THE EFFECTS OF OFFICIAL DEVELOPMENT AID ON FOOD SECURITY IN KENYA

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DECLARATION

This research project is my original work and has not been presented for a degree award in any other university or institution of higher learning.

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APPROVAL

This research project has been submitted for examination with my approval as the university supervisor.

19th November 2021

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DEDICATION

I dedicate this work to my family members and in particular my grandmother for her support and encouragement throughout the entire course of this paper and master's degree.

ACKNOWLEDGEMENT

I am very grateful to the Almighty God for seeing me through my masters and this thesis paper. I am truly gratefully for the guidance and support from Prof. Tabitha Kiriti – Nganga my supervisor throughout this paper

ABSTRACT

This study's main focus can be summarized as being to determine how agricultural Official Development Aid (ODA) flows into Kenya's agriculture sector affects its food security status. A further breakdown of the study's purpose are: evaluating the effect of agricultural foreign aid on agricultural productivity in Kenya, analysing the impact that agricultural foreign aid on government spending in agriculture and to provide policy recommendations in relation to agricultural Official Development Aid flows. The study was guided by two research questions namely; what impact does agriculture foreign aid have on food agricultural productivity in Kenya? Second, what is the effect of agricultural foreign aid on government spending into agriculture in Kenya? The agricultural sector in Kenya requires investment, foreign aid into agriculture is one form of investment into the sector. The study aimed to evaluate whether foreign aid into Kenya's agriculture sector goes to improve or deteriorate the state of food security. The study was anchored on the modernization and dependency school of thoughts on development of economies. The explanatory variables included other than agricultural Official Development Aid are: government expenditure directed to agriculture in Kenya; annual greenhouse house emission, exchange rate and Kenyan population. Gross domestic product growth rate was included as a control variable. Secondary data was used to do empirical analysis, the source of the data being Food Agriculture Organization Statistics, World Bank and International Food Policy Research Institute. The data was analysed using STATA computer software and applying Autoregressive Distributed Lag (ARDL) model and the Error Correction Model (ECM) to evaluate the relationship and extent of impact of the independent variables on the dependent variable. The ECM results revealed that Agriculture Official Development Aid had a positive and significant effect at 10 percent on Food Production Index therefore, Agriculture Official Development Aid contributes positively to food security in Kenya. Public spending on agriculture was only significant in the short run at 10 percent and positively boosted productivity hence food security. The study notes that the agricultural sector in Kenya is in dire need of financial support both in the short run and long run and therefore recommends for increased budgetary allocations to agriculture and proactive management of the allocated resources to ensure efficient and effective utilization. The study also recommends for the government to align its policies with aid donors particularly with regards to agriculture so as to boost aid received in the sector.

Contents

DECLARATION ii
DEDICATION iii
ACKNOWLEDGEMENT iv
LIST OF TABLES viii
LIST OF FIGURES ix
LIST OF ABBREVIATIONS AND ACRONYMS x
CHAPTER ONE: INTRODUCTION 1
1.1: Background of the Study 1
1.1.2: Recent Agriculture Trends in Kenya 5
1.1.3: Definition and Trend of Development Resource Flow 9
1.2: Statement of the Problem 11
1.3: Research Objectives 12
1.4: Research Questions 12
1.5: Significance of the Study 13
1.6: Organization of the Study 13
CHAPTER TWO: LITERATURE REVIEW 14
2.1: Introduction 14
2.2: Theoretical Literature Review 14
2.2.1: Modernization Theory 14
2.2.2: Dependency Theory 17
2.2.3: World-System Theory 19
2.3: Empirical Literature Review 20
2.5: Literature Review Overview 23
CHAPTER THREE: RESEARCH METHODOLOGY 25
3.1: Introduction 25
3.2: Theoretical Framework 25
3.3: Conceptual Framework 27
3.4: Model Specification 27
3.5: Variables Definitions, Measurement and Expected Signs 28
3.6: Data Type and Sources 29
3.7: Data Analysis 29

3.8: Diagnostic Tests 29
3.8.1: Unit Root Test 30
3.8.2: Multicollinearity 30
3.8.3: Autocorrelation 30
3.8.4: Co-integration 31
3.9: Limitation of the Study 31
CHAPTER FOUR: RESULTS AND DISCUSSION 32
4.0. Introduction 32
4.2. Pre-estimation Diagnostic Tests 32
4.2.1. Unit Root Test 32
4.2.2. Multicollinearity 33
4.2.3. Autocorrelation 34
4.2.4. Lag Length Selection Criterion 34
4.2.5. Cointegration 35
4.3. Error Correction Estimates of the ARDL Model 35
4.4: Granger causality test to determine relatioship between AODA and GAE 38
4.5. Postestimation diagnostics 38
4.5.1. Autocorrelation 38
4.5.2. Heteroskedasticity 38
4.5.3 Model stability 39
CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 41
5.1. Summary of Study Findings 41
5.2. Conclusion 41
5.3. Recommendations 42
5.4. Areas for Further Research 43
REFERENCES 44
APPENDICES 48
Appendix 1: Raw Data for the Period 1980 to 2018 48
Appendix 2: Granger causality Wald tests 50
Appendix 3: Post-estimation test results 50

LIST OF TABLES

Table 1: 3-year average of number of people undernourished in some East African countries
Table 2: Kenya's Production of Maize, Potatoes, Rice and Wheat over 2005-2018 (Tonnes)
Table 3: Kenya's Total Imports of Consumer Foods and Fish Products
Table 4: Foreign Agriculture Aid as a Percentage of Net Total ODA into Kenya
Table 5: Variable Definitions, Measurement and Expected Signs of the Coefficients
Table 6: Descriptive Statistics
Table 7 : Augmented Dickey Fuller Test
Table 8: VIF with Differenced Variable
Table 9: Breusch-Godfrey LM test for Autocorrelation
Table 10: Lag Length Selection Criteria
Table 11: Cointegration Diagnostic Test Results of FPI, GAE, AODA, ER, POPL, GHG and GDPGR
Table 12: Model summary
Table 13: The Long Run Relationship
Table 14: The Short Run Relationship

LIST OF FIGURES

Figure 1: A Trend Analysis of Prevalence Of Undernourishment (PoU) In Africa and Its Sub-Regions
Figure 2: A trend analysis of Kenya's Maize and Wheat Imports and Exports
Figure 3: A trend analysis of ODA Disbursed to Different Economic Sectors in Kenya
Figure 4: Conceptual Framework
Figure 5: Cusum6 Test
Figure 6: Cusum6 Squared Test

LIST OF ABBREVIATIONS AND ACRONYMS

ADF Augmented Dickey Fuller Test

AIC Akaike Information Criterion

AIH Africa Information Highway

ODA Official Development Aid

ARDL Autoregressive Distributed Lag

CUSUM Cumulative Sum Control Chart

ECM Error Correction Model

ER Exchange Rate

FAO Food and Agriculture Organization

FAOSTAT Food and Agriculture Organization Corporate Statistical Database

GAE Government Agricultural Expenditure

GDP Gross Domestic Product

GDPGR Growth Domestic Product Growth Rate

GHG Greenhouse Gas Emission

GMM Generalised Method of Moments

HQIC Hannan and Quinn Information Criterion

IFAD International Fund for Agricultural Development

KNBS Kenya National Bureau of Statistics

LL Lag Length

LM Linear Model

NCCAP National Climate Change Action plan

NEPAD National Partnership for Africa's Development

OECD Organization for Economic Co-operation and Development

OLS Ordinary Least Squares method

PoU Prevalence of undernourishment

SBIC Schwarz/Bayesian Information Criterion

SDGs Sustainable Development Goals

SSA Sub-Saharan Africa

UN United Nations

UNICEF United Nations Children's Fund

USDA United States Department of Agriculture

VIF Variance Inflation Factor

WFP World Food Programme

WHO World Health Organizatio

CHAPTER ONE: INTRODUCTION

1.1: Background of the Study

Food security is a major macro and micro problem in several countries and hence its inclusion as a goal in the Sustainable Development Goals (SDGs) 2030 through the first three goals; ensure no human being suffers from any form of poverty and hunger and attaining good health and wellbeing for all respectively (United Nations, (UN, 2015)). Achieving the SDG 2: Zero hunger, realise worldwide food security and eliminate the different types of malnutrition and fostering sustainable agriculture, (UN, 2015) is very crucial in Africa as it has a positive ripple effect on attainment of SDG 1 and SDG 3 because of the aspect of promoting sustainable agriculture. The most comprehensive definition of food security was coined in 1996 during the UN World Food Summit which redefined and adopted the definition as; "food security exists when all people at all times have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life "(Food Agriculture Organization (Food and Agriculture Organizaion, (FAO)), 2010, pg. 10). That broad definition brought out the following dimensions of food security; the availability of food, access, stability and utilization (FAO, 2008). Currently issues like obesity and malnutrition are the main focus, malnutrition being a major problem in Africa (FAO, 2019).

The global food security situation is deteriorating after several decades of declining food insecurity levels; according to FAO (2017) hunger has been on the rise globally from the year 2016 with total undernourished around the world estimated at 815 million people compared to 777 million people in the year 2015. Moreover, the world ecosystem has been overexploited at the expense of feeding the world and as a result the productive potential of natural resources has declined; soil is degraded with reduced fertility, fish stocks and forest cover have declined and water scarcity has increased (FAO, 2018). In Sub-Saharan Africa (SSA) the Prevalence of undernourishment (PoU), a measure of hunger, has been on an upward trend from 2015; a decrease was experienced from the year 2005 (24.3%) to 2010 (21.7%), however, a rise from 20.8 percent to 22.7 percent between 2015 and 2017 was observed with the worst hit countries being Eastern and Middle Africa at 30.8 percent and 26.5 percent respectively (FAO, 2019). This clearly shows that East Africa needs to rethink the issue of food security so as to at least come

close to attaining SDG 2 by 2030. Table 1 shows the number of undernourished people in Ethiopia, Kenya, Tanzania and Uganda, which lie in East Africa.

Table 1: 3-year average of number of people undernourished in some East African countries

Year	Total undernourished (million) in Ethiopia	Total undernourished (million) in Kenya	Total undernourished (million) in Uganda	Total undernourished (million) in Tanzania
1999-2001	34.6	9.8	6.7	12.5
2000-2002	33.5	10.3	6.8	13
2001-2003	32.9	11	6.8	13.3
2002-2004	32.1	11.3	6.6	13.7
2003-2005	31.3	11	6.5	13.7
2004-2006	30.5	10.2	6.9	13.6
2005-2007	30.3	9.8	7.6	13.6
2006-2008	30.1	9.7	8.6	13.9
2007-2009	29.6	9.9	9.4	14.8
2008-2010	28.8	9.9	10	15.4
2009-2011	28.1	9.7	10.5	16
2010-2012	27.6	9.6	11.1	16
2011-2013	26.7	9.8	11.7	16.1
2012-2014	25.3	10	12.6	16.4
2013-2015	23.8	10.5	13.6	16.7
2014-2016	22.7	11.8	15.1	17
2015-2017	21.9	13.3	16.5	17.2

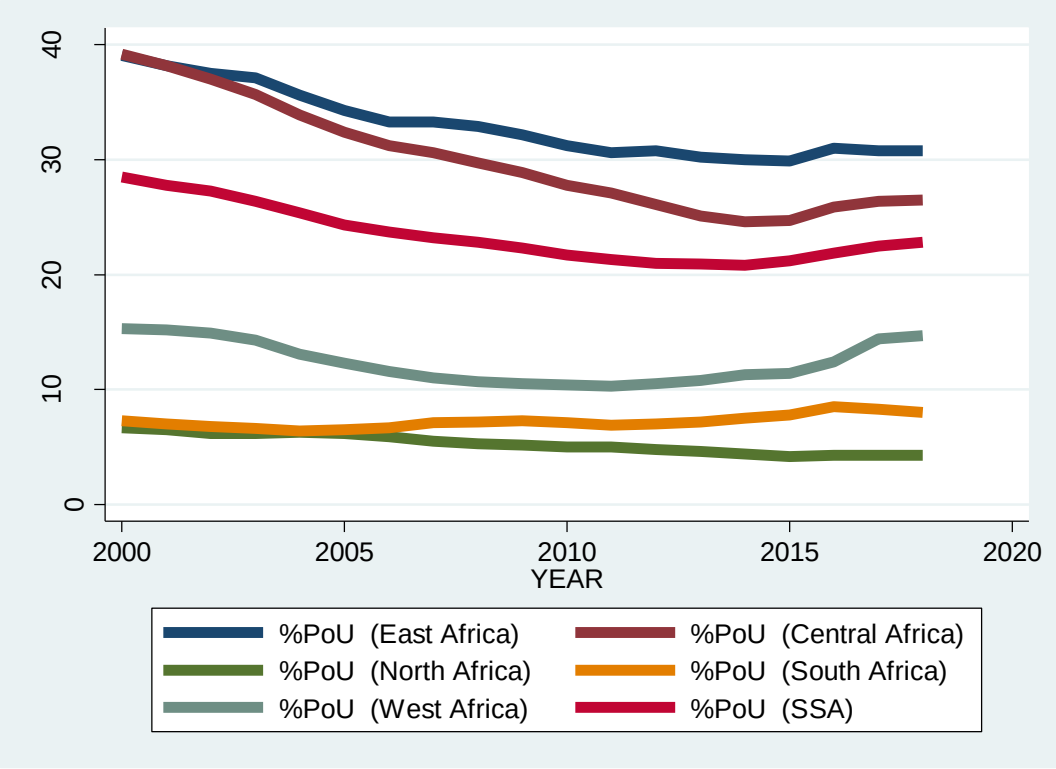
2016-2018	21.6	14.6	17.6	17.6

Suite of Food Security Indicators FAOSTAT data

Table 1 shows how the number of people undernourished has been on an increasing trend from 2010-2012 for Kenya, Uganda and Tanzania. Ethiopia has the highest number of undernourished people which is a consequence of an unstable political and economic situation in the 1970s and 1980s (Norwegian Institute of International Affairs, 2018). The food insecurity situation in Ethiopia has been on a declining trend due to improved political climate which has led to food security measures by the government in conjunction with international bodies; adoption and implementation of a productive safety net programme which has been the paramount and largest safety net programme in Africa (FAO, 2019); the government has greatly invested in agriculture making it the sole East African country whose budgetary allocation to the agriculture sector was a minimum of 10 percent in line with the Maputo declaration (African Development Bank (AfDB), 2010) . East African countries are highly dependent on rain-fed agriculture and adverse climatic conditions experienced over the years affected agriculture productivity and incomes of agriculture dependent industries of which these countries depend on largely (AfDB, 2010).

Prevalence of undernourishment (PoU) a measure of food deprivation also reveals that SSA has been experiencing elevated levels of food insecurity in the last decade; for several decades food security was on the rise, however all around the world in the last decade hunger has been on the rise and most notable in Africa where a majority of its sub-regions have a prevalence of undernourishment of 20 percent against the world PoU of 11 percent (FAO, International Fund for Agricultural Development (IFAD), United Nations Children's Fund (UNICEF), World Food Programme (WFP) and World Health Organization (WHO), 2019). Figure 1 reiterates that East Africa's food security situation is troubling, the PoU is estimated at 30 percent.

Figure 1: A Trend Analysis of Prevalence of Undernourishment (PoU) In Africa and Its Sub-Regions



Figurek 1 shows that the PoU in SSA had flat lined between 2010 and 2015 but the status quo changed and an increase is observed from 2015 onwards. The same trend is observed for each sub-region of Africa apart from North Africa with West Africa experiencing the highest increase.

Food security is a human welfare issue and has been taken up by several agencies like FAO, IFAD and WFP all of which have underscored that underperforming agriculture sector in African countries hinders achievement of food security. The agriculture sector in Africa is poorly invested in resulting in low productivity and a decline in the sector (National Partnership for Africa's Development (NEPAD), 2003). Investing in agricultural productivity has been identified to be crucial for countries aiming to avert food crises in the long run (Timmer, 2010).

In the 2003 Maputo Declaration on Agriculture and Food Security, African countries established a policy aimed at boosting government spending into the agriculture sector to a minimum of 10 percent of a country's government expenditure towards achieving agriculture growth rate of 6 percent per year (NEPAD, 2003). SSA countries acknowledge the critical role agriculture plays

where 70-80 percent of Africans depend on agriculture, however, the African states have been withdrawing support from the sector and only a few countries have adhered to allocating a minimum of 10 percent of national budgetary expenditure to agriculture (NEPAD, 2003). Moreover, Africa's food items importation has been on the rise and accounts for 15 percent of total imports with East Africa's trend raising greater alarm as more of its gross export revenues are continuously used up to import food the trend being an increase from 12 percent in 1998 to over 30 percent in 2000 (NEPAD, 2003).

The FAO, WFP and IFAD (2012) underscored the major role played by agricultural investment in promoting agricultural growth which leads to poverty and hunger reduction. Islam (2011) also underscored that declining agriculture investment is a major contributing factor for poor agriculture growth and performance in SSA. Kalibata (2010) postulated that agricultural foreign aid can promote agricultural productivity by solving several issues ailing farming through: improved inputs and seeds, infrastructure development to facilitate marketing, agribusiness credit and private sector investments to spur growth and technology advancements in agriculture. This study will focus on food security in Kenya, the aim being to find out how development resources flow into the agriculture sector directly impacts food security.

1.1.2: Recent Agriculture Trends in Kenya

The agriculture sector is still a major economic activity contributing largely to several countries Gross Domestic Product (GDP) in SSA (Organization for Economic Co-operation and Development (OECD) and FAO, 2016). In Kenya the sector is said to directly contribute up to a tune of 30 percent to the country's GDP and indirectly through interdependence within economic sectors up to a tune of 27 percent; moreover, the agriculture sector employs more than 40 percent and about 70 percent of the rural population is dependent on the agriculture sector (FAO, 2015). The agriculture sector is crucial in Kenya and was identified as a major sector to help achieve the vision 2030 and particularly a 10 percent economic growth rate (Government of Kenya (GoK), 2007). In Kenya the sector is mostly small-scale on farms averaging 0.2 to 3 hectares and accounts for 75 percent of agriculture output (GoK, 2010).

The agriculture sector in Kenya faces several challenges. First are climatic changes which have affected the issue of availability of enough and safe food through detrimental effects on food production. According to FAO (2019) the effects of climate change and increasing climate

variability and extremes are experienced in the agriculture sector and natural resources, which has a negative influence on food systems and rural livelihoods, including a decrease in the number of farmers. According to the National Climate Change Action plan (NCCAP), the impact of climatic changes which include heat stress, floods and droughts adversely affects the economy of Kenya because of over-reliance on climate-sensitive industries such as agriculture (GoK, 2018). A decline in agricultural productivity occasioned by drought was witnessed in 2017 when a growth of 1.6 percent was registered compared to 4.7 percent in 2016 (KNBS, 2018). Alila and Atieno (2006) highlight over-reliance on rain-fed agriculture to be a cause of fluctuations in production and especially for rural areas which is a major cause of food insecurity. If climate mitigation strategies are not implemented food insecurity will continue to rise; failure by countries to put efforts towards climate change adaptation and mitigation is likely to cause an increase in the number of people suffering from food insecurity by approximately 71 million worldwide with sub-Saharan Africa having over half the number by 2050 (FAO, 2018).

Second is poor infrastructure in the rural agricultural areas; Alila and Atieno (2006) pointed out that the main concerns for the agriculture sector are; inaccessibility of rural roads, unorganized markets and poor transport system leading to high transactional costs for farmers and inaccessibility to input and output markets.

Third is high population, Kenya's population is increasing at a high rate, from the 2019 census the population stands at approximately 47.5 million with a growth rate of 2.2 percent. High population puts pressure on land reducing arable acreage; at the current population growth rate Kenya's population will double in the next 27 years, reaching 81 million by 2039, this rapid increase reduces productive parcels of land which reduces food production (FAO, 2014). Nyariki (2007) underscores the adverse effects that an increasing population has, humans exploit water catchment areas in search of a place to settle resulting in cultivation of the fragile Arid Semi-Arid Lands (ASALs).

Though the sector is faced with several problems, food crop production in Kenya improved in 2018 largely due to increased rain compared to the preceding years which witnessed a downward trend in production. The 2018 production of maize, potatoes, rice and wheat stood at 4.0 million tons, 1.87 million tons, 110,325 tons and 336,600 tons respectively (FAOSTAT). An analysis of output produced of some food crops in Kenya reveals that there was a decline from 2012/2013

largely due to poor climatic conditions (KNBS, 2019). Table 2 shows the production of four main food crops over 15 years.

Table 2: Kenya's Production of Maize, Potatoes, Rice and Wheat over 2005-2018 (Tonnes)

Year	Maize	Potatoes	Rice	Wheat
2005	2,905,559.00	2,640,600.00	62,677.00	368,879.00
2006	3,247,200.00	2,415,080.00	64,840.00	329,193.00
2007	2,928,793.00	2,192,280.00	47,256.00	322,320.00
2008	2,367,237.00	2,900,000.00	21,881.00	336,688.00
2009	2,439,000.00	2,299,086.00	42,202.00	219,301.00
2010	3,464,541.00	2,725,936.00	85,536.00	511,994.00
2011	3,376,862.00	2,365,263.00	111,229.00	268,482.00
2012	3,749,880.00	2,915,067.00	138,204.00	441,944.00
2013	3,592,688.00	2,192,885.00	125,256.00	449,641.00
2014	3,513,171.00	1,626,027.00	112,263.00	228,900.00
2015	3,825,000.00	1,963,495.00	116,473.00	238,600.00
2016	3,339,000.00	1,335,883.00	101,510.00	214,700.00
2017	3,688,090.00	1,519,870.00	101,866.00	165,200.00
2018	4,013,777.00	1,870,375.00	110,325.00	336,600.00

Source: FAOSTAT1 data

A concern on the increase of Kenya's food crop imports is a clear indication that crop production is below the demand which has led to a rise in imports of food crops (United States Department of Agriculture (USDA), 2019). An analysis of the domestic exports against imports to meet demand shows that crop imports have been on the rise.

The main food crops with relative importance in the whole country are maize, wheat and rice (GoK, 2009). Figure 2 shows that maize and wheat imports have been on a high rise and are much higher than exports of the same crops. The increased importation can be an indicator of the deficit of domestic production to meet local consumption. Importation of consumer food is on an upward trend a clear indication of the deficit in Kenya; table 3 further reiterates the increase in food imports for the last six years.

Figure 2: A trend analysis of Kenya's Maize and Wheat Imports and Exports

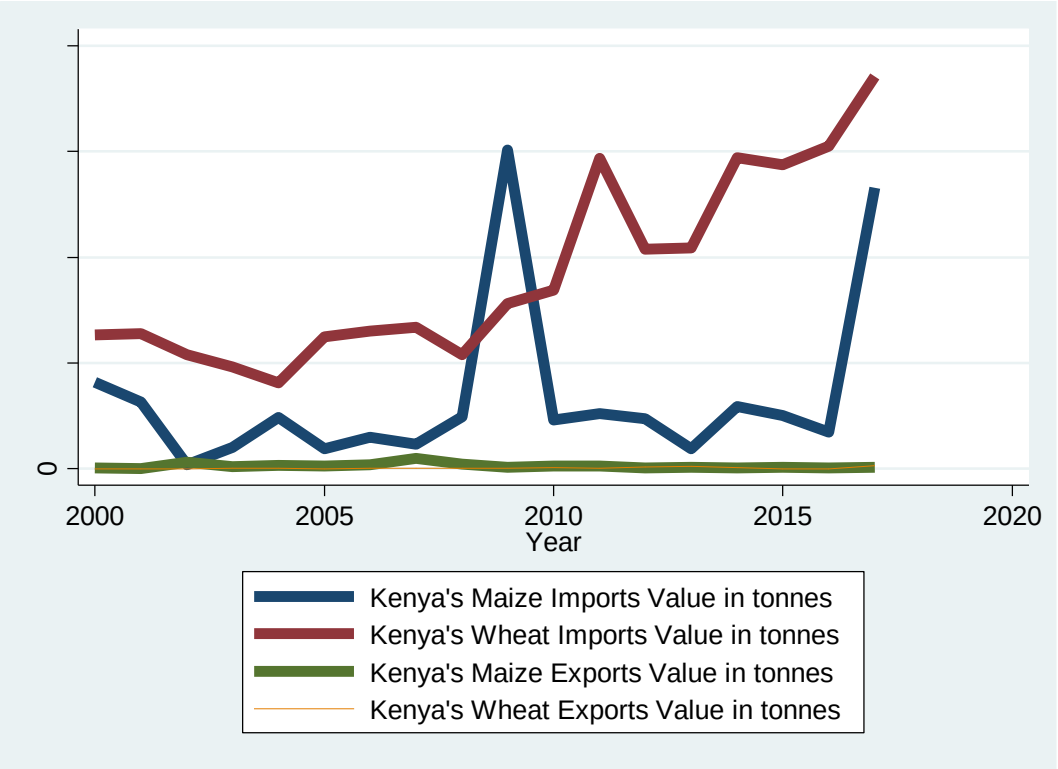


Table 3: Kenya's Total Imports of Consumer Foods and Fish Products

Year	Total Import of Consumer-oriented foods and Fish Products from the World (in million US$)
2014	286
2015	309
2016	310
2017	442
2018	460
2019 *	500

*Source: United States Department of Agriculture *represents estimated value*

The agriculture sector in Kenya is robust but productivity is below its potential (FAO, 2015) and there is therefore need to address the critical issues ailing the sector to promote and boost productivity and be able to meet the food demand requirements of the increasing population. Investment into a sector is one way to combat the problems the sector faces; public expenditure has been below the committed level agreed under the Maputo Declaration of 10%. The national budget allocation to agriculture in the financial year 2015/2016 was 3.6 percent and in

2016/2017 was 2.8 percent (GoK, 2018). Foreign aid is one crucial source of investment into the sector as highlighted by Kalibat (2011).

1.1.3: Definition and Trend of Development Resource Flow

Official Development Assistance is made up of finances which are concessional with a grant element of at least 25 percent directed to countries categorized as developing and must be for fostering economic development and welfare of the recipient countries and (Organization for Economic Co-operation and Development (OECD), 1972). Aid into Kenya was on an increasing trend from the 1970s and 1980s but slacked in the mid-1990s all through to early 2000 due to the failure of Kenya to adhere to its commitment to donors (Oduor and Khainga, 2009). The country's foreign aid inflows increased from 2000 and in 2007/2008 and 2011 Kenya and the whole of Africa experienced a surge in agriculture foreign aid due to the world food crises. A surge in investment into developing countries by Developed countries was necessitated by the need to produce crops at low costs so as to cushion against the increasing food prices. The motivation behind increased international investment to boost food output was rising concerns of food insecurity worldwide especially due to spiking food prices which caused a panic in 2008 when the food index reached a peak of 201.4 percent. Uncertainties in food security forced countries to look for opportunities overseas.

Islam (2011) revealed that SSA topped the list of recipients of foreign aid into their agricultural industry to a tune of about 34 percent over the period of 2010/2011and agriculture aid in SSA growth rate was almost at par to the growth rate of total foreign aid allocated to the region. A similar trend is observed on growth of agriculture aid into Kenya as table 4 depicts. The percentage of foreign agriculture aid averaged at 6 percent containing a maximum and a minimum of 8.4 percent and 3.48 percent respectively, moreover, a simultaneous increase in total ODA and foreign agriculture aid is observed. However, this also reveals that the share of agriculture aid is not growing, it averages at 6 percent of total ODA.

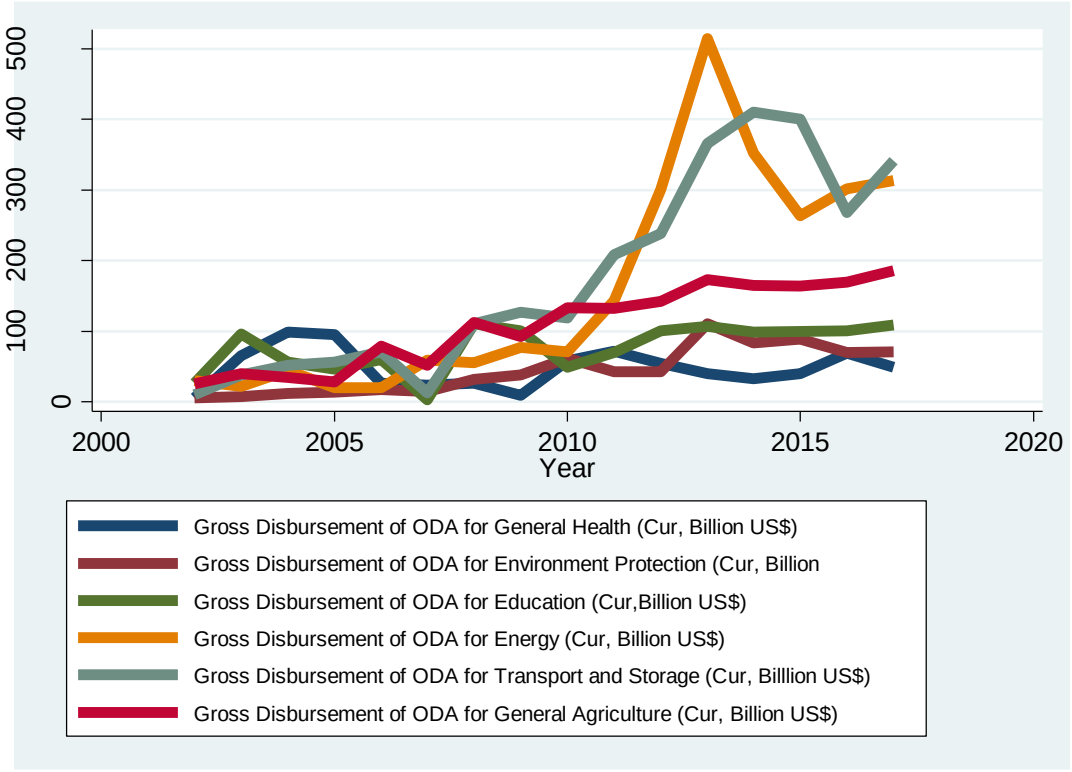
Table 4: Foreign Agriculture Aid as a Percentage of Net Total ODA into Kenya

Year	Net Total ODA (Official Development Assistance) from All Donors (Cur, US $)	Total Gross Disbursement of ODA for Agriculture, Forestry and Fishing (Cur, US$)	% of ODA to Agriculture
2002	392,810,000.00	25,156,164.00	6.404156
2003	523,000,000.00	40,112,296.00	7.669655
2004	660,240,000.00	34,544,490.00	5.232111
2005	759,200,000.00	27,952,803.00	3.681876
2006	941,650,000.00	79,092,368.00	8.399338
2007	1,329,360,000.00	51,557,098.00	3.87834
2008	1,363,400,000.00	111,966,923.00	8.212331
2009	1,782,480,000.00	92,270,662.00	5.176533
2010	1,631,260,000.00	132,764,953.00	8.138798
2011	2,478,820,000.00	132,710,228.00	5.353766
2012	2,653,660,000.00	141,872,713.00	5.346303
2013	3,306,840,000.00	173,236,701.00	5.238739
2014	2,661,030,000.00	164,865,494.00	6.195552
2015	2,464,180,000.00	163,751,633.00	6.645279
2016	2,187,740,000.00	169,100,683.00	7.729469
2017	2,474,760,000.00	185,414,990.00	7.492241
Average	1,725,651,875.00	107,898,137.44	6.30
Maximum	3,306,840,000.00	185,414,990.00	8.40
Minimum	392,810,000.00	25,156,164.00	3.68

Source: Author's Computations from African Development Bank Group data

In Kenya, a trend of steady but slow increase of agricultural foreign is observed while other sectors in the economy; energy and transport and storage experienced a great surge in the amount of foreign aid allocated to them. Figure 3 shows how the two sectors' share of foreign aid increased from around 2010 before which they were at par with agriculture aid and rose far above the share received by the agriculture sector.

Figure 3: A trend analysis of ODA Disbursed to Different Economic Sectors in Kenya



1.2: Statement of the Problem

Food security is a worldwide issue hence its inclusion in the SDGs. Kenya is within East Africa which according to FAO is performing poorly with regards to PoU. Kenya ranked 86 in the Global Food Index (GFI) of 2019 scoring 25 placing it under the serious category of food insecurity (Concern World Wide and Welthungerhilfe, 2019). Food insecurity and poverty have been linked to the increasing low productivity in the agriculture sector (GoK, 2009). The other causes identified are; limited access to productive assets, poor infrastructure, limited marketing and inadequate access to technologies (GoK, 2009), these causes can be addressed through increased investment in the agriculture sector as pointed out by Kalibata (2010), Isalam (2011) and FAO, WFP and IFAD (2012). Kalibata (2010) underscored the importance of agricultural foreign aid in overcoming issues of low productivity in agriculture.

The economic and welfare effects of foreign aid on developing countries have been widely studied by researchers who are divided between the dependency and modernization theory. However, several of these studies are cross country hence not specific to a country; Chenery & Strout (1966) used the two-gap model to study effects of foreign aid and pointed out that the role of aid was to bridge the investment-domestic savings gap. Bacha (1990) and Taylor (1994) also

underscored the importance of foreign aid as a boost to government revenues and its positive impact if used to fund public expenditures. Burnside and Dollar (2000), Chatterjee and Turnovsky (2005) and Rodman (2003) also study foreign aid and economic growth nexus.

Research that has linked aid to food security focuses on food aid; Gilligan and Hoddinott, 2007 concluded that food-aid in rural Ethiopia had negative effects on long-term food security, contrary to studies by Smets, Tusiime and Renard (2013) in Uganda and Broussard, Dercon and Samanathan (2014) in Ethiopian households which concluded that the effect of food-aid on food security was favourable but was also dependent on other factors. A sectoral study conducted in 47 countries in SSA on how agriculture growth and productivity are impacted by non-food assistance found that there is a statistically significant and positive relationship between sectoral aid and agriculture productivity (Alabai, 2014). Two studies carried out on non-food aid and agriculture in Nigeria have conflicting conclusions; Akpokodje and Omojimite (2008) study concluded that aid positively contributed to Nigeria's agriculture while Ighodaro and Nwaogwugwu (2013) empirical study concluded that foreign aid is not beneficial to Nigeria's agriculture sector both in the short-run and long-run.

This study will try to fill the gap in research on effects of non-food aid on food security and will therefore take on the same direction as the studies conducted in Nigeria; it will be country and sector specific and will aim to establish the effect of non-food agricultural aid on food security directly through agriculture productivity and growth.

1.3: Research Objectives

The main objective of this study was to assess the effects of ODA on food security.

The specific objectives of the study are:

i. To evaluate the effect of agricultural foreign aid on agricultural productivity in Kenya
ii. To analyse the relationship between agricultural foreign aid and Government spending in agriculture
iii. To provide policy recommendations.

1.4: Research Questions

The overall research question; how does ODA affect food security in Kenya?

Specific research questions are:

i. How does agriculture foreign aid affect food agricultural productivity in Kenya

ii. What is the effect of agricultural foreign aid on government expenditure into agriculture in Kenya?

1.5: Significance of the Study

The main purpose of this study was to analyse the effect of international aid on food security in Kenya directly through agricultural investment. The agricultural sector in Kenya is in need of investment; foreign aid into agriculture is one form of investment into the sector. This study aimed to evaluate whether foreign aid into Kenya's agriculture sector goes to improve or deteriorate the state of food security. The outcome of this study would therefore be of importance to policy makers in Kenya as it will help determine whether they should attract agriculture foreign aid to boost investment in agriculture sector implying foreign aid improves agricultural productivity hence food security or shun it away and encourage investment into other sectors and direct more public expenditure into the sector to meet the much-needed investment in the sector. This study was also conducted to deepen understanding of food security and non-food foreign aid in agriculture.

1.6: Organization of the Study

This research paper contains five chapters. Chapter one gives the introduction to the study. It discusses the background to the study by looking at the definitions and trends of food security and foreign aid. It also highlights the problem statement; objectives of the research and research questions. The chapter further provides significance of the study and organization of the study. Chapter two will give the literature review that will be done in two parts: theoretical and empirical literature. This will be followed by Chapter three which will cover the methodology employed in the research. In this respect, Chapter three identifies and discusses the theoretical framework, model specification, variables, definitions, measurements and expected signs, data type and sources, data analysis, diagnostic tests and limitation of the study. Chapter four gives the results and discussion. Under it, a report of the results will be given and the findings will be discussed in light of objectives of the study. The last Chapter (five) will be the summary of the findings, conclusions and recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1: Introduction

In this chapter, the first part reviews theories that have a bearing on food security and foreign aid; focusing on contribution of foreign aid on agricultural productivity and how it affects government expenditure into agriculture, second part is on empirical underpinnings analysed by researchers on foreign aid with regards to food security, agricultural productivity and government expenditure into agriculture sector are discussed and how they form a critical basis for this research in Kenya.

2.2: Theoretical Literature Review

Development foreign aid has been a subject of discussion from as early as 1944 around the time the International Bank for Reconstruction and Development (World Bank) and the International Monetary Fund (IMF) were set up (OECD, 1994). Discussion and research pertaining to foreign aid can be grouped into two camps; those who support the modernization theory, with a perception that foreign assistance is an impetus for development in countries categorized as developing by focusing on the positive impact of aid. The other camp is for those who support the dependency theory and argue that foreign aid fosters dependency and propagates underdevelopment in the recipient countries (Kabonga, 2017).

2.2.1: Modernization Theory

"Modernization theory developed as a way of presenting the elements of reform-oriented modernization within democratic Western countries and, therefore, providing a model of the 'correct' way to modernize for other countries" (Bhambra, 2014, p. 20). Early western modernization scholars theorized that modernizing states go through stages of development which relate to how the Western states developed; Lerner (1958), Levy (1965) and Rostow (1960) making the Western nations a yard stick of development. The process of modernization can be assessed by looking at how modernizing states grow focusing on specific characteristics which Lerner (1958) identified as; the state of markets for free trade which was the most efficient way to allocate resources, increasing literacy which enhanced economic participation, growth of mass media which he considered as an enhancer of modernization, rural-urban migration leading to urbanization, growing population density and modern and democratic institutions.

Rostow (1960) identified and explained five economic and social stages of development which all societies go through in their modernization pursuit. The stages are:

a) The traditional society; it is a society characterized by limited productivity due to lack of or and limited utilization of modern science and technology in production. Social organization was based on family and clan. Political power generally lay in regions and particularly with land owners.
b) The pre-condition for take-off; this stage called for fundamental and substantive changes on the social structure, political system and production techniques of a well-established traditional system. This stage is characterized by; capital mobilization through banks and other institutions; increased investment in the transport, communication and manufacturing; growth in commerce both internally and externally and utilization of modern technology in the manufacturing sector. Rostow points out that these activities proceed at a slow pace especially for states that are characterized by traditional low productivity. Politically, centralized governance begins to take shape characterized by coalitions and nationalism.
c) The take-off: Rostow refers to take-off as the stage when the old blocks and resistance to steady growth are overcome. The activities that begun in pre-condition for take-off expand and dominate the society. A surge in technological development is experienced in industry and agriculture
d) The drive to maturity: at this stage the economy demonstrates that it can produce anything it chooses to. The economy's make-up changes continuously with improved production techniques. The state's economy enters the international economy with production of a wide variety of goods such that goods formerly imported are produced locally and there new import requirements.
e) High mass-consumption; mass production of goods and the economies begin to move to production of durable consumer goods and services.

Modernization school of thought believe that developing countries go through development on provision of much needed capital for investment and technological advancement (Shallal,1994); this is in agreement with Harrod-Dormar growth model which places a lot of importance on capital stock for investment as a stimulus for growth. Capital stock has two main sources;

domestic savings and foreign capital inflows. The Marshall plan of the post-world war II was used to further the idea that underdeveloped states can go through modernization with the help of developmental aid (Matunhu, 2011). Most African countries have a savings deficit therefore foreign aid is seen as an essential source of funding. Government spending on agriculture is another source of investment to the sector, however, African governments spending on the sector is low; a focus on four East Africa countries (Kenya, Uganda, Tanzania and Ethiopia) reveals that only Ethiopia spent above 10 percent on the sector between 2002 and 2008 (Salami et.al, 2010).

Modernization of the agriculture sector is adoption of new and improved production methods including use of new methods of production, cultivation of new and wider variety of crops and employing different marketing skills (Ellis and Biggs, 2001). These activities that entail modernization of agriculture require capital investment hence the belief that modernization goes hand in hand with development aid from developed nations into underdeveloped nations (Matunhu, 2011).

Modernization theory has been criticized for failing to achieve modernization in some of the third world states. Matunhu (2011) underscores the characteristic of modernization theory as a linear model which is deterministic hence changes leading to development are initiated externally which explains the continuous interference of the western nations into the economic and political conditions of third world nations. Matunhu argues that this interference is a disguise to exploit their resources.

Modernization theory is criticized for assuming that development is linear, however, countries plagued by natural disasters, war and conflict can move back and forth through the stages; the theory was developed from only western societies ignoring the nature, history and unique characteristics of other states. The theory also failed to take into consideration that the western nations development was largely driven by exploiting natural resources and repatriating surplus from the states they colonized therefore the colonized states cannot be expected to follow the same development path as their colonizers (Osterhammel, 1999).

2.2.2: Dependency Theory

The dependency theory has its origin in the Third World countries, Latin America being its source. The theory came about from the unequal economic situation that Third World countries were in and scholars trying to explain the reason these countries were not developing like the western developed nations and the persisting inequality, and by extension to find a way forward for development of these countries. Prebich, an Argentina is credited to have given the theory its roots through his ideas on unequal trade relations between the core-periphery nations (Love, 1980). This theory places a lot of emphasis on the relationship that exists between the core and periphery countries and rejects the theory of comparative advantage as the path for less developed nations to develop.

Unlike the modernization theory which prescribed to the underdeveloped nations the same path that developed nations followed to develop, Prebich (1944) argued that periphery states cannot use the same monetary tools used by the United States to pursue full employment because of unequal exchange and its side effects on foreign exchange on peripheral countries. Prebich (1948) postulated that terms of traded were favourable to exporters of industrial goods and worsened for exporters of raw material, his arguments were backed by later findings of Singer through the United Nations (U.N) in 1949 on relative prices of imports and exports of underdeveloped countries. Singer's scholarly writing on technical progress was in line with Prebich's (1944) core-periphery ideas. According to Singer, technical progress in developed nations was experienced in their manufacturing industries leading to incomes increasing, while in underdeveloped nations technical progress was witnessed in their agricultural sector consequently food production raw materials productivity increased causing prices to fall (Love, 1980). Singer explained the differentials in technical progress using different income elasticity of demand for primary and manufactured goods. Since developed nations imported raw materials and undeveloped nations imported manufactured goods the core-periphery trade relations benefited the core leaving the periphery worse-off. Frank (1966) argued that third world countries were undeveloped but their under-development was as a result of the nature of their relationship with developed capitalist nations which dominated and exploited them.

Rodney (1972) and Samir et al (1987) also make use of the core-periphery relationship to illustrate how Europe (the core) exploited Africa (the periphery) during colonization; Europe grew and developed by exploiting Africa's resources and expatriating profits from Africa

produced by Africans leaving the African people worse-off. The idea that aid is a tool used by developed states to grow and improve their economies at the expense of third world countries is also shared by Matunhu (2011) who argues that Africa's impoverished condition is not one of natural occurrence but is as a result of an orchestrated capitalist dominance by the metropolis whose aim is extraction and repatriation of surplus value from Africa to the metropolis. Kabonga contributes to this body of knowledge and claims that, "Aid has become a tool for the development of underdevelopment; for it is creating more employment and demand for services and goods in the core countries than in the periphery" (Kabonga, 2017, p. 10).

Dependency school of thought argues that foreign aid causes international economic dependency slowing growth of developing countries (Shallal, 1994). Slow and no growth of the agricultural sector coupled with high population growth in poor countries has often been cited as a main cause of food insecurity (Grigg, 1985, Paddock and Paddock, 1975 and Yates, 1986). Supporters of dependency school of thought postulate that food aid can lead to neglect of the agriculture sector by recipient governments because effects of food shortage are not felt hence not politically considered for reforms and because food aid is a solution though temporary, there are no early warning signs that would evoke the need for action (Stevens, 1978). Trade and emergency food aid has been cited as one of the reasons political leaders in Africa fail to priorities the issue of food shortage in their countries (FAO, 2006). Mellor (1988) faulted under-investment of the agriculture sector in developing countries for its poor performance as these countries instead focus on urban capital-intensive industries in their development strategies. Janvry (1976-1977) argued that developed countries produce food crops in surplus which are directed to developing countries cheaply, the long-term effect is the collapse of agriculture in developing countries, causing a hunger crisis.

Developed countries dominate and structure the world trade systems and foreign aid with the aim of sustaining and securing the stability of their economic, social and political systems (Toton, 1988). The study further posited that hunger is a consequence of policies structured to protect and promote economic systems of developed nations.

Dependency theory is criticized for not considering and interrogating the appropriateness of development projects initiated externally and by extension the theory calls for a static state (Matunhu, 2011). Adoption of dependency theory in Ghana in the 1970s and 1980s neither led to

development or independency of its economy instead it entrenched poverty and misery which by extension increased its dependency on foreign aid (Ahiakpor, 1985).

2.2.3: World-System Theory

Wallerstein is credited for development of the world system theory which is an alternative explanation of development and is closely linked to the dependency school of thought. Wallerstein came up with this theory around 1974 when the modernization theory of development was under heavy criticism and Wallerstein took the same path and aimed to develop an alternative to this theory (Wallerstein, 2000). The world system theory posits that the world should be looked at in totality as a world system which is divided into three; the core states whose production process are capital intensive and are technologically advanced and are the developed nations; the peripheral states whose production process are labour intensive and lag behind in technological advancement and are the underdeveloped nations; lastly the semi-peripheral states which are neither capital nor labour intensive in production, its productive activities are more advanced than those in the periphery but lag behind those in the core states. The semi-peripheral also exploit the peripheral and are exploited by the core, they therefore aim to move to being core states and are under pressure to not slip into peripheral states. The world system theory underscores the relationship between core and peripheral states; core states dominate and exploit the peripheral states through several mechanisms of unequal exchange, economic exploitation promoted and advanced capitalism (Wallerstein, 1974). The theory studies the world as a capitalist economic system, "The real innovation of the world systems approach lies in the choice of the primary unit of analysis – the capitalist world economy" (Petras, 1981, p. 148).

Coccia, (2018) points out that Wallerstein opposed the argument that states are the sole units of analysis and that there is one path that countries must follow to develop. He further rejects the argument that underdeveloped countries should rely on exports to develop. Coccia states that Wallerstein bases his theory on three schools of thought; the Anneles School from which he borrows its historical perspective and use of geo-economics regions as units of analysis; Max ideas on capital accumulation by capitalist so as to obtain surplus value and on competitive class struggles; the dependency theory on the exploitative relationship that exists between the core and periphery states where the core dominates the periphery.

Brenner (1977) criticizes Wallerstein work especially on how labour is incorporated in the capitalist system. Brenner propounded that the determiners of economic development as suggested by the world system theory which are; growth of trade leading to greater utilization of economic resources, transfer of surplus to the core state and specialization of labour control systems increasing effectiveness of surplus extraction by the ruling class cannot determine the rise of a world system. Brenner further observes that Wallerstein fails to take technology and innovation into consideration as factors that greatly impact on accumulation of capital, Brenner argues that taking innovation into account would undermine Wallerstein's notion that the core states developed as result of transfer of surplus from the periphery which underdeveloped the periphery.

2.3: Empirical Literature Review

This is a review of empirical studies and results undertaken relating to ODA and how it impacts agricultural productivity and by extension food security. The earliest research focused on determining how ODA affected the economic growth of developing countries while recent research has been sectoral empirical studies.

Burnside and Dollar (1997) investigated the relation between aid, policies and growth in 56 developing countries using 2 stages least squares (2SLS) method; they estimated simultaneous equations on aid, policies and growth. Instrumental variables and over-identifying of the system of equations was applied to test the inter-relationship of aid and policies and their effect on growth. The study concluded that aid had positive effects only when there were good policies and in particular; fiscal, monetary and trade policies, however, on average the impact was minimal. They went a step further to determine factors that greatly influence ODA received by countries and donor interest was established to have greater influence than recipient country's policies.

Dalgaard, Hansen and Tarp (2004) looked into the link between aid and growth by critiquing the Country Policy and Institutional Assessment Index (CPIA) by Collier and Dollar (2001, 2002). They used Over-lapping Generations model (OLG) and the Grande Causality whose results led to the conclusion that aid does have a favourable effect on productivity and hence growth and development, they however, cautioned that aid is only a stimulant to the process and not a solution in itself. The empirical analysis of the study also found a weak link between policy and

aid which was a contradiction of Collier and Dollar (2001, 2002) and further revealed a robust pattern of the ineffectiveness of aid in tropical areas.

Research that has been conducted on food security and foreign aid has majorly focused on food aid and some of studies done are; Abdulai, Barrett and Hoddinott 2004; Gelan, 2007; Ninno, Dorosh and Subbarao (2005). Effects of food-aid flows into India, Bangladesh, Zambia and Ethiopia which are major aid recipients were analysed and the conclusion reached was that if food aid is targeted toward food insecure households and timed such that producers do not suffer adverse price changes then food aid enhances food security (Ninno, Dorosh and Subbarao, 2005). Abdulai, Barrett and Hoddinott (2004) used the GMM to estimate a vector auto-regression model on panel data of 42 Sub-Saharan countries from 1970 to 2000 and found that food aid stimulated food production once country specific unobservable were controlled. Their study concluded that food production and food aid have an inverse relationship; increase in food productivity in current years implies a reduction in food aid in the future years and vice-versa.

Gelan (2007) employed computable general equilibrium modelling to analyse the effects of food aid on food production in Ethiopia. The simulation modelling found that removing food aid had a positive and significant effect on agriculture through raising employment by 4 percent and 2 percent in the agriculture and non-agriculture sectors respectively. Moreover, there was an increase in the use of agriculture land by 1.4 percent and GDP rose by 0.45 percent.

There exist a good number of studies on the effect of non-food foreign aid on agriculture growth and productivity. Norton, Ortiz and Pardey (1992) analysis on the effects of aid on agricultural growth for 98 less developed countries from 1970 to 1985 using Ordinary Least Squares method (OLS) concluded that over the period under study foreign aid had a significant effect on the productivity of the agriculture sector in Asia and sub-Saharan Africa. Over the period Asia's marginal value product (MVP) of foreign aid was 10.38 per dollar of aid while that of sub-Saharan Africa was 0.40 per dollar of aid, and for the world excluding the Middle East was 0.85 per dollar of aid. The study also used a set of models to estimate the effect of external debt on agriculture output using relative external debt levels per agricultural worker and found that in countries whose external debt exceeded 10,000 dollars per agricultural worker, foreign aid negatively impacted agricultural output. They linked this observation to the trade-off the governments in these countries had to make to pay off debt over investing and supporting

agriculture. Petrikova (2015) analysed panel data of 85 developing countries to investigate the impact of development aid on food security; the analysis used the General Method of Moments (GMM) and the 2 stage least squares (2SLS) estimators and arrived at the conclusion that general aid played a significant role in fostering food security over the period of 1994-2011. The study postulated that concessional loans, bilateral aid and agriculture aid improved food security only in countries with good governance.

Kaya, Kaya and Gunter (2008); Gyimah and Adesugba (2015); Ssozi, Asongu and Amavilah (2017) and Alabai (2014) found that increased total non-food foreign aid to the agriculture sector had a positive and significant impact on agriculture productivity in African countries. Alabai's study made use of data from 47 SSA countries for the period of 2000-2010 and applied a Generalised Method of Moments (GMM) model. The analysis revealed that foreign agricultural aid was not only beneficial but also significant on agricultural GDP and agricultural productivity at 10 percent significance. The study disaggregated foreign aid into bilateral and multilateral which revealed that bilateral agriculture aid contributed greatly to agriculture productivity while multilateral agriculture foreign aid contributed more to GDP hence economic growth was greater, this led to the conclusion that the type, nature and origin of aid could have a different impact on the recipient economy. The study also found that of the total agriculture aid, agriculture development and agriculture policy and administration received the highest amount at 25 percent and 22 percent respectively compared to the other agriculture sub-sectors that received below 10 percent each. Ssozi, Asongu and Amavilah (2017) went further to analyse the effect of ODA on food crop and industrial crop production. They used the system two-step GMM on data from 36 SSA for the period of 2002-2015, their results and conclusion were that ODA improved industrial crop productivity but a negative relationship existed between ODA and food crop production. The study underpinned the importance of good public institutions and economic freedom as enablers of agricultural productivity growth and increased ODA effectiveness.

Akpokodje and Omojimite (2008) looked into the effects of development assistance on Nigeria's agriculture growth through simultaneous equations with control variables and found that foreign aid positively and significantly impacted agriculture growth. Their results and conclusion were however contradicted by a subsequent similar study in Nigeria; Ighodaro and Nwaogwugwu

(2013) use autoregressive distributed lag (ARDL) method and the Error Correction Models concluded that domestic savings and not foreign aid produces a positive impact on agriculture growth in the short and long run in Nigeria.

The target of literature on foreign aid in Kenya is the nexus between foreign aid and economic growth and development and is on the economy as a whole. Oduor and Khainga (2009) analysed effectiveness of aid on poverty reduction; they concluded that ODA has been impactful in eradicating poverty in the districts that had ODA funded projects. Njeru (2003) analysis showed that foreign aid flows and project aid positively and significantly influence development expenditures which implies a significant effect on the public financial planning process. He further postulated that the government switches overseas aid from the intended development activities to recurrent expenditures; this concurs with Devarajan et al., (1998) conclusions on aid fungibility.

The focus of this research paper is on agriculture foreign aid; its impact on productivity and eventual food security in Kenya. Investment is vital for agriculture productivity to be realized, however, Kenya's public expenditure into the sector is below the recommended 10 percent Maputo agreement and hence foreign aid can supplement the deficit. In this respect, I have not come across existing research study of this nature conducted in Kenya; those conducted in Sub-Saharan Africa and developing countries have led to differing conclusions as earlier discussed and propose opposing policies to be adopted on issues of foreign aid. The study findings would be of importance to economic policy formulaion in Kenya and donors as it will inform as to whether foreign agriculture aid is beneficial and promotes food security. The study will further try to establish the relationship between agriculture foreign aid and government spending into the agriculture sector; this would help in reforming the sector through the much-needed investment.

2.5: Literature Review Overview

From the discussed literature conducted on food security, official development aid and agriculture; it can be concluded that most of the studies on ODA focus on economic growth of economic blocks while those studies conducted relating ODA to food security have majorly focused on food-aid. There are few studies that have been conducted relating ODA to agriculture and how that affects food security however no such study has been conducted in Kenya.

Literature shows that ODA has a positive impact on economic growth and some research went

ahead to conclude that governance policies play a role in explaining to what extent the positive impact is experienced in a country. Literature is divided on the impact of food-aid on a country's food security. Research conducted on interaction of agricultural ODA with agricultural productivity reveal that ODA contributes positively to agricultural productivity of countries.

This research paper will focus on agricultural ODA and its impact on agricultural productivity in Kenya which impacts on food security in the country. The research will further attempt to analysis the relationship between Agricultural ODA and the government's spending into the agriculture sector. By extension, it will be useful in policy formulation which will assist in making informed policy decisions with regards to ODA sector investment and government spending into the agricultural sector.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1: Introduction

This chapter provides a description of various steps and methods that the research employed so as to realize the objectives of the study. It accounts for the theoretical framework, model specification, variable descriptions, measurement and expected signs, data type and sources, data analysis, model diagnostic tests and limitation of the study.

3.2: Theoretical Framework

The main objective achieved here is research of the effect of agricultural foreign aid on agricultural productivity and government investment into the sector. The results of the study will be useful in formulating policy recommendations that would help improve agriculture productivity and by extension improve food security in Kenya. Data was analysed in the form of a multiple linear regression model through selection of determinants of food security and incorporating agricultural ODA into the factors. Aker and Lemtouni (1999) put forward eight determinants of food security for their function;

$$FS = f\left(Y, R, P, GDP, Gini, {}^{TDS}/_{XGS}, FI, H\right) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdot \; eqn\ 1$$

The variables are:

Y = domestic food production; R = average annual rainfall; P = world food prices; GDP = Gross Domestic Product; Gini = Gini coefficient of income distribution; TDS/XGS = total debt service obligations/exports of goods and services; FI = female illiteracy rate and FS= Food security

This study made use of Aker and Lemtouni equation with slight modifications on the variables. Country level measures of food security mostly focus on one dimension of food security which is the food availability (Jones et al., 2013). This study is country wide and the focus is how agriculture contributes to food security, therefore food availability will be the main focus since for a country to be food secure it has to ensure that food is available. The other dimensions of food security; accessibility of food, utilization of food and stability of food availability, accessibility and nutritional value rely on the availability dimension of food security. For that reason, this study made use of the food production index as a proxy for food security and incorporate factors that affect food security. The general form of the multiple linear regression equation that was applied is as below:

$$FPI = f(AODA, GAE, GHG, ER, POPL, GDPGR\ ) \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \; eqn\ 2$$

FPI being Gross Food Production Index Number (2004-2006 = 100) for Kenya

AODA being agricultural official development aid to Kenya in US dollars

GAE being government expenditure directed to agricultural in Kenya in Kenya shillings

GHG is Greenhouse gas emission in Kenya

Exchange Rate (ER) for Kenya

Popl is the Kenyan population

GDPGR is Kenya's growth domestic product growth rate

The explanatory variables chosen are factors that affect agricultural productivity. Annual greenhouse house (GHG) emission is a representative of climatic change. GHG emissions affect the ozone layer causing global warming. The effects of global warming; changes in temperature and precipitation, natural disasters like floods, droughts and heat waves all adversely affect agricultural activities and make the country more food insecure (GOK, 2018). Studies by Verter (2017) and Hanif, Nisa and Yaseen (2019) used Carbon dioxide (Co2) emission to represent climate change and from econometric analysis Co2 emission appeared to depress agricultural productivity. Exchange rate affects agricultural productivity though import of inputs and machinery used in agricultural activities; prices of these imports vary with fluctuations of the exchange rate. Uremadu et al (2018) empirical analysis revealed a positive significant effect of government agriculture expenditure in Nigeria's agricultural productivity while real exchange rate produced a negative effect on agricultural output though insignificant. Population growth affects agricultural productivity through increased occupation of land suitable for agriculture, high altitude and humid areas have high crop productivity however due to population density land subdivision is rendering farming an uneconomical activity (GOK, 2010). Population growth also provides cheap labour for agriculture which reduces reliance on and adaptation of improved, mechanized and efficient ways of carrying out agricultural activities. Ighodaro and Nwaogwugwu (2013) and Uremadu et al (2018) studies showed that population affected agriculture and the empirical results revealed an inverse relationship.

Gross domestic product growth rate (GDPGR) was a control variable. Growth rate of GDP is associated with business cycles and hence influences an economy's productivity.

The variables under consideration that are not in percentage form; FPI, GAE, GHG and POPL will be transformed using natural logarithms such that the coefficients yielded from the analysis will be percentages which are more informative in regards to the impact of the variables.

3.3: Conceptual Framework

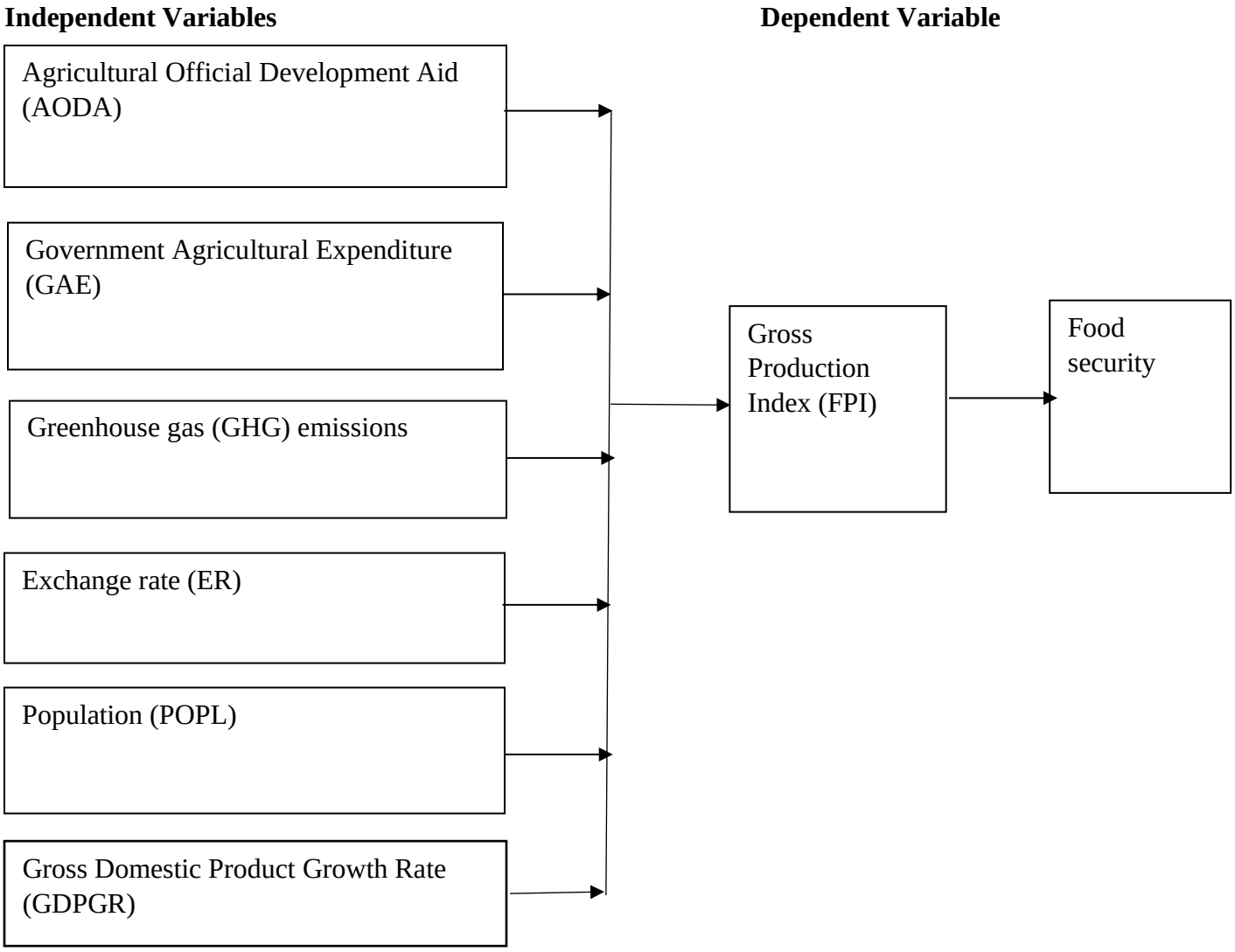


Figure 4: Conceptual Framework

Source: Author

3.4: Model Specification

A multiple linear regression function was estimated with food production index being the regressor variable determined by the following factors; agricultural official development aid to Kenya, government expenditure directed to agriculture in Kenya; annual greenhouse house emission, exchange rate, Kenyan population and growth rate of gross domestic product in the function.

$$lnFPI = \alpha_0 + \alpha_1\, lnAODA_t + \alpha_2 lnGAE_t + \alpha_3 lnGHG_t + \alpha_4 ER_t + \alpha_5 lnPopl_t + \alpha_6 GDPGR + \varepsilon_t \quad \cdots\cdots\cdots\cdots\cdots eqn\ 3$$

$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5\ and\ \alpha_6$; are the coefficients of the independent variables to be estimated and are indicative of the extent of impact they each have on the dependent variable and $\varepsilon_t$is the error term.

To measure the impact of the independent variables on the dependent variable and to establish their interaction the study used the Autoregressive Distributed Lag (ARDL) and the Error Correction Model (ECM). The ARDL and ECM models allows for testing of existence of both the short run and long relationship of the variables being studied. When the F-statistics from ARDL model is less than the lower bound only the short run model equivalent to equation 3 is estimated. The long run relationship is estimated when the F-statistic obtained is greater than the lower and upper bound, which leads to estimation of the ECM. The short run and long run relationship that was estimated is as below;

$$\begin{aligned}\Delta lnFPI = {} & \alpha_0 + lnFPI_{t-1} + \alpha_1\, lnAODA_{t-1} + \alpha_2 lnGAE_{t-1} + \alpha_3 lnGHG_{t-1} + \alpha_4 ER_{t-1} \\ & + \alpha_5 lnPOPL_{t-1} + \alpha_6 GDPGR_{t-1} + \sum_{i=1}^{n} \Delta\beta_1 FPI_{t-i} + \sum_{i=0}^{n} \Delta\beta_2 lnAODA_{t-i} \\ & + \sum_{i=0}^{n} \Delta\beta_3 ER_{t-i} + \sum_{i=1}^{n} \Delta\beta_4 lnGAE_{t-i} + \sum_{i=1}^{n} \Delta\beta_5 lnPOPL_{t-i} \\ & + \sum_{i=1}^{n} \Delta\beta_6 GDPGR_{t-i} + \sum_{i=1}^{n} \Delta\beta_7 lnGHG_{t-i} + \varepsilon_t \cdots\cdots\cdots eqn\ 4\end{aligned}$$

Where $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5\ and\ \alpha_6$ are the long run coefficients and $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5\ and\ \beta_6$are the model dynamics over a short run period and n is representative of the number of optimal lags.

3.5: Variables Definitions, Measurement and Expected Signs

This is a description of the measurement of the variables used in the study together with their expected signs.

Table 5: Variable Definitions, Measurement of variables and Coefficients Expected Signs

Variable	Measurement	Expected Sign	Authors who have used similar variables
Dependent Variable			
Food Production Index (FPI)	US dollars	Positive (+)	
Independent Variable			
Agricultural ODA	US dollars	Positive (+)	Akpokodje Omojimite (2008), Alabai (2014) Ighodaro and Nwaogwugwu (2013)
Agricultural Government Expenditure	Kenya Shillings	Positive (+)	Uremadu et al (2018), Ebenezer et al (2019)
Population	Persons	Negative (-)	Ighodaro and Nwaogwugwu (2013)
ER	Kenyan shilling per USD	Negative (-)	Kadir and Tugaal (2015)
GHG	Tonnes	Negative (-)	Hanif, Nisa and Yaseen (2019)
GDPGR	% of US$, 2015 prices	Positive (+)	Aroriode and Ogunbadejo (2014) _

3.6: Data Type and Sources

This study used annual time series data spanning 1980 to 2017 at the National level and data was obtained from; FAO Statistics, World Bank and International food policy research institute (IFPRI).

3.7: Data Analysis

Data analysis and evaluation was done using Stata Statistical software. The statistical analysis of the data conducted made it possible to establish how and to what extent the independent variables considered in this study and in particular agricultural official development aid influenced food productivity and by extension food security.

3.8: Diagnostic Tests

The following tests were carried out before estimating the regression model:

3.8.1: Unit Root Test

Economic time series data can have a characteristic of a strong trend hence produce a spurious regression which is commonly referred to as a non-stationary time series. Gujarati, 2004 states that a stationary time series is one whose properties that is the mean, variance and autocorrelation are invariant over time therefore a regression process will not depend on time. Non-stationary time series are difficult to model and hence the need to make them stationary through a unit roots test. The trend is removed through de-trending the series to remove the non-stationarity in it. The Dickey-Fuller tests will be used to test for the presence of unit roots and if present, differencing will be used to de-trend a non-stationary time series. The Augmented Dickey Fuller Test (ADF) is a robust test as it allows inclusion of an optimal number of lags enabling elimination of autocorrelation in the error term.

We test the following hypothesis when investigating stationarity:

$$H_O: \rho = 0 \text{ (For a non} - \text{stationary time series)}$$

$$H_1: \rho < 0 \text{ (For a time series that is stationary)}$$

Rejection of the null hypothesis occurs only on establishment that a time series data is stationary or stationarity attained.

3.8.2: Multicollinearity

Multicollinearity is a statistical regression problem experienced when one of the independent variables is highly correlated with another independent variable or a combination of independent variables. A high correlation between or among one or more of the predictor variables produces a regression not stable and whose coefficients cannot be relied upon to interpret the economic phenomenon under study. This study will test for existence of multicollinearity among the predictor variables by use of the Variance Inflation Factor (VIF). The rule of thumb is that any VIF values exceeding 10 imply that multicollinearity between variables is very high and such variables cannot be used together in the regression model.

3.8.3: Autocorrelation

Autocorrelation arises when a variable's values are related over time implying that there exists a relationship of the variable with itself. Presence of great autocorrelation in a time series data set suggests that the disturbance term will not be independent as OLS assumes for its analysis. The

study will make use of the Breusch-Godfrey Test, AR(q) to check for the presence of autocorrelation.

3.8.4: Co-integration

The test for co-integration was done to establish whether two or more non-stationary time series data sets analysed had a long-run equilibrium such that if the variables were linearly combined the error terms would be stationary. A co-integration test aims to establish whether the residuals of the co-integrating regressions are integrated of either order zero or order one. ARDL bounds test for co-integration was used to test for cointegration. Pesaran, Shin and Smith (2001) came up with the ARDL bounds test of cointegration that allows for cointegration test to be conducted on time series data stationary at different levels; a combination of stationary at level I (0) and stationary at first difference I (1) unlike the Johansen test that requires stationaruty at same difference. This test of cointegration also provides long run estimates that are unbiased (Alimi, 2015). The hypothesis tested under ARDL bound test is that there is no cointegrating equation ($H_0 = no\ cointegration$). Rejection of the null hypothesis at the 10%, 5% or 1% level is under two instances: if the F-statistic obtained is greater than the critical value for the upper bound $\langle I(1) \rangle$ and also greater than the critical values for the lower bound $\langle I(0) \rangle$.

3.9: Limitation of the Study

This study focuses on the food availability dimension of food security on a country level analysis and is hence not a reflection of the state of food security at the household level. Though the other dimensions of food security are dependent on food availability they are not necessarily achieved when food availability is achieved. The study would also like to assess how the state of rural infrastructure extensively affects food security that is in respect to state of transportation, communication and mechanization of Kenyan rural areas. However, this is not possible at the time because of unavailability of sufficient data.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0. Introduction

In this chapter, results of the study are given in line with the objectives of the study. Pre-estimation diagnostic tests results are first given, followed by the Autoregressive distributed lag (ARDL) and Error correction model (ECM) results and results findings. The chapter ends with the post-estimation diagnostic test results.

Table 6 is a summary of descriptive statistics of the variables for the period of 1980 to 2018. Descriptive statistics give an insight of the data being used. Exchange rate (ER) has the highest mean and the largest maximum while its minimum is the second smallest, this shows high volatility of the exchange rates within the period under consideration which is further underscored by its large standard deviation. The other variables have considerably low standard deviations.

Table 6: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lnFPI	39	4.147127	.3361399	3.553918	4.624679
ER	39	56.87998	31.01424	7.420187	103.4109
lnPOPL	39	17.23081	.3377955	16.61384	17.755
lnGHG	39	10.70797	.3154537	10.2543	11.28414
lnGAE	39	22.84216	1.087886	20.84371	24.78547
lnAODA	39	18.43463	.8376586	16.37429	19.96225
GDPGR	39	4.934677	2.3026	.200506	9.405699

Source: Author's Computation

4.2. Pre-estimation Diagnostic Tests

Time series data is tested before regression modeling to determine its characteristics and align it to statistical modelling. Tests carried out were unit root test for stationarity using the ADF test, multicollinearity test to test for residuals correlation through the variance inflation factor test and cointegration to test for existence of long run equilibrium of the variables.

4.2.1. Unit Root Test

Complied study data set was subjected to a unit roots test to determine the order of integration for stationarity of the data. The order of integration was particularly useful when performing the ARDL bounds test as it limits to order one of integration, if variables are stationary at higher

orders of integration the test becomes invalid (Ouattara, 2004). The null hypothesis being tested: $H_o = Stationary$

The Augmented Dickey Fuller (ADF) test was used to determine unit roots. Table 7 presents a summary of the ADF test for the variables. First, entire data set was tested at level, zero lags. Variables not stationary at percent levels of 1, 5 and 10 were differenced and retested for unit roots.

Table 7 : Augmented Dickey Fuller Test

	At level		**First difference**	
Variable	**P-Value**	**Test Statistic (t)**	**P-Value**	**Test Statistic (t)**
lnFPI	0.275	-1.109 ***	0	-7.190
lnGHG	0.978	0.028 ***	0	-6.072
ER	0.442	-0.777 ***	0	-5.711
lnPOPL	0	-20.68	-	
lnGAE	0.042	-2.105 ***	0	-4.882
lnAODA	0.004	-3.045 *	0	-7.807
GDPGR	0.01	-3.442*	0	-6.763

*Source: Author's Computation. The values with the subscripts *, ** and *** shows failure to reject the Ho at the 1%, 5% and 10% critical levels respectively*

The absolute values of the t statistic for; lnPOPL is greater than the critical values at all levels of significance therefore the null hypothesis was rejected hence stationary at value. The absolute values of lnFPI, lnGHG, ER, lnGAE, GDPGR and lnAODA are not less than the absolute critical values at various levels of significance therefore the null hypothesis was not rejected hence their time series was non-stationary at level. In order to make the series stationary, the first difference for lnFPI, lnGHG, ER, lnGAE, GDPGR and lnAODA was obtained and the unit root test performed which yielded stationary series as shown in table 7.

4.2.2. Multicollinearity

A test for multicollinearity was conducted using the variance inflation factor. Table 8 shows the variance inflation factor and its inverse for each variable in its stationary form.

Table 8: VIF with Differenced Variable

Variable	**VIF**	**1/VIF**
dlnGHG	1.16	0.861465
dER	1.08	0.926719
lnPOPL	1.08	0.924396

dlnGAE	1.09	0.916621
dlnAODA	1.12	0.892337
dGDPGR	1.05	0.948483
Mean VIF	1.10	

Source: Author's Computation

The test results revealed that there was no multicollinearity among the independent variables since the VIF values for all the six variables are less than 10.

4.2.3. Autocorrelation

The data was tested for serial correlation of the residuals using the Breusch-Godfrey LM test. The null hypothesis tested was that the residuals are not serially correlated and it is rejected when the p-value is greater than 5 percent. Table 9 shows the test results obtained with a p-value of 0.1603.

Table 9: Breusch-Godfrey LM test for Autocorrelation

Lags (p)	chi2	Df	Prob > chi2
1	1.971	1	0.1603

Source: Author's Computation

H_O: No serial correlation1

The p-value obtained is greater than 5 percent which is an indication that the data was not adversely affected by serial correlation.

4.2.4. Lag Length Selection Criterion

A test for lag selection was conducted using varsoc. Table 10 shows the results for lag length selection; Final prediction error (FPE), Akaike information criterion (AIC), Hannan-Quinn information criterion (HQIC) and Schwarz information criterion (SBIC) were minimized at lag 2. SBIC had the lowest value and was chosen for this study.

Table 10: Lag Length Selection Criteria

Lag	**LL**	**LR**	**Df**	**p**	**FPE**	**AIC**	**HQIC**	**SBIC**
0	-138.003				6.0e-06	7.83799	7.94544	8.14276
1	168.604	613.21	49	0.000	5.6e-12	-6.08668	-5.22712	-3.64853
2	270.428	203.65*	49	0.000	4.4e-13*	-8.94204*	-7.33037*	-4.37052*

Source: Author's Computation

4.2.5. Cointegration

The ARDL bound test for cointegration was conducted instead of the Johansen Test for cointegration as earlier proposed because the variables are stationary at different levels. The Johansen test for cointegration is best suited when the variables are stationary at first difference however since the unit root test conducted revealed that the variables under consideration are stationary at different levels the ARDL bound test was applied. The hypothesis tested under ARDL bound test is that there is no cointegrating equation ($H_0 = no\ cointegration$). The null hypothesis is rejected at the 10%, 5% or 1% level under two instances: if the F-statistic obtained is greater than the critical value for the upper bound $\langle I(1) \rangle$ and also greater than the critical values for the lower bound $\langle I(0) \rangle$.

Table 11 is a presentation of the ARDL bounds test for cointegration carried out. The results indicate that the F-statistic is greater than the critical values of the lower bound and upper bound. Therefore, we reject the null hypothesis and conclude that there is cointegration. This implies that the variables have a long run relationship and hence the error correction model was estimated to establish the long run relationship of the variables.

Table 11: Cointegration Diagnostic Test Results of FPI, GAE, AODA, ER, POPL, GHG and GDPGR

F = 5.193

	10 percent level		5 percent level		2.5 percent level		1 percent level	
	(1_0)	(1_1)	(1_0)	(1_1)	(1_0)	(1_1)	(1_0)	(1_1)
K_6	2.12	3.23	2.45	3.61	2.75	3.99	3.15	4.43

Source: Author's Computations

4.3. Error Correction Estimates of the ARDL Model

Table 12 gives the summary results for the ECM ARDL model run; it shows that 38 data sets were used. The R-squared of 63.06 percent indicates the extent which the independent variables elucidates movement in the dependent variable by 63.06 percent which is an indication that the model is a good fit.

Table 12: Model summary

Description	Value
Number of observations	38
R-squared	0.6306
Adj R-squared	0.4743
Log likelihood	82.200637
Root MSE	0.0336

Source: Author's Computations

The results of the ECM ARDL model are as represented in table 13 and table14. Table 13 shows the long run relationship of the variables. From the long run empirical results population has a significant effect on gross production index at 1 percent level. A one percentage increase in population causes FPI to increase by 2 percent. The results for population are contrary to the expectations of this study but are in agreement with economic theory where greater population implies more labour force which impacts productivity favourably. Exchange rate and greenhouse gas emission are significant at 5 percent level and both have an inverse relationship with FPI which is in agreement with the study's expectations and economic theory. A one per centum increment in exchange rate causes FPI to decline by 0.0037 per centum on the other hand if GHG rises by one per centum FPI declines by 0.244 percent, this observation concurs with economic theory that increase in greenhouse gas emissions negatively impacts on productivity. AODA is significant at 10 percent level and has a positive impact on FPI where a percentage increase in AODA causes FPI to increase by 0.022 percent. GAE and GDPGR have a positive impact on FPI however, they are insignificant at the three levels of significance (1 percent, 5 percent and 10 percent).

The error correction term is negative (-0.95) and highly significant and indicates the rate at which the short run model adjust to the long run equilibrium. A coefficient of -0.95 is an indication that the short runs adjust to long run equilibrium at a high pace.

Table 13: The Long Run Relationship

dlnFPI	Coef.	Std. Err.	T	P>T	[95% Conf. Interval]	
ADJ lnFPI L1	-.9534245	.1762491	-5.41	0.000	-1.31571	-.5911393
lnAODA	.0223601	.0128699	1.74	0.094	-.0040944	.0488145
lnGHG	-.2444149	.114119	-2.14	0.042	-.47899	-.0098399
ER	-.0036515	.0012113	-3.01	0.006	-.0061413	-.0011616
lnGAE	.0272354	.0250509	-1.09	0.287	-.0787283	.0242575
lnPOPL	2.000483	.2516124	7.95	0.000	1.483286	2.51768
GDPGR	.0032886	.0033742	0.97	0.339	-.0036472	.0102244

Source: Author's Computations

Table 14 is the output for the short run relationship of the variables. In the short run only lagged population and government expenditure have positive and significant impact on future productivity. A one per centum population growth causes FPI to increase by 31 percent while an increment of GAE by a per centum causes FPI to increase by 0.035 percent. AODA is insignificant and negative in the short run which implies that a 1 percent increase in AODA leads to reduced productivity which is the inverse of its impact in the long run. GAE positively impacts FPI which is the inverse of the long run effect, this is likely to be caused by the meager allocations to the sector, its positive impact in both the long run and short run is an indication of its positive feedback effects into agriculture and hence the need to increase the allocations.

Table 14: The Short Run Relationship

dlnFPI	Coef.	Std. Err.	T	P>T	[95% Conf. Interval]	
ΔAODA	-.0156621	.0103577	-1.51	0.143	-.0369526	.0056285
ΔlnGHG	.1210586	.118282	1.02	0.316	-.1220734	.3641907
ΔER	.0013661	.0013581	1.01	0.324	-.0014255	.0041576
ΔlnGAE	.0354431	.0214289	1.65	0.100	-.0086047	.0794909
ΔlnPOPL	31.02843	9.8231	3.16	0.004	10.83676	51.2201
_cons	-27.4754	5.170438	-5.31	0.000	-38.10338	-16.84741

Source: Author's Computations

The overall ECM ARDL model equation is:

$$\Delta lnFPI = -27.475 - 0.95[lnFPI_{t-1} - 0.022lnAODA - (-0.322)lnGHG - (-0.0037)ER - (-0.027)lnGAE - 2lnPOPL - 0.003GDPGR] - \Delta 0.016lnAODA + \Delta 0.001ER + \Delta 0.035lnGAE + \Delta 31.028lnPOPL$$

4.4: Granger causality test to determine relatioship between AODA and GAE

The granger causality null hypothesis tested was there is no causality between variables under consideration. The point of rejection is a p-values less than or equal to 0.005. Table 15 shows the granger causality tests obtained for lagged and differenced AODA and GAE. The P-values obtained (0.474 and 0.423) are greater than 5 percent which is an indication that the two variables do not granger cause each other. These results agree with the Granger causality Wald tests in Appendix 2. Therefore, no significant relationship exists between AODA and GAE.

Table 15: Granger causality test results for AODA and GAE

	dlnFPI	dlnGHG	dlnAODA	dlnGAE	lnPOPL	dGDPGR	dER
dlnAODA L1.							
Coef.	4.283497	-1.668883	-.3650305	-.1309597	49.06834	-.0221124	.0071646
Std. Err.	2.015088	1.652992	.1294317	.3469264	68.56558	.0455045	.0167903
Z	2.13	-1.01	-2.82	-0.38	0.72	-0.49	0.43
P>z	0.034	0.313	0.005	0.706	0.474	0.627	0.670
dlnGAE L1.	dlnFPI	dlnGHG	dlnAODA	dlnGAE	lnPOPL	dGDPGR	dER
Coef.	1.753763	2.892179	-.1750618	-.9703391	.0135495	.0534932	21.61005
Std. Err.	2.028186	1.663736	.130273	.3491814	.0168995	.0458003	69.01125
Z	0.86	1.74	-1.34	-2.78	0.80	1.17	0.31
P>z	0.387	0.082	0.179	0.005	0.423	0.243	0.754

Source: Author's Computations

4.5. Postestimation diagnostics

These are statistical tests to determine suitability, reliability and stability of estimated coefficients. The tests will check for autocorrelation and homoscedasticity of residuals and stability of the model of the parameters.

4.5.1. Autocorrelation

The Durbin-Watson d-statistic of 2.17 indicates no autocorrelation which is in aggreement with the Breusch-Godfrey LM test whose P-value is greater than 5 percent indicating absence of serial correlation.

4.5.2. Heteroskedasticity

The White's test for heteroskedasticity yielded a P-value of 0.4236 which means that the null hypothesis of presence of homoskedasticity was not rejected.

4.5.3 Model stability

To establish stability of the model; the equation obtained was subjected to a recursive estimate test was by running the CUSUM tests and CUSUM of squares tests. The CUSUM test is a cumulative sum of the recursive residuals which are plotted with the 5 percent critical lines. Parameter stability occurs when the cumulative sum falls between the areas of two critical lines. 5 percent level of significance. The results from figures 5 and 6 show that the model is stable at 5 percent level of significance.

Figure 5: Cusum6 Test

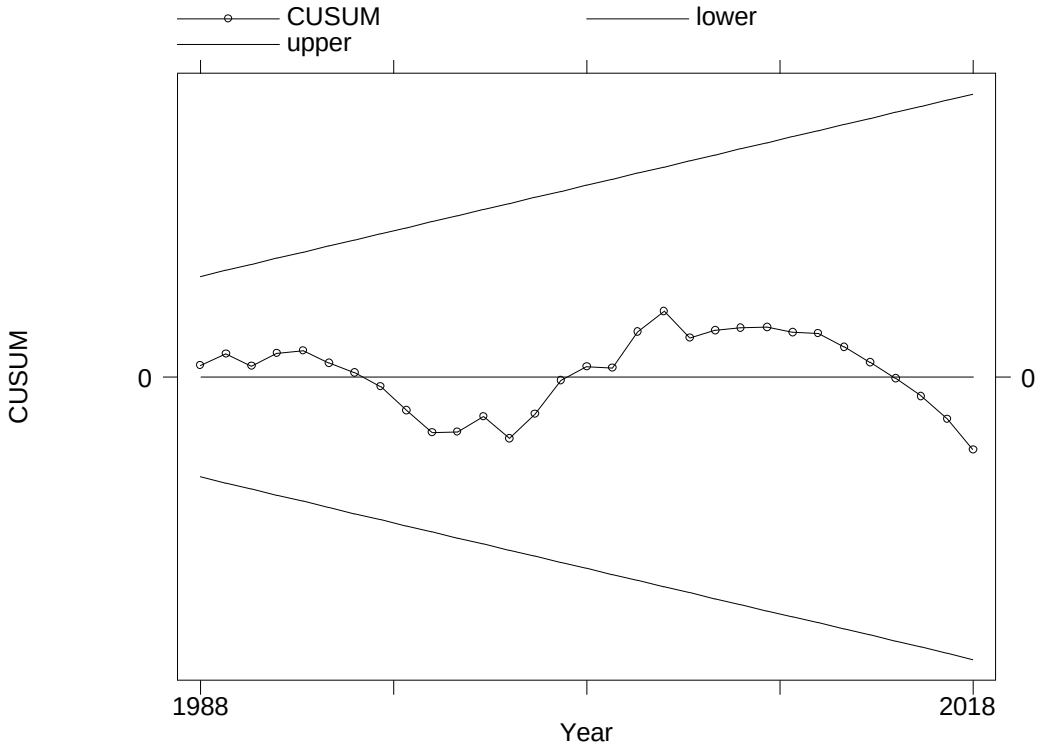
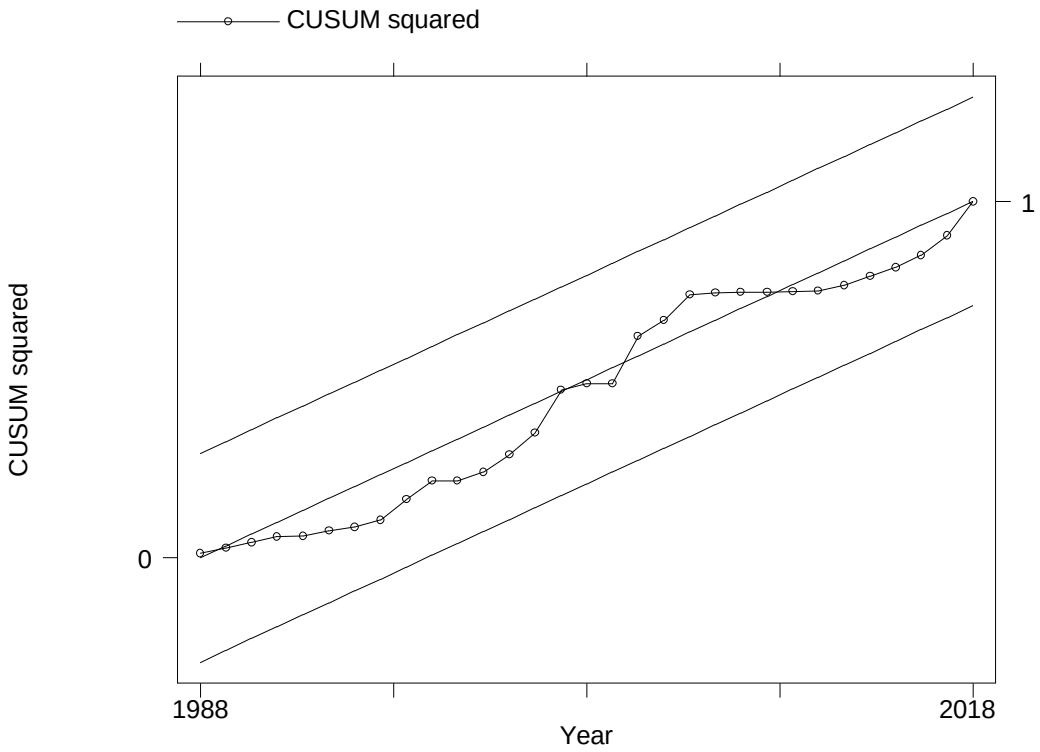


Figure 6: Cusum6 Squared Test



CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary of Study Findings

This study aimed to assess the effect of two major sources of investment into the agriculture sector in Kenya; agricultural foreign aid on agriculture and government expenditure into the sector with the study results aimed at formulating policy recommendations that would help improve agriculture productivity and by extension improve food security in Kenya.

The empirical analysis done on data for the period of 1980 to 2018 revealed that foreign aid in the form of official development flows to agriculture is significant in the long run with a positive impact implying that an increase in aid to agriculture increases productivity in the long run. However, it was insignificant and negative in the short run. That inverse effect can be attributed to the volatile nature of aid coupled with lengthy procedures for committed aid to be disbursed, the lags between commitment and disbursements delay implementation of projects and eventual benefits to the agriculture sector. Government expenditure into agriculture was positive both in the short run and long run but was only significant in the short run. The positive effect aligns with economic theory and research undertaken. For example, Kipruto and Nzai (2018) in their analysis on agricultural expenditure in agriculture in Kenya concluded that public expenditure has a positive and significant effect on agriculture output. Two studies in Nigeria conducted by Adofu (2012) and Ewubare and Eyitope (2015) analysis on public spending into agriculture revealed a significant and positive contribution of public spending into agricultural productivity.

5.2. Conclusion

The ECM results show that AODA positively impacts on agriculture productivity and is significant in the long run. Government expenditure into agriculture though insignificant does have a positive effect on agriculture productivity in the long run and significant in the short run at 10 percent with a positive effect. Food security is therefore boosted as productivity increase. The granger causality results indicated no relationship between AODA and GAE, that is, one cannot be used to predict the future of the other therefore they do not influence each other.

Greenhouse gas emissions was significant and negatively affects agricultural productivity hence lowers food security. The government should implement and enforce policies that will lower emissions and increase absorption of gasses through increased forest coverage.

5.3. Recommendations

Great concern has been raised on the declining food security in the last decade. Kenya being an agriculture dependent economy needs to focus attention on how to boost productivity in the sector and one such way to do it is increase funding to the sector. From this study's findings AODA is positively and significantly influences agriculture productivity in the long run while government agriculture expenditure though insignificant in the long run does positively influence productivity. In the short run government expenditure significantly and positively impacts productivity. Therefore, the following recommendations would go a long way to boost productivity.

i. The government through the ministry of treasury should allocate more resources to the agriculture sector to improve productivity.
ii. The study recommends for the government to align its policies with aid donors particular with regards to agriculture so as to boost aid received in the sector. Aid disbursed should also be followed up to ensure management of the aid by ensuring it is directed to improve the areas and factors limiting agricultural productivity like improving infrastructure to promote ease of movement of inputs and outputs and accessibility of markets and mechanization of agriculture activities.
iii. The government should take conscious efforts to monitor finances meant for agriculture are utilized in the sector and for the purpose intended. This will ensure that budgetary allocations and foreign aid are not mismanaged.
iv. Policies should be put in place to reduce emission of greenhouse gasses since they have detrimental long-term effects on agriculture productivity and hence food security.
v. The government through the central bank should purpose to implement monetary policies with an aim to stabilize the exchange rate. This will help to stabilize prices of imported agriculture inputs.

5.4. Areas for Further Research

This study found inverse results on the impact of aid to agriculture in the short and long run. Therefore, further studies need to be done, first on the effect and extent of impact of disaggregated sources of aid; that is bilateral and multilateral aid on agricultural productivity in Kenya. Second, there is need to analyse the effect of utilization of agricultural foreign aid received on agricultural productivity in Kenya: the study would analyse the different uses agricultural foreign aid is put into in the agricultural sector that is; administrative, research and technology, training and information dissemination, land development, extension services, inputs, water resources and irrigation developments, agricultural cooperatives and post-harvest activities. The focus of this study was non-food aid, a study on the effects of food aid on food security in Kenya should be conducted to establish the impact of food aid on food security in Kenya.

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APPENDICES

Appendix 1: Raw Data for the Period 1980 to 2018

Year	FPI	POPL	ER	GHG	GDPGR	AODA	GAE
1980	34.95	16,417,197.00	7.420187	28,468.69	5.591976207	84,970,000.00	1,128,000,020.98
1981	35.1	17,063,876.00	9.047498	28,404.28	3.773544197	79,250,000.00	1,868,000,030.52
1982	39.12	17,736,326.00	10.92232	29,812.38	1.506478254	101,070,000.00	1,745,000,004.77
1983	40.32	18,431,761.00	13.31152	31,668.24	1.309050242	92,410,000.00	2,023,999,929.43
1984	37.5	19,146,400.00	14.41387	33,170.18	1.755216977	48,150,000.00	1,659,999,966.62
1985	42.11	19,877,083.00	16.43212	33,349.26	4.30056182	43,550,000.00	2,674,000,024.80
1986	46.02	20,622,560.00	16.22574	34,675.61	7.177555391	38,130,000.00	2,773,999,929.43
1987	46.1	21,382,112.00	16.45449	34,921.40	5.937107446	240,100,000.00	4,184,999,942.78
1988	50.15	22,153,676.00	17.7471	36,807.31	6.20318382	258,810,000.00	2,855,999,946.59
1989	52.44	22,935,092.00	20.57247	38,381.07	4.690348768	87,650,000.00	7,559,000,015.26
1990	51.42	23,724,579.00	22.91477	38,490.00	4.192050974	183,920,000.00	5,374,499,797.82
1991	53.67	24,521,703.00	27.50787	37,250.00	1.438346791	286,410,000.00	3,190,000,057.22
1992	54.95	25,326,078.00	32.21683	37,250.00	-0.79949396	137,810,000.00	3,883,000,135.42
1993	53.19	26,136,216.00	58.00133	37,050.00	0.353197256	106,290,000.00	4,184,000,015.26
1994	54.68	26,950,513.00	56.05058	37,310.00	2.632784519	95,320,000.00	6,115,999,698.64
1995	55.5	27,768,296.00	51.42983	37,650.00	4.406216526	42,670,000.00	9,068,999,290.47
1996	52.71	28,589,451.00	57.11487	37,190.00	4.146839267	32,300,000.00	7,304,999,828.34
1997	53.87	29,415,659.00	58.73184	37,110.00	0.47490192	79,190,000.00	7,647,999,763.49
1998	56.99	30,250,488.00	60.3667	38,560.00	3.290213723	36,620,000.00	8,294,199,943.54
1999	61.15	31,098,757.00	70.32622	40,730.00	2.305388596	18,700,000.00	10,317,999,839.78

Year	FPI	POPL	ER	GHG	GDPGR	AODA	GAE
2000	57.66	31,964,557.00	76.17554	39,680.00	0.599695392	60,860,000.00	9,408,220,291.14
2001	63.51	32,848,564.00	78.5632	39,200.00	3.779906496	40,380,000.00	9,536,165,237.43
2002	66.06	33,751,739.00	78.74914	40,100.00	0.54685953	12,920,000.00	10,670,681,953.43
2003	67.93	34,678,779.00	75.93557	41,070.00	2.932475546	67,930,000.00	10,487,529,754.64
2004	70.05	35,635,271.00	79.17388	43,690.00	5.104299776	75,570,000.00	12,206,629,753.11
2005	79.64	36,624,895.00	75.55411	44,060.00	5.906666082	112,300,000.00	10,850,476,264.95
2006	82.71	37,649,033.00	72.10084	44,530.00	6.472494299	173,650,000.00	9,920,269,966.13
2007	85.02	38,705,932.00	67.31764	61,330.00	6.850729771	136,440,000.00	14,141,613,960.27
2008	86.82	39,791,981.00	69.17532	62,660.00	0.232282746	57,520,000.00	16,791,904,449.46
2009	90.41	40,901,792.00	77.35201	63,080.00	3.306939815	219,990,000.00	23,876,750,946.04
2010	95.67	42,030,676.00	79.23315	64,700.00	8.405699224	357,490,000.00	31,809,448,242.19
2011	91.49	43,178,274.00	88.81077	67,080.00	6.10826372	87,090,000.00	39,793,964,385.99
2012	95.22	44,343,467.00	84.5296	66,430.00	4.563209131	167,720,000.00	56,380,786,895.75
2013	98.06	45,519,981.00	86.12288	68,440.00	5.878680567	322,850,000.00	43,508,396,148.68
2014	98.39	46,700,055.00	87.92216	71,370.00	5.357125644	191,630,000.00	53,094,184,875.49
2015	100.62	47,878,336.00	98.17845	73,990.00	5.718507131	295,900,000.00	33,202,262,878.42
2016	100.99	49,051,534.00	101.5044	79,550.00	5.8789493	223,600,000.00	41,449,066,162.11
2017	100.25	50,221,142.00	103.4109	76,750.00	4.805696525	467,190,000.00	58,102,519,989.01
2018	101.97	51,392,565.00	101.3016	78,830.00	6.318450702	208,850,000.00	2,752,503,962.48
Source	FAOSTAT	WORLD BANK	WORLD BANK	IFPRI	WORLD BANK	FAOSTAT	IFPRI

Appendix 2: Granger causality Wald tests

Equation	Excluded	chi2	df	Prob >chi2
dlnGAE	dlnFPI	.87413	2	0.646
dlnGAE	dlnGHG	3.2552	2	0.196
dlnGAE	dlnAODA	1.926	2	0.382
dlnGAE	dER	2.1197	2	0.347
dlnGAE	dGDPGR1	1.5964	2	0.450
dlnGAE	lnPOPL	2.2792	2	0.320
dlnGAE	ALL	13.66	12	0.323
dlnAODA	dlnFPI	10.877	2	0.004
dlnAODA	dlnGHG	1.5733	2	0.455
dlnAODA	dlnAODA	.14839	2	0.928
dlnAODA	dER	1.4524	2	0.484
dlnAODA	dGDPGR1	2.1718	2	0.338
dlnAODA	lnPOPL	3.61	2	0.164
dlnAODA	ALL	27.514	12	0.007

Appendix 3: Post-estimation test results

1. Durbin-Watson d-statistic (12, 38) = 2.170154
2. Breusch-Godfrey LM test for autocorrelation

Lags (p)	chi2	df	Prob > chi2
1	1.314	1	0.2516

3. Breusch-Godfrey White test of Heteroskedasticity

Ho: homoscedasticity Against Ha: unrestricted heteroskedasticity

chi2 (37) = 38.00

Prob > chi2 = 0.4236