregressive conditional heteroscedasticity (ARCH) probability value							0.5247

Note *, ** and *** denotes 10%, 5% and 1% significance level (sign) respectively.

The variables that are statistically significant in the single equation model are the adjustment coefficient of wheat imports (ECM_{t-1}) which is strongly significant at 1% level, tariff which is a dummy of government policy is significant at 10% level, Relative price is significant at 5% level and ending stock is significant at 10% level for the long run effects. Relative price is the only significant variable in the short run at 10% significance level.

According to the theoretical aspects, the sign of the adjustment coefficient should be negative and significant when there is cointegration in time series data. The findings of our study show that the adjustment coefficient is -1.593 and significant at 1% significance level which is true according to theory. The adjustment coefficient of 1.59 indicates how the deviation from the long-term equilibrium is corrected in the next period. The deviations of the wheat import from the long run equilibrium are corrected by 159% in the next period. The disequilibrium of wheat import will take approximately 6 months (1/1.59=0.63) to be fully adjusted to its equilibrium in an oscillatory manner. This is due to a higher adjustment coefficient hence shorter adjustment period is expected. The results show that wheat imports are overcorrected in the coming period by over 59% because the deviations get cleared at 100% level. This may explain why Kenya wheat imports have been surging in the last two decades with no sign of slowing down soon assuming all factors remain constant. This study confirms the previous work of Musyoka (2009) who found that wheat imports have faster adjustment within a year, implying there is over-importation of wheat in Kenya. When the lagged error correction term coefficient is somewhere between -1 and -2 in the regression, the error correction term causes dampening oscillations. This indicates that the error correction process varies around the long-run value in a dampening approach, rather than uniformly converging to the equilibrium level. After this process is done, then convergence to the equilibrium path is faster (Narayan & Smyth, 2006). Therefore, it can be deduced that wheat imports are over-adjusted in Kenya because of the dampening nature of wheat imports in Kenya causing a persistent increase in the imports.

From the results, tariff which is a government policy (dummy in this case) on wheat imports in Kenya is significant at 10% significant level. This indicates that whenever the government of Kenya imposes tariffs on wheat imports, the level of wheat imports declines by 11.2% at *ceteris paribus* conditions. This is true based on theory. The study confirms the findings of Alizadeh *et*

al. (2019) and Schram *et al*. (2019) that tariffs have a negative influence on imports. Additionally, the study corroborates to results of Elsheikh *et al*. (2015) that a decrease in wheat import tariff leads to an increase in wheat imports and a decline in domestic production of wheat and *vice versa*. The use of tariffs as a government policy to regulate wheat importation in Kenya has an impact on reducing the quantity of wheat imports in the country. This is a policy that can be varied following how the wheat sector performs. However, according to Musyoka (2009), when the government imposes tariffs on wheat imports, it has far-reaching implications on other agricultural commodities in which Kenya exports. As it happens that the nations that Kenya exports its coffee and tea (Kenya key foreign exchange earner crops) are the major exporters of wheat to Kenya. He added that import controls (trade instruments that reduce the level of imports for example imposing import tariffs) make imported wheat less affordable by increasing the price. Therefore, policies related to tariffs imposition and are directed to wheat markets have to deal with trade agreements advocating for free trade in the global economy (Liu, 2017). The use of tariff dummy also indicates trade liberalization based on works of Monroy *et al*. (2013). In Kenya, wheat imports have continued soaring after tariffs were removed from wheat imports, a possible indication of improvement in the trading terms for wheat importers in Kenya. This is because Kenya is a member of several trading blocs for example World Trade Organization (WTO), Common Market for Eastern and Southern Africa (COMESA) and East Africa Community (EAC) which advocate for free and fair trade.

The finding of relative price is inelastic and significant at 5% level because the p-value of 0.028 is less than the 5% significance level. Therefore, we reject the null hypothesis and accept the alternative hypothesis. The results indicate that when the relative price increase by one per cent, wheat imports decline by 0.987% at *ceteris paribus* conditions. Even though the result was inelastic, it had a high magnitude level (0.987), which may imply that relative price is critical in determining wheat imports in Kenya. The possible explanation is that relative prices indicate a substitution effect, in this case domestically produced commodities become substituted for wheat imports when the price of wheat imports goes up. This reasoning is basically that, when wheat imports become more expensive, more income is devoted to available domestic products for consumption. It can be further explained that international wheat prices are transmitted to the domestic sector lowering domestic wheat prices in the long run. This however creates a dampening

effect in the domestic wheat sector. In consequence, it lowers domestic production causing stagnation of Kenya wheat sector as farmers are discouraged to engage in wheat production due to low price incentives and high competition from wheat imports. This finding corroborates with the works of Hor *et al*. (2018), Kavaz (2020), Matlasedi (2017), Mehmood *et al*. (2013), Mugableh (2017) and Musyoka (2009) who found that relative price to be statistically significant and have a negative impact on import demand empirically and theoretically. However, for Matlasedi (2017) the relative price was elastic in the import function. Nevertheless, for Hor *et al*. (2018), Kavaz (2020), Mehmood *et al*. (2013), Mugableh (2017) and Musyoka (2009) the relative price was inelastic in the long run and consistent with the findings of this study. The inelasticity of the relative price could be due to the availability of alternative products that can be used as substitutes for wheat imports in Kenya. Therefore, wheat import demand is less responsive to the changes in the relative prices in Kenya.

In the long run, the ending stock elasticity of wheat was inelastic and statistically significant at the 10% level. Therefore, with a 1% increase in ending stock Kenya wheat imports increase by 0.16% at *ceteris paribus* conditions. This implies that with ending stock being more available more wheat is going to be imported holding other factors constant. This perhaps can be linked to wheat importers using wheat reserves to project wheat importation planning with other factors that are at their disposal at that moment. This argument is supported by the fact that imported products are habit-forming in the long-term and therefore when stock is incorporated in the demand system of a product the impact that it causes is greater than zero. This finding supports the work of Houthakker and Taylor (1970) who proposed that the stock parameter being greater than zero is interpreted as a sense of habit. This is confirmed by their finding with a coefficient estimated in the dynamic food model with a positive value of (0.12) and close to the results of our study (0.16). It is further claimed that higher demand for a commodity in the current period increases the potentiality of consumers to willingly purchase more of that product in the future inclined to the force of habitual nature at the *ceteris paribus* conditions (Mukherjee *et al*., 2017). Based on wheat consumption, it can be argued that wheat imports to Kenya have been changing our food preference from domestic wheat towards wheat imports in the long term with the influence of other factors as supported by the study of Morris and Byerlee (1993).

In the short run relative prices of wheat is inelastic and statistically significant at 10% level.

The short run effect only occurs after differencing of the variables in the regression analysis. From the results, when relative price increases by one per cent in the short run wheat imports increase by 0.794% at *ceteris paribus* conditions. This is consistent with Mehmood *et al*. (2013) on the inelastic properties of imports in the short run. This finding contradicts with theory as it is expected for demand to have an inverse relationship with prices. However, this shows the short-term effect of wheat relative prices on wheat imports in Kenya, an implication that many factors of the economy cannot be changed at that moment. The underlying reason may be the effect of relative price correlated with income (GDP per capita) in the short run even though not significant it has a positive sign. Implying further that when income improves people buy more of a commodity than before. Therefore, when relative prices increase instantaneously, wheat importers take the advantage of importing more wheat at their current capacity to maximize their gain in trade during such periods.

4.8 Post estimation diagnostic tests of the ARDL-ECM model

Post estimation tests were done to ensure there were no violations of Central Limit Regression Model (CLRM) assumptions. When there are violations of the CLRM assumptions, the results of the regression analysis cannot be used for making inferences about the population because interpretations may be misleading. Therefore, it is necessary to test if there exist any violations to address them as recommended in the research.

4.8.1 Ramsey RESET test for omitted variables

To ensure that no omitted variable bias can arise in the modelling, the post-estimation of Ramsey RESET test using powers of the fitted values of logMt was performed. The existence of omitted variable problems leads to multicollinearity, serial correlation as well as inefficient parameter estimates. The results of the Ramsey RESET test in Table 14 show that the model has no omitted variables. This is because the p-value (0.24) is greater than the significance level (0.05) and therefore the null hypothesis of no omitted variables is accepted as the alternative hypothesis is rejected in the hypothesis testing.

4.8.2 Serial correlation

The presence of serial correlation in regression analysis makes standard errors not to be reliable hence no inference making from the output. To ensure that the model does not suffer from serial correlation problems the following test was conducted. The Durbin Watson test was used to check

for any possibilities of spurious regression based on the rule of thumb (where when R^2>Durbin Watson statistic it indicates the regression is spurious) (Shrestha & Bhatta, 2018). Since our regression R^2 output (0.9279) was not greater than the Durbin Watson statistic (2.19), there was no spurious regression. Also, the Durbin Watson statistic provided a clue on the serial correlation of the model. The results of the Breusch-Godfrey LM test for serial correlation of all orders, confirm that there is no serial correlation in the model. This is because the null hypothesis of no serial correlation is accepted because the p-value of 0.17 is greater than the 0.05 significance level as recorded in Table 14.

4.8.3 Normality test

The normality test of the residuals in the regression was tested using JB statistics. The finding confirms that the residuals of the ARDL-ECM regression were normally distributed with a p-value of 0.5196 as captured in Table 14. Therefore, the null hypothesis of normality was accepted.

4.8.4 Heteroscedasticity

The existence of heteroscedasticity in the regression analysis makes the estimators inefficient. Therefore, it is necessary to test the presence of heteroscedasticity after regression analysis. This study employed the following tests to test for heteroscedasticity; White's test, Cameron and Trivedi's decomposition of IM-test, Breusch-Pagan and LM test for Auto-Regressive Conditional Heteroscedasticity (ARCH). In all above tests, the null hypothesis showing the presence of constant variance was accepted with the following p-values; 0.39, 0.34, 0.65 and 0.52 respectively being greater than the 0.05 significance level as captured in Table 14. Hence the coefficients estimated were efficient.

4.8.5 Multicollinearity test

Testing of multicollinearity was done by use of variance inflation factors (VIF) check. Any value that is greater than or equal to 10 is an indicator of the existence of multicollinearity (Franke, 2010). The results of VIF from this study are tabulated in Table 15 and there was no multicollinearity because all the VIF values of the variables did not exceed 10. Therefore, the output of the study is reliable for making inferences and policy recommendations.

Table 15:Variance inflation factors

Variable	VIF	1/VIF
TARt	7.55	0.132400
logSTKt D1.	7.54	0.132595
logFOREXt	7.29	0.137196
logRPt D1.	6.03	0.165744
--.	5.90	0.169551
logSTKt	5.57	0.179570
logGDPTAt	4.70	0.212633
DlogMt L1.	2.93	0.341427
logGDPTAt D1.	2.05	0.486658
logYLDSt	1.70	0.589542
Mean VIF	5.13	

4.8.6 Parameter stability

The cumulative sum of squared recursive residuals (CUSUMSQ) is used to show if the parameter estimates are stable in the estimated models. When there exists parameter stability in the model, the results can be used for policy recommendations. The finding of this research established that there was parameter stability of the ARDL-ECM analysis because the CUSUMSQ plot bands around the null hypothesis (absence of any instability of the coefficients) at 95% confidence level as captured in Figure 3.

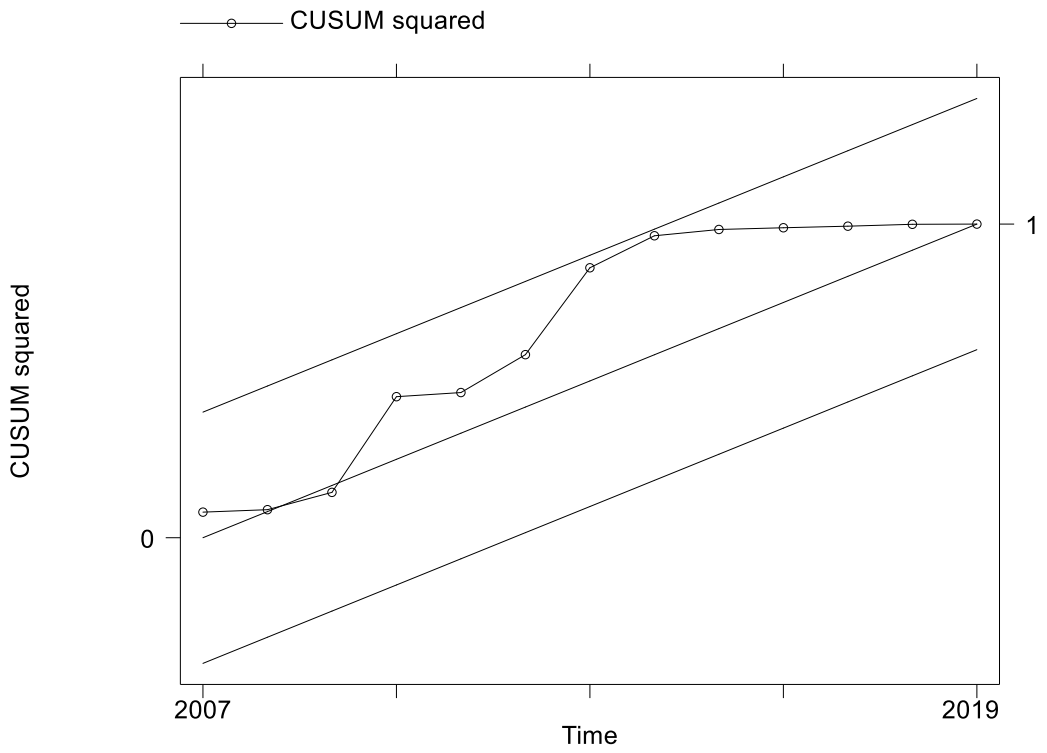


Figure 3: Cumulative Sum of Squared Recursive Residuals

Note; The two diagonal lines indicate 95% confidence level in which the CUSUMSQ Plot bands around the null hypothesis.

The post estimation tests of the ARDL-ECM model show that there were no violations. This ascertains the dynamic properties of the time series data that was analyzed. Therefore, the output of the study is reliable for making inferences and policy recommendations.

4.9 Granger Causality in Wheat Importation Model in Kenya.

Granger causality was conducted to determine the causality of the variables on wheat imports. The results of the pairwise Granger causality test in Table 16 show long run and short run Granger causality. The maximum number of lags for the Granger model is 2 because it was annual data. In the long run, the findings of the study show that GDP per capita and wheat imports have a bidirectional relationship. This is because both their null hypothesis is rejected and the alternative hypothesis accepted as captured by the p-values being less than 5% significance level. This implies that when the economy grows, more wheat is imported because of the availability of resources in the economy and *vice versa*. The result corroborates with those of Awokuse (2008), El Alaoui

(2015) and Islam *et al*. (2012), where there was bidirectional causality. This finding contradicts the results of Ghosh (2009) and Muluvi *et al*. (2014) who found that there exists unidirectional causality from real GDP to real imports. This may be due to the use of nominal values of GDP per capita used in this study.

Table 16: Pairwise Granger causality in wheat importation model in Kenya.

Pair	Null hypothesis	Long run		Short run	
		F-statistics	P-value	F-statistics	P-value
1	GDPTAt does not Granger cause Mt	15.068	0.001*	0.710	0.701
	Mt does not Granger cause GDPTAt	7.793	0.020*	6.509	0.039*
2	TARt does not Granger cause Mt	2.022	0.364	2.568	0.277
	Mt does not Granger cause TARt	20.560	0.000*	7.341	0.025*
3	FOREXt does not Granger cause Mt	1.118	0.572	1.460	0.482
	Mt does not Granger cause FOREXt	6.774	0.034*	0.818	0.664
4	YLDSt does not Granger cause Mt	0.796	0.672	0.549	0.760
	Mt does not Granger cause YLDSt	3.235	0.198	2.01	0.367
5	RPt does not Granger cause Mt	3.443	0.179	2.224	0.329
	Mt does not Granger cause RPt	1.579	0.454	3.050	0.218
6	STKt does not Granger cause Mt	4.076	0.130	0.389	0.823
	Mt does not Granger cause STKt	3.558	0.169	1.531	0.465

The null hypothesis of tariff does not Granger cause wheat imports is accepted while that of wheat import does not Granger cause tariff is rejected which imply that there is unidirectional Granger causality from wheat imports to the tariff. This may mean that whenever there is a tremendous increase in wheat imports the government is forced to impose a tariff to control wheat imports as tariffs make wheat imports to be expensive hence discouraging its importation. The finding is in line with the following studies Alizadeh *et al*. (2019), Elsheikh *et al*. (2015) and Schram *et al*. (2019).

Consequently, wheat imports Granger cause foreign exchange rate. This is because the null hypothesis of wheat imports does not Granger cause foreign exchange was rejected. This may suggest that when wheat imports increase, Kenya's foreign exchange rate weakens because more resources are devoted to paying import bills leading to unfavourable balance of trade. The outcome

supports the work of Kiptui (2018), who established that trade balance is more sensitive when the exchange rate is weakening than when it is strengthening.

Yields, relative price and ending stock have no Granger causality with wheat imports in the long run. This suggests that they are independent and their previous values cannot be used to predict wheat imports in Kenya. This corroborates to study of Ali *et al*. (2020).

In the short run, there is unidirectional Granger causality from wheat imports to GDP per capita and tariff. This implies that wheat imports improve the economy in the short term and the government is forced to provide short term measures by imposing tariffs whenever it is necessary to regulate wheat imports. Although, in the long term that may not be the case. However, foreign exchange rate, yields, relative price and ending stock have no Granger causality with wheat imports in short run because there is no statistical significance as displayed in Table 16.

In summary, the results of Granger causality exhibited three types of causality bidirectional, unidirectional and no Granger causality (independent). Since there was at least more than one-way Granger causality it reinforced the finding of existence of cointegration in the ARDL-ECM model. This is because according to Dash (2005), when there is cointegration then at least one Granger causality should exist.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study explored the analysis of wheat importation and its associated effects on domestic wheat production in Kenya from 2000 to 2019. Secondary data from international and national sources was used to understand why wheat imports skyrocketed in Kenya over the last two decades. The study used ADF, PP and KPSS tests to carry out unit root tests for the time series data. Results show that all the variables were stationary either at level or first difference and none of these variables were stationary at the second difference. An ARDL bound test was used to test cointegration. The findings of the study indicate existence of long run equilibrium when wheat import is the dependent variable. This made it possible to estimate short run and long run effects using the single equation model (ARDL-ECM technique). The findings of the study are empirically consistent with some of the previous studies and conform to the theoretical basis.

The import demand function estimated explained 98.2% of total wheat imports in Kenya. Therefore, this model can be adapted to predict quantity of wheat imports to avoid over-importation of wheat in Kenya. The statistically significant variables were relative prices, lagged wheat imports, ending stock and yields which are easily available from government data structures.

In the ARDL-ECM model, the findings of the study reveal inelastic response for relative prices, ending stock of wheat and government tariff on wheat, which have long run effects on wheat importation in Kenya. In the short run relative price was inelastic and the only variable that affects wheat importation in Kenya. The following paragraphs explain the policy implications for each variable.

First and foremost, the tariff was negative and statistically significant suggesting that it has the potential of reducing wheat imports in Kenya. Nevertheless, because globalization is necessary for trade, Kenya should embrace those policies that will competitively improve wheat production. This may entail training farmers through extension officers, planting wheat that meets their market needs and piloting projects to expand wheat planting areas to boost wheat availability and reduce overreliance on wheat imports. In as much as the yield increase has the potential to offload the burden of some imports, Kenya should target to increase their production volume to above 50% of total consumption to cope with the high demand witnessed by the surging imports instead of

imposing tariffs. This will help fulfill domestic wheat requirements partially as well as saving foreign exchange that could have been used to import wheat.

Secondly, the relative price of wheat was significant both in short run and long run suggesting that prices play a critical role in influencing the amount of wheat imported in Kenya. Thus, much emphasis should be placed on scrutinizing the price to understand if the prices are reflecting the actual cost of production in both importing and exporting countries. The inelasticity of relative prices on wheat imports suggests that the consumers of wheat should shift their consumption whenever the prices of wheat imports increase to domestically produced commodities to enhance the agricultural sector in Kenya.

Thirdly, ending stock was statistically significant with a positive sign. It thus follows that wheat imports affect the habits of its consumers in the long run. Therefore, most of them prefer to have stock for unexpected shortages in the future. Because of the nature in which wheat imports have a high influence on food preference Kenyans should however embrace other locally produced products to increase rural-urban synergies in Kenya.

The findings of Granger causality enforced the results of the existence of cointegration in the ARDL-ECM model. Since there was bidirectional Granger causality between GDP per capita and wheat imports, unidirectional Granger causality from wheat imports to tariff and foreign exchange rate in long run. In the short run, there was unidirectional Granger causality from wheat imports to GDP per capita and tariff. This further confirms that drivers of wheat import in Kenya move together with wheat imports over time.

On basis of the results, it can be concluded that tariff, relative price, yields and ending stock are the key determinants that affect wheat imports in Kenya. Therefore, policies that target wheat imports in Kenya should revolve around these four variables with relative price having the greatest impact on wheat importation.

5.2 Policy recommendations

To ensure that Kenya can feed its population wheat imports are only necessary for the short term but leads to growing import bills in the long run. Therefore, this study recommends the following:

i. In conformance with this research, the government should strive to maintain domestic wheat production and develop competitive wheat production policies in light of the rising

demand for wheat and its by-products for alternative uses. These policies are, for instance, wheat farmers training through the use of extension officers, soil testing and the use of the right inputs in terms of quality and quantity.

ii. Because of the habitual nature of wheat products, Kenya should utilize their fast land to massively produce the crop as it will create a multiplier effect on the economy in the long run. Therefore, Kenya should strive to tap the benefits of multiplier effects in the wheat agricultural sector. This includes; job creation, source of raw materials for agro-processing industries, source of market for the agro-dealers and saving foreign exchange among others. Hence, policymakers should plan to increase the competitiveness in the wheat sector to build its wheat capacity. This can be made possible through Kenya investing in modern technologies by benchmarking and sending researchers to the world's leading producers of wheat like Russia, USA and Ukraine to ensure we can adapt their technologies to compete globally in the wheat sector.

iii. Wheat producers should be guided by the government to produce those varieties that are in high demand by the wheat milling companies. This will be a demand-driven production mechanism and it can help alleviate the high import reliance as well as reduce the wheat import bills in Kenya.

iv. Government to utilize available data to estimate wheat imports required in Kenya because future can be estimated by using present or past values. Furthermore, stakeholders are to strictly adhere to policies being implemented by the government of Kenya in the wheat sector and agriculture in general.

5.3 Areas of further research

From the research conducted, the study was limited by the data availability. Hence this research resort to use secondary annual time series data. Therefore, more frequency data should be availed. Future research works in this field should consider using quarterly or monthly data to produce more robust results. The study used tariff to check on trade liberalization and hence in future dumping and comparative analysis of wheat in Kenya could be considered.

REFERENCES

Africa, C. (2020). Kenya's food import bill increases to KSH 69 billion. *CGTN Africa*. https://africa.cgtn.com/2018/06/12/kenyas-food-import-bill-increases-to-ksh-69-billion/

Agarwal, S. (2014). Economic order quantity model: A review. *VSRD International Journal of Mechanical, Civil, Automobile and Production Engineering*, *4*(12), 233–236.

Agriculture in Sub-Saharan Africa: Prospects and challenges for the next decade. (2016). In OECD & FAO, *OECD-FAO Agricultural Outlook 2016-2025* (pp. 59–95). OECD. https://doi.org/10.1787/agr_outlook-2016-5-en

Ali, B. J. A., Hasan, H., & Oudat, M. S. (2020). Relationship among Export, Import and Economic Growth: Using co-integration analysis. *Psychology and Education Journal*, *58*(1), Article 1. https://doi.org/10.17762/pae.v58i1.2068

Alizadeh, P., Mohammadi, H., Shahnoushi, N., Saghaian Nejad, S. H., & Pooya, A. (2019). Investigating Factors Affecting Import Demand of Meat and Livestock Inputs in Iran. *Agricultural Economics*, *13*(3), 1–28. https://dx.doi.org/10.22034/iaes.2019.114832.1727

Amwata, D. A. (2020). *Situational analysis study for the agriculture sector in Kenya*. CGIAR Research Program on Climate Change, Agriculture and Food Security. https://ccafs.cgiar.org/resources/publications/situational-analysis-study-agriculture-sector-kenya

Awokuse, T. O. (2008). Trade openness and economic growth: Is growth export-led or import-led? *Applied Economics*, *40*(2), 161–173. https://doi.org/10.1080/00036840600749490

Babu, S. C., & Shishodia, M. (2017). Analytical review of African agribusiness competitiveness. Africa Journal of Management, 3(2), 145-162. https://doi.org/10.1080/23322373.2017.1319721

Baiyegunhi, L. J. S., & Sikhosana, A. M. (2012). An estimation of import demand function for wheat in South Africa: 1971-2007. *African Journal of Agricultural Research*, *7*(37), 5175–5180. https://doi.org/10.5897/ajar11.2053

Ben Hassen, T., & El Bilali, H. (2022). Impacts of the Russia-Ukraine War on Global Food Security: Towards More Sustainable and Resilient Food Systems? *Foods*, *11*(15), Article 15. https://doi.org/10.3390/foods11152301

Binfield, J., Boulanger, P., Davids, T., Dudu, H., Ferrari, E., Mainar-Causape, A., & Meyer, F. (2019). Enhancing CGE analysis with PE modelling of Kenyan agricultural and trade policy reforms. *Invited Paper Presented at the 6th African Conference of Agricultural Economists*, 1–23.

Birch, I. (2018). *Agricultural productivity in Kenya: Barriers and opportunities* [K4D Helpdesk Report.]. Brighton, UK: Institute of Development Studies.

Boansi, D., & Favour, R. M. (2015). Why the Persistent Increase in Ghana's Rice Imports? Prescriptions for Future Rice Policy. *Asian Journal of Agricultural Extension, Economics & Sociology*, 1–21. https://doi.org/10.9734/AJAEES/2015/18834

Boulanger, P., Dudu, H., Ferrari, E., Causapé, A. J. M., Balié, J., & Battaglia, L. (2018). *Policy options to support the Agriculture Sector Growth and Transformation Strategy in Kenya*. https://doi.org/10.2760/091326

Clapp, J. (2015). *Food Security and International Trade: Unpacking Disputed Narratives*. http://www.fao.org/3/i5160e/i5160e.pdf

Çulha, O. Y., Eren, O., & Öğünç, F. (2019). Import demand function for Turkey. *Central Bank Review*, *19*(1), 9–19. https://doi.org/10.1016/j.cbrev.2019.03.001

D'Alessandro, S., Caballero, J., Lichte, J., & Simpkin, S. (2015). *Kenya Agricultural Sector Risk Assessment*. *96289*, 126.

Dash, A. K. (2005). An econometric estimation of the aggregate import demand function for India. *International Business Research Conference*, 1–19.

El Alaoui, A. (2015, June). *Causality and cointegration between export, import and economic growth: Evidence from Morocco* [MPRA Paper]. https://mpra.ub.uni-muenchen.de/65431/

Elsheikh, O. E., Elbushra, A. A., & Salih, A. A. A. (2015). Economic impacts of changes in wheat's import tariff on the Sudanese economy. *Journal of the Saudi Society of Agricultural Sciences*, *14*(1), 68–75. https://doi.org/10.1016/j.jssas.2013.08.002

Enghiad, A., Ufer, D., Countryman, A. M., & Thilmany, D. D. (2017). An Overview of Global Wheat Market Fundamentals in an Era of Climate Concerns. *International Journal of Agronomy*, *2017*. https://doi.org/10.1155/2017/3931897

Engle, R. F., & Granger, C. W. J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing Published by: The Econometric Society Stable URL: http://www.jstor.org/stable/1913236. *Econometrica*, *55*(2), 251–276.

FAO. (2015). *The State of Food and Agriculture 2015 | FAO | Food and Agriculture Organization of the United Nations*. http://www.fao.org/publications/sofa/2015/en/

FAO. (2017). *Strengthening sector policies for better food security and nutrition results*. 32.

Franke, G. R. (2010). Multicollinearity. *Wiley International Encyclopedia of Marketing*. https://doi.org/10.1002/9781444316568.wiem02066

Frost, J. (2017, April 2). Multicollinearity in Regression Analysis: Problems, Detection, and Solutions. *Statistics By Jim*. http://statisticsbyjim.com/regression/multicollinearity-in-regression-analysis/

Gasiorek, M., Magntorn Garrett, J., & Serwicka, I. (2019). Winners and Losers from International Trade: What do we know and what are the implications for policy? *Briefing Paper*, *33*.

Gertz, G. (2008). Kenya's Trade Liberalization of the 1980s and 1990s: Policies, Impacts and Implications. *Paper on the Impact of Doha Round on Kenya*, *July 2007*, 1–18.

Ghosh, S. (2009). Import demand of crude oil and economic growth: Evidence from India. *Energy Policy*, *37*(2), 699–702. https://doi.org/10.1016/j.enpol.2008.10.021

Gitau, R., Mburu, S., Mathenge, M. K., & Smale, M. (2011). *Trade and agricultural competitiveness for growth, food security and poverty reduction: A case of wheat and rice production in Kenya*. http://41.89.96.81:8080/xmlui/handle/123456789/2347

Gitonga, K. (2019). Kenya Grain and Feed Annual Kenya Imports of Corn, Wheat, and Rice Expected to Surge. *USDA Foreign Agricultural Service*, 1.

Gitu, K. (2012). Agricultural Development and Food Security in Kenya: Building a Case for More Support. 2004. *A Paper Prepared for FAO*, *September*.

GoK. (2008). Agricultural Policy Frameworks in Kenya. *Food and Agriculture Policy Decision Analysis*, 1–4.

Goldstein, M., & Khan, M. S. (1985). Income and price effects in foreign trade. *Handbook of International Economics*, *2*, 1041–1105. https://doi.org/10.1016/S1573-4404(85)02011-1

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, *37*(3), 424–438. https://doi.org/10.2307/1912791

Gujarati, D. N. (1995). Basic Econometrics, McGraw-Hill, New York. *Basic Econometrics. 3rd Ed. McGraw-Hill, New York.*

Hart, C. E., & Babcock, B. A. (2001). *Implications of the WTO on the Redesign of US Farm Policy*.

Hellegers, P. (2022). Food security vulnerability due to trade dependencies on Russia and Ukraine. *Food Security*. https://doi.org/10.1007/s12571-022-01306-8

Hemphill, W. L. (1974). The effect of foreign exchange receipts on imports of less developed countries. *Staff Papers*, *21*(3), 637–677.

Hor, C., Keo, K., & Suttiprapa, C. (2018). An empirical analysis of Cambodia's import demand function. *Journal of Management, Economics, and Industrial Organization*, *2*(1), 1–12.

Houthakker, H. S., & Taylor, L. D. (1970). *Consumer demand in the United States*.

Iloh, E. C., Nwokedi, M., Onyebukwa, C. F., & Ekeocha, Q. (2020). World Trade Organization's Trade Liberalization Policy on Agriculture and Food Security in West Africa. *Regional Development in Africa*. https://doi.org/10.5772/intechopen.86558

Islam, F., Muhammad Adnan Hye, Q., & Shahbaz, M. (2012). Import-economic growth nexus: ARDL approach to cointegration. *Journal of Chinese Economic and Foreign Trade Studies*, *5*(3), 194–214. https://doi.org/10.1108/17544401211263964

Kamwaga, J., Macharia, G., Boyd, L., Chiurugwi, T., Midgley, I., Canales, C., Marcheselli, M., & Maina, I. (2016). Kenya Wheat Production Handbook. *Kenya Agricultural and Livestock Research Organization: Nairobi, Kenya*, 78.

Kang, H., Kennedy, P. L., & Hilbun, B. M. (2009). An empirical estimation of the import demand model and welfare effects: The case of rice importing countries. *AgEcon Conference Paper*. http://dx.doi.org/10.22004/ag.econ.46082

Kasahara, H., & Lapham, B. (2013). Productivity and the decision to import and export: Theory and evidence. *Journal of International Economics*, *89*(2), 297–316. https://doi.org/10.1016/j.jinteco.2012.08.005

Kavaz, İ. (2020). Estimating the Price and Income Elasticities of Crude Oil Import Demand for Turkey. International Econometric Review, 12(2), 98-111. https://doi.org/10.33818/ier.754989

Kipruto, K. P. (2019). *An Evaluation Of The Transmission Of International Wheat Prices Into Kenya'S Domestic Market* [PhD Thesis]. UoN.

Kiptui, M. C. (2018). The dynamics of the exchange rate and bilateral trade balances: Evidence from Kenya using nonlinear ARDL approach. *International Journal of Contemporary Research and Review*, *9*(7). https://doi.org/DOI: 10.15520/ijcrr/2018/9/07/539

KNBS. (2019). Statistical Abstract, 2019. *Kenya Bureau of Statistics - Statistical Abstracts*.

Knutson, R., Penn, J. B., Flinchbaugh, B., & Outlaw, J. (2007). *Agricultural and Food Policy* (6th ed.). Pearson Education.

Kripfganz, S., & Schneider, D. C. (2018). ARDL: Estimating autoregressive distributed lag and equilibrium correction models. *Proceedings of the 2018 London Stata Conference*.

Krugman, P. R. (1979). Increasing returns, monopolistic competition, and international trade. *Journal of International Economics*, *9*(4), 469–479. https://doi.org/10.1016/0022-1996(79)90017-5

Krugman, P. R., & Obstfeld, M. (2008). *International Economics*.

Liu, P. (2017). *The future of food and agriculture: Trends and challenges. Fao*.

Los, B. (2017). Input–output analysis of international trade. *Handbook of Input–Output Analysis*. https://www.elgaronline.com/view/edcoll/9781783476312/9781783476312.00014.xml

Mabeta, J. (2015). Determinants of Non-Traditional Agricultural Exports Growth in Zambia: A Case of Cotton and Tobacco. *Journal of Agriculture and Applied Economics*, *3*(2), 54–67.

Macauley, H., & Ramadjita, T. 2015. (2015). *Cereal crops: Rice, maize, millet, sorghum, wheat*. http://ir.ucc.edu.gh/jspui/handle/123456789/4510

Macharia, G. (2018). *In the" Big Four", food security looms tall-but not without irrigated wheat*.

Marbuah, G. (2018). Understanding crude oil import demand behaviour in Africa: The Ghana case. *Journal of African Trade*, *4*(1–2), 75–87. https://doi.org/10.1016/j.joat.2017.11.002

Mason, N. M., Jayne, T. S., & Shiferaw, B. (2012). Wheat consumption in sub-Saharan Africa: Trends, drivers, and policy implication. *MSU International Development Working Paper*, *127*, 1–29.

Matlasedi, T. N. (2017). The influence of the real effective exchange rate and relative prices on South Africa's import demand function: An ARDL approach. *Cogent Economics & Finance*, *5*(1), 1419778. https://doi.org/10.1080/23322039.2017.1419778

Mburu, S., Ackello-Ogutu, C., & Mulwa, R. (2014). Analysis of Economic Efficiency and Farm Size: A Case Study of Wheat Farmers in Nakuru District, Kenya. *Economics Research International*, *2014*(October), 1–10. https://doi.org/10.1155/2014/802706

Mehmood, H., Ali, A., & Chani, M. I. (2013). Determination of Aggregate Imports Function: Time Series Evidence for Tunisia. *International Journal of Economics and Empirical Research (IJEER)*, *1*(6), 74–82.

Meyer, F., Traub, L. N., Davids, T., Kirimi, L., Gitau, R., Mpenda, Z., Chisanga, B., Binfield, J., & Boulanger, P. (2016). *Modelling wheat and sugar markets in Eastern and Southern Africa; Regional Network of Agricultural Policy Research Institutes (ReNAPRI)*. https://doi.org/10.2788/437123

Monroy, L., Mulinge, W., & Witwer, M. (2013). *Analysis of incentives and disincentives for wheat in Kenya. Technical notes series, MAFAP, FAO, Rome.* (Technical Notes Series). Monitoring African Food and Agricultural Policies project (MAFAP). http://www.fao.org/3/at561e/at561e.pdf

Moran, C. (1989). Imports under a Foreign Exchange Constraint. *The World Bank Economic Review*, *3*(2), 279–295. https://doi.org/10.1093/wber/3.2.279

Morris, M. L., & Byerlee, D. (1993). Narrowing the wheat gap in Sub-Saharan Africa: A review of consumption and production issues. *Economic Development and Cultural Change*, *41*(4), 737–761.

Mugableh, M. I. (2017). Estimating elasticity function of Jordanian aggregate import demand. *Applied Economics and Finance*, *4*(2), 33–37. https://doi.org/10.11114/aef.v4i2.2085

Mukhamadeev, A. F., Tufetulov, A. M., & Khadiullina, G. N. (2019). Influential processes of import substitution on the potential of food security in the modern Russian economy. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, *10*(16). https://doi.org/10.14456/ITJEMAST.2019.221

Mukherjee, P., Mukherjee, V., & Das, D. (2017). Estimating elasticity of import demand for gold in India. *Resources Policy*, *51*, 183–193. https://doi.org/10.1016/j.resourpol.2016.12.007

Muluvi, A., Kamau, P., & Gitau, C. (2014). *Discussion Paper No. 162 of 2014 on Import Structure and Economic Growth in Kenya*. http://repository.kippra.or.ke/handle/123456789/2535

Musyoka, P. M. (2009). *Wheat Import Demand and Welfare Effects of Import Controls in Kenya*. Kenya Institute for Public Policy Research and Analysis.

Narayan, P. K., & Smyth, R. (2006). What determines migration flows from low-income to high-income countries? An empirical investigation of Fiji–Us migration 1972–2001. *Contemporary Economic Policy*, *24*(2), 332–342. https://doi.org/doi:10.1093/cep/byj019

Narayan, S., & Narayan, P. K. (2010). Estimating import and export demand elasticities for Mauritius and South Africa. *Australian Economic Papers*, *49*(3), 241–252. https://doi.org/doi: 10.1111/j.1467-8454.2010.00399.x

Negassa, A., Shiferaw, B., Koo, J., Sonder, K., Smale, M., Braun, H. J., Gbegbelegbe, S., Guo, Z., Hodson, D. P., Wood, S., Payne, T. S., & Geleta, A. B. (2013). *The potential for wheat production in Africa: Analysis of biophysical suitability and economic profitability*.

Nguyen, G. V., & Jolly, C. M. (2013). A cointegration analysis of seafood import demand in Caribbean countries. *Applied Economics*, *45*(6), 803–815. https://doi.org/10.1080/00036846.2011.613771

Nightingale, A. (2009). Triangulation. In R. Kitchin & N. Thrift (Eds.), *International Encyclopedia of Human Geography* (pp. 489–492). Elsevier. https://doi.org/10.1016/B978-008044910-4.00552-6

Nishiwaki, M. (2017). An empirical analysis of the determinants of collusion. In *Competition, Innovation, and Growth in Japan*. African Economic Research Consortium. https://doi.org/10.1007/978-981-10-3863-1_3

Nyangito, H., Ikiara, M., & Ronge, E. (2002). Performance of Kenya's Wheat Industry and Prospects for Regional Trade in Wheat Products. *Kenya Institute for Public Policy Research and Analysis(KIPPRA).*, *17*.

Nyangito, H., Nzuma, J., Ommeh, H., & Mbithi, M. (2004). Impact of agricultural trade and related policy reforms on food security in Kenya. *Kenya Institute for Public Policy Research and Analysis (KIPPRA)*, *39*. http://dx.doi.org/10.13140/RG.2.2.18944.02567

Omondi, F., Peter, N., & Lilian, K. (2018). *Updates on COMESA Developments*. *August*.

Onyango, K., Njagi, T., Kinyumu , Nthenya, & Kirimi , Lilian. (2016). *Changing Consumption Patterns among Rural & Urban Households in Kenya*. 4.

Orsini, K. (2017). *What drives Croatia's high import dependence? 8030*(July). https://doi.org/10.2765/288376

Pek, J., Wong, O., & Wong, A. C. (2017). Data transformations for inference with linear regression: Clarifications and recommendations. *Practical Assessment, Research, and Evaluation*, *22*(1), 9. https://doi.org/10.7275/2w3n-0f07

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326.

Rakotoarisoa, M. A., Iafrate, M., & Paschali, M. (2011). *Why has Africa become a net food importer? Explaining Africa agricultural and food trade deficits*. Trade and Markets Division, Food and Agriculture Organization of the United Nations.

Rivera-Batiz, L. A., & Romer, P. M. (1991). Economic Integration and Endogenous Growth. *The Quarterly Journal of Economics*, *106*(2), 531–555. https://doi.org/10.2307/2937946

Roland, G. (2004). *Transition and Economics: Politics, Markets, and Firms*. https://www.researchgate.net/publication/227458508_Transition_and_Economics_Politics_Markets_and_Firms

Sahoo, A., Shiferaw, B., & Sika, G. (2016). Economy-Wide Impacts of Promising Maize and Wheat Technologies on Food Security and Welfare in Kenya. *SSRN Electronic Journal*, *June*. https://doi.org/10.2139/ssrn.3167260

Sandström, V., Lehikoinen, E., & Peltonen-Sainio, P. (2018). Replacing Imports of Crop Based Commodities by Domestic Production in Finland: Potential to Reduce Virtual Water Imports. *Frontiers in Sustainable Food Systems*, *0*. https://doi.org/10.3389/fsufs.2018.00067

Schram, A., Aisbett, E., Townsend, B., Labonté, R., Baum, F., & Friel, S. (2019). Toxic trade: The impact of preferential trade agreements on alcohol imports from Australia in partner countries. *Addiction*, *115*(7), 1277–1284. https://doi.org/10.1111/add.14925

Sharma, R., Nyange, D., Deteutre, G., & Morgan, N. (2005). The Impact of Import Surges: Country Case Study Results for Senegal and Tanzania. In *Policy* (Issue 11).

Shavanov, M. V., & Shigapov, I. I. (2020). Wheat industry compared and contrasted between Russia and the USA. *IOP Conference Series: Earth and Environmental Science*, *548*, 022099. https://doi.org/10.1088/1755-1315/548/2/022099

Shinyekwa, I. M., Munu, M. L., & Katunze, M. (2016). *Has the Common External Tariff Sensitive list of Products for the EAC Generated Intra-export Trade? 73*. https://media.africaportal.org/documents/EAC_generated_intra-export_trade_1.pdf

Shrestha, M. B., & Bhatta, G. R. (2018). Selecting appropriate methodological framework for time series data analysis. *The Journal of Finance and Data Science*, *4*(2), 71–89. https://doi.org/10.1016/j.jfds.2017.11.001

Sukati, M. (2016, March 11). *COMESA's Revealed Comparative Advantage in Common Agricultural Commodities* [MPRA Paper]. https://mpra.ub.uni-muenchen.de/69989/

Tadesse, W., Bishaw, Z., & Assefa, S. (2019). Wheat production and breeding in Sub-Saharan Africa: Challenges and opportunities in the face of climate change. *International Journal of Climate Change Strategies and Management*, *11*(5), 696–715. https://doi.org/10.1108/IJCCSM-02-2018-0015

Teräsvirta, T., & Eliasson, A.-C. (2001). Non-linear error correction and the UK demand for broad money, 1878–1993. *Journal of Applied Econometrics*, *16*(3), 277–288. https://doi.org/10.1002/jae.611

Thao, D., & Hua, Z. (2016). ARDL Bounds Testing Approach to Cointegration: Relationship International Trade Policy Reform and Foreign Trade in Vietnam. *International Journal of Economics and Finance*, *8*, 84. https://doi.org/10.5539/ijef.v8n8p84

USDA. (2020). *Strengthening the U.S.-Kenya Trade Relationship to Grow U.S. Agricultural Exports to East Africa | USDA Foreign Agricultural Service*. https://www.fas.usda.gov/data/strengthening-us-kenya-trade-relationship-grow-us-agricultural-exports-east-africa

Uzunoz, M., & Akcay, Y. (2009). Factors affecting the import demand of wheat in Turkey. In *Bulgarian Journal of Agricultural Science* (Vol. 15, Issue 1).

van Berkum, S., & van Meijl, H. (2000). The application of trade and growth theories to agriculture: A survey. *Australian Journal of Agricultural and Resource Economics*, *44*(4), 505–542. https://doi.org/10.1111/1467-8489.00123

Vos, R. (2015). Thought for Food: Strengthening Global Governance of Food Security. *Un Desa*, *29*, 1.

Wang, J., & Hu, Y. (2018). The impact of trade liberalization on poverty reduction in rural China. *China Agricultural Economic Review*, *10*(4), 683–694. https://doi.org/10.1108/CAER-01-2018-0019

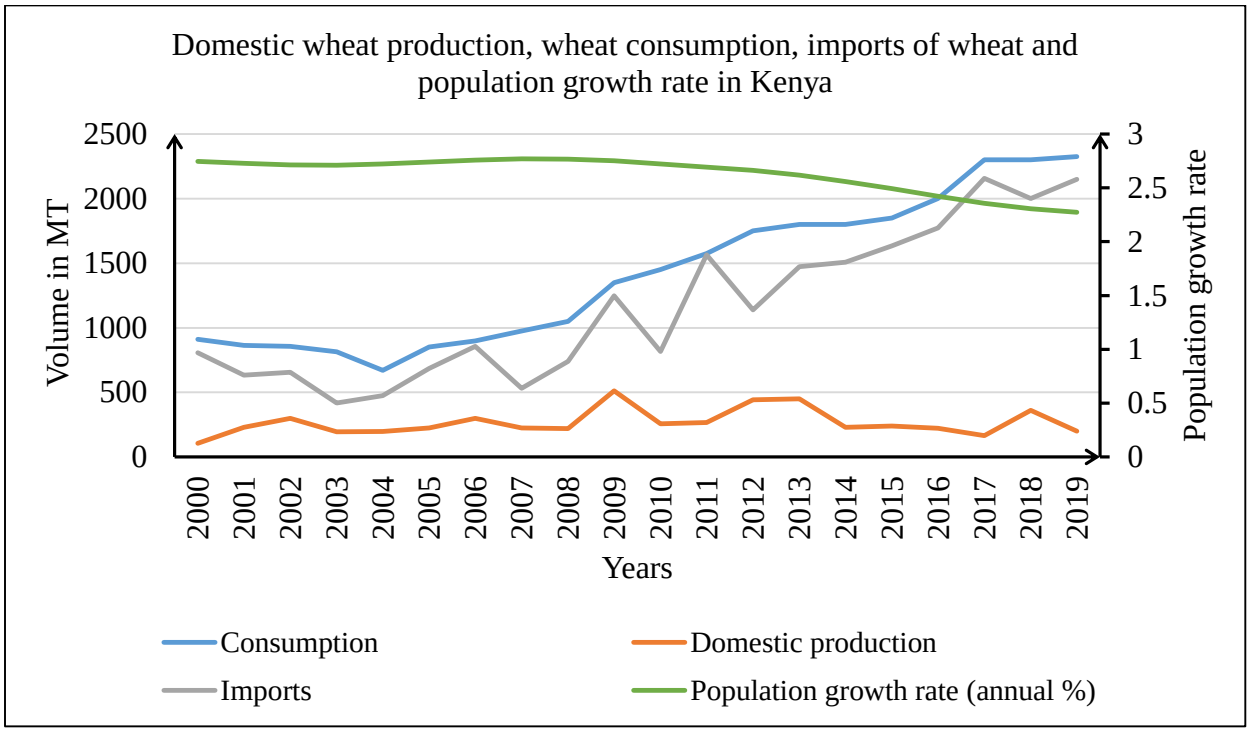
Wanjau, B. M. (2014). *The Relationship among Real Exchange Rate, Current Account Balance and Real Income in Kenya*. *5*(9), 22.

WITS. (2020). *Kenya Trade Statistics | WITS*. https://wits.worldbank.org/CountryProfile/en/KEN

Zahonogo, P. (2017). Trade and economic growth in developing countries: Evidence from sub-Saharan Africa. *Journal of African Trade*, *3*(1–2), 41. https://doi.org/10.1016/j.joat.2017.02.001

APPENDICES

Appendix I: Graph showing domestic wheat production, wheat consumption, imports of wheat and population growth rate in Kenya from 2000 to 2019.



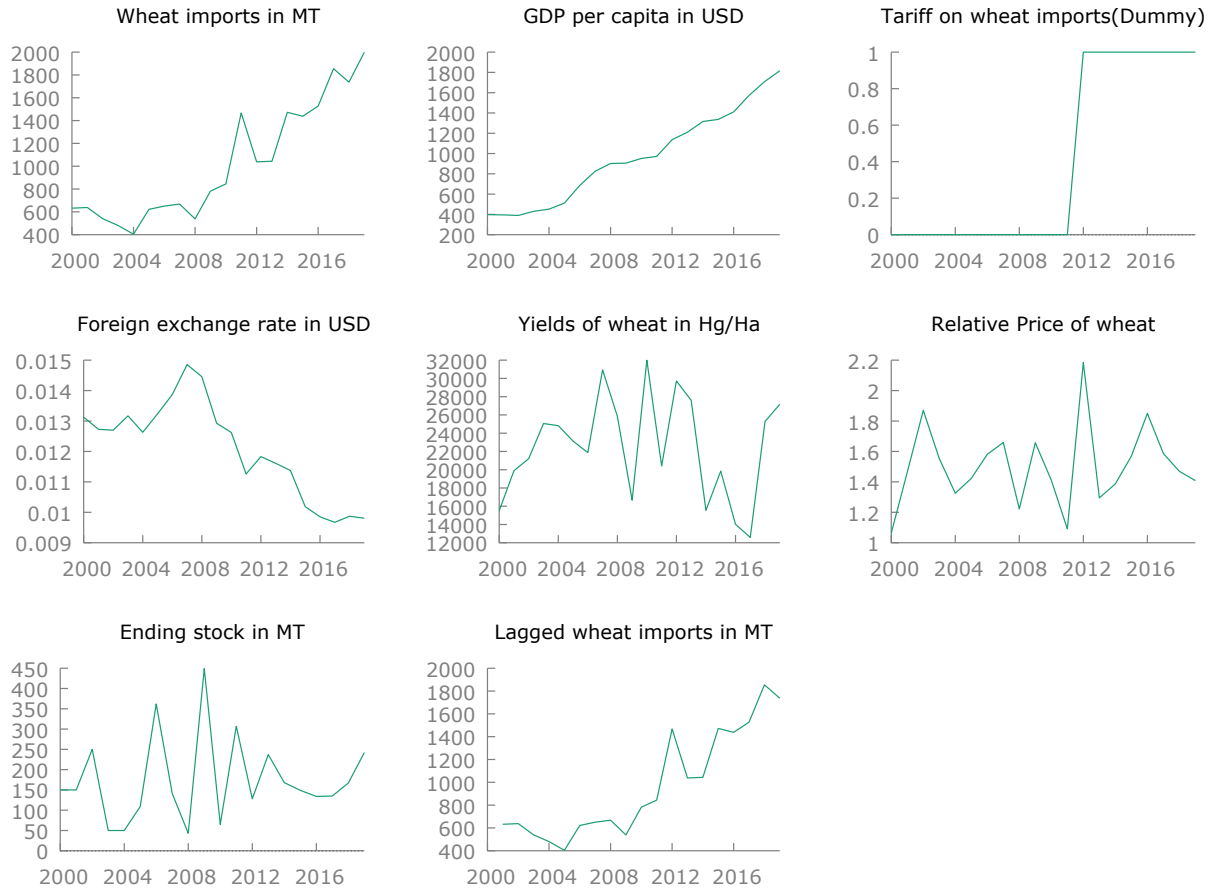
Source: Author generation using data from FAOSTAT

Appendix II: Average production and consumption of major staples in Kenya over the past two decades between 2000-2009 and 2010-2019

Staples	Average production in MT			Average consumption in MT		
	2000-2009	2010-2019	% Δ	2000-2009	2010-2019	% Δ
Maize	2,656	3,596	35.4	3,077	3,913	27.2
Wheat	310	322	3.87	924	1,938	109.7
Rice	47	114	143	247	815	230

Source: Author computation using data from FAOSTAT

Appendix III: Graphs of the collected data for each variable



Appendix IV: OLS Linear regression on import demand function

logMt	Coef.	Std.Err.	t-value	p-value	[95% Conf	Interval]	Sign
logGDPTAt D1	.034	.891	0.04	.971	-1.928	1.995	
TARt	.004	.094	0.05	.964	-.204	.212	
logFOREXt D1	.392	1.505	0.26	.8	-2.922	3.705	
logYLDSt	-.378	.212	-1.78	.102	-.845	.088	
logRPt	-.789	.329	-2.40	.036	-1.513	-.064	**
logSTKt	.163	.073	2.23	.048	.002	.324	**
logLMt	.908	.228	3.99	.002	.407	1.41	**
Constant	2.002	1.385	1.45	.176	-1.046	5.05	
Mean dependent var		5.965	SD dependent var				0.220
R-squared		0.918	Number of obs				19
F-test		17.557	Prob > F				0.000
Akaike crit. (AIC)		-36.049	Bayesian crit. (BIC)				-28.494
Serial correlation							
Durbin-Watson d-statistic							2.521607
Durbin's alternative probability value							0.112
Breusch-Godfrey LM test for autocorrelation F (small)							0.079
Heteroscedasticity							
White's test							0.3918
Cameron & Trivedi's decomposition of IM-test chi2							0.472
Breusch-Pagan / Cook-Weisberg test for heteroscedasticity							0.0496

Note, ** p<0.05

Post estimation tests of the estimated import demand function using OLS

The OLS regression results captured in appendix IV violate assumptions of no serial correlation and existence of heteroscedasticity as captured by the p-values of 0.079 and 0.0496 for Breusch-Godfrey and Breusch-Pagan tests respectively. Therefore to correct the violations, Cochrane Orcutt regression analysis was used and the results were used to estimate import demand of wheat in Kenya as tabulated in Table 13.

Appendix V: Multicollinearity check using variance inflation factors for import demand function run by OLS regression

Variable	VIF	1/VIF
TARt	6.33	.158
LogLMt	6.153	.163
D.logFOREXt	3.452	.29
D.logGDPTAt	2.263	.442
logYLDSt	1.639	.61
logRPt	1.441	.694
logSTKt	1.242	.805
Mean VIF	3.217	.

The VIF results of the OLS import demand function captured in appendix V show that the model does not suffer from any multicollinearity issues because all VIF values are less than 10 as noted by (Franke, 2010).

Appendix VI: Publication Abstract

Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.12, No.16, 2021

What Explains the Trends of Wheat Imports in Kenya; A Cointegration Analysis Using ARDL-ECM Modelling

Henry Kipsang Too* Hillary Kiplangat Bett Raphael Gitau
Department of Agricultural Economics and Agribusiness Management, P.o Box 536-20115,
Egerton University-Kenya

Abstract
This study aims to determine the cointegration of wheat imports and its determinants in Kenya. To achieve this objective, annual time series secondary data from 2000 to 2019 was utilized. The time frame was considered because it was during this period that wheat imports in Kenya skyrocketed. Data was collected from national and international published sources. The findings of the Auto-Regressive Distributed Lag-Error Correction Model (ARDL-ECM) analysis shows that wheat imports in Kenya are determined by the tariff, relative prices and ending stock in the long run. In the short run relative price was the main determinant that influenced wheat imports in Kenya. It was also realized that wheat imports in Kenya are inelastic to its determinants. Therefore, the study recommends that policymakers should embrace policies that increase the competitiveness of domestic wheat production in Kenya to tap the multiplier benefits that can be realized from the wheat sector. This can be done by embracing modern and efficient production technologies.

Keywords: ARDL model, Kenya, Time series, Wheat Import Demand, Error Correction Model.
DOI: 10.7176/JESD/12-16-10
Publication date: August 31st 2021

Appendix VII: Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: **807040**

Date of Issue: **25/June/2021**

RESEARCH LICENSE

This is to Certify that Mr.. HENRY KIPSANG TOO of Egerton University, has been licensed to conduct research in Nakuru on the topic: ANALYSIS OF WHEAT IMPORTATION AND ITS ASSOCIATED EFFECTS ON DOMESTIC WHEAT PRODUCTION IN KENYA for the period ending : 25/June/2022.

License No: **NACOSTI/P/21/11263**

807040

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.