DRIVERS OF HORTICULTURAL EXPORTS IN KENYA: CO-INTEGRATING VECTOR ERROR CORRECTION APPROACH

BY

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A THESIS SUBMITTED TO THE SCHOOL OF AGRICULTURE AND NATURAL RESOURCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN AGRICULTURAL ECONOMICS AND RESOURCE MANAGEMENT

MOI UNIVERSITY

2020

DECLARATION

Declaration by Candidate

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

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DEDICATION

This thesis is dedicated to the Almighty God.

ACKNOWLEDGEMENTS

I am indebted to several persons who in various ways have contributed to the completion of this research thesis. First, I extend my deep appreciation to Dr. Alfred Serem and Dr. Jared Mose for their willingness to serve as my supervisors. They have been key players in the formulation and supervision of this thesis. I would also like to thank my colleagues in the Department of Agricultural Economics and Resource Management. I enjoyed resourceful and thoughtful encouraging discussions that we had together on a wide range of issues concerning this thesis. Lastly, I thank my family members for the moral and financial support they accorded me from the start to the end without hesitation. May God bless you all in your endeavors.

ABSTRACT

Kenya's economy is dependent on horticultural exports. The stability of these horticultural exports, however, is not stable in terms of their markets and it is not guaranteed, as it is highly unstable. The main objective of this study was to find out the major drivers of horticultural exports in Kenya by utilizing monthly time series data obtained from IMF, Food and Agriculture Organization Statistics and Central Bank of Kenya for the period 2005 - 2017. It was hypothesized that inflation, exchange rate and interest rate have no effect on horticultural exports. Conventional unit root tests were performed to test for unit root using Augmented Dickey-Fuller and Philips-Perron and further, Kwiatkowski-Phillips-Schmidt-Shin unit root test was performed. Zivot-Andrews test was applied to test for unit root with one structural break and further and Clemente-Montañés-Reyes unit root test was used to test for unit root with multiple structural breaks. Unit root tests indicated that all the variables had unit root at levels and after first difference, they were stationary and thus integrated of order one *I (1)*. Johansen's test for cointegration was carried to test for cointegration and the results indicated the variables were cointegrated. VECM model was estimated to determine the long run relationship with respect to each of the variables. Diagnostic tests such as Jarque-Bera test for normality and it indicated data was normally distributed, Lagrange Multiplier test for serial correlation showed no serial correlation. Breusch–Pagan/Cook–Weisberg test for heteroscedasticity indicated that errors are homoscedasic and variance inflation factor showed no multicollinearity. Model stability was carried out and it was found that the model was stable hence the model was suitable for analysis and making statistical inferences. The results indicated that the variables were cointegrated at $r = 2$ of $11.37280 < 15.41$ and greater than its critical value at 5 percent level of significance and that there existed a long-term relationship between inflation rate, exchange rate and interest rate. VECM model showed that the error correction term of -0.0853, which was statistically significant ($p - value\ 0.0000 < 0.0500$). Error correction term of -0.0853 showed that 8.53 percent of the adjustments are made in the first month and it takes approximately 11.72 months for the system to return to its long run equilibrium path. Inflation (p - value 0.00 < 0.05), exchange rate ($p - value\ 0.03 < 0.05$) and interest rate ($p - value\ 0.0207 < 0.05$) showed that they significantly affect horticultural exports). It is recommended that the government should intervene with commercial banks to further reduce interest rate. There is need to design policy aimed at stabilizing macroeconomic environment to increase horticultural exports such as targeted exchange rate through application of foreign reserves adjustments.

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OPERATIONAL DEFINITION OF TERMS

Cointegration: Cointegration implies the presence of long-term association among economic variables.

Differencing: Transforming a non-stationary series to achieve stationarity by computing the differences between consecutive observations.

Error correction model: Time series model used where data have long run stochastic relationship.

Error correction term: Error correction term measures the speed of adjustment towards long-term equilibrium relationship among variables.

Exchange rate: Is the value of a country's currency as compared to that of another country or economic zone.

First difference: First difference of time series data implies a series of changes from one period to the next period.

Inflation rate: Persistent price increase of goods and services over a given period.

Integration: A series of successive differences d that transforms a time series data to achieve stationarity.

Interest rate: Proportion of a loan that is charged as interest to the borrower, typically expressed as an annual or monthly percentage of the amount of loan outstanding.

Levels: Defines a time series data which becomes stationary without differencing.

Long run: Occurring over or involving a relatively long period.

Multivariate: One, which is concerned with interrelationships among variables.

Short run: Occurring over or involving a relatively short period.

Spurious regression: Is a phenomenon that arises when time series variables contain unit root or are non-stationary.

Stationarity: A stationarity time series whose statistical properties such as mean and variance do not change over time.

Unit root: Refers to stochastic process in time series.

Univariate: Refers to data, which consists of observations on only a single characteristic or attribute.

ABBREVIATIONS AND ACRONYMS

ADF:	Augmented Dickey-Fuller
AGDP:	Agricultural Gross Domestic Product
AGOA	African Growth Opportunity Act
AIC:	Akaike Information Criterion
AO:	Additive Outlier
ARDL:	Autoregressive Distributed Lag
BRC	British Retail Consortium
CBK:	Central Bank of Kenya
CBS:	Central Bureau of Statistics
CMR:	Clemente-Montañés-Reyes
COMESA:	Common Market for East and Southern Africa
CPI:	Consumer Price Index
EAC:	East African Community
ECM:	Error Correction Model
ECT:	Error Correction Term
ELI:	Export Led Industrialization
EOI:	Export Oriented Industrialization
EPC:	Export Promotion Council
ESI:	Export Substitution Industrialization
EU:	European Union
EUREGAP:	European Retailers Protocol for Good Agricultural Practice
EXR:	Exchange Rate
FAO:	Food and Agriculture Organization
FAOSTAT:	Food and Agriculture Organization Statistics
FPE:	Final Prediction Error

FPEAK:	Fresh Producers and Exporters of Kenya
GDP:	Gross Domestic Product
GoK:	Government of Kenya
Ha:	Hectares
HACCP	Hazard Analysis and Critical Control Points
HCDA:	Horticultural Crops Development Authority
HOE:	Horticultural Exports
HQIC:	Hannan-Quinn Information Criterion
IMF:	International Monetary Fund
INF:	Inflation Rate
INT:	Interest Rate
IO:	Innovation Outlier
KALRO:	Kenya Agricultural Livestock Research Organization
KEPHIS:	Kenya Plant Health Inspectorate Service
KFC:	Kenya Flower Council
KHC:	Kenya Horticulture Council
KHE:	Kenya Horticultural Exporters
KIPPRA:	Kenya Institute of Public Policy and Research Analysis
KNBS:	Kenya National Bureau of Statistics
KPSS:	Kwiatkowski-Phillips-Schmidt-Shin
Kshs	Kenya Shillings
LLRT:	Likelihood Ratio Test
Ln:	Natural logarithm
MAPs:	Medicinal and Aromatic Plants
MOALF:	Ministry of Agriculture, Livestock and Fisheries
MRLs:	Maximum Residue Limits

MT:	Metric Tons
NGOs:	Non-Governmental Organizations
OLS:	Ordinary Least Squares
PCPB:	Pest Control Products Board
PP	Philips-Perron
RGDP:	Real Gross Domestic Product
SBIC:	Swartz-Bayesian Information Criterion
SRA	Strategy of Revitalizing Agriculture
UN-WIDER:	United Nations World Institute for Development Economics Research
USA:	United States of America
VAR:	Vector Autoregressive Model
VECM:	Vector Error Correction Model
VP	VegPro
WDI:	World Development Indicators
WITS:	World Integrated Trade Solutions
WTO:	World Trade Organization
ZA:	Zivot-Andrews

CHAPTER ONE

INTRODUCTION

This chapter presents background of the study, statement of the problem, study objectives, hypothesis of the study, justification, and scope of the study.

1.1 Background of the Study

1.1.1 Overview of Agricultural Sector in Kenya

In Kenya, agriculture is one of the crucial sectors in the economy as it provides employment, source of food, a source of foreign exchange earnings and provides linkages to other sectors of the economy (Salami *et al.,* 2011). Agriculture has an important role in growth and development in any economy of the developing countries and it is known to be the driving force behind the industrialization of many nations (Tainbak *et al.,* 2012). Kenya's GDP growth rate was at 5.7 percent in 2014 and 5.3 percent in 2017 and the major contributor was agriculture and fishing (Kenya National Bureau of Statistics, 2014).

With the promulgation of the new constitution in 2010, agriculture was devolved to county government (Mwenda, 2010). During this period, the stability of the Kenya's currency was relatively stable as compared with its major trading currencies (Asongu, Folarin & Biekpe, 2020). Inflation rate rose by a small margin but remained within the stipulated CBK lending rate. Agriculture sector contributed approximately 34.5 percent of the total gross domestic product (GDP) in 2000s coming second after tourism sector. However, the trend has been gradually reversed due to changes in macroeconomic environment and changes in global events that have negatively affected agricultural development through trade, and this has been escalated by adverse climatic changes.

Agricultural sector's performance directly mirrors that of the overall economy (Tiffin & Irz, 2006). A decline in agricultural production Kenya implies a decline in overall growth of the economy and vice versa (Christiaensen, Demery & Kuhl, 2011). The performance of agricultural sector since 2007 to date, has been steadily declining; culminating in a negative growth rate in agricultural production and consequentially a reduction in horticultural exports m.

Poverty increase in Kenya has been attributed to declining agricultural production and rising food prices and to reverse this trend is a major concern to policy makers in Kenya (Collier & Gunning, 1999). One way to address these challenges is the knowledge and force that drives agricultural growth and productivity. (Cao & Birch-enall, 2013) cited agricultural productivity as the major factor in reallocation of re-sources and employment in agriculture dependent sectors. Slow growth in agriculture can lead to slow growth in industrial development (Gollin, Parente & Rogerson, 2002). This will in turn result in overall growth in country's GDP and poverty reduc-tion (Abro, Alemu, & Hanjra, 2014).

Agricultural sub-sector in Kenya is still the most important in economic development as it is a major contributor to gross domestic product in the least developed countries including Kenya. In early 1980s, Kenya's real gross growth rate averaged 4.56 per-cent, but it declined to an annual growth rate of about 2.07 percent during the libera-tion era and during this period, agriculture contribution was about 16 percent. At the beginning of the year 2000s, Kenya's real GDP was estimated to have an annual growth rate of 3.43 percent (World Bank, 2017). This increased growth rate was im-mensely contributed by increasing exports of agricultural exports with horticultural exports being the major contributor of the largest share (Nyachieo, 2008). However, in late 2007 and 2008, this increased export of agricultural products the country experienced a decrease, and this was occasioned by vagaries of drought that negatively affected agricultural production and hence reduced GDP growth (Keya & Rubaihayo, 2013). The sustained decrease was further hastened by post poll chaos of 2007/2008. These factors have intermeshed to affect agricultural production negatively. Agricultural GDP was found to have decreased from Kshs 207,970 million in the third quarter of the year 2017 from Kshs 267,619 in the second quarter of the year 2017. Further, in 2009 agricultural GDP averaged Kshs 205,042.23 million in 2009 up to 2017, reaching its peak of 286,308 million Kshs in the first quarter of 2017 and record low of 142,195 Kshs during the fourth quarter of the year 2009 (Klaus, 2020).

In December 2017, Kenya's consumer price indices increased by approximately 4.5 percent from 4.7 percent in November 2017 (Mutwiri, 2017). This was regarded as the lowest since May 2013 as the prices of major commodities such as housing, food and other social amenities grew at a slower rate. Between 2005 and 2017, the average rate of inflation was approximately 10.09 percent, reaching an all-time high of 31.50 percent in May 2008 and low of 3.18. In October 2010, inflation rate recorded a low percentage of 3.18 percent (World Bank Group, 2013).

During industrial revolution in Europe and the phase out of political and economic conflicts, industrial and investment sectors were highly regarded the major determinants of economic growth (Koch & Basse Mama, 2016). However, this was later disputed given that agriculture has remained one of the most important sectors that highly contributes to national economic development (Hashemi, Ghosh & Psaupathy, 2014).

1.1.2 Horticultural Subsector in Kenya

Historically, manufacturing sector has been recognized as the engine of economic growth and change. However, in the recent past, owing to the rising number of services and development of agro-industries including horticulture, innovation has made horticulture industry share similar characteristics with manufacturing. According to Hallward and Nayyar (2017) because they are tradable, high added value per employee and can easily absorb large number of moderately qualified workers. In Kenya, the production and exports of horticultural crops dates to colonial period when Kenya was required to contribute towards running of East Africa budget.

However, after independence the industry grew and flourished as the Kenya's exports to Europe increased and this led to opening of Kenya's export markets. In terms of household income generation, foreign exchange earnings and food security at household and national, horticulture has continued to play an important role.

In Kenya, horticultural subsector accounts for approximately 33 percent (US$300 Million) of agricultural gross domestic product and 38 percent of the total national export earnings thus making it one of Kenya's main contributors of foreign exchange (Bijaoui, 2017). The production of horticultural products in Kenya is approximately 3 million MT per year, which makes Kenya one of the major world exporter of horticultural products according to Kenya Horticulture Council. Approximately 4.5 people million work directly in production, processing and marketing activities. Another 3.5 million are engaged indirectly through trade and other related activities (Boulanger *et al.*, 2018).

1.1.3 Exports Performance of Horticultural Sub-sector in Kenya

According to Muendo, Tschirley & Weber (2004), horticulture production in Kenya has received a lot of attention from international NGOs and Governments given its rapid and growing of export sector in major importing countries such as those in the Europe and the United States of America. In USA for instance, Kenya's horticultural exports such as French beans were allowed into their markets, which is a clear indication that there is room for horticultural exports outside its traditional markets of Europe. Kenya's exports to European markets increased in the 1970s with Netherlands as the largest importer with a 71 percent share by volume. Kenya's exports to the United Kingdom is about 20 percent and Germany at 6 percent. France, Switzerland, Belgium, Saudi Arabia Italy and South Africa are the other important importers of Kenya's horticultural exports(World Bank Group, 2013). Kenya's horticultural exports is important in general growth of the economy and therefore its expansion is an important process for economic growth. Promotion of horticultural exports has been a commercial policy which has attracted a lot of attention from national and international levels (Orindi, 2011).

Kenya's government has focused on promoting horticultural exports due to its reduction markets in both international and its local market. Studies such as those of Mania and Rieber (2019) shows that exports of a country are important as it provides a country a base for expansion of growth which is brought about by increased foreign exchange earnings. In Kenya, it is evident that horticultural exports generate employment and attracts foreign exchange earnings and further, a major factor in economic development (Barrett, 2008).

The cause of Kenya's increase in exporting quality horticultural exports has been facilitated by increased airfreight arrivals to it major destinations with several interceptions due to MRLs exceedance in countries from Europe. On the other hand, decrease in horticultural exports has been highly associated with unpredictable weather patterns which resulted in low yields, lack of value addition of technologies, increased post-harvest losses and the inability of horticultural farmers to access the right quality of planting materials.

1.1.4 Exchange Rate Regimes and Agricultural Exports in Kenya

In Kenya, the fixed exchange rate systems spanned for years 1966 to 1992. The rate of exchange for Kenya was pegged to the US dollar up to 1974 after which discrete devaluations was changed to the special drawing rate (SDR) and during this period the nominal exchange rate was highly volatile. In 1990s, the liberalized floating exchange rate system was introduced, and the exchange rate was allowed to float. According to Husain, Mody & Rogoff (2005) flexible exchange rate regimes, there was increased deficit in the trade balance as compared to the fixed exchange rate regime. After the introduction of floating exchange rate system, Kenya had to cope with adverse effects of floating exchange rate with fluctuations ranging from periods of depreciation and appreciation. The export earnings from horticultural, tea and coffee showed an increasing trend (Kiptui, 2007).

1.1.5 Trend of Horticultural Exports in Kenya in the last Two decades

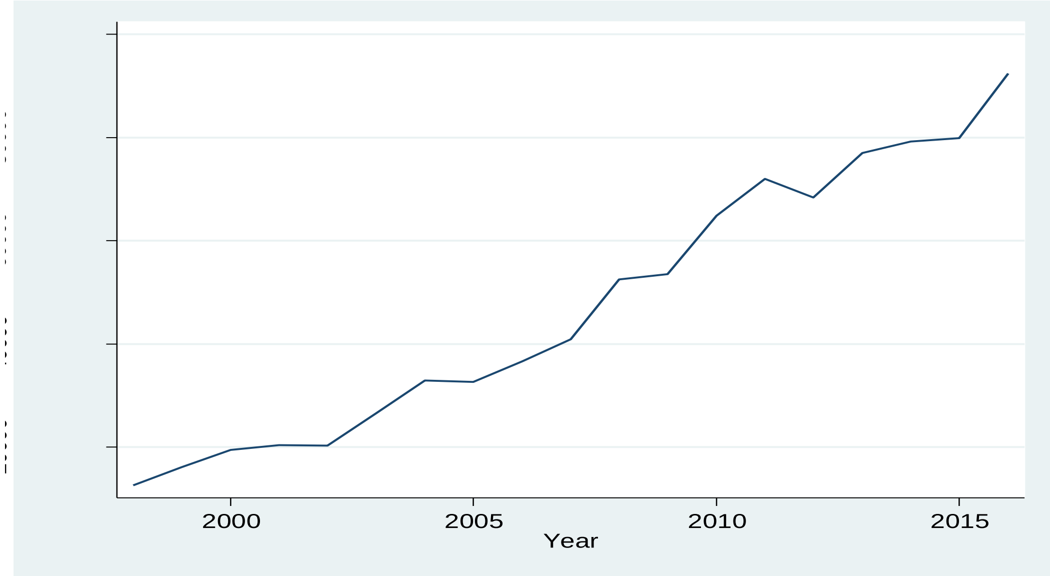


Figure 1.1: Trend of Horticultural Exports in Kenya
Source: Authors Compilation from CBK Data, 2017

Figure 1.1 shows that Kenya's Horticultural exports have exhibited an increasing trend over the last two decades though not stable as evidenced by small and continuous fluctuations. This sustained increase is attributed to various policy interventions to increase horticultural exports by the government effort to stabilize macroeconomic variables such as exchange rate and the increased interest rate from wide range of stakeholders. On the other hand, the deviations have been partly due to unfavorable macroeconomic environment such as variability in exchange rate. Horticultural exports rose steadily over the years, except in 2000 which was largely as a result of ban on some of horticultural exports products from Kenya because they did not meet requirements of GLOBAL GAP as a consequence of excess of MRLs. In 2013, horticultural exports recorded a sharp decline, this was attributed to the fluctuations in Kenya's currency instability in terms of prices fluctuation, dynamic, and versatile operational environment that include bureaucracy in decision making, regional trading challenges, unfavorable global trade (Nayioma, 2016). This was partially attributed to uncertainties of 2013 general elections by the investors in agricultural sector.

1.1.6 Horticultural Sub-sector in East African Countries

East African countries are highly dependent on agricultural products horticultural sub-sector contributing to a substantive share to overall GDP. In Kenya, agriculture contributes approximately 25 percent, while Uganda 31.1 percent and 43.2 percent of GDP the total in Tanzania (Nyangweso *et al.*, 2004) and majority of its population is highly dependent on agriculture. Despite horticulture being the most vital subsector in growth of economy and abundant of natural resources in most East African countries, poverty among small scale farmers is still prevalent and has yet to exploit its full potential from the sector (Diao *et al.,* 2006).

It has been argued that horticultural exports play an important role in their economic development. As an economic activity, it is also an important agricultural sub-sector which comprises of the production and processing of cut flower, fruits, vegetable, nuts and ornamental plants. In Uganda, its horticultural exports are spread across several countries, ranging from US to UK hence provides a base for expansion. Currently Ugandan exports from floriculture to the US amounts to approximately US$ 1billion with an average and has been found to increase annually by approximately 3.0 percent. Its success is attributed to its abundant supply of water, low cost of production, which favors all year-round uniform production.

In Tanzania, the total foreign exchange earnings from horticultural subsector was about USD 46.7 Million in 2006/ 2009, in 2008/2009 it was estimated at USD 112.7 and in 2010/11 the sector accounted for USD 127.7 million in (Haug & Hella, 2013). Its exports has been greatly hampered by several challenges ranging from low production base, lack of enough finances for increased production, low productivity, invisibility, poor land policies, poor infrastructural development, limited market development, weak industrial linkages, inadequate horticultural production skills to limited entrepreneurial skills in the sector. Generally, over the last two decades, EAC has recorded an improved performance in horticultural sectors particularly in fresh fruit and vegetables and according to Belwal and Chala (2008) the impressive performance is associated with intensive efforts by individual countries efforts to promote vegetable production and fruit farming among small scale farmers. According to Senbet & Simbanegavi (2017) exports from vegetables and fruits from the tree East African (Kenya, Uganda and Tanzania) countries have greatly surpassed export earnings from its traditional exports such as coffee and tea in the recent past for instance a rise from 62,857 million US$ in 2007 to 206,402 million US$ 2011). Statistics from individual member countries shows that exports from horticultural are less as compared to other exports in other sectors (Lubinga *et al.,* 2014).

1.1.7 Different Categories of Horticultural Products in Kenya

Table 1. 1: Categories of Horticultural Crops Grown in Kenya

Vegetables	Artichokes	Cauliflower	Sprout
	Asparagus	Celery	Cabbages
	Baby marrow	Lettuce	Capsicums
	Beetroot	Okra Onions	Carrots
	Brinjal	Potatoes Radish	Alka
	Brussels	Chilies	Karela
	Spinach	Cucumber	Kolrabi
	Turia	Snake gourd	Dudhi
Fruits	Avocadoes	Mangoes	Papayas
	Apples	Mulberry	Passion fruit
	Bananas	Oranges	Pears
	Cape	Figs	Pineapples
	Gooseberries	Grapes	Plums
	Lemons	Guavas	Pomelos
Cut flowers	Agapanthus	Chrysanthemum	Orchids
	Alliums	Heliconia	Ornithogalum
	Alstromeria	Iris	Roses
	Bells of Ireland	Liatris	Strelitzia
	Carnation	Mollucell	Tuberose

Source: Nyangweso *et al*., (2004)

The main horticulture producing areas in Kenya include; areas around Lake Naivasha, Mt. Kenya, Nairobi, Thika, Kiambu, Athi-River, Kitale, Nakuru, Kericho, Nyandarua, Trans Nzoia, Uasin Gishu, Kajiado, Meru, Laikipia, Machakos, Kirinyaga and Embu (Tsimbiri, Moturi, Sawe, Henley & Bend, 2015).

1.1.8 Regulators of Horticultural Industry in Kenya

The ministry of Agriculture is the leading regulator of the horticultural subsector whose mandate directly affects production and exports of horticultural products. The ministry mandate is to provide policy, regulation, and overall direction (Sola *et al*., 2014).

Table 1. 2: Main Regulators of Horticulture Industry in Kenya

Institution	Functions(s)
MOA	Kenya's Ministry of Agriculture has been mandated to develop national legislations, policies and other regulations related to agriculture that is aimed at increasing Kenya's commercialization of agriculture and its competitiveness.
KEPHIS	Helps in providing science based regulatory services and ensuring supply of quality farm inputs with the overall aim of increasing agricultural production by controlling weeds, pests and other harmful species
Horticultural Crops Directorate (HCD)	HCD has been tasked with coordination of the horticultural subsector which commercially oriented
KALRO	KALRO is a body that has the sole aim of providing information, innovative technologies to enhance horticultural production in the country, strengthens agricultural values chains and development of environment most suitable for horticultural production. It avails information regarding crops such as vegetables, medicinal aesthetic products, fruits and flowers
Export Promotion Council	The body has been tasked to address the various challenges faced by exporters and the producers of export products with the sole aim of increasing performance of exports in Kenya
FPEAK and KFC	Its main responsibility is to promote markets access and competitiveness in the horticultural subsector in Kenya.
Pest Control Products Board	This body was established to represent both small and large producer farmers in the country

Source: (Muriithi & Matz, 2015)

1.1.8.1 Major Producers and Exporters Companies in Kenya

In 2011, it was estimated that 568 Ha of land was under horticultural production and it comprises of flowers, vegetables, fruits, nuts, medicinal and aromatic plants (MAPs). Production of flowers is predominantly carried out by large farms while vegetables, fruits, nuts and MAPs is produced by small mainly by smallholder farmers (Twaroq, 2009)

1.1.8.2 VegPro (K) Limited

This is one of the largest exporters of fresh produce in Kenya. It has six own farms and manages about 1,700 smallholder farmers in the four major producing areas of Kenya. VP Food grows and packs a wide range of quality vegetables all year round. VP Food is also an expert in fresh cut produce including complex benefit lines such as stir-fries.

1.1.8.3 East African Growers Group (EAG Group)

EAG owns farms beside contracted firms in Kenya and it produces horticultural products for exports according to European market standards that adheres to certification of international standards that includes Global Good Agricultural Practices (GLOBAL GAP) food safety standards and British Retail Consortium and Ethical Trade initiative.

1.1.8.4 Wilham Kenya Limited

Wilham Kenya Limited consolidates the movements from several firms and does onward freighting to EAG markets. It has pack house of high care quality, loading areas for horticultural exports general package areas, offices blocks for marketing, team operation and other technical operations.

1.1.8.5 Mara Farming Group Limited

Founded in 2013, the Mara Farming Group limited has the sole responsibility of reducing the traders in between farmers and the final markets. Through partnerships in Tanzania, Zimbabwe and Ethiopia and with its main operations in Kenya. Mara EPZ grows vegetables and fruits predominantly for export and currently venturing into the local market. The rationale behind venturing into the local market is to provide the same high quality fresh vegetables and fruits with minimum to no use of chemicals and fertilizers to a growing local clientele that places great importance on how the vegetables and fruits they consume are produced, handled, packaged and delivered.

1.1.8.6 Kakuzi Limited

Kakuzi limited does cultivation and marketing of tea. It also engages in marketing of horticultural products such as Avocados, grow pineapples, Macadamia. It also does forestry development and livestock keeping. Kakuzi farms own 408 Hectares of avocado producing and exporting both Fuertes and Hass cultivars.

1.1.8.7 AAA Growers

It is the leading grower and exporter of premium and prepared vegetables and chilies from Kenya. AAA Growers aims at providing quality products that redefine what innovative, healthy and delicious vegetables should be. AAA currently harvests 30 metric tons of products a day and export annually over 4,000 metric tons of fresh produce.

1.1.8.8 Kenya Horticultural Exporters Limited

KHE commits itself to HACCP system and BRC code of practice that ensures exporting of safe and quality products is always adhered. In Kenya, KHE has three large firms and three pack houses with cold chain systems that includes packaging facilities

- MAP (Modified Atmosphere Packaging). This organization plays the role of maintaining third party certifications by an internationally recognized body to demonstrate compliance to HACCP and the BRC code of Practice. KHE supply EU with a range of vegetables, avocado, passion fruits and herbs.

1.1.8.9 Flamingo Horticulture Kenya Limited

This vertically integrated horticulture venture is tasked with the processing, distribution, and marketing of produced flowers and premium vegetables. It also grows horticultural crops such as vegetable and flowers. It also obtains it products from Tanzania. It is the first supplier of Fair-trade vegetables in the United Kingdom.

1.2 Statement of the Problem

Given that Kenya's economy is dependent on exports of agricultural, it has been found out that in the recent past its market stability has not been guaranteed. Its markets are unstable in terms of exchange rate fluctuation and the decline in global income over the last decade (White, 2009). Given these interlocking factors, consumption of highly priced agricultural commodities such as fresh fruits and vegetables has been static if not declining and thus this has caused market demand to stagnate while its supply abundant (Rikken, 2011).

With increasing liberalization and regional integration, the horticultural industry in Kenya has witnessed the saturation of cheap horticultural exports from other competing countries such as South Africa (Ridolfi, Hoffmann & Baral, 2018). This situation has affected the expected benefits of horticultural sector players. This situation has been worsened by high cost of production especially the adoption of modern technologies, increasing cost of electricity, transport and storage costs, change in consumer preference and other consumer concerns. This has significantly affected the production and a drop in production from 8.127 million tons in 2015 to 7.983 million tons in 2016 (KNBS, 2015/2016). Horticulturalists have been subjected to multiple taxation at both national and local levels without corresponding provision of requisite services. This has contributed to a reduction in the net farm incomes and created distortions in marketing structures without necessarily improving the revenues for local authorities (Alila, 2006). Consequently, this has depressed prices of horticultural thus has consequently affected the livelihood of Kenyans engaging in horticultural industry. Kenya has been a great beneficiary of several including Economic Partnership Programmes Agreements for the period 2008-2010 that has seen improvement in Kenya's horticultural exports to European Markets. Despite all these, the sector continues to face challenges both in local and international markets that has gone beyond price and quality parameters to placing market regulation, legislations and standards in order to access international markets. These standards come in because of increased consumer demand for safer products hence the need by exporters to comply with these regulations. The implications of these sectoral problems are far reaching given that millions of Kenyans are highly dependent on this subsector and Kenya's economy. However, given its comparative advantage in production, Kenya's benefits from horticultural subsector is still below its potential and in this regard, there is need to determine the major factors that influences horticultural exports in Kenya in order to design the necessary policies to ensure stability of agricultural markets, reduces poverty, increases economic growth and fill these gaps for sustainable agricultural growth.

1.3 Objective of the Study

This section presents the general objective and specific objectives of the study.

1.3.1 General objective of the study

The study sought to determine the drivers of horticultural exports in Kenya for the period 2005 to 2017 by employing cointegrating vector error correction model approach.

1.3.2 Specific objectives

The study was guided by basic objectives stated as:

i. To determine the effect of inflation on horticultural exports in Kenya
ii. To establish the effect of exchange rate on horticultural exports in Kenya
iii. To evaluate the effect of interest rate on horticultural exports in Kenya

1.4 Study Hypotheses

The following hypotheses were tested:

H_{o1}: Inflation rate have no significant effect on horticultural exports in Kenya

H_{o2}: Exchange rate have no significant effect on horticultural exports in Kenya.

H_{o3}: Interest rate have no significant effect on horticultural exports in Kenya

1.5 Justification of the Study

Determining the factors that affect horticultural exports is of importance in the developing world because horticultural exports provides an opportunity to improve the export performance of Kenya's horticultural exports which is highly dependent on traditional exports such as tea and coffee.

In today's world, economic growth in any given country have been found to be stimulated by growth in agricultural subsector and this calls for need to formulate, strengthen agricultural policies to accelerate growth in agricultural subsector (Teichman, 2016). To effect these polices, there is need to understand the dynamics in macroeconomic policies and their effects on horticultural subsector and as in this study.

The significance of the study lies in the centrality of the agriculture sector in the overall growth and development of Kenya's economy. This research work is important to Kenya's economy in drawing up policy recommendations that addresses some of the problems facing horticultural sector for sustained agricultural production to achieving Vision 2030 and sustainable development goals.

1.6 Scope of the Study

This study covered selected macroeconomic variables within Kenya economy for the period 2005 to 2017. This period was chosen because it has various economic, political and economic events. This period is also characterized by various macroeconomic policy regime changes such as those in ERS. Its aim included wealth and employment creation, which, between 2003 and 2007, largely focused on supporting agriculture within which in 2004 the Ministry of Agriculture unveiled the strategy of revitalizing agriculture (SRA) for the period 2004-2014 with its main mission being to transform Kenya's agriculture into profitable, commercial and internationally competitive activity.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter presents empirical and theoretical literature that aims at developing an understanding of the causal linkage between inflation rate, exchange rate, interest rate and horticultural exports. Conceptual framework is also presented in the chapter.

2.2 Empirical Literature Review

There have been several studies in the recent past to determine the relationship between major macroeconomic variables and horticultural exports owing to the importance of agricultural production on the growth and development of many nations (Dlamini *et al.*, 2012). They include (Tweeten, 1980); (De Haas *et.al*., 2013) (Chambers & Just, 1982) (Orden & Fisher, 1991) and in the recent past (Prasetyo & Susanto, 2016) has redefined the major links between agricultural export and the major macroeconomic variables.

Chao *et al.,* (2011) studied the importance of macroeconomic variables on agricultural subsector and the major concern was on exchange rates as a major factor in determining agricultural policies. In the study, it was found that the devaluation of the dollar impacts in agricultural subsector and overvaluation of the dollar to correct the deficiencies during hard economic times resulted in fluctuation of the most important share that targeted the consumer benefit. (Tabak, Khoong, Chambers & Brownson, 2012) in their study: the effect of income, exchange rate and money supply on agricultural trade balance using autoregressive - distributed lag model and found that exchange rate is the main determinant in both the long run and short run. It was found that trading partners' income and money supply have major significant effect on United States agricultural trade.

In their study (Wang, Wu, & Yang, 2014) investigated the effects of changes in petroleum prices on agricultural production and found out that the sudden change in oil prices have negative externalities on agricultural production in the United States of America in the short run. (Razmi, Chin, & Habibullah, 2015) in their study also studied the effects of fluctuation in exchange rate on bilateral agricultural trade of the US and its major trading partners using ARDL model and it was found that both the variables have significant effects on the US agricultural trade in the short run. Iganiga and Unehilm (2011) studied short run and long run effects of Federal Government farming spending and other major variables on agricultural yield using error correction model and they discovered that savings is a catalyst in agricultural yield and should be accompanied with credit facilities and on the other hand, domestic production should be discouraged and the government should put in place policies that stimulates local agricultural production.

Meme (2015) investigated the performance of horticultural subsector exports in Ethiopia by applying autoregressive-distributed lag Cointegration test use of secondary data for the period 1985 to 2016. The error correction model revealed a significant negative relationship long run relationship between foreign direct investment, GDP, exchange rates and prices. He further concluded that the performance of horticultural exports significantly affected by structural breaks both in the long -run and in the short run.

Musonda (2008) investigated the effect of exchange rate and prices, which is a reflection of agricultural exports competitiveness on Zambia's agricultural exports by using export demand framework for ten years. The study applied generalized autoregressive conditional heteroscedasticity. It found out that there existed a negative and substantial relationship between exchange rates and Zambia's agricultural exports. Similarly, Kiptui (2007) studied the effects of exchange volatility on Kenya's exports using bounds test approach. The study showed that exchange rates and Kenya's exports historically have a negative relationship with exchange a phenomenon that varies year to year due to changes in volumes of exports.

Mwangi (2015) found out that exchange rate and French beans exports in Kenya had a significant and negative relationship. It indicated that the responsiveness of French beans export demand in Europe is elastic. It is concurring with the fact that majority of the African exports lack forward exchange markets.

A study by (Lawal, 2011) to determine the effects of government spending on Gross Domestic Product and inferred that there is a direct relationship between GDP and agriculture and that government spending has unpredictable path and thus it was suggested that there is need to increase the allocation to agricultural subsector given its pivotal role it plays in nations development.

Kaabia & Gill (2001) analyzed the effects of mixed financial policies and exchange rate fluctuations on agricultural exports and agricultural price both in the long run and short run using by applying cointegration procedure. They studied the variables that included trade openness, exports, income, agricultural input supply, agricultural input prices, interest rates, exchange rates, inflation, agricultural GDP and money supply. It was concluded that variation in macroeconomic variables had a direct effect on agricultural GDP.

Alagh (2011) examined the effects of macroeconomic variables and their relationship with agricultural production in India and he posed a question: is there a limitation in agriculture in a dynamic world? This led to other studies that involve the use of lags in detailing the use of the model and this has led to the formulation of many policies that affect the agricultural production. (Kadir & Tunggal, 2015), examined the effect of macroeconomic variables that included money supply, inflation, government expenditure, real exchange rates and agricultural GDP in Malaysia using cointegration and ECM approach. They applied ARDL model to test for short run and long run effects between the dependent and explanatory variables. They concluded that agricultural productivity in the short run is influenced by net exports, government expenditure and interest rates and the exchange rates only affect agricultural production in the long run. They stated that agricultural producers can easily understand the relationship among these variables and can help them improve their future agricultural production.

(Earnshaw, Dlamini & Masarirambi, 2012) found out that macroeconomic variables in Nigeria have effects and can greatly reduce the rate of inflation and increase foreign direct investment in agriculture, bring a balance in exchange rates and make credit facilities easily available to farmers. Some of the major macroeconomic variables are cornerstone of development of any nation through the input of agricultural production (Headey & Fan, 2008). These major macroeconomic variables have substantial positive impacts on sustainability of agricultural production and agricultural trade.

Some of exchange regimes during the period of Structural Adjustment Programmes (SAPs) in some African countries have been found not to achieve any notable agricultural exports over time. For instance, during the year 1993 in Nigeria, the percentage contribution of agricultural production was at a mere approximately 1.7 percent of the total exports (CBN, 2006). Considering this, a lot must be done in the African continent in order to achieve macroeconomic stability to enhance agricultural exports. Instability of macroeconomic variables and sudden change in policy formulation escalates the instability of macroeconomic variables in a country (Akpokodje, 2000). In their study (Enu & Attah-Obeng, 2013) on the factors that affect agricultural production in Ghana they point out that some of the key macro-economic factors that highly affect agricultural production in Ghana are labor force, real exchange rate, and real GDP per capita. In this study, the findings of the study yielded a negative relationship between agricultural exports and real exchange rate since the dollar is more valuable than the Ghanaian currency because Ghana imports more of agricultural equipment and consequently increasing the cost of production and reduces the value of agricultural production in the long run.

Shane *et al.*, (2008) in their study on the macroeconomic determinants of US exports earnings, concluded that US agricultural exports is mainly determined by real income of their trading partners and that the devaluation of the US dollar promotes its agricultural exports. (Musyoki *et al*., 2012) studied the volatility of exchange rate in Kenya after liberalization by applying ECM and it was found out that increasing interest rate differential, increased external inflows and improvement in account balance improves the performance of the shilling against US dollar. The study concluded that exchange rate fluctuations are undesirable and negatively impacts on the Kenya's export earnings. Mwanza (2007) did a study on the factors affecting Kenya exports using annual time series data for the period 1996 to 2009 and found out that Kenya's shilling has been highly volatile and which has an effect on Kenya's export earnings and he further notes that export earnings were adversely affected and in 2003 the country experienced a loss in export earnings.

Imahe & Alabi (2005) studied the factors that determines agricultural production in Nigeria and found that total arable land, per capita income, average rainfall, fertilizer distribution, value of food imports, agricultural capital expenditure and interest rates. It was concluded that these variables contribute significantly to annual variation in agricultural production. They recommended that there is need to promote the timely distribution of fertilizer and commercial bank loans as agriculture was found to be cornerstone determinant in Nigeria's development and achievement of millennium development goals.

In analyzing the factors that influences the agricultural exports in Romania, Cristea *et al.,* (2016) demonstrated that the only variables that significantly influence agriculture are real exchange rate in relation to Euro that has indirect influence, the rate of interest from the commercial banks and interest rate for direct deposits both had direct influence on agriculture while consumption price index for food products do not have effect on agricultural GDP on a short period.

On the other hand, (Odhiambo *et al.*, 2004b) carried out a study on determinants of agricultural and productivity in Kenya and it was deduced that agricultural productivity in Kenya is majorly contributed by factor inputs such as labor, land and capital while growth in output is not attributed to factor or total factor productivity during the entire period of study that span from 1965 to 2005.

Hashemi (2014) studied the macroeconomic factors such as exchange rates, inflation and monetary aggregates their influence on agricultural sector using unrestricted VAR for the period 1981-2011 in Iran and it was found out that the relationship between agricultural sector and these macro-economic variables is long term. Rabiee *et al.,* (2011) investigated the existence of long-term and short-term variation in macro-economic factors on agricultural sector. It this study, it was concluded that a long-term relationship between major macroeconomic variables and agricultural GDP exists. Interest rate and exchange rate prove to have a negative relationship with agricultural GDP while exchange rate has a positive relationship with the agricultural GDP. Agricultural product price had negative impacts in the long run and positive in the short run and subsidies provided by government agencies had no significance effect on agricultural total value of agricultural produce by farmers.

Clottey, Karbo & Gyasi (2009) studied the effects of financial and macroeconomic variables on agricultural food prices in Eastern and Southern Africa by applying Johansen cointegration and error correction model and it was concluded that changes in agricultural output coupled with financial aspect and exchange rate significantly affect agricultural food prices in African countries. On the other hand, (Iganiga & Unemhilin, 2011) examined the effects of federal government spending on agricultural output while intertwining other factors such as annual rainfall, agricultural credit, the rate of growth in GDP, net food exports and inflation rates and he found out that there is need to encourage local producers by banning of food imports and agricultural credit facilities should be made accessible by federal governments as it is a crucial component in agricultural production.

Similarly, Lawal (2011) examined the effect of level of spending by government on agricultural production and its contribution to GDP in Nigeria. It was deduced that government spending follows an irregular curve and its influence on GDP has a direct impact and therefore there is need by government to increase its allocation on agriculture since it is the main driver in any development of a nation. (Abugamea, 2008) studied the dynamic determinants of agricultural production in Palestine for the period 1980-2003 by applying Johansen and Granger cointegration approach. It was noted that there was negative and significant relationship between agricultural determinants and agricultural production while there exists a positive and significant relationship with capital and labor force and in the short run but in the long run capital and labor were the major factors of agricultural production. On the other hand,(Hye & Jafri, 2011) found out that there exists a positive and long run relationship between trade openness and real gross Domestic Product in Pakistan.

Kim *et al.*, (2004) demonstrated that there is relationship between agricultural prices and fluctuation of the dollar by testing the long run relationship and from the findings, it was concluded that a one percent decrease in the value of dollar has an impact of 0.131 percent increase of food prices in the United States.

Nampewo *et al.*, (2012) studied the effects of monetary policy for a period of 12 years in Ugandan economy by applying VAR model established that exchange rate, interest rate and credit are the most effective monetary policies that affect agricultural production and Muroyiwa *et al.*, (2014) of South Africa by applying Vector Error Correction Model approach established that there exists a negative relationship between interest rates, inflation and agricultural exports. Abbas *et al*., (2014) studied the relationship between macroeconomic variables and agricultural exports and concluded the selected variables have an impact on agricultural exports in Mozambique.

The literature shows that macroeconomic variables have effect an on agricultural exports, however many of the studies that have been done have failed to incorporate the structural changes that have occurred as a result of changes in regimes and economic policies. Majority of the studies have also shown that most of the explanatory variables have mixed effect on exports therefore, this research intended to close the existing gaps by including structural breaks and using expanded time frame.

2.3 Theoretical Literature Review

This section of the thesis presents aggregate supply response theory, export growth led hypothesis and the conceptual framework.

2.3.1 The Theory of Aggregate Supply Response

Developing countries have emphasized on market-oriented strategies with and much more interests in the agricultural sector. Several structural reforms have been put forward among countries with low incomes and particularly, the agricultural sector, which is dependent on aggregate response in supply, however the magnitude of these parameters have remained unknown and has taken a different angle in agricultural sector. Several studies such as those of Wani (2015) used different methodologies and approaches to estimate the impact of some of the variables on agricultural exports for different countries. This have been motivated by land size and improved technology within the industry, which have been used by different players in the sector.

Horticulture industry in Kenya is characterized by seasonality in production at different level of production and consumption. Therefore, the aggregate Nerlovian model of 1958 is frequently modelled to take care of price dynamics and partial adjustments in both the long run and in the short run.

$$Q_t^d = \beta_1 + \beta_2 P_t^e + \beta_3 Z_t + \mu_t \quad \text{(2.1)}$$

Where;

Q_t^d = this is the quantity that is desired

βs = this represents the estimates of parameter

P_t^e = prices that is expected

Z_t = this implies the set of exogenous variables in horticultural exports

μ_t = this represents the random effects. Its expected values is zero.

Nerlovian model is adjusted to yield equation 2.1 and 2.3 since the total supply of could also be affected by other factors that causes the output to differ.

$$Q_t - Q_{t-1} = \delta\left(Q_t^d - Q_{t-1}\right) + \gamma_t \ldots\ldots (2.2)$$

$$Q_t = Q_{t-1} + \delta\left(Q_t^d - Q_{t-1}\right) + \gamma_t \ldots\ldots (2.3)$$

In this case;

Q_t= give the total output ant time *t*, Q_{t-1} implies the total output at time *t-1* and δ is the partial adjustment parameter. The values of this partial adjustment parameter values is in the range between zero and one. A partial change is defined because the level of production cannot be achieved due to policy constraints. Application of this model in time series analysis may produce a spurious coefficient of determination and usually the VECM model is used to cater for this problem.

2.3.2 Staple Growth Theory of Primary-Export-Led Growth

Sustainable development has been a major issue among many countries of the world and this has drawn attention of several scholars ranging from classical to neoclassical economists that have fronted to study the effects of exogenous factors on agricultural production. The neo-classical theory has dominated several studies for several decades. For instance, the Solow-Swan development model argued that considered growths is as a result of only three factors: technology, labor growth and capital; however, this model provided for few connections between growth and other explanatory variables. Consequentially, this led to development of other growth models to accommodate other exogenous variables that explain output.

A Canadian, the leading innovator being Harold Innis in his pioneering historical studies, invented the Staple Growth Theory. This Harold Innis theory its first applicability was on cod fisheries and the fur trade as put forward by (Grant and Watkins, 1993). It is a development strategy aimed at focusing on foreign market to improve the economic condition of a particular economy. The theory is as result of consensus on economic openness which is illustrated by Hecksher-Ohlin-Samuelson theory of comparative advantage; a country will export the commodity that utilizes intensively its most abundant factor of production (Ohlin, 1933); (Samuelson, 1948); Dornbusch *et al.*, 1980). It has been shown that foreign exchange from exports can be used to finance the imported manufactured and capital goods and technology, which contribute to growth (Chenery & Strout, 1966), competition leads to economies of scale, the technological advance and growth Helpman and Krugman 1987). Export Oriented Industrialization or export led growth is a trade policy that promotes industrialization process of a country through exporting products that have comparative advantage

Adopted theory for this study is Staple Theory of Growth, which emphasizes on the crucial role of primary export(s) in the economic growth process. The staple theory of growth emphasizes the linkages of the staple export(s) with the rest of the economy. It also stresses its benefits as improved utilization of existing resources, expanded factor endowments and linkage effects. The theory makes assumption that exports are the major determinants of economic growth propelling the other sectors of the economy (Khan *et al.*,2013). Giles and Williams (2000) applied the export led growth hypothesis and found out that cross-country studies supported the export led growth hypothesis but did not consider other variables that affect exports for instance inflation, exchange rates and rate of interest. Therefore, this current study intended to close this gap.

2.4 Conceptual Framework

This research was based on the conceptual framework presented in figure 2.1. This framework shows how inflation rate (INF), exchange rate (EXR) and interest rate (INT) interact to bring effect on horticultural exports (HOE) in Kenya.

Independent variables **Dependent variable**

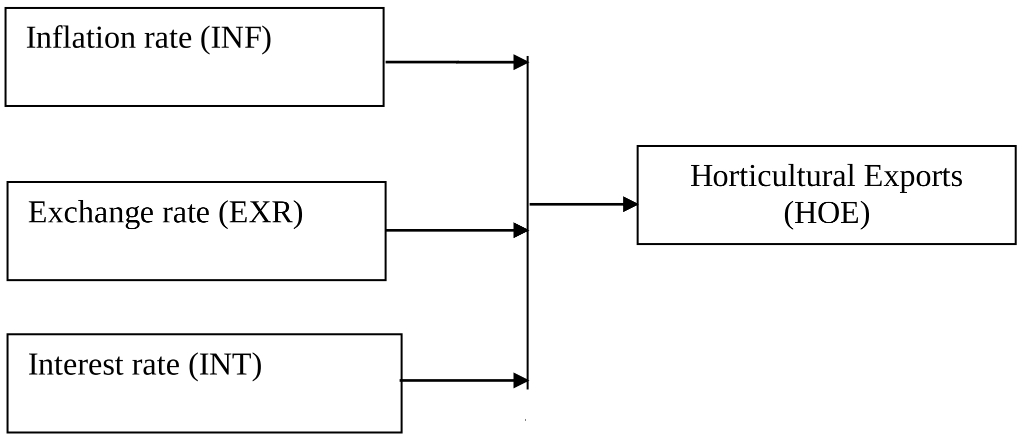


Figure 2.1: Conceptual Framework
Source: Researcher's Own Conceptualization, 2016

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter of the thesis presents research design, study area, data type and sources, unit root tests with structural breaks and without structural breaks. Optimum lag length, Johansen's test for cointegration and estimation of the VECM model is discussed. Diagnostic checks such as Lagrange Multiplier test for serial autocorrelation, Jarque – Bera test for normality, Breusch – Pagan/Cook – Weisberg test for Heteroscedasticity test for heteroscedasticity and VIF test for multicollinearity is presented. Test for model stability is also discussed. The last section of this chapter discusses assumptions multivariate time series analysis.

3.2 Research Design

It is said to be the actions that links the philosophical assumption of a particular study to it specific methods. It specifies the basic arrangement conditions that include data analysis in a way that seeks to incorporate the purpose of the study (Bradshaw, Atkinson & Dody, 2017). The study utilized longitudinal research design, which is time series in nature and it involves the measurement of a single variable at a regular interval of time. Longitudinal research design was applied because the variables under study were secondary time series data and was used as given (published) without manipulation.

3.3 Study Area

The study area was Kenya. It is located approximately between latitudes 5^oN (i.e. at Ilemi triangle) and $4^o40'$ south. It is almost bi-sected by the Equator horizontally into almost two halves and vertically by 38^o East longitude. Longitudinally it extends from longitude $33^o53'$ East of Greenwich Meridian from Suba, Mfangano, Ilemba and the pyramid islands on Lake Victoria to 41°55.5' East in the location of Mandera. It has a total area of 582,646 Km^2 of which 2.3 percent of the total area is occupied by water bodies. It is East Africa's largest economy and is divided into 47 semi-autonomous governing units by elected governors.

3.4 Sources and Types of Data

For the period between 2005 and 2017, monthly time series data was used for analysis. This period was chosen because of data availability. Data for this study was obtained from secondary sources. Exchange rate was obtained from International Financial Statistics of IMF while horticultural exports, interest rate and inflation rate were obtained from the Central Bank of Kenya. Data was also supplemented from various sources such as Kenya Trade reports and FAOSTAT.

Table 3. 1:Definition and Measurement of variables

Variable	Definition	Measurement
Inflation rate	Persistent price increase of goods and services over a given period	Percentage
Exchange rate	Value of a country's currency verses that of another country or economic zone	Percentage
Interest rate	Proportion of a loan that is charged as interest to the borrower	Percentage
Horticultural Exports	Total value of goods from horticulture	Kshs Millions

Source: Researcher's Compilation, 2017

3.5 Unit Root Tests without Structural Breaks

Failure to factor in unit root results in spurious regression as pointed out by (Mesike *et* al*.,* (2010). It is important to carry out unit root tests because it checks if the data is stationary (if they do not change over a period) or not according to Habte *et al.,* (2016). It also ensures validity of the test statistics such as t, F statistic and R^2. As pointed out by Ansari *et al.,* (2011, testing for stationarity or non-stationarity in time series data is an important factor because it can influence behavior of variables. Augmented Dickey Fuller (ADF) and Philips Perron (PP) tests were estimated to check for stationarity of variables.

3.5.1 Augmented Dickey Fuller Test

The ADF test statistic is based on the t-statistic of the coefficient φ from OLS estimation as per Dickey & Fuller (1979). It does not have an asymptotic standard normal distribution, but it has a non-standard limiting distribution. ADF test estimates equation 3.1 on time series model to accommodate serial autocorrelation, auto covariance and covariance (Pfaff, 2008).

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \sum_{i=1}^{p} \propto_i \Delta Y_{t-1} + \varepsilon_t \text{ ………………………..………….. } (3.1)$$

Where: ΔY_t: Represents first difference of each variable; β_1: Represents the intercept; β_{2t}: Represents the time trend; δ: Represents the co-efficient of the lagged variable. The *"p"* represents the optimum lag length.

ADF tests two hypotheses $H_0 : \phi = 0$ versus $H_1 : \phi < 0$ H1: $\varphi < 0$ and is based on t-statistic of the coefficient φ from OLS estimation as per Dickey & Fuller (1979). It does not have an asymptotic standard normal distribution, but it has a non-standard limiting distribution. Critical values is by simulation, for instance, (Dickey & Fuller, 1979). Presence of unit root in equation 3.1 generates spurious regression results if appropriate techniques are not applied.

3.5.2 Philips Perron Test

Performing regression analysis using OLS may generate the problem of serial correlation (Daw & Hatfield, 2018). Phillips and Perron (1988) proposed two alternative statistics; Phillips and Perron's test statistics can be viewed as Dickey–Fuller statistics that have been made robust to serial correlation by using Wang & Wu, (2012) heteroskedasticity and autocorrelation-consistent covariance matrix estimator.

To take into account the problem of serial correlation, the Augmented Dickey–Fuller test's regression includes lags of the first differences of ΔY_t. The Phillips–Perron test involves fitting I (1), and the output is used to calculate the test statistics. Phillips – Perron builds on Dickey–Fuller unit root test and it involves fitting the following regression equation 3.2;

$$\Delta Y_t = \phi Y_{t-1} + \sum_{j=1}^{p-1} \alpha_j^* \Delta Y_{t-j} + \upsilon_t \text{ ………………………………………………… (3.2)}$$

3.5.3 Kwiatkowski-Phillips-Schmidt-Shin Test

There has been increasing interest to test for unit root test using alternative methods such as KPSS, Zivot Andrews and CMR. Busetti and Harvey (2001), Lee and Strazicich (2001) and Kurozumi (2002) tested for structural breaks in deterministic components and further Philips and Jin (2002) examined that these tests are time invariant in seasonal dummies. Kwiatkowski-Phillips-Schmidt-Shin (KPSS) model is presented in equation 3.3.

$$y_t = \xi t + r_t + \varepsilon_t \text{ ………………………………………………………………… (3.3)}$$

r_t is the random walk with $r_t + r_{t-1} + u_t$ and u_t is N(0,σ_u^2). This test is usually performed as a compliment of ADF and Philip-Perron tests.

3.5.4 Unit Roots in Presence of Structural Breaks

Since the study dealt with economic variables, there is high likelihood that these variables may have experienced some significant structural breaks or shocks at some point in time given that some of the variables like exchange rate are not endogenously determined but rather determined exogenously. To test for structural breaks Zivot-Andrews tests (1992) and Clemente-Montañés-Reyes Unit-Root Tests were used. Zivot-Andrews (ZA) test treats the the structural break point as endogenously determined and the outcome of the procedure.

The Zivot-Andrews tests the null hypothesis against the alteranative hyplothesis of one time structural break with three models. Model 1 tests alternative of trend stationarity process with a shift in the intercept, Model 2 allows the testing of a one-time change in the slope of the trend function series while Model 3 allows the testing of both changes. These three models are presented in Equations 3.4, 3.5 and 3.6.

Mode- 1: $\Delta Y = \beta t + \alpha Yt - p + \varphi DUt + \sum_{i=1}^{p} \mathrm{Ci}\Delta \mathrm{Yt} - 1 + \varepsilon t$……………………..…(3.4)

Mode- 2: $\Delta Y = \beta t + \alpha Yt - p + \gamma DTt + \sum_{i=1}^{p} \mathrm{Ci}\Delta \mathrm{Yt} - 1 + \varepsilon t$……………………...(3.5)

Mode- 3: $\Delta Y = \beta t + \alpha Yt - p + \varphi DUt + \gamma DTt + \sum_{i=1}^{p} \mathrm{Ci}\Delta \mathrm{Yt} - 1 + \varepsilon t$……………(3.6)

Where DU_t and DT_t are dummy variables for a mean shift and trend shift repecctively and at each of the points the shift occurs at the break point : T_B ($1 < T_B < T$) and is stated formally as;

$DU_t = \begin{cases} 1\ if\ t \geq T_B \\ 0, therwise \end{cases}$ and ………………………..……...………………………….(3.7)

$DU_t = \begin{cases} t - T_B\ \ if\ t \geq T_B \\ 0, otherwise \end{cases}$ ……………………………………….……………......(3.8)

p is the maxinmum number of lags to be determined for each of the structural breaks by the suitable criterion and $\alpha = 0$ is the null hypothesis and $\alpha = 0$ this shows the time series has a unit root with a drift in the absence of a structural break and the alternative hypothesis shows that the series has a trend and stationarity with unknown time break.

3.5.5 Clemente-Montañés-Reyes Unit-Root Test with Two Structural Breaks

Zivot-Andrews test identifies only one structural break in each variable, but the variable may be experiencing more than one structural break in the study period. To solve this problem Clemente-Montañés-Reyes (1998) unit-root test is applied to determine the number of the breaks in each of the variable. The test is given by the following equation, the null hypothesis; that is $H_0$and the alternative hypothesis H_1.

$$H_0 : Y_t = Y_{t-p} + \emptyset_1 DTB_{1t} + \emptyset_2 DTB_{2t} + \varepsilon_t \quad (3.9)$$

$$H_1 : Y_t = Y_{t-p} + \emptyset_1 DTB_{1t} + \emptyset_2 DTB_{2t} + \varepsilon_t \quad (3.10)$$

In the equations 3.9 and 3.10, DTB_{it} is the variable pulse equivalent to 1 if $t = TB_i + 1$ and zero if otherwise and $DU_{it} = 1$ if $TB_i < t$ $(i = 1,2, \dots)$ and if the assumption is violated then it is equal to zero and when the average is modified it assumes time periods TB_1 and TB_2. This is further simplified with assumption that $TB_1 = \varphi_1 and\ T = 1,2$ where $1 > \varphi > 0$ while $\varphi_1 < \varphi_2$ Clemente-Montañés-Reyes (1998).

3.6 Determination of Optimum Lag Length

Economic relationship between macro-economic variables are sensitive to the number of lags (Greene, 2008) and therefore there is need to determine lag order before estimating the VECM model in time series analysis. The first criterion that was applied to determine the optimum number of lags was AIC. The model chooses the maximum number of lags to minimize the following equation.

$$AIC_p = \ln |\sum_p^n| + 2\frac{M(P^2+1)}{T} \quad (3.11)$$

In this case, M is the number of parameters in the entire equations of VAR model.

The second method of obtaining the optimum number of lags in the model was SBIC and takes the following form of equation.

$$SBIC = \ln|\sum_{p}^{n}| + (lnT)\frac{M(P^2+1)}{T} \qquad (3.12)$$

The third criterion applied was HQIC, which chooses to minimize equation 3.13.

$$AIC_p = \ln|\sum_{p}^{n}|)(2lnlnT)\frac{M(P^2+1)}{T} \qquad (3.13)$$

and the final form of criterion applied was the FPE, which minimizes the following form of equation;

$$FPE=\left(\frac{T+M_P+1}{T-M_P-\quad 1}\right)^\wedge m|\sum_{p}^{\wedge}| \qquad (3.14)$$

The model form for single series that was used in each of the above information criteria was as follows:

$$IC_{(p)} = \left(\frac{\varepsilon_t'\varepsilon_t}{T-p-K^*}\right) + (p+K)\left(\frac{A^*}{T-p-K^*}\right) \qquad (3.15)$$

The model form for multivariate series for each specification above was as follows:

$$IC_{(p)} = \log\left(\left|\frac{1}{T}\sum_{t=1}^{T}\hat{\varepsilon}_t\hat{\varepsilon}_t'\right|\right) + (KM^2+M)\cdot\frac{C(T)}{T} \qquad (3.16)$$

Likelihood Ratio Tests (LRT) tested the series for joint hypothesis tests. If they were jointly insignificant, the lag was dropped and the VAR was re-estimated. The new longest lag was then tested for significance. The process was repeated until a significant lag was found. The largest lag length is p that was being considered. The value of $p_{\max}$ was determined using Schwert Relations.

$$p = \text{integer part of } [12 \times (T/100)^{.25}] \qquad (3.17)$$

Greene, (2008) and Hayashi, (2000) showed that the model with the smallest $IC_{(P)}$ value was chosen in each of the above information criteria.

3.6.1 Johansen's Test for Cointegration

The concept of cointegration was introduced following the work of Granger (1988). As noted by Gujarati & Potter (2009) cointegration implies the presence of long-term association among economic variables. In this study, Johansen test for cointegration was applied to test for cointegration among the variables under study.

$$\Delta Y_t = A_t Y_{t-1} + \cdots + A_p Y_{t-p} + BX_t + \varepsilon_t \text{…………………………...……….. (3.18)}$$

Where; Y_t is a k-vector of non-stationary variables; $x_t$is a - vector of deterministic variables and $\varepsilon_t$is the error term.

H_0= no cointegration, $\varphi = 0$

H_1= co-integration, $\varphi \neq 0$

Johansen test estimates the maximum likelihood ratio based on maximum eigen values on the trace of the stochastic matrix.

3.6.2 Estimation of the Vector Error Correction Model (VECM)

If the variables exhibits cointegration, it implies that there exists a long term relationship among variables (Sohail & Hussain, 2009) it is appropriate to apply the VECM model for analysis to explain the characteristics of the cointegrated series as noted by Greene (2008). The VECM multivariate equation takes the following forms:

$$\Delta HOE = \sum_{i=0}^{p} \beta_1 \Delta INF_{t-1} + \sum_{i=0}^{p} \delta_1 \Delta EXR_{t-1} + \sum_{i=0}^{p} \delta_1 \Delta INT_{t-1} + \varepsilon_{t-1} \text{.. (3.19)}$$

Where, ECT is error correction term,

HOE denotes value of Horticultural exports (in Million Kshs)

INF is inflation (in percentage)

EXR is exchange rates (in percentage) and;

INT is interest rates (in percentage)

For the model to have long-term relationship, the ECM (ε_{t-1}) must have negative and significant coefficient.

The attractiveness of the VECM model is that it allows for testing of the links between long run and short run dynamics elasticities between variables. Further, in VECM is the resulting coefficients from VECM model are more efficient if the model is correctly specified (Kuo, 2016).

3.7 Diagnostic Tests

Diagnostic checks are important as it detects the problems encountered in model estimation or data set (Rasouli, Kotseruba, Kunic & Tsotsos, 2019). Thus, diagnostic in econometric modeling checks if model assumptions are violated and if there are observations, which exert undue influence on analysis (Kirtland, 2017).

3.7.1 Lagrange Multiplier Test for Serial Autocorrelation

Before performing inference and post estimation analysis on the VARM and VECM, the LM test applied to test if autocorrelation exist among the residuals. The LM test hypothesizes that there is no correlation at a specific lag order of i. for $i=1,2,\cdots,p$. The model form to test this hypothesis was as follows;

$$\Delta Y_t = \alpha \hat{E}_t + \sum_{i=1}^{p-1} \Phi_i^* \Delta Y_{t-i} + \varepsilon_t \quad \text{……………………………………………………………… (3.20)}$$

$\hat{E}_t = \hat{\beta} Y_t$ which is $r \times 1$ vector of the estimated cointegration relations (Lutkepohl, 2005).

3.7.2 Jarque-Bera Test for Normality

Before performing inference from the estimated VECM model, Jarque-Bera test was applied to test whether the sampled data have skewness and kurtosis that follows normal distribution. Jarque-Bera test for normality has a joint hypothesis and hypothesizes that disturbances are normally distributed. Jarque – Bera test is based on the following statistical model;

$$JB = \frac{T}{6}\left[T^{-1}\sum_{t=1}^{T}\left(\hat{\varepsilon}_t^{p}\right)^3\right]^2 + \frac{T}{24}\left[T^{-1}\sum_{t=1}^{T}\left(\hat{\varepsilon}_t^{p}\right)^4 - 3\right]^2 \quad \text{…………………………..……….. (3.21)}$$

The test statistic was used to test a pair of hypotheses

$$H_0 : E\left(\varepsilon_t^p\right)^3 = 0 \text{ and } E\left(\varepsilon_t^p\right)^4 = 3 \text{ versus } H_1 : E\left(\varepsilon_t^p\right)^3 \neq 0 \text{ or } E\left(\varepsilon_t^p\right)^4 \neq 3 \quad \text{…………..(3.22)}$$

The expected skewness of a sample from a normal distribution is expected to be zero, which is equal to kurtosis of three according to Thadewald & Büning (2007).

3.7.3 Breusch – Pagan/Cook – Weisberg Test for Heteroscedasticity

Breusch–Pagan/Cook–Weisberg test for Heteroscedasticity is designed to detect any form of linear heteroscedasticty. Presence of heteroscedasticity implies that the estimators are *'BEST'* since the error variances are biased (Papadopoulos & Tsionas, 2020). Heteroscedasticity in data gives incorrect standard errors, invalid t-statistics and F statistics and the LM will no longer be valid (Zeng, 2019). This study utilized

Breusch & Pagan (1979) test to detect presence of heteroscedasticity which estimates the following linear equation 3.23.

$$e_1^2 = \beta_1 + \beta_2 \widehat{y_1} + \mu_1 \qquad (3.23)$$

3.7.4 Test for Multicollinearity

Variance inflation factor (VIF) was applied to check presence of multicollinearity in the estimated VECM model. VIF measures how variance has been increased the estimates of the slope. High VIFs reflects an increase in the variances of estimated regression coefficients due to collinearity among predictor variables over variances obtained when predictors are orthogonal (Murray *et al.*, 2012). Models with multicollinearity have lower precision and have problems in forecasting (Midi, Sarkar & Rana, 2010). VIF for each of the independent variables in the model is computed. In computing VIF, the following equation is estimated;

$$VIF_k = {}^{1}\!/_{1 - R_K^2} \qquad (3.24)$$

VIF_k is the variance inflation factor of each of the independent variables in the model and R_K^2 is the coefficient of multiple determination of the variable k.

3.7.5 Model Stability

Before making statistical inference on estimated VECM, the stability conditions of the estimates were computed. For VECM model to be stable, it is required that that all characteristics of the companion matrix lies inside the unit circle. This requires that the variables be covariant stationary.

$$A = \begin{pmatrix} A_1 & A_2 & \cdots & A_{p-1} & A_p \\ I & 0 & \cdots & 0 & 0 \\ 0 & I & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & I & 0 \end{pmatrix} \quad \text{..........} \quad (3.25)$$

The modulus of the companion matrix was computed. If the model is stable, its modulus of each of the eigen values of the matrix A in equation 3.25 must lie inside the unit circle and strictly is less than one (Lütkepohl, 2005) and (King, Plosser, Stock & Watson, 1987).

3.8 Assumptions of Multivariate Time Series

In time series analysis, a given series follow a one systematic pattern. These patterns could be seasonality or trends that can be exhibited both in quadratic or linear form and usually regression analysis is applied to find out these trends and seasonality, which systematically repeats itself over time. It is also assumed that the data exhibits randomness, which makes it difficult to identify patterns in time series data. To dampen the error, usually some filtering techniques are employed. Other potential patterns have to do with lingering effects of earlier observations or earlier random errors (Brockwell, 2002). The third assumption is data stationary which assumes that it has constant mean and variance. If not stationary, some transformations such as differencing are carried out.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Overview

This chapter presents descriptive statistics, pairwise correlation analysis, visual inspection of variables at levels and at first difference. Unit root tests, determination of optimum lag length, Johansen's test for cointegration and VECM model is presented. The last section of this chapter presents various diagnostic checks such as Lagrange Multiplier test for serial autocorrelation, Jarque Bera test for normality, Breusch – Pagan/Cook – Weisberg test for heteroscedasticity and test for model stability. Model stability is also presented and finally test of hypothesis.

4.2 Descriptive Statistics

Table 4.1 presents the descriptive statistics of INF, EXR, INT and HOE. Descriptive statistics were performed to show the summary characteristics of the variables in the study to identify outliers and to describe the general characteristics of the sample. From the results, INF had mean 8.2692 percent, standard deviation of 3.7388 which is not close to its mean. A standard which is away from its mean implies that INF is more spread.

EXR reported a monthly average of 84.0192 percent and a standard deviation of 10.7734 percent implying that there is much variability which is a sign of volatility in EXR. The findings resonates with the previous findings of Saunders (2009). This high variabilty in EXR is an indicator that Kenya's currency is unstable as compared to those of their major trading partners such as the US$ and Euro.

INT had a monthly average of 15.2272 percent and a standard deviation of 2.0618 percent. It indicates that its standard deviation is not clustered around its mean and this indicates that INT highly varies from one period to another.

Table 4. 1: Descriptive Statistics

Variable	Obs	Mean	Std dev	Min	Max
INF	156	8.2692	3.7388	1.85	19.72
EXR	156	84.0192	10.7734	62.029	105.293
INT	156	15.2272	2.0618	12.1200	20.3400
HOE	156	5415.37	1753.52	1977.27	9493.3

Note: INF-inflation rate, EXR-exchange rate, INT-interest rate, HOE-horticultural exports and Obs-Observations
Source: Researcher's Compilation from STATA 12.0 output, 2017

On the other hand, horticultural exports (HOE) reported a monthly average of Kshs 5415.37 million. Its standard deviation of 1753.52 indicates that there is much variability in horticultural exports in Kenya. This implies an underlying seasonal variations in value of horticultural exports in Kenya occasioned by natural calamities such as Icelandic volcanic eruption in 2009 and low rainfal which resulted in low export volumes. HOE also registered a minimum of Kshs 1977.27 million and maximum of Kshs 9493.3 million.

4.3 Pairwise Correlation Analysis

Pairwise correlation was performed to show the strength and direction of association between variables. Results of pair wise correlation analysis are presented in Table 4.2. From the results in Table 4.2, it is shown that correlation of each variable and itself is equal to unity. It is indicated that there is a positive and significant relationship between inflation (INF) and exchange rate (EXR), $\sigma = 0.1824$ (p-value = 0.0227 < 0.05).

INT with INT rates recorded a weak, positive and insignificant correlation with σ = 0.0115 (p-value = 0.8867 > 0.05). INF and HOE revealed a weak, positive and significant correlation with σ = 0.1858 (p-value = 0.0202 < 0.05). INT and HOE registered a negative correlation of σ = -0.4229. EXR and INF showed a positive and significant relationship with a correlation coefficient of 0.4280 (p-value = 0.0000 < 0.05) while EXR and HOE indicated a relatively strong, significant and negative relationship. Its correlation coefficient is -0.5934 (p-value = 0.0000 < 0.05). INT and HOE are negatively related. Its correlation coefficient was significant σ = -0.4229 (p-value = 0.0000 < 0.05).

Table 4. 2: Pairwise Correlation Matrix

Variable	INF	EXR	INT	HOE
INF	1.0000			
EXR	0.1824 (0.0227*)	1.0000		
INT	0.0115 (0.8867)	0.4280 (0.0000*)	1.0000	
HOE	0.1858 (0.0202*)	-0.5934 (0.0000*)	-0.4229 (0.0000*)	1.0000

Note: Figures in brackets represents significant correlation coefficients at 5 percent level of significance
Source: Researcher's Compilation from STATA 12.0 output, 2017

4.4 Visual Inspection of Univariate Properties of Variables at Levels

Figure 4.1 shows the graphical presentation of INF, EXR, INT and HOE at levels. From the graphs presented in Figure 4.1, it is shown that there were periodic up and down movements (sinusoidal functions) for INF, EXR INT and HOE. It has upward and downward trends with drifts visually confirming the variables are not stationary at levels.

Inflation showed deviations between 2005M1 and 2009M1, however, between 2010M1 and 2014M1, it is indicated there are high fluctuations. For EXR it showed a downward trend between 200M1 and up to around 2009M12 it showed an upward trend in 2012M1. A drop in EXR is observed between 2012M1 and 2017M1.

INT exhibited an increasing trend as from 2008M1 and a drop at the beginning of the following year (2009M1). However, there was a slight rise between 2008M1 and 2010M1 and a sharp decline 2012M1 and a further downward trend beyond this period. For HOE, it is shown that there is an increasing trend through the period with slight decreases in various periods.

Figure 4. 1: Time Series Line Plots of Variables at Levels
Source: Researcher's Compilation from STATA 12.0 output, 2017

4.5 Visual Inspection of Univariate Properties of Variables at Levels

In Figure 4.2 , graphs of variables after first difference is presented. Visual inspection of differenced INF, EXR, INT and HOE indicates that the series osciliates around their means which indicates that after first difference, INF, EXR, INT and HOE achieved stationarity.

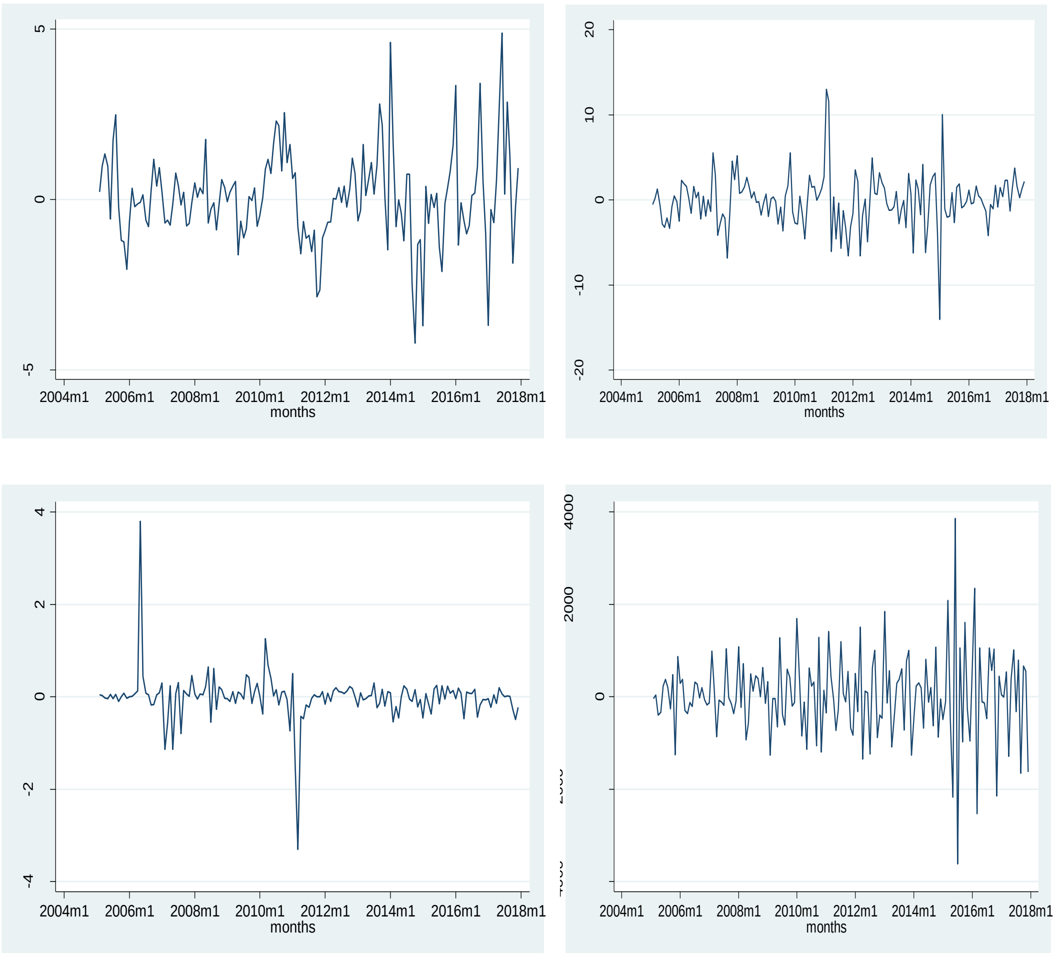


Figure 4. 2: Time Series Line Plots of Variables after First Difference
Source: Researcher's Compilation from STATA 12.0 output, 2017

4.6 Unit Root Tests

According to (Huang *et al.*, 1998) variables may not be stationary at levels and its impact in the system may not be eliminated. If the mean and variance is not constant then it means that time series variable is stationary and for this reason, it is necessary to carry out unit root tests to determine this time series property (Casini & Perron, 2018). This was done by applying conventional methods of PP and ADF and further, KPSS, ZA and CMR.

4.6.1 Augmented Dickey Fuller Test for Unit Root

Table 4.3 presents the results of Augmented Dickey Fuller unit root test.

Table 4.3: Results of ADF Test for Unit Root

Variables	ADF	p-values	Critical values			Conclusion
			1%	5%	10%	
INF	-6.503	0.8169	-3.572	2.925	-2.598	*Unit root*
EXR	-9.570	0.4388	-3.572	-2.925	-2.598	*Unit root*
INT	-3.733	0.6386	-3.572	-2.925	-2.598	*Unit root*
HOE	-3.733	0.9938	-3.572	-2.925	-2.598	*Unit root*
First Difference						
INF	-14.285	0.0000**	-3.573	-2.926	-2.598	*I(1)*
EXR	-10.132	0.0000**	-3.573	-2.926	-2.598	*I(1)*
INT	-8.559	0.0000**	-3.573	-2.926	-2.598	*I(1)*
HOE	-6.454	0.0000**	-3.573	-2.926	-2.598	*I(1)*

***** I(1) represents the variables that are stationary at 5 percent level of significance***
Source: Researcher's Compilation from STATA 12.0 output, 2017

ADF test was applied to determine if INF, EXR, INT and HOE had unit root or not. ADF test was applied to test for unit root in each univariate series and results presented in Table 4.3. The results showed that INF (p-value 0.8169 > 0.05), EXR (p-value 0.4388 > 0.05), INT (p-value 0.6389 > 0.05) and HOE (p-value 0.9938 > 0.05) all indicated critical values greater than 0.05 and it failed to reject null hypothesis presence of unit root.The variables were then differenced and tested for unit root. The results of differenced series showed that they were integrated of order one *1(1)* with (p-values 0.0000 < 0.05) and thus all the variables were stationary after first difference. These results are in line with the findings of (Fentahun, 2011) who found out that a time series data become stationary after first difference.

4.6.2: Phillips – Perron Test for Unit Root

Table 4.4: Phillips-Perron Unit Root Test

	ADF	Prob	Critical values			Conclusion
Variable			1%	5%	10%	
INF	-64.476	0.0944	-19.008	-13.348	-10.736	*Unit root*
EXR	-6.518	0.1918	-3.572	-2.925	-2.598	*Unit root*
INT	-3.683	0.4196	-3.572	-2.925	-2.598	*Unit root*
HOE	-7.168	0.7500	-3.572	-2.925	-2.598	*Unit root*
Variable			**First Difference**			
INF	-20.213	0.0000	-3.573	-2.926	-2.598	*I(1)*
EXR	-11.457	0.0000	-3.573	-2.926	-2.598	*I(1)*
INT	-9.095	0.0000	-3.573	-2.926	-2.598	*I(1)*
HOE	-6.454	0.0000	-3.573	-2.926	-2.598	*I(1)*

Note: I(1) represents the variables that are integrated of order one
Source: Researcher's Compilation from STATA 12.0 output, 2017

Table 4.4 shows the results of Philips-Perron test of unit root at both levels and at first difference. Philips-perron test indicated that INF (p-value 0.0944 > 0.05), EXR (p-value 0.1918 > 0.05), INT (p-value 0.4196 > 0.05) and HOE (p-value 0.7500 > 0.05) had all critical values greater than 0.05 at 5 percent level of significance and all failed to reject the null hypothesis of unit root.

After first difference, it was found that INF (p-value 0.0000 < 0.05), EXR (p-value 0.0000 < 0.05), INT (p-value 0.0000 < 0.05) and HOE (p-value 0.0000 < 0.05) all the p-values rejected the null hypothesis of unit root and thus exhibited stationarity implying they are integrated of order one, *I (1).* Stationarity tests of the differenced variables are in line with the findings of Greene (2007) who found out that time series variables becomes stationary after first difference.

4.7 Kwiatkowski-Phillips-Schmidt-Shin Test for Unit Root

There has been an increasing interest to test for stationarity of time series variables by use of alternative tests other than the standard conventional unit root tests of Philip-Peron and Augmented Dickey-Fuller tests. ADF and Philip-Perron tests sometimes fail to reject the null hypothesis because variables may suffer from fractional disintegration (Nelson & Plosser, 1982).

Table 4. 5: Results of KPSS Test for Unit Root

			Levels		
Variable	p-value	Critical values			Remarks
		1%	5%	10%	
INF	0.0279	0.2160	0.1460	0.1190	*Unit root*
EXR	0.0102	0.2160	0.1460	0.1190	*Unit root*
INT	0.0336	0.2160	0.1460	0.1190	*Unit root*
HOE	0.0371	0.2160	0.1460	0.1190	*Unit root*
			First difference		
INF	0.0530	0.2160	0.1460	0.1190	*I(1)*
EXR	0.1020	0.2160	0.1460	0.1190	*I(1)*
INT	0.2110	0.2160	0.1460	0.1190	*I(1)*
HOE	0.1450	0.2160	0.1460	0.1190	*I(1)*

Source: Researcher’s Compilation from STATA 12.0 output, 2017

Busetti and Harvey (2001), Lee and Strazicich (2001) and Kurozumi (2002) demonstrated how this is taken into account to incorporate structural changes among the variables and therefore KPSS Test for unit root was performed to compliment Philip-Perron and Augmented Dickey-Fuller tests and to take into account the fractional integration of variables.

Results of KPSS unit root tests are presented in Table 4.5. The aim of this test was to remove deterministic trend of the series in order to make it stationary. From the results in Table 4.5, it is shown that INF (p-values 0.0279 < 0.05), EXR (p-values 0.0102 < 0.05), INT (p-values 0.0336 < 0.05) and HOE (p-values 0.0371 < 0.05) all had p-values, which are, less than 0.05 critical value and this caused the rejection of null hypothesis of stationarity. After first difference, INF (p-values 0.0530 > 0.05), EXR (p-values 0.1020 > 0.05), INT (p-values 0.2110 > 0.05) and HOE (p-values 0.1450 > 0.05) all indicated critical values which are greater than 0.05 and therefore, this failed to reject stationarity. It was concluded that all the variables were integrated of order one denoted by *I (1).* The results support first generation unit root tests of ADF and PP tests of variable being stationary after differencing. They were consistent with the findings of (Lutkepohl, 2005; Hamilton, 1994; and Enders, 2015).

4.8 Unit Root Tests with Structural Breaks

According to Glyn *et al.,* (2009) a structural break is an abrupt change at a point time in economic entity which may be as a result in policy adjustment, legislation, technical or institutional change. It can also be a change in economic policy for instance, changes in oil prices, shifts in various macroeconomic environment that cause a variable to exhibit unit root or non-stationarity and thus have a permanent pattern (Perman & Bryne, 2006). For this reason, unit root tests with structural breaks helps to identify when and whether there is any significant change, Test for structural breaks produces unbiased output and identifies the time when the structural break occurred. To test for structural breaks in time series analysis, this study applied Zivot-Andrews

(1992) and Clemente Montane-Reyes (1997). Results of Zivot Andrews test with one structural break is presented in Table 4.6 and further reinforced by figure 4.3.

4.8.1 Zivot Andrews Test

Table 4.6 presents Zivot Andrews test for unit root with one structural break.

Table 4.6: Results of Zivot Andrews Unit Root Test with One Structural Break

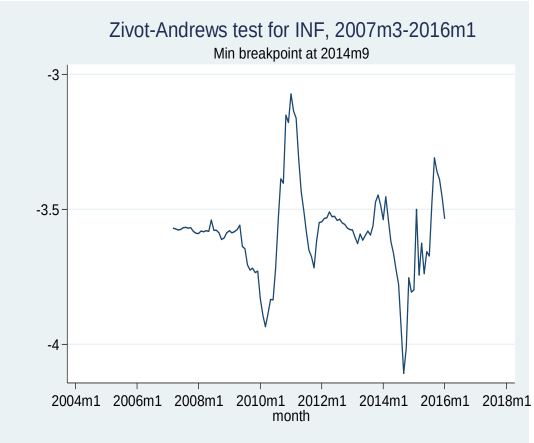
Variable	t-statistics	Critical values			Lag(s)	Break Dates
		1%	5%	10%		
INF	-4.1080**	-5.34	-4.80	-4.80	3	2014
EXR	-3.9190**	-5.34	-4.80	-4.80	1	2007
INT	-4.4660*	-5.34	-4.80	-4.80	3	2011
HOE	-11.4750*	-5.34	-4.80	-4.80	0	2012

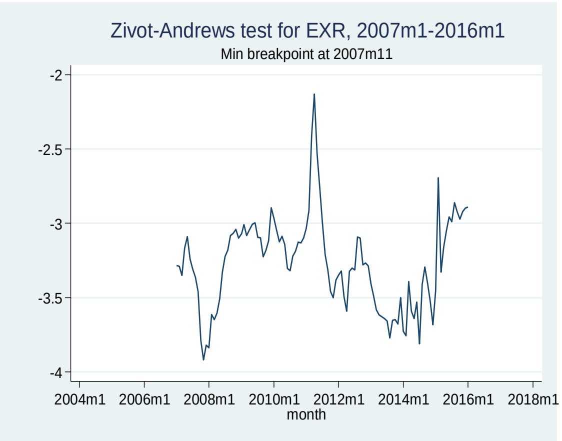
***** denotes the variables that are statistically significant at 5 percent level of significant while * shows the variables that are significant at 1 percent.***
Source: Researcher's Compilation from STATA 12.0 output, 2017

Several policy measures undertaken by the government of Kenya has cumulative effects on the overall of the economy, especially in the horticultural subsector. Structural breaks were tested to ascertain whether these policy measures have had significant effects. In this regard to test for one structural break in the variable, Zivot Andrews was tested.

There is high likelihood that the null hypothesis is rejected, if the conventional methods such Philips-Perron an Augmented Dickey Fuller tests are applied without considering the effect of structural breaks. This is because these earlier had the assumption that structural breaks are determined exogenously. In this regard, Zivot Andrews (1992) test endogenizes structural breaks at the intercept. The results of Zivot Andrews test is presented Table 4.6. The findings indicate that there is one structural break for INF in 2014. The spillover effects of multiparty elections of 2013 can explain this structural break. This given is due to high amount of money in circulation pumped into the economy in the run up to elections. For EXR, there was one structural break, which occurred in 2007. This is attributable to 2007/2008 post poll chaos that led to depreciation of Kenya shilling against other major world currencies.

For interest rate, it attested a significant break in 2011 at 5 percent level. This structural break is explained by Kenya's economic recovery. This was despite the rise in world oil prices that caused Kenya's terms of trade deteriorate, reduced economic growth and fueled inflation. After liberalization, Kenya's economy became more opened and its balance of payment improved, with increased exports and higher foreign reserves. HOE, it is indicated that there was significant structural break in 2012 (Eichengreen & Rose, 2012). This was associated to the high demand for flowers, canned fruits in the US and this increased Kenya's horticultural exports to US owing to range of products allowed to enter key markets (Kuhlmann & Flowers, 2017).). This was facilitated under the ordinary trade and preferential African Growth Opportunity Act (AGOA).





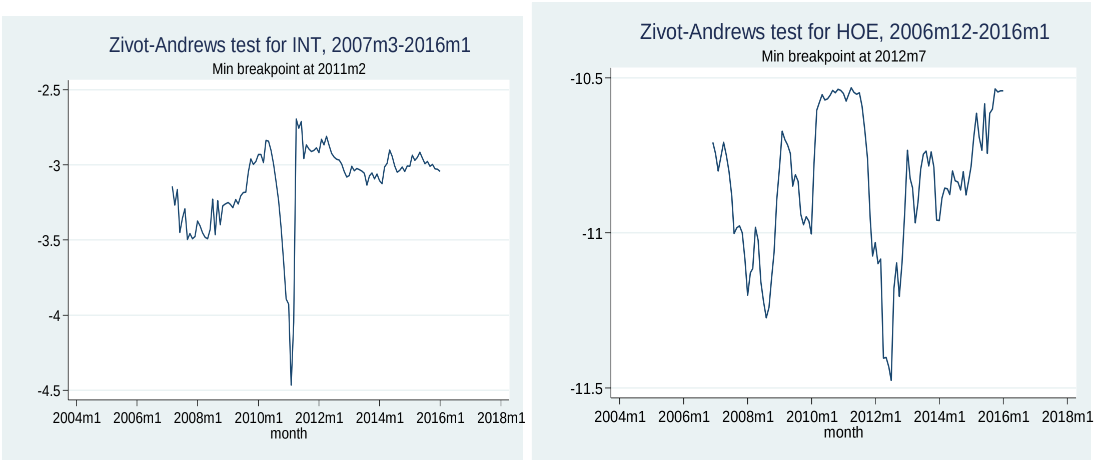


Figure 4. 3: Zivot - Andrews Graphs with One Structural Break
Source: Researcher's Compilation from STATA 12.0 output, 2017

4.8.2 Clemente-Montañés-Reyes Unit-Root Test with Single Mean Shift, A Model with Two Structural Breaks

Zivot Andrews test identifies one structural break in time series, the next step in analysis was to test for unit root with two structural breaks since there might be multiple structural breaks in time series data. This was performed by applying Clemente-Montañés-Reyes (1998) test. The CMR results are presented in Table 4.7.

Table 4.7: Clemente-Montañés-Reyes Unit-Root Test with Two Structural Breaks

Variable	Breaks	coef	t-stat	p-value	Break
INF	D1	6.8717	6.1860	0.0000	2013
	D2	-7.6569	-6.1310	0.0000	2015
EXR	D1	-10.5337	-8.9340	0.0000	2012
	D2	-11.7082	-8.2320	0.0000	2015
INT	D1	2.9763	8.4790	0.0000	2009
	D2	-5.1180	-1.5118	0.1233	2002
HOE	D1	10.96226	4.0880	0.0000	2009
	D2	12.5047	3.5900	0.0000	2015

∗ ***$DU1$ and $DU2$ are two dummies that allow structural changes***
Source: Researcher's Compilation from STATA 12.0 output, 2017

For inflation, Clemente-Montannes-Reyes indicated two significant structural breaks. The first structural break was experienced in 2013 while the second was in 2015. The two breaks were associated with effects of monetary policies between 2013 and 2015 to curb the rising food prices that was occasioned by unfavorable weather conditions in Kenya (Ochieng, 2016). The policies caused inflation being sustained above single digit.

For exchange rate (EXR), it was found that there were two significant structural breaks in 2012 and 2015. The first break of 2013 was caused by uncertainties of the impending general elections and the possibilities of change in regime. In 2015, the structural break was as a result from low balance of payment and sustained volatility of exchange rate in Kenya. Interest rate registered on structural break in in 2009. This was due to anticipated increase of interest rate by commercial banks that stood 12.76 percent (Njoroge & Kamau, 2010).

Horticultural exports indicated two significant structural breaks in 2009 and 2015. The first break in 2009 is explained by the impacts due to increase in economic growth between 2008 and 2009. In 2008, economic growth was by a margin of 1.7 percent while in 2008 it grew by approximately 2.6 percent. During this period, economic growth was negatively affected by economic turn down that depressed exports markets, erratic rainfall patterns that negatively affected agriculture and post-election violence of 2007/2009 that caused reduction in horticultural exports (Bloom, Eifert, Mahajan, McKenzie, & Roberts, 2013). In 2015, structural break is attributed to unstable Kenya’s exchange rate (CBK, 2016) and (Mutisya, 2016).

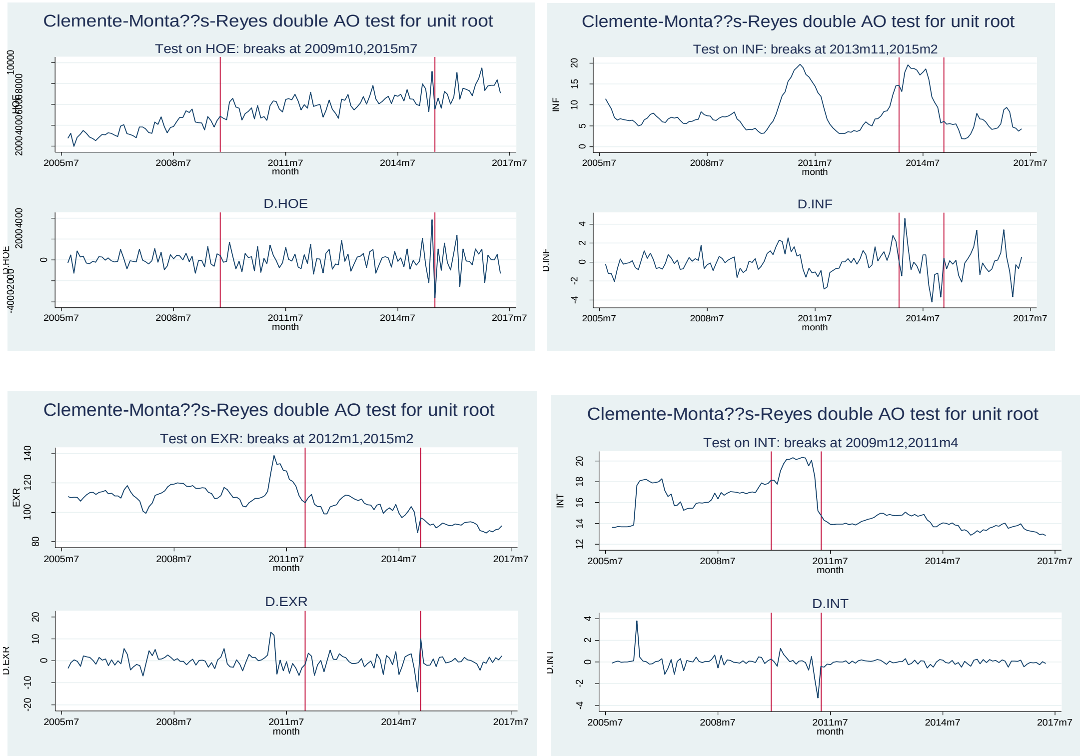


Figure 4. 4: Clemente-Montannes-Reyes Graphs with Two Structural Breaks
Source: Researcher's Compilation from STATA 12.0 output, 2017

4.9 Determination of Optimum Lag Length

Having established that there is no unit roots, and that all the variables (INF, EXR, INT and HOE) are stationary, it was necessary to determine the number of lags before estimating the vector error correction model (VECM).

Table 4. 8: Results of Lag Length Selection

Lag	LL	LR	DF	P	FPE	AIC	HQIC	SBIC
0	-2005.15				4.2e+06	26.611	26.6438	26.6912
1	-1961.01	88.277	16	0.000	4.2e+06*	26.24*	26.2386*	26.6382*
2	-1948.08	25.866	16	0.056	4.2e+06	26.279	26.5714	26.9936
3	-1933.47	29.224	16	0.022	4.2e+06	26.298	26.7197	27.3367
4	-1918.61	29.711	16	0.020	4.2e+06	26.312	26.8648	27.6715

***Indicates the Optimum Lag lenghts slected by Various Criteria**
Source : Researcher's Compilation, 2017

Barndorff, Nielsen & Shephard, (2002) noted that the methods used to determine the lag order for a VAR model is used for *I (1)* variables. All the criteria FPE, AIC, SBIC and HQIC, predicted the optimum number of lags at the first period. Wooldridge (2013) recommends the use of one lag in the case of time series data to estimate VECM Model. Cheung *et al.*, (2019) proposes lag selection order remains the discretion of the researcher to choose the optimum lag order to use.

One lag was therefore used as the optimum lag length as indicated by "*" in the output lag length selection results. This gave a lower value and consequently this resulted in a better model and eliminated serial correlation and does reduce the degrees of freedom.

4.10 Johansen's Cointegration Test

Cointegration relationship exist when there is a long run relation among economic variables. To show existence of long run relationship in an economic model, this study used Johansen's (1990; 1991) test. Johansen's cointegration output is presented in Table 4.9.

Table 4.9: Johansen's Cointegration Test

R	Parms	LL	Eigen values	Trace Statistic	Critical Values
0	20	-1995.0799		58.1015	47.21
1	27	-1981.0010	0.1671	29.94360	29.68
2	32	-1971.7156	0.1136	11.37280*	15.41
3	35	-1966.5595	0.0648	16.0606	3.76
4	36	-1966.0292	0.0069		

R implies cointegrating ranks and * indicates the number of cointegrating equations

Source: Researcher's compilation from STATA 12.0 output, 2017

From Table 4.9, it is clearly indicated that trace statistic at $r = 0$ of 58.1015 is greater than its critical value of 47.21, at r =1 of 29.94360 > 29.68, r = 2 of 11.37280 < 15.41, $r = 3$ of 16.0606 > 3.76. It is observed that the entire trace statistic for all levels of r's except at r = 2 are greater than its critical values at 5 percent level and therefore it was concluded that there were at least two co-integrating vectors and the hypothesis of no cointegration was rejected. Since inferences on the statistics depend on cointegrating equations, it is paramount that the specification of the model is checked. This was done by predicting cointegrating equations and graphing them over time.

4.11 Long Run Co-Integrating Relationships

Table 4.10: Co-integrating Relationships

Equation	Parms	Chi^2	P > Chi^2
Co-integration Equation 1	6	172.1374	0.0000
Co-integrating Equation 2	6	40.3916	0.0000

Source: Researcher's Compilation from STATA 12.0 output, 2017

The predicted cointegration equations is presented in figure 1 and figure2 (see appendix I). The zero average in the graph represents the long run relationship between INF, EXR, INT and HOE. It is observed that there were large fluctuations in 2011, which is a clear indication that the period deviated significantly from the long-term equilibrium path. This sharp decline was occasioned by drastic depreciation of Kenya's currency and rapid inflation rate (Were, Tiriongo & Secretariat, 2012).

4.12 Vector Error Correction Model

Since Johansen's cointegration demonstrated that there exist a long-term relationship running from INF, EXR, INT to HOE, VECM model was estimated. The principle aim of this model was to take into account the changes in horticultural exports and identify the speed of adjustment it takes the system to correct itself and adjust to its equilibrium path. The output of VECM model is summarized in Table 4.11.

Table 4.11: Summary Estimates of the Vector Error Correction Model

Equation	Parms	RMSE	R-Sq	Chi^2
D(HOE)	6	8.8511	0.7403	128.2536

" D" implies first difference
Source: Researcher's Compilation from STATA 12.0 output, 2017

The estimated VECM model, which is the model of interest, reported an R square of 0.7403. It indicates that INF, EXR and INT explained 74.03 percent of the total variation while the remaining 25.97 percent is attributed to the variables not captured in the model.

After determining that the long run association among variables and that they are cointegrated, VECM model was estimated to determine the dynamics of horticultural exports in the short run and in the long run. The speed of adjustment of the error correction term towards its long-term adjustment path or to the point of convergence because of temporary shocks was also determined. The estimated VECM is presented in the Table 4.12.

Table 4.12: Vector Error Correction Model

VECM	coef	std error	Z	p>|z|
ECT	-0.0853	0.0245	-3.4816	0.0010
INF	0.3599	0.0721	4.9917	0.0000
EXR	0.20595	0.06819	3.0200	0.0300
INT	-0.0241	0.0118	-2.0400	0.0207
CONS (-1)	.	.	.	.

Note: ECT is the error correction term
Source: Researcher's Compilation from STATA 12.0 output, 2017

As per (Lutkepohl, 2005) and Lutkepohl & Kratzik, 2004) coefficients represent the short run elasticities in the model. The value of error correction term (ECT) was negative and statistically significant at 5 percent level of significance with critical value p-value of 0.001 < 0.0500 according to Engle & Yoo (1987) theorem.

The negative and significant ECM coefficient indicates that it exists a long-term relationship between horticultural exports, inflation, exchange rate and interest rate in Kenya. Its absolute value is 0.0853 and it indicates that 8.53 percent of the disequilibria are adjusted from lagged period of error shocks. It also indicates that the past values of the independent variables affect the present values in the short run.

(Maddala & Lahiri, 1992). ECT coefficient also indicated that horticultural exports (HOE) are highly sensitive to its deviation from long-term original path. This ECT term also confirms the long-term relationship. The ECM term also shows that it takes approximately 11.72 months (obtained by taking the reciprocal of the ECT term) for the deviations from the short run to come back to its long run equilibrium path.

It is shown that coefficients of lagged differences of INF, EXR and INT attached to it were 0.3599, 0.20595 and -0.0241 respectively and were all significant (p - value < 0.0500) implying that they all explain horticultural exports in the long run. This indicates that inflation has the highest effect on horticultural exports as it recorded the highest positive value of the coefficient.

The findings from the study indicated that inflation and horticultural exports have a positive and significant relationship, *ceteris paribus*. The positive sign was not expected and conflicted with economic theory. These findings concur with finding by Rikken, (2011) and Rono and Rotich (2018) where they identified that changes in inflation rate and export volumes affects export earnings positively in many flower firms in developing nations. These results are also in tandem with the findings of Gylfason (2001) who found out that inflation rates had a positive relationship with exports. These results were found to contradict previous findings by Meme (2015) and Oliver (2014), who argued that increasing inflation rate, have negative relationship with horticultural exports implying that an increase in inflation rates causes a decrease in horticultural exports in Kenya, this is because increasing inflation translates to an increase in cost of borrowing as a result of increased cost of production that reduces horticultural exports.

Exchange rates reported a positive significant coefficient at 5 percent (p-value of $0.0300 < 0.0500$) which is consistent with economic theory. This implies that increasing exchange rate causes horticultural exports to increase by 20.6 percent increase in horticultural exports, *ceteris paribus*. These findings agree with results of (Meme, 2015), Shane *et al.,* (2008), Chege *et al.,* (2014) and Mesike (2010). Devaluation of the local currency against those of their major trading partners makes horticultural exports more competitive therefore increase in demand. Pierola & Freund (2012) also found out that low exchange rate volatility causes exports to increase. Bhattarai and Armah (2005) in their study concluded that Ghana's exports are stimulated by currency depreciation.

However, the findings are inconsistent with findings previous studies by (Okot & Nyanzi, 2014) and Mwangi (2015). They found out that in the short-run, exchange rate influences flower exports negatively because exports from the industry is increased in the short run. The findings also disagreed with the findings of Serenis (2011), Wang and Barret (2007) who concluded that exchange rates negatively influence exports.

Interest rates showed a negative coefficient, which was also significant. The findings resonate with economic theory. It implies that a one percent increase in the levels of interest rates causes a drop in horticultural exports by approximately 2.41 percent. This negative relationship between interest rate and horticultural exports can be explained by the fact horticulture industry is a capital-intensive venture in comparison to other agricultural subsectors in terms of technology acquisition, inputs, materials required to set greenhouses structures, irrigation systems agrochemicals required. Therefore, increased interest rates by commercial banks is likely to reduce disposable incomes of investors because they will be forced to pay more money in terms of increased rates and this consequently leads to decrease in aggregate supply of horticultural exports (Meme, 2015). The findings resonate with the previous researches such as those of Adofu *et al.,* (2010), Kaabia, and Gill (2001) and Keror *et.al.,* (2018) and Mabeta (2015) who found out that interest rates are unfavorable for cut flower exports in Kenya.

The structural breaks were also determined to show their influence on horticultural exports in Kenya. The findings from analysis showed that some of structural breaks were significant while others were not. This shows the significance of policies such as EUREGAP and EU regulations including harmonization of EU standards with WTO standards in the year 2003.

4.13 Diagnostic Tests

This section presents the diagnostic checks that were carried before making inference on the estimated VECM model. Lagrange multiplier test for serial correlation, Jarque-Bera test for normality, Breusch – Pagan/Cook – Weisberg test for heteroscedasticity and test for multicollinearity using variance inflation factor (VIF).

4.13.1 Lagrange Multiplier Test for Serial Correlation

Table 4.13: Lagrange Multiplier Test for Serial Correlation

Lag order	Chi^2	$\text{Prob} > \text{Chi}^2$
1	77.0429	0.1269

H_0 : no autocorrelation at a specified lag order
H_1: presence of autocorrelation at a specified lag order
Source: Researcher's Compilation from STATA 12.0 output, 2017

The LM test was used to test for the presence of autocorrelation in the estimated VECM model. Table 4.13 shows that at lag one and two, the values of Chi square (p $>\chi^2$) failed to reject null hypothesis that there is no serial correlation hence no relationship between residual of variables.

4.13.2 Jarque-Bera Test for Normality

Jarque-Bera Test for Normality tests has a null hypothesis that the sample data was not significantly different from normal.

Table 4.14: Jarque –Bera Test for Normality

Equation	Ch^2	DF	Prob > Ch^2
INF	2.921	2	0.3423
EXR	3.460	2	0.1887
INT	1.567	2	0.467
HOE	1.564	2	0.540
ALL	7.838	8	0.356

Source: Researcher's Compilation from STATA output, 2017

Table 4.14 reports the output of joint (skewness and kurtosis) Jarque-Bera test. It is shown that none of the Jarque-Bera statistic rejected the null hypotheis. This confirms that the sample data was drawn from a normal disribution.

4.13.3 Breusch – Pagan/Cook – Weisberg Test for Heteroscedasticity

The test has the null hypothesis that the error variances are all equal against alternative hypothesis that error variances are multiplicative function of one another. A Ch^2 value of 7.97 was obtained with a probality of 0.1233 at five percent level of significance and it failed to reject null hypothesis that error variances are homoscedastic.

4.13.4 Test for Multicollinearity

Table 4.15 presents the output of test for multicollinearity, the output of variance inflation factors (VIF) and the reciprical of VIF $(1/_{VIF})$.

Table 4.15: Variance Inflation Factor

Variable	VIF	$\frac{1}{VIF}$
INF	1.27	0.7853
EXR	1.23	0.8122
INT	1.04	0.9613
Mean VIF	**1.18**	

Source: Researcher's Compilation from STATA output, 2017

VIF was calculated for each of the independent variables in the model. The mean VIF was 1.18, which is less than 10, and this indicates absence of multicollinearity.

4.14 Stability Condition of the Model

Results of model stability condition is shown in Table 4.16. To test for model eigen values in a unit circle are plotted.

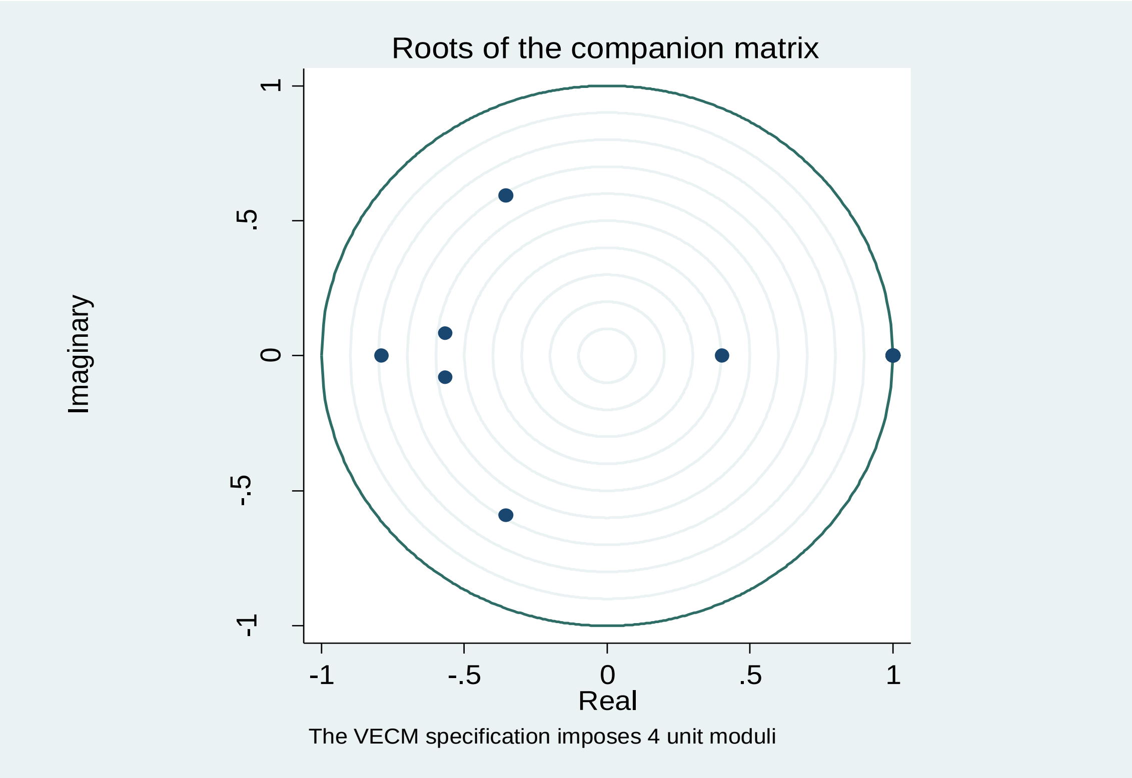
Table 4.16: Model Stability Condition

Eigen Values	Modulus
1	1
1	1
1	1
1	1
-0.78829	0.78829
-.3548637 + .5925274*i*	0.6907
-.3548637 - .5925274*i*	0.6907
-.5654477 + .0816154*i*	0.5713
-.5654477 - .0816154*i*	0.5713
0.4023771	0.402377

Source: Researcher's Compilation from STATA output, 2017

(Lutkepohl, 2005;Lukepohl & Das, 2019) indicated that a *K*-variable with *r* cointegrating equations, then the companion matrix has K-r unit of eigen values and therefore, the moduli of the remaining eigen values has to be less than one and has lie inside a unit circle. For the model estimated, it is shown that all eigen values of the resulting inverse matrix all appeared inside the unit circle. It was therefore concluded that the model is stable and thus suitable for inferential analysis and forecasting.

4.14.1 Roots of Companion Matrix



Note: *Eigen values on a complex plane.The horizontal axis is for the real part while the vertical axis is for the imaginary part of the eigen values and the referrence circle is the unit circle

Figure 4. 5: Roots of Companion Matrix

Source: Researcher's Compilation from STATA output, 2017

Determining the stability of the estimated model graph option was also defined and its own values was plotted as a companion matrix. It is shown that none of the eigen values appeared closer to the unit circle and none of the values lied outside the unit circle suggesting that the model was properly defined thus stable. The results of diagnostic tests indicated that the growth model employed in this study had the desired fit and was well specified.

4.15 Test of Hypotheses

In this study, it was hypothesized that inflation rate has no significant effect on horticultural exports in Kenya. VECM regression analysis results showed that this variable determines the value of horticultural exports in Kenya and therefore, this hypothesis was rejected, and it was concluded that inflation has effect on horticultural exports in Kenya.

The second hypothesis of the study was that exchange rate has no significant effect on horticultural exports. VECM results showed that exchange rate is an important determinant of horticultural exports in Kenya. This concurs with the findings of (Hausmann, Pritchett & Rodrik, 2005) who concluded that depreciation of local currency leads to an increase in economic growth. The findings imply that an increase in exchange rate or depreciation of Kenya's currency and would lead to an increase in the horticultural exports from Kenya. The second hypothesis was rejected and it is concluded that exchange rate significantly affect horticultural exports in Kenya.

The third hypothesis was that interest rate has no significant effect on horticultural exports in Kenya. The findings suggest that interest rate is an important determinant of horticultural exports in Kenya. An increase in interest rates leads to decrease in horticultural exports, this is due to the fact that horticulture industry is capital intensive and an increase in rate of interest increases the cost of borrowing that include purchasing inputs, cost of installing irrigation pumps and agrochemicals and consequently discourages investment in this sector and therefore, this hypothesis was rejected.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Overview

This chapter presents the summary of the key findings from the study. Conclusions and policy recommendations based on the study are also discussed. The last section of this chapter discusses the limitations of the study and the possible suggestions for future research in this area of study.

5.2 Summary of the Findings

Study objective was to find the effect of inflation rate, exchange rate and interest rate on value of horticultural exports in Kenya for the period 2005 - 2017 by applying Johansen cointegration test and VECM model. Before estimating the VECM model, descriptive statistics were computed. Descriptive statistics such as minimum, maximum mean and standard deviations were computed to provide general characteristics of the sample and to check for outliers. Conventional unit root tests such as Philip-Perron (PP) and Augmented Dickey Fuller (ADF) showed that the variables contained unit root at levels but attained stationarity after first difference and therefore, it was concluded that the data contained no unit root hence stationary.

KPSS test results supported PP and ADF tests that the variables were not stationary at levels but became stationary after first difference. Zivot - Andrews unit root test with single structural break was also tested and it is shown that variables exhibited structural breaks at different points in time. Further, Clemente, Montanes and Reyes unit root test showed that there existed significant structural breaks for each of the variables at a specific time. It was also found out that the structural breaks were variable specific and associated with certain economic and political episodes.

Johansens' test for cointegration was carried out to determine cointegration and the findings showed that INF, EXR INT and HOE. Cointegration test showed that there is a long-term relationship between INF, EXR, INT and HOE hence, VECM model was estimated. The long-term relationship was supported by the negative and statistically significant coefficient of error correction term (ECT). It was concluded from the study that inflation rate (INF) and exchange rate (EXR) affect horticultural exports positively while interest rate (INT) affect negatively.

Diagnostics checks were carried out to determine if model assumptions are violated. Lagrange Multiplier Test for serial correlation showed no serial correlation. Jarque Bera test for normally indicated that the data is normally distributed, Breusch – Pagan/Cook – Weisberg test for heteroscedasticity showed that the errors homoscedastic and VIF reported absence of multicollinearity.

5.3 Conclusions from the Study

Kenya's economy is much dependent on agriculture and specifically horticultural exports. From the findings of this study, it is concluded that inflation and interest rate have a positive influence while exchange rate has negative effect on horticultural exports. The results of the study imply that as exchange rate increases (depreciation) horticultural exports also increases. Inflation recorded a positive relationship which contradicted economic theory. However, interest rate increase leads to a reduction in horticultural exports. This negative relationship is attributed to the fact that horticulture is capital intensive venture and when commercial bank and other lending institutions increases interest rate, it increases cost of borrowing which discourages businesses owners from borrowing to finance their horticultural production. This will eventually lower aggregate supply thereby leading to low horticultural exports.

5.3 Policy Recommendations

The study recommends to the government that there is need to formulate both long and short-term economic policies that stimulate investment opportunities in horticultural sector and increase funding for current agricultural production as its current production affects the future production. This can be done through encouraging both local and foreign investors to invest in agricultural subsectors such as horticulture production by creating conducive environment for investment.

The government through Central Bank of Kenya needs to stabilize macroeconomic environment that is essential in formulating trade policies to increase horticultural exports by finding out appropriate exchange rates and finding appropriate strategies to control inflation rate. This can be done by CBK through application of monetary policy instruments such as regulation of foreign reserves and money supply.

From the findings of the study, it is recommended that there is need for commercial banks to further reduce interest rate. This can also be achieved through radical changes in the borrowing structure and application of monetary policies such as credit control.

5.4 Limitations of the Study

In this study, data inadequacy and inconsistency were the main challenge. Like any other developing countries, Kenya has the problem of maintaining clear and consistent database, particularly with regard to macroeconomic variables. Hence, data was obtained from different sources and this gave varying values for given macroeconomic variables.

5.5 Suggestions for Further Research

First, it is suggested that future studies should carry out panel data analysis for different countries or economic blocks such as County governments, EAC, COMESA because of increasing globalization. Secondly, it is further suggested that there is need to incorporate other various variables that were not included and use alternative models such as ARDL to determine effect of other macro -economic variables that were not captured on horticultural exports in future studies.

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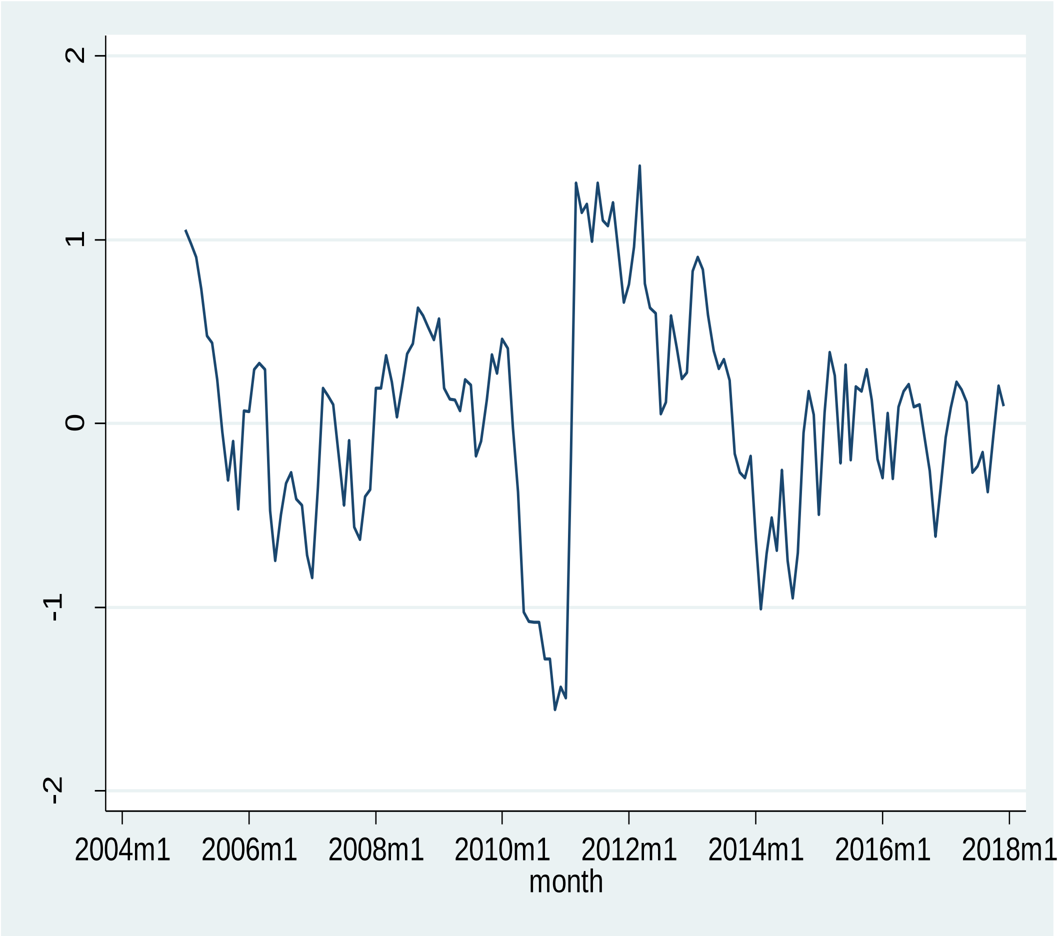
APPENDICES

Appendix I: Graphical Presentation of Cointegrating Equations



Predicted Cointegrating Equation (ce1)
Source: Researchers' compilation from STATA 12.0 output, 2017

Appendix II: Summarized Raw Stata Output of Vector Error Correction Model

```
Vector error-correction model

Sample:  2005m3 - 2017m12

                                                  AIC             =   8.83355

Log likelihood = -653.1833                        HQIC            =  9.049831

Det(Sigma_ml)  =  .0567779                        SBIC            =  9.366003

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

             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]

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

D_LHOE       |

        _ce1 |

         L1. |  -.0853818     .024533  -3.48    0.001    -.1334657   -.0372979

             |

        HOE |

         LD. |  -.3964989   .0767535    -5.17   0.000    -.5469331   -.2460648

             |

         INF |

         LD. |  -.0042041   .0091902    -0.46   0.647    -.0222165    .0138082

             |

         EXR |

         LD. |    .003972   .0038052     1.04   0.297     -.003486      .01143

             |

         INT |

         LD. |   .0006915   .0235879     0.03   0.977      -.04554     .046923

             |

       _cons |   .0104874   .0118256     0.89   0.375    -.0126904    .0336652

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

D_INF        |

        _ce1 |

         L1. |     .02026   .1842008     0.11   0.912    -.3407669    .3812868

             |

        HOE |

         LD. |  -.2348569    .657146    -0.36   0.721    -1.522839    1.053126

             |

         INF |

         LD. |   .4238632    .078684     5.39   0.000     .2696455     .578081
```

```
             |
         EXR |
         LD. |  -.0081166    .032579    -0.25   0.803    -.0719703    .0557372
             |
         INT |
         LD. |   .2324769   .2019543     1.15   0.250    -.1633463    .6283001
             |
       _cons |   .0414513   .1012483     0.41   0.682    -.1569917    .2398943
-------------+----------------------------------------------------------------
D_EXR        |
        _ce1 |
         L1. |  -2.141005   .4385179    -4.88   0.000    -3.000484   -1.281526
             |
        HOE |
         LD. |  -.2592915   1.564436    -0.17   0.868     -3.32553    2.806946
             |
         INF |
         LD. |  -.3050497   .1873192    -1.63   0.103    -.6721885    .0620892
             |
         EXR |
         LD. |   .1411836   .0775593     1.82   0.069    -.0108299    .2931971
             |
         INT |
         LD. |  -.4546699    .480783    -0.95   0.344    -1.396987    .4876474
             |
       _cons |  -.0010678   .2410369    -0.00   0.996    -.4734915    .4713559
-------------+----------------------------------------------------------------
D_INT        |
        _ce1 |
         L1. |   .1618201   .0732232     2.21   0.027     .0183053    .3053348
             |
        HOE |
         LD. |  -.4365843   .2612275    -1.67   0.095    -.9485808    .0754122
             |
         INF |
         LD. |   .0215766   .0312783     0.69   0.490    -.0397278    .0828809
             |
```

EXR						
LD.	-.025109	.0129508	-1.94	0.053	-.0504921	.000274
INT						
LD.	.1727746	.0802805	2.15	0.031	.0154276	.3301215
_cons	-.0170899	.040248	-0.42	0.671	-.0959747	.0617948

Source: Researchers' Compilation from STATA 12.0 output, 2017

Appendix III: Map of the Study Area (Kenya)

Source: https://www.nationsonline.org/oneworld/map/kenya_map2.htm

Appendix IV: Raw Study Data

YEAR	INF	EXR	INT	HOE
2005m1	4.5	121.968	13.64	2963.44
2005m2	4.73	121.422	13.68	2919.57
2005m3	5.72	121.587	13.71	2951.12
2005m4	7.06	122.85	13.69	2555.51
2005m5	8.04	122.242	13.65	2216.64
2005m6	7.47	119.401	13.7	2445.56
2005m7	9.21	116.177	13.66	2816.67
2005m8	11.7	114.049	13.71	3015.63
2005m9	11.48	110.681	13.61	2749.93
2005m10	10.28	109.869	13.61	3230.95
2005m11	9.04	110.363	13.69	1977.27
2005m12	6.99	110.171	13.66	2844.97
2006m1	6.35	107.672	13.66	3137.69
2006m2	6.68	109.984	13.67	3515.18
2006m3	6.47	111.885	13.73	3222.49
2006m4	6.34	113.479	13.86	2861.37
2006m5	6.26	113.659	17.66	2733.58
2006m6	6.4	112.099	18.1	2525.36
2006m7	5.8	113.688	18.18	2844.96
2006m8	5	113.96	18.22	3121.29
2006m9	5.27	114.842	18.04	3101.02
2006m10	6.45	112.599	17.87	3295.28
2006m11	6.84	113.023	17.91	3225.97
2006m12	7.78	111.114	18	3051.05
2007m1	8.01	111.109	18.3	2919.69
2007m2	7.32	109.766	17.16	3909.23
2007m3	6.72	115.301	16.58	4053.92
2007m4	5.97	118.225	16.82	3190.13
2007m5	5.84	114.087	15.68	3114.5
2007m6	6.62	111.358	15.75	2992.78
2007m7	7.03	109.717	16.06	2805.98
2007m8	6.87	107.538	15.26	3847.36
2007m9	7.08	100.706	15.4	3833.61
2007m10	6.31	99.405	15.46	3683.4
2007m11	5.61	103.945	15.47	3315.95
2007m12	5.53	106.32	15.93	3226.4
2008m1	6.02	111.522	15.99	4305.68
2008m2	6.09	112.279	15.94	4080.64
2008m3	6.43	113.205	16	4794.99
2008m4	6.6	114.736	16.04	3864.7
2008m5	8.36	117.396	16.26	3285.31
2008m6	7.67	118.929	16.91	3777.64

2008m7	7.39	119.157	16.36	3900.35
2008m8	7.3	120.094	16.97	4355.91
2008m9	6.41	119.783	16.7	4746.66
2008m10	6.27	119.577	16.91	4748.19
2008m11	6.86	117.806	17.06	5380.49
2008m12	7.21	117.495	17.03	5234.5
2009m1	7.15	118.178	16.99	5559.58
2009m2	7.36	116.219	16.89	4296.38
2009m3	7.76	116.333	17	4256.9
2009m4	8.29	116.666	16.86	4212.57
2009m5	6.67	116.511	16.96	3563.48
2009m6	6.03	113.656	17.02	4836.81
2009m7	4.91	112.812	16.97	4453.46
2009m8	4.05	109.183	17.45	3845.63
2009m9	4.14	109.646	17.87	4442.57
2009m10	4.11	111.308	17.73	4861.44
2009m11	4.45	116.858	17.84	4659.3
2009m12	3.67	115.467	18.13	4531.97
2010m1	3.2	112.769	18.15	6226.53
2010m2	3.25	109.912	17.78	6594.43
2010m3	4.14	110.347	19.04	5748.7
2010m4	5.32	108.798	19.73	5628.95
2010m5	6.09	104.2	20.13	4490
2010m6	7.74	103.597	20.15	5115.24
2010m7	10.05	106.505	20.3	5348.15
2010m8	12.22	107.992	20.12	5663.81
2010m9	13.06	109.572	20.22	4605.82
2010m10	15.61	109.553	20.34	5890.67
2010m11	16.69	110.055	20.28	4697.08
2010m12	18.31	111.424	19.54	4837.01
2011m1	18.93	114.146	20.04	4487.97
2011m2	19.72	127.134	18.51	5899.09
2011m3	18.91	138.737	15.21	6344.71
2011m4	17.32	132.68	14.79	6285.8
2011m5	16.67	133.042	14.32	5557.92
2011m6	15.53	128.478	14.14	5282.89
2011m7	14.48	128.113	13.91	6471.25
2011m8	12.95	122.418	13.88	6543.1
2011m9	12.05	121.142	13.92	6431.76
2011m10	9.19	117.881	13.92	6978.73
2011m11	6.54	111.288	13.92	6296.13
2011m12	5.42	108.161	14.03	5465.07
2012m1	4.51	106.535	13.87	5970.26
2012m2	3.84	110.073	13.95	5648.96

2012m3	3.18	112.197	13.85	7157.27
2012m4	3.21	105.612	13.98	5805.44
2012m5	3.22	103.792	14.18	5926.77
2012m6	3.57	103.896	14.29	6012.41
2012m7	3.49	98.992	14.39	4771.01
2012m8	3.88	98.79	14.46	5404.49
2012m9	3.66	103.707	14.58	6411.75
2012m10	3.97	104.457	14.8	5526.08
2012m11	5.18	105.094	14.98	5132.13
2012m12	5.95	108.268	14.98	4663.35
2013m1	5.32	110.268	14.76	6511.66
2013m2	5	111.684	14.85	6380.64
2013m3	6.62	111.245	14.78	6941.38
2013m4	6.74	110.014	14.74	5858.57
2013m5	7.36	108.835	14.76	5475.95
2013m6	8.44	108.024	14.79	5768.43
2013m7	8.6	109.028	15.09	6140.88
2013m8	9.61	106.228	14.85	6748.16
2013m9	12.42	105.077	14.71	6030.01
2013m10	14.6	104.979	14.87	6803.28
2013m11	14.69	101.725	14.67	7803.44
2013m12	13.22	104.845	14.78	6535.94
2014m1	17.83	105.561	14.87	6053.85
2014m2	19.54	99.329	14.33	6282.92
2014m3	18.74	101.673	14.12	6582.99
2014m4	18.73	102.958	13.66	6770.65
2014m5	18.33	101.239	13.66	6091.82
2014m6	17.12	105.405	13.9	6897.43
2014m7	17.87	99.208	14.06	6775.55
2014m8	18.61	96.316	14.01	6975
2014m9	16.12	98.083	13.91	6345.02
2014m10	11.9	100.793	14.06	7412.97
2014m11	10.58	103.963	13.84	6537.46
2014m12	9.4	100.157	13.78	6490.93
2015m1	5.7	86.088	13.32	5996.42
2015m2	6.08	96.126	13.39	5889.08
2015m3	5.38	95.087	13.24	7968.31
2015m4	5.53	93.058	12.87	7493.18
2015m5	5.3	91.151	13.04	5315.64
2015m6	5.48	91.987	13.29	9173.94
2015m7	4.07	89.332	13.14	5553.61
2015m8	1.96	90.818	13.38	6607.97
2015m9	1.85	92.681	13.33	5628.85
2015m10	2.19	91.769	13.56	7235.13

2015m11	3.02	91.043	13.64	6979.27
2015m12	4.63	90.872	13.78	6023.8
2016m1	7.98	92.03	13.74	6689.8
2016m2	6.64	91.58	13.93	9039.86
2016m3	6.55	91.262	14.01	6510.08
2016m4	5.93	92.863	13.54	7563.37
2016m5	4.92	93.339	13.64	7453.42
2016m6	4.16	93.501	13.72	7318.8
2016m7	4.28	92.962	13.79	6846.35
2016m8	4.47	91.638	13.95	7899.01
2016m9	5.44	87.454	13.51	8467.28
2016m10	8.85	86.901	13.33	9493.3
2016m11	9.39	85.841	13.27	7342.07
2016m12	8.39	87.526	13.2	7787.81
2017m1	4.7	86.69	13.16	7831.07
2017m2	4.4	88.151	12.93	7824.02
2017m3	3.72	88.559	12.97	8363.82
2017m4	4.27	90.855	12.83	7075.75
2017m5	6.87	93.165	13.03	7462.36
2017m6	11.76	91.835	13.09	8477.1
2017m7	11.92	93.245	13.09	8157.29
2017m8	14.78	96.974	13.11	8950.78
2017m9	16.02	98.55	13.12	7294.39
2017m10	14.15	98.803	12.84	7956.14
2017m11	13.94	100.142	12.35	8506.4
2017m12	14.87	102.334	12.12	6875.93

Note:M1-M12 implies months of the year

Source: EXR-IMF, INF, INT and HOE- CBK and FAOSTAT.