IMPACT OF AGRICULTURAL SUB-SECTORS ON AGRICULTURAL GROSS DOMESTIC PRODUCT IN KENYA

BY

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DECLARATION

Declaration by the Candidate

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This thesis is dedicated to my beloved parents Mr. and Mrs. Alexander Ndung'u for inspiration, guidance and mentoring. May God surely bless you.

LIST OF ACRONYMS AND ABBREVIATIONS

ACF	Autocorrelation Function
ADF	Augmented Dickey Fuller
AR	Autoregressive
ARCH	Autoregressive Conditionally Heteroscedastic
ARIMA	Autoregressive Moving Average
AIC	Akaike Information Criteria
CBS	Central Bureau of Statistics
DGPs	Data Generation Process
ESP	Economic Stimulus Program
FAO	Food & Agriculture Organization
FFEPP	Fish Farming Enterprise Productivity Program
FPEC	Final Prediction Error Information Criteria
GDP	Gross Domestic Product
GoK	Government of Kenya
HQIC	Hannan-Quinn Information Criteria
IGAD	Intergovernmental Authority on Development
KARI	Kenya Agricultural Research Institute
KCC	Kenya Cooperative Creameries
KNBS	Kenya National Bureau of Statistics
KPMG	Klyveld Peat Marwick Goerdeler
Ksh	Kenya Shillings

K£	Kenya Pound
LD	First Lagged
L2D	Second Lagged
LPI	Livestock Policy Initiative
LIC	Log Likelihood Criteria
LJB	Log Jarque-Bera
LM	Lagrangian Multiplier
MA	Moving Average
MoA	Ministry of Agriculture
MLD	Ministry of Livestock Development
OLS	Ordinary Least Squares
PACFs	Partial Autocorrelation Functions
PPP	Public Private Partnership
R&D	Research & Development
SAFCs	Sample Autocorrelation Functions
SBIC	Schwert-Bayesian Information Criteria
STATA	Simulator Training Research Advance Test bed for Aviation
USAID	United States Agency for International Development
VECM	Vector Error Correction Model

ABSTRACT

The impact of the Agricultural sub-sectors (horticultural production, livestock production, fish farming and crop farming) and their contribution to the Agricultural National Economy are considered to be significant in attaining positive economic change mostly by developing economies. It was therefore important to find out if Agricultural sub-sectors performance can act as stimulus to Agricultural National Gross Domestic production or vice versa. This determined whether Agricultural sub-sectors were still significant sub-sectors that may transform Kenyan Agricultural Gross Domestic production. The study was developed owing to the underlying fact that, though Agricultural sector is considered to have highest percentage contribution to National Gross Domestic Product (25%), the sector has continuously performed poorly. The study had the following objectives: to determine the net effect of the horticultural sub-sector performance on Kenyan Agricultural Gross Domestic Product; to find out the relationship between livestock rearing output and Kenyan Agricultural Gross Domestic Product; to examine whether crop production impacts significantly on Kenyan Agricultural Gross Domestic Product; and to indentify whether fish farming output has significant relationship with Kenyan Agricultural Gross Domestic Product. To achieve these objectives, it was hypothesized that Agricultural sub-sectors do not significantly contribute to Kenya Agricultural Gross Domestic product. Time series data set was employed from 1980 to 2010. The variables of the study were Kenya Agricultural Gross Domestic Product, and Horticultural Production, Livestock Production, Crop Farming and Fish Farming. Unit root tests were conducted using Augmented Dickey-Fuller and Phillip-Perron test. Cointegration analyses were done using Johansen's Multivariate Cointegration test methodology, and Granger causality. The results showed that there was a co-movement of the variables both before and after differencing the data. In the short run, there were mixed results from the various sub-sectors like fish farming indicating huge fluctuation between 1980 and 1985. This was not the case in the long run and the fluctuations were seen during early period of the study. The study also revealed that the entire five variables did actually co-move together with drifts and trends and were deterministic and stochastic in nature. The main conclusions therefore were that the variables output performance can be used to solve short run problems and that horticultural production, livestock production, and crop farming remains significant sub-sectors that drive the Kenya Agricultural Gross Domestic Production. The policy recommendations from the results were that the Government should design policies that are all inclusive of Agricultural sub-sectors in the overall macro-economic set up and promote domestic Production of agricultural products by reducing farming cost. Also, the Government should encourage mixed farming since variables have shown significant effect on Kenya Agricultural Gross Domestic Production.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

For decades now, agricultural sector has been considered to contribute significantly to economic growth. According to InvertorWords.com (2013), economic growth was referred to as a positive rate change in the level of production of goods and services by a country over a certain period of time. Here, the term production cuts across several economic pillars such as industrial, agricultural and household, among others. To attain positive economic change therefore, certain sectors performance have to be improved. This has led to the rise of the concern as to how

Agriculture as a sector has affected National GDP and hence stimulating National Economic growth.

Good performance of the agricultural sub-sectors (horticultural production, livestock production, fish farming and crop farming) and their contribution to the National economy is still considered to be significant in attaining positive economic change mostly by developing economies. This is argued by the fact that the sub-sectors play a key role in economic growth since their products form basic items that consumers buy to get satisfaction and also earning foreign exchange. The sub-sectors still absorb key factors of production such as capital and labour which make them to be included in macro-economic growth analysis.

Likewise, majority of the developing economies, Kenyan economy included, still consider the agricultural sector as the backbone of their economy. In Kenya, for example, it is the single most important sector in the economy contributing approximately 25 per cent of the total National GDP and employing about 75 per cent of the National Labor force (Republic of Kenya, 2005). The sector still is considered to support over 80 per cent of Kenyan population living in the rural areas, either directly or indirectly. Based on this argument, one can ask: is the development of the sector therefore important in achieving economic growth for the entire economy? Since even with the 75 % contribution, the Kenyan economy still continues to perform poorly.

The agricultural sector is made up of five main sub-sectors. These are: industrial crops, food crops, horticulture, livestock and fisheries. In the contribution to the National GDP, industrial crops contribute about 17 per cent of the total agricultural contribution. Horticulture on the other hand is considered to be the largest Foreign Exchange earner as a sub-sector in agricultural output exports. Although they have some potential of doing well, according to the GoK (2005), livestock and fisheries are considered to be having a declining performance since 2000. This has given them an important consideration even under Kenyan Vision 2030 Goals (GoK, 2007).

Agricultural productivity is however constrained by a number of factors including high cost of inputs (especially the price of fertilizer and seeds), poor livestock husbandry, limited extension services, over-dependence on rain-fed agriculture, lack of markets and limited application of agricultural technology and innovation. However, for some crops, the productivity of Kenyan farmers is close to international standards, which is a good indication for the growth of the economy. For example, yields for wheat, which is grown predominantly by estate farmers are only 20 per cent below those in the US (GoK, 2005). If this is the position of some of the agricultural sub-sectors output, why is the economy still performing poorly? Is the impact of agricultural sub-sectors to Kenya Agricultural GDP well established? The study intended to find out the answers to these questions and establish the relationship between these agricultural sub-sectors with agricultural GDP both in long run and short run.

1.2 Problem Statement

Kenya refers to agricultural sector as the main source of its income. Majority of the National GDP is believed to be contributed by the Agricultural sector (GoK, 2005). Regardless of this important position, the sector continues to perform poorly except some few crops such as tea, wheat, and coffee which are regarded to be close but still below international standards. On the other hand, the Kenyan economy has continued to perform poorly to even reaching as low as negative 2 per cent in some periods (MoA, 2013). In fact, on average, the per capita income growth from 1979 to 2002 was about negative 2 per cent, meaning that overall Kenyans were worse off in 2002 than they were 1979 in terms of economic well being (Kimenyi, 2013). Of recent the Government of Kenya has been trying to do a lot of investment in Agricultural sector with the aim of developing the economy by more than 10 per cent per annum that is “double digit”. These facts lead to the rise of concern whether there exists a gap that the Government wants to seal in the sector in so doing.

The interaction between the two (economic growth and agricultural sectors production) has therefore led to the concern whether agricultural development stimulates economic growth or whether economic growth stimulates agricultural development. Clarity of this concern is therefore important so as to determine what can be done to develop agriculture as well as accelerating economic growth. The study was therefore intended to establish the impact of agricultural sub-sectors in Kenya Agricultural GDP hence promote the Economic Growth. The knowledge gap and policy to be adopted between what should be done to ensure economic growth and agricultural development forms the main subject and concern of this research work.

1.3 Purpose of the Study

If the agricultural sub-sectors performance has no significant effect on the Kenya Agricultural GDP to stimulate economic growth, then the economy is agricultural independent. According to GoK (1997), agricultural sector absorbs a majority labour force and is regarded to provide an average of 60 per cent of total domestic agricultural related industries with raw material. If this is the case, then we can nullify the introductory statement and re-state that a shortage of agricultural sub-sectors output will negatively affect the agricultural sector performance and increase unemployment. Based on the above argument therefore, the establishment of the relationship between the Agricultural sub-sectors output and Kenya Agricultural GDP performance stands significant.

It was therefore empirically significant to determine the relationship between agricultural sub-sectors performance and the aggregate output effect on Kenya Agricultural GDP which is the main subject of this thesis. This added information on the current debate on the role of Agricultural sub-sectors in promoting the National Economic Growth through positive effect on Kenya Agricultural GDP. The research results formed a good reference as Kenya tries to achieve her short term and long-term economic goals. The results and recommendations formed part of publication for future research and studies.

1.4 Objectives

1.4.1 General Objective

The general objective is to determine the impact of the agricultural sector in the promotion of the economic growth, which is the magnitude of the rates of change between Agricultural sub-sectors performance and Kenya Agricultural Gross Domestic Product.

1.4.2 Specific Objectives

i. To determine the net effect of the horticultural sub-sector performance on Kenyan Agricultural Gross Domestic Product;
ii. To find out the relationship between livestock rearing output and Kenyan Agricultural Gross Domestic Product;
iii. To examine whether crop production impacts significantly on Kenyan Agricultural Gross Domestic Product;
iv. To indentify whether fish farming output has significant relationship with Kenyan Agricultural Gross Domestic Product;

1.5 Research Hypotheses

Based on above research objectives the following were the four Null research hypotheses:

H_{01}: Horticulture sub-sector performance has no significant effect on Agricultural Gross Domestic Product;

H_{02}: Livestock rearing output has no significant relationship with Agricultural Gross Domestic Product;

H_{03}: Crop production does not significantly impact Agricultural Gross Domestic Product;

H_{04}: Fish farming output has no significant relationship with Agricultural Gross Domestic Product;

1.6 Significance of the Study

There is need to indentify the determinants of Economic growth so that the authorities know on which variables to concentrate on as they try to make Economic performance better off in formulating relevant policies. Agricultural sub-sectors play an important role in providing food for the households and raw materials for the agricultural related industries. Also, the sub-sectors provide market for industrial output and offers significant employment opportunities to local people in rural areas (GoK, 1997). The sub-sectors in so doing are therefore regarded as a main engine for the economy, and can be placed at the central position of the whole economy.

However, the economy has not been much developed and transformed from low productivity in agricultural output to high value added industrial products. The need arises therefore to determine which sub-sector of the agriculture sector significantly impacts the Kenya Agricultural GDP so that economic growth can be accelerated by transforming it.

According to Mwangi (2013), most labor is still in low productivity meaning that regardless of the important role the sub-sector plays, people have not yet embraced the technology and specialization. The information generated therefore helped interested groups such as farmers, National government and County governments in setting the best standard to the relevant sub-sector(s) for better growth transformation.

Although a lot has changed in the economy in the last 50 years, the structure of production has largely remained the same (Mwangi, 2013). This has resulted to constant agricultural production and the rise in the demand for the farm products cannot be met. Rise in the demand and inadequate supply of the farm output have resulted to the poverty, hunger and reduction in the per-capita income. As a way of finding solution to these problems, determination of the impact of agricultural sub-sectors and their effects to Kenya Agricultural GDP is significant.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter begins by discussing the general overview of the agricultural sector as a sector contributing to GDP. The agricultural sector here is used to represent a combination of the five sub-sectors considered at the later section of this chapter. These are: horticultural sub-sector, livestock sub-sector, fisheries, industrial crops and crop farming. At specific review, the study discusses researches done on each of these sub-sectors in detail in terms of their contribution and impact to Kenyan GDP. The chapter concludes with conceptual framework showing the relationship between the dependent and independent variables considered in this research.

2.2 General Review

With agriculture being the source of income and livelihood for 70 per cent to 80 per cent of people suffering from hunger in developing countries (FAO, 2003), it is clear that sustainable reduction in poverty, food insecurity and malnutrition cannot be obtained without special attention to the development of the Agricultural sector in these countries and their economies co-currently.

The sector forms the backbone of most economies in sub-Saharan African. In Kenya, agriculture has remained the mainstay of the economy since independence in 1963. Although its contribution to the GDP decreased from 35 per cent in 1963 to 25 per cent in 1996, it still plays an important role in the provision of labour force and provides most of the food requirements for the nation and earns the country about 60 per cent of the foreign exchange (GoK, 1997). Despite this importance of the agricultural sector in Kenyan economy and in most sub-Saharan African countries, its performance has been continuously poor since 1970s (World Bank, 1981; Chibber, 1988; Mosley, 1989). Much of the blame for the poor performance of the sector is attributed to the policies adopted which tends to aggregate all sub-sectors without considering the external factors affecting different sub-sectors differently.

The Kenyan government has tried to boost agricultural production in the past by continuous increase in the expenditure in the sector. During the financial year 1982/83 for example, the government allocated K£ 96.7 million to the sector which increased up to K£ 561.3 in the financial year 1996/97. However, there was a decline in allocation during the financial year 1990/91 from K£ 78.8 million to K£ 18.2 million in the financial year 1991/92. These fluctuations means that the government had not yet established the reason(s) to boost the sector (see table 2.1 below).

Also, as a way of boosting the sector and develop food security, irrigation sector was allocated Ksh. 80 million and Ksh. 1 billion for agribusiness in 2012 budget (KPMG, 2013). This was to be achieved by involvement of financial sector. Another measure was to write off debts owned by coffee, rice and sugar farmers that totaled to about Ksh. 1.5 billion. This was a small proportion and measures for investment and support bearing in the mind that the sector contributed a total of 21.4 per cent and 24 per cent of total GDP for 2010 and 2011 respectively (KPMG, 2013). However, there were concerns about whether more than this could be done with the sole motive of increasing the contribution to Kenya Agricultural GDP.

Table 2.1 Government Expenditure for all Sectors and Agriculture in million K£, 1982/83-1996/1997

Year	Agri. Recurrent	Agri. Dev't	Total Agri.	Total Public expenditure	% Share of Agri.
1982/83	52.4	44.3	96.0	1,190.7	8.1
1983/84	58.3	14.7	72.9	1,242.4	5.8
1984/85	90.4	39.0	129.4	1,521.7	8.5
1985/86	62.2	77.6	139.8	1,628.4	8.5
1986/87	122.7	99.7	222.4	2,063.1	10.7
1987/88	168.1	67.7	135.8	2,198.9	6.1
1988/89	310.0	91.6	401.6	3,101.9	12.9
1989/90	82.7	71.1	153.8	3,156.0	4.8
1990/91	38.6	40.2	78.8	2,815.7	2.8
1991/92	13.3	4.9	18.2	4,926.7	0.4
1992/93	117.0	177.2	294.2	6,064.7	4.8
1993/94	160.6	302.9	463.5	9,007.7	5.1
1994/95	184.4	192.2	376.6	9,205.6	4.1
1995/96	216.1	170.5	386.6	9,170.4	4.2
1996/97	229.5	331.8	561.3	10,147.8	5.5

Source: **Republic of Kenya, Statistical Abstract (various issues)**

How much the government should spend on each of the Agricultural sub-sector will be determined by the significance of contribution and impact to Agricultural GDP. It is important therefore to determine how each sub-sector has been performing in relation to contribution to Kenya Agricultural GDP for the past periods. This will indentify the major contributors to the economy so that even as the government tries to fulfill its short term and long-term objective, investment can be done in the significant sector(s) to accelerate the economic performance and promote development.

2.3 Agricultural Sector Reviews

The section is divided into four agricultural sub-sectors considered to be significant in boosting the economy (GoK, 2007: pg 43). Their role, contribution and impact to National GDP have been used to form the basis of this discussion.

2.3.1 Horticultural Sub-Sector Contribution to Kenya Agricultural GDP

Horticultural sub-sector is among the leading contributors to the Agricultural related GDP at 33 per cent and continues to grow at a rate between 15 per cent and 20 per cent per year according to Ministry for Agriculture (2010). It is believed that the industry is also among the leading sub-sectors in foreign exchange earning apart from contributing food and income to households. The sub-sector has also absorbed 6 million Kenyans both directly and indirectly (MoA, 2010). The proportion of consumption is about 96 per cent and 4 per cent is exported but still regarded as huge amount of foreign exchange. This shows how the sub-sector is important and significant to the domestic consumption as well as external trade.

Kenya is a major exporter of horticultural produce to the European market. According to MoA (2010), the success is partly attributed by compliance of the international market standards. Though 96 per cent of horticultural produce is locally consumed, still government has not done much to ensure domestic market compliance is met. A good example is the continued increase in the cost of production which lowers the output. Measures are therefore necessary to be instituted to safeguard the situation since about 60 per cent of smallholder’s farmers derive their livelihood from horticulture (USAID/Kenya, 2010).

From the above discussion, then one can say that the contribution of horticulture to Kenyan Agricultural GDP still holds a significant position, though not much has been done to improve it. The sub-sector continues to be the mainstay of the country's economy in achieving food security, income and employment generation, foreign exchange earnings, raw materials for agro-processing industry such as flower industry and poverty eradication.

The trend of the performance in the sub-sector continues to fluctuate in area, quantity and even the value of products. In 2012, domestic value totaled Ksh. 217 billion occupying an area of 662,835 Ha with a total production of 12.6 million tons (see Fig. 2.1 below) as compared to 2011, where the total value, area, and production changed by 6 per cent, 9 per cent and 38 per cent respectively. This was due to the favorable weather condition in the production areas that saw increased production and subsequently the value. The major contributors to the increased value were just bananas and potatoes (GoK, 2012). This proves that more can be done to improve the production output of the sub-sector.

The figure 2.1 below indicates a fluctuating comparison trend in the quantity and the value of products in the sub-sector for three successive years:

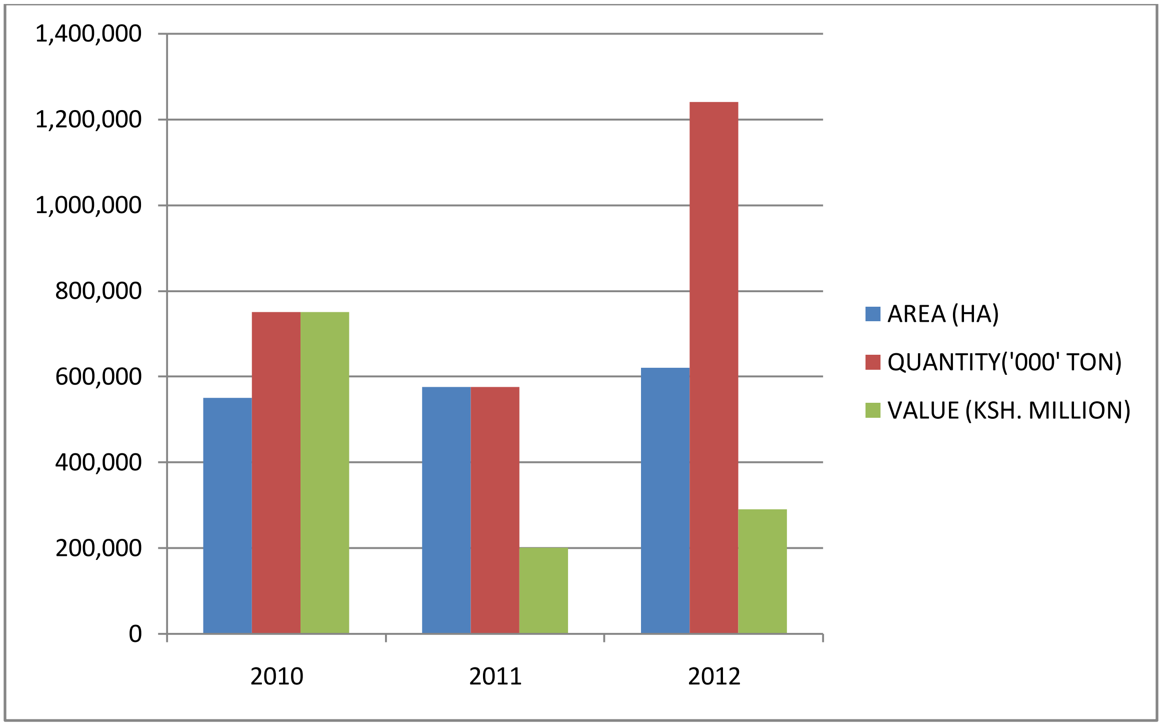


Fig 2.1 Trend of Horticulture Sector 2010 to 2012

Source: Kenya Economic Survey Diary, 2012:10

In conclusion one can state clearly that the sub-sector is considered to play an important role to the National Economy (MoA, 2010). Products which are included in this industry include cut flowers, vegetables, fruits, nuts, herbs and spices (GoK, 2010).

Whether the vicious cycle of poverty and low horticultural production can be “cut off” depend on the investment to be done in the sub-sector. This investment can be by government and/or private sector investments. However investment can not be done where the return is not significant. All agricultural sub-sectors contribution and effect to Agricultural GDP has an important concern and need be established.

2.3.2 Livestock Rearing Output Contribution to Kenya Agricultural GDP

Kenyan societies like many others in developing countries keep livestock for its products and service provision. These are meant to help an individual attain better livelihood. Livestock are kept for benefits such as meat, wool, plough and sale for earning income. Regardless of this importance, African countries have been undermining the contribution of livestock to their National Output. According to IGAD (2011), it was revealed that majority of these countries; Kenya included, regards the sub-sector as insignificant and has minimal contribution. This however is not a good view. According to IGAD (2010), the sub-sector has been considered and seen to contribute double in 2010 that what was estimated in 2009. This double contribution of 150 per cent over official estimates means that the livestock contribution to Agricultural GDP is only slightly less than that from arable agriculture, example, Ksh 320 billion for livestock versus Ksh 399 for crop and horticulture in the year 2009 (IGAD, 2010). Unlike neighboring countries such as Ethiopia, Sudan, and Somalia, Kenya is a livestock importer rather than an exporter. According to the same report (IGAD, 2010), an estimated 22 per cent of the nation’s beef is supplied by cattle walked across the Kenya’s borders.

According to KNBS (2009), there are averages of 9 kinds of livestock in Kenya. These are: cattle, sheep, goats, camels, donkeys, pigs, and beehives, indigenous and commercial chickens. All these are kept for different purposes and in different environments. This makes the government to use different policies such as vaccination and immunization differently with sole aim of supporting the farmers.

Based on KNBS (2009), the cost of the inputs used in livestock production totaled Ksh. 50.243 billion in 2009. Deducting these from intermediate costs from the gross value of production which was estimated as Ksh. 369.214 billion gives a value of Ksh. 318.871 billion, the value added to the agricultural sector of the National GDP by the livestock (See table 2.2 below).

Table 2.2 Estimated Gross Value of Livestock Production in 2009

PRODUCT	BILLION Ksh.
Cattle milk	197.018
Camel milk	16.190
Goat milk	44.603
Subtotal estimated milk offtake	**257.811**
Cattle offtake	53.960
Camel offtake	1.948
Sheep offtake	3.699
Goat offtake	7.540
Subtotal estimated ruminant offtake	**67.147**
Egg production	10.305
Chicken offtake	4.616
Pigs offtake	1.506
Subtotal non-ruminant production	**16.427**
Manure for fertilizer	27.829
Change in stocks	No estimate
TOTAL PRODUCT OUTPUT	**369.214**

Source: **KNBS Census (2009)**

As indicated in the table above the amount of contribution of livestock to Kenya Agricultural GDP still stands significant. The concern of whether Kenyan Government should boost livestock rearing more through supporting private sector investment will be determined if the sub-sector has significant effect on Kenya Agricultural GDP.

2.3.3 Kenyan Fisheries Contribution to Kenya Agricultural GDP

In Kenya, fishing is done at farm land (fish ponds), at natural fresh water lakes or rivers. A farmer who is considering creating his own fish pond should consider several factors such as accessibility to market, soil type, and topography of the land and availability of good quality water. All these are meant to have good quality fish so as to increase the demand and hence earn more.

As a sub-sector for contribution to Kenya Agricultural GDP, the Kenya's fishery is considered to play an important role. The sub-sector contributed 0.5 per cent GDP in the year 2006. The value is considered to be below what can be attained if value additions at various stages of the supply chain are considered and post harvest losses minimized. In 2005, the sub-sector was considered and estimated to have a growth of 4.1 per cent (FAO, 2007). Further studies reveal that the sub-sector supports about 80,000 Kenyans directly and about 800,000 indirectly assuming a dependency ratio of 1:10 (GoK, 2006). In 2006, a total of 159,776 metric tons of fish valued at Ksh 8.7 billion to fishers was produced in the country. In the same year, fish exports earned the country approximately Ksh. 5 billion (GoK, 2006). The significance of the sector has continued to gain recognition to the extent of introduction of some development programs aimed at promoting the sub-sector such as Economic Stimulus Program (ESP), which aimed at facilitating the integration of small holder farming systems to provide employment opportunity and diversify income options for farmers.

Though the fish farming has a tendency of fast growth both globally and locally, Kenyan aquaculture potential has still not been fully exploited. A survey done by Nyonje *et al* (2011) revealed that until introduction of ESP the fish exploitation was below 3 per cent which was translated to 4,000 metric tons around the year 2011. This means that there was a huge fluctuation of fish production from 159,776 metric tons in 2006 to 4,000 metric tons in 2011. This leads to development of other programs such as Fish Farming Enterprise Productivity Program which aimed at increasing fish production and stabilizing these fluctuations. Individual regional production of fish has indicated that former Rift Valley province is the largest producer while former Nairobi province is the smallest producer as indicated in the table 2.3 below signifying the capacity of marine production at all regions. This is a good view as Gross Domestic Production is a national production rather than output from a small selected region.

Table 2.3 Fish Production before the Government sponsored fish farming through Fish Farming Enterprise Productivity Program (FFEPP) in 2007

Province	Total production before ESP (Kgs)	Annual production (2011) (Kgs)	Projected production ESP (I) (Kgs)	Projected production ESP (II) (Kgs)	Projected production ESP (III) (Kgs)	Projected total National production
Central	2,209,911	9,481	870,000	435,000	1,305,000	4,068,534
Coast	35,473	30,000	149,000	465,000	614,550	1,252,512
Eastern	480,888	15,529	638,000	540,000	1,178,000	2,673,386
Nyanza	421,922	62,654	842,000	525,000	1,367,550	3,013,568
R. Valley	3,706,797	141,252	840,000	517,000	1,367,550	5,161,486
Western	421,086	59,779	720,000	360,000	1,357,500	2,437,916
Nairobi	-	-	30,000	90,000	1,080,000	240,000
Total	727,6077	323,695	4,090,100	2,932,500	7,022,600	18,847,402

Source: **FAO Fishery Statistics (2012)**

Whether the aquaculture is a significant sub-sector to affect the economy is an ongoing discussion. This research helped in identifying the role the sub-sector plays in contribution to Kenya Agricultural GDP thereby suggesting whether to invest in it or not in short or long run.

2.3.4 Crop Production Contribution to Kenya Agricultural GDP

Crop production under this study was considered to be a combination of two minor sub-sectors; first, crop farming to represent farming for local consumption by the household and secondly industrial crop to include all that farming intended for sale whether in small scale or large scale. The two have been combined to represent the farm cultivation production. The two require similar inputs and output have similar effect to household and in Kenya Agricultural GDP accounts they are treated the same hence need to aggregate their output. These include roles such as income generation, food provision, and employment creation among others. Crop farming can also be referred to as food crop while industrial crops can be referred to as cash crops.

Under Kenyan economy food crops can be categorized into cereals, pulses, roots and tubers. The main examples of food crops in Kenya are maize, rice, wheat, sorghum, potato, cassava, vegetables, and beans. On the other hand main industrial crops are tea, coffee, sugar cane, cotton, sunflower, pyrethrum, barley, tobacco, sisal, and coconut, all contributing about 55 per cent of agricultural exports (Mwangi, 2013).

According to GoK (2010), the production of the food crop has been increasing since 2002. The report continues to state that production of maize increased from 2.4 million tons in 2002 to 3.2 million tons in 2006. However, this production reduced in 2007 to 2.9 million. On the other hand beans production increased from 481,225 tons to 531,800 tons on the same period. Roots and tubers registered an increase of 0.7 million tons over the same period. In contrast the other food crops production registered a reduction specifically legumes and root crops. Regardless of this fluctuation in food crop production, the consumption requirement has not yet been met and hence some people are still on hunger and starvation regularly.

Based on the same government report (GoK, 2010), tea has been recognized as the leading foreign exchange earner in the country. Its production increased from 287,100 tons in 2002 to 370,200 tons in 2007, while the value of its exports increased from Ksh 34.3 billion in 2002 to Ksh 47.3 billion in 2006 but it experienced a slight decline in 2007 of Ksh 0.5 billion. In comparison to coffee production, the value of exports increased from Ksh 6.5 billion to Ksh. 8.7 billion an increase of 33.8 per cent over the same period.

Regarding the other crops in the sub-sector, a decline was recorded in pyrethrum registering a decline of 13 per cent and sugar industries being able to produce an annual output of 400,000 tons from 600,000 tons over the same period. The report, registered that other commercial crops production have still remained low despite large unexploited potential such as cotton, pyrethrum, oil crop, cashew nuts, and sisal.

The impact of the agricultural sub-sectors on Kenya Agricultural GDP has not yet been indentified since from the discussion above and many other studies, what has been the topic of discussion is contribution rather than their significance impact. The need therefore arose to establish the sub-sectors' impact to Kenya Agricultural GDP so as to know what and how to invest both short and long term such as under Vision 2030. Research on the Agricultural sub-sectors contribution to Kenya Agricultural GDP carries important and significant information for achieving macroeconomic growth. To know how to move the economy then its drivers must be established. This made the development of this study so that to relate the agricultural sub-sectors contributions to Kenya Agricultural GDP. This helped in deciding where to invest so that more output can be obtained and in long run achieve the economic growth or raise the gross domestic product per capita.

The impact of the agricultural sub-sectors to Kenya Agricultural GDP can not be indentified without first determining how much each of agricultural sub-sectors contributes to Kenya Agricultural GDP. The above discussion has been able to reveal that many studies have been done concerning this contribution. One of the main observations revealed, is that there has been a continuous investment on Agricultural sectors but the output performance has been fluctuating, even some time reaching below 0 per cent. To have a sustained development in Kenya Agricultural GDP, the need arises as to determine impact of agricultural sub-sectors to it.

2.4 Conceptual Frame Work

From the above discussion about the contribution of the four agricultural sub-sectors and their net effect to the Kenya Agricultural GDP, it is clear that agriculture is viewed as the backbone of the economy by most developing economies. This is due to the functions the sub-sectors play in the sustenance of the economic growth through provision of food, raw materials and employment opportunities. Generally, the sector is said to have the following four main functions: the provision of raw materials to the industrial sector, the provision of food for the household sector, offering of the employment to the majority of the rural people, and offering market for the industrial output.

The above four main functions of the agricultural sub-sectors places them in a significant location in the whole economy and therefore it cannot be ignored in macro-economic analysis. The agricultural sector can be viewed as a combination of four sub-sectors which contribute to development, based on this study. These are; crop production, livestock rearing, fish farming and horticultural farming. The indication of this and from previous discussion is that, for developing nations to boost their economies then agriculture sector cannot be ignored. Lack of concern in the sector results to poor economic growth and therefore its study analysis becomes crucial and important.

Growth of Agricultural sub-sectors is seen as one way of development since development revolves around several factors and agricultural performance is one of them. It is therefore important to establish the significant effect of the individual agricultural sub-sectors to the Kenya Agricultural GDP. The study has adopted the four agricultural sub-sectors contribution to be Independent Variables and be regressed against Kenya Agricultural GDP as Dependent Variable. These means that, the level of Kenya Agricultural GDP will depend directly on crop production outputs, level of horticultural outputs, amount of fish production and the level of livestock rearing production outputs. However this will be clearly established upon analysis of the Cointegration results. These can be expressed as follows:

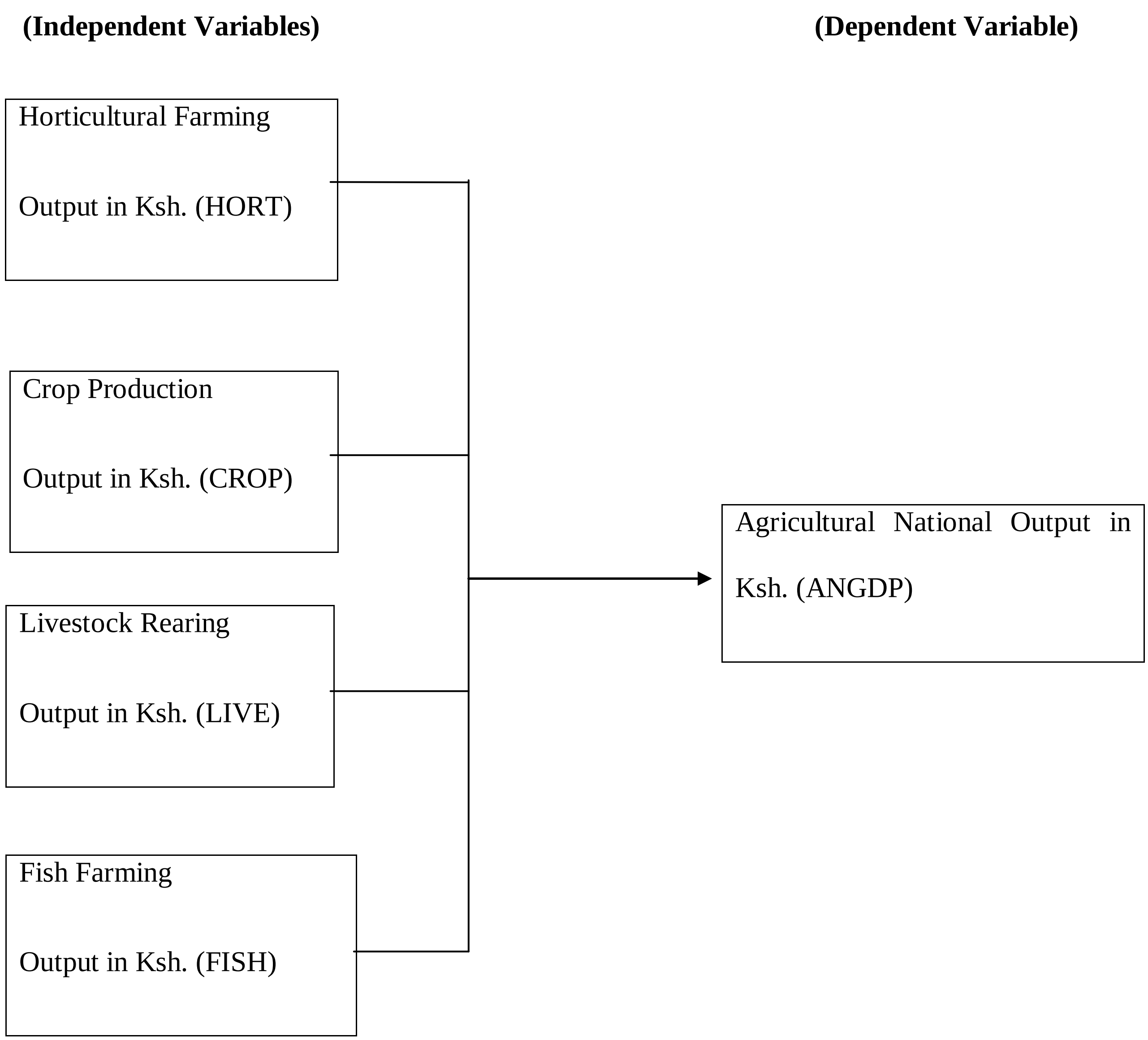


Figure 2.2 Conceptual Framework

Source: Researcher (2013)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with research methodology adopted in this study. This include test of data and model specification that was regressed for the analysis of the whole study. The data analysis procedure, test and measure of the significance of the time series variables also form part of this chapter. The methodology discussed represents the research design, sources of data, and data analysis procedure for the whole research work. The chapter is organized into the following sections: research design, the study area, types and source of data, data collection procedure, and data analysis procedure which included; data transformation, properties of time series variables and tests. The chapter concludes with the summary of the Error Correction Model with Cointegration process and Forecasting.

3.2 Research Design

The study adopted a Correlation Research Design with Dynamic Differential Equation analysis. Multivariate time stochastic differential equations were related and dynamic relationship was evaluated using Cointegration analysis and Granger Causality. The design is used to test the dynamic relationships between variables (Magister, 2011). This is because the study was concerned with how multiple time series variables are related jointly in a dynamic macroeconomic setup. Such a concern is well explained by analysis of multivariate time series techniques. It is an oriented methodology used to investigate inter-relationship between variables for a certain time period. The comparison of dynamic relationships provided qualitative and quantitative description of the trends and drifts and the relationship between the time series variables under analysis.

3.3 The Study Area

The study was based on Kenyan economy, an economy that is agricultural dependent. It analyzed four agricultural sub-sectors performances (horticultural, livestock sector, fish rearing and crop farming both food crop and cash crop). According to a study done by Simon and David (2008), the four contribute substantially to the Kenyan Agricultural National Gross Domestic Product.

The economy (Kenyan) was selected as it is one of the developing economies depending heavily on the agricultural sector for its growth (MoA, 2010) and the period 1980 to 2010 was seen appropriate to incorporate the transition Kenyan government had that reported different economic growth and affected agricultural sub-sectors differently. The area was also seen appropriate due to the transformation the country is under going, as it tries to raise its Kenyan Agricultural National Gross Domestic Product output through what is called Food Secured Nation (Mwangi, 2013). The availability of data and the ease of comparing the trend and business cycle also led to the selection of study area. These have been necessitated by the presence of documented data that describe and show the reforms in the agricultural sub-sectors geared towards creating market competition through removal of price controls by government and encouraging more private sector investments and participation, referred to as the Public Private Partnership (PPP) program, in the sector and aiming to have a long and short run effect of more output.

3.4 Types and Source of Data

The research was based on the collection and analysis of secondary data which was used to depict trend, show relationships and draw conclusions. Various books, government reports (National Abstracts and Economic Survey Reports) and scholarly study reports were used for data collection purposes. Data from the Ministry of Agriculture, Kenya National Bureau of Statistics, and Kenya Agricultural Research Institute (KARI) were used.

Due to the causal relationship that exists between the four independent variables under the study and the level of Kenyan Agricultural National Gross Domestic Product, the following kinds of data were found to be necessary:

i. Statistical data of the level of earning from the export and domestic consumption of horticultural products,
ii. Data indicating the contribution of livestock and fish farming products to the Kenyan Agricultural National Gross Domestic Product, and
iii. The contribution of output of crop production both cash crop and subsistence crop farming on the Kenyan Agricultural National Gross Domestic Product.

This research used the following two ways to draw data. First, it studied the level trend of output for the entire agricultural sub-sectors since 1980 to 2010. Two, the study checked on demand trends-both locally and in exports on the four agricultural sub-sectors outputs and their level of contribution to Agricultural sector. The dataset consisted of the five time series variables: horticultural production, livestock production, fish farming and crop farming. All variables were in natural logarithms after transformation that is INGDP for log Kenya Agricultural GDP, INLIVE for log livestock production, INFISH for log fish farming, INHORT for log horticultural production, and INCROP for crop farming.

3.6 Data Collection Procedures

Data was collected through the recording from the secondary source. The data unit were in form of Kenya Shillings (Ksh.) for the recent data but for the past, data were in form of Kenya Pound **(**K£) hence needed the transformation to the Kenyan currency that is Kenyan shillings.

3.7 Transformation of Time Series Variables

Data transformation was conducted into two ways. First it was necessary to transform it so as to have common Kenyan currency units and be standardized to one common base year, 2001 of Ksh. 100.00. The following were the steps that were followed using ANGDP as Agricultural National Gross Domestic Product, HORT as Horticultural Output, CROP as Crop Production Output, FISH as Fish Production Output, and LIVE as Livestock Production Output.

To convert Kenya Pound **(**K£) into Kenyan shillings (Ksh), the following rate table was adopted based on the rate exchange rate then.

Table 3.1 Currency Rates used

YEAR	**K£.**	**Ksh.**
1996	1353.67	27073.4

1K£ = Ksh. 20

Source: Kenya, Economic Survey (various issues)

The study adopted a comparison of the currency at different base year and came up with the following table as a conversion table.

Table 3.2 Base Year Change of Currency

	Referred Year	1976/1982 Ksh.	2001 Ksh.
ANGDP	2000	27407.4	310716.9
HORT	1999	37880.0	21307515
CROP	1999	8174060	56665245
FISH	2003	7973488	6956112
LIVE	2000	2213556	15047105

Source: Kenya, Economic Survey (various issues)

This can be summarized with the following formulae:

$$Y = \frac{X \times 2001(Ksh.)}{1982(Ksh.)} \quad \ldots\ldots 3.1$$

Where:

Y = Ksh. based on 2001

X = Ksh. based on 1976 or 1982

3.7 Statistical Properties of the Time Series Variables

The study analyzed these data through plotting and tests. This enabled to draw conclusions regarding the relationship between agricultural sub-sectors with Kenyan Agricultural National Gross Domestic Product. The ultimate result was to find the net impact of these sub-sectors to Kenya Agricultural GDP both in long and short run.

3.7.1 Plot of Time Series Variables

The first step of the analysis was to plot the time series variables. This was necessary in order to identify the nature of the Data Generation Process (DGPs), identify significant structural breaks and identify potential outliers. The plot of the time series variables also dictates the type of unit root procedures that were adopted.

3.7.2 Correlograms of Time Series Variables

The next step was to obtain the Correlograms of the variables under investigation. This was done in order to find out potential autocorrelation among the univariate time series variables. The plot of the univariate dataset also helped in identification of the nature of DGPs whether Autoregressive (AR) processes, Moving Average (MA) or Autoregressive Moving Average (ARIMA) processes. This was done because it is not always easy to see from the plot of a time series variables whether it is reasonable to assume that it has a stationary DGP. Therefore, it is useful to consider some statistics related to a time series.

3.7.3 Spectral Density Functions of the Univariate Time Series Variables

Following Greene (2007) and one of the research assumptions, the next step of the analysis was to compute and plot the Spectral Density Functions of the Univariate Time Series Variables. This was done in order to find out if the variables are affected by stochastic business cycles. When all the variables are affected simultaneously by the same business cycles and stochastic shocks it implies that the variables can jointly be modeled and analyzed.

The model that was estimated was as follows;

For each time series variable $\{X_t\}_{t=1}^{T}$, the spectral density function is as follows;

$$\hat{S}(\omega)=\frac{1}{T}\,|\sum_{t=1}^{T}e^{-i\omega t}X_t\,|^2 \quad\text{3.2}$$

Where X_t is the univariate time series variable under analysis, T is the population size, and e is the natural exponential.

3.8 Formal Unit Root Test

Estimation of time series that is modeled in the equation 3.16 below may lead to spurious regression results and conclusions. To avoid this phenomenon it was therefore necessary to test for the presence of unit roots in each of the time series variables. For this analysis Augmented Dickey-Fuller and Phillips-Perron tests were used.

3.8.1 Augmented Dickey-Fuller Unit Root Test

Conducting the DF test in Random Walk Model, Random Walk with Drift and Random Walk with both Drift and Trend assumes that the error terms (ε_t), are uncorrelated. But in case that ε_t are correlated, then it is necessary to use Augmented Dickey–Fuller (ADF) test**.** This test is conducted by "augmenting" the preceding random walk process by adding the lagged values of the dependent variable. To be specific, the ADF test here consists of estimating the following regression equation:

$$\Delta Y_t=\beta_1+\beta_2 t+\delta Y_{t-1}+\sum_{i=1}^{p}\alpha_i\Delta Y_{t-i}+\varepsilon_t \quad\text{3.3}$$

Where ε_t is a pure white noise error term and where $\Delta Y = Y_i - Y_{i-1}$. The number of lagged difference terms that were included was determined empirically using various information criteria. The main idea was to include enough lagged terms so that the error term in equation 3.3 above is serially uncorrelated. The test statistic in the ADF to test whether δ (standard error) is 0 and the ADF test follows the same asymptotic distribution as the DF statistic. So the same critical values can be used.

3.8.2 Phillip-Perron (PP) Unit Root Test

The second unit root test that was used is Philips-Perron test suggested by Phillips and Perron (1988). This test was used to improve on the finite sample properties and to accommodate more modeling framework (Greene, 2007). This test statistic was applied for the three functional forms on the following regression equation;

$$Y_t = \delta_t + \gamma Y_t + \gamma_1 \Delta Y_{t-1} + \gamma_1 Y_{t-1} + \ldots\ldots + \gamma_p \Delta Y_{t-p} + \varepsilon_t \ldots\ldots 3.4$$

Where

Y_t = is the dependent time series variable,

p = is the lagged value.

Where δ_t may be 0, or may be μ, or $\mu + \beta t$. The procedure modifies the two Dickey-Fuller statistics that is shown by equations 3.6 and 3.9 below.

$$Z_t = \sqrt{\frac{C_0}{a}}\left(\frac{\hat{\gamma}-1}{v}\right) - \frac{1}{2}(a - C_0)\frac{T_V}{\sqrt{as^2}}, \ldots\ldots 3.5$$

$$Z_\gamma = \frac{T(\hat{\gamma}-1)}{1-\hat{\gamma}_1-\hat{\gamma}_2-\ldots-\hat{\gamma}_p} - \frac{1}{2}\left(\frac{T^2 v^2}{s^2}\right)(a - C_0) \ldots\ldots 3.6$$

Where:

$$s^2 = \frac{\sum_{t=-1}^{T} e_t^2}{T-K} \quad \text{...} 3.7$$

v^2 = estimated asymptotic variance of $\hat{\gamma}$,

$C_j = \frac{1}{T}\sum_{s=j+1}^{T} e_t e_{t-s}$, $j = 0,1, \ldots\ldots\ldots\ldots, p = j^{th}$ auto covariance of the residuals,

$$C_0 = [(T-K)/T]S^2 \quad \text{...} 3.8$$

$$a = C_0 + 2\sum_{j=1}^{L}\left(1 - \frac{j}{L-1}\right)C_j \quad \text{...} 3.9$$

In the equations 3.5 to 3.9 above:

Z_t *and* Z_γ are used to represent test statistics,

T *and* C are used to represent number of observation and coefficient constant or intercept from the regression model respectively,

t is the time period for the optimum lag length j = 1,2,3…. p,

L is Optimum lag length already determined,

K is the information Criteria used, and

υ is Number of the parameters determined at a degree of freedom.

The next step of transformation was done after the unit root test in two ways. The aim for transforming the time series variables was to be able to go for the rate change rather than just obtaining the contribution only. The first step was to take log transformation. Therefore results are interpreted as rates of change. The next step was to difference the series. The differenced series were then plotted and formal unit root test were performed again for each series to test for the stationarity.

3.9 Determination of the Optimum Lag Length in Univariate Model

This was determined empirically by using various information criteria. According to Green (2007), when there is a conflict among the information, autocorrelation test is performed. The model had 30 observations. However, too many lagged terms would reduce degrees of freedom, not to mention introducing the possibility of multi-colinearity. Including too few lags on the other hand would lead to specification errors. To mitigate this Green suggested, Akaike, Schwarz (SBIC), Hannan and Quinn (HQIC), Akaike Information Criteria (AIC), Final Prediction Error Information Criteria (FPEC), and Log Likelihood (LIC) criteria to choose the model that gave the lowest values of these criteria. In the models 3.10, 3.11, and 3.12, m represent the number of regressor parameters including the intercept, T stands for number of observations, and p the lagged length.

3.9.1 The Akaike Information Criteria

The Akaike Information Criteria was used to choose that model that gave the lowest values of these criteria. The model that was estimated was as follows;

$$AIC_{(p)} = In\left|\sum_{p} est\right| + 2\frac{m(p^2+1)}{T} \qquad \text{...3.10}$$

In this model specification $m(p^2+1)$ is the number of parameters of the estimation equations.

3.9.2 The Hannan-Quinn Information Criteria

The next information Criteria that was used to choose the model that gave the lowest values of these criteria is the Hannan-Quinn Information Criteria. The model that was estimated was as follows;

$$HQ_{(p)} = In\left|\sum_{p} est\right| + 2InInT\frac{m(p^2+1)}{T} \quad \text{...3.11}$$

In this model specification $m(p^2+1)$ is the number of parameters of the estimation equations

3.9.3 The Schwert-Bayesian Information Criteria

Also information Criteria that was used was the Schwert- Bayesian Information Criteria. The number of lags that was estimated was clearly determined by use of STATA 10.0 Econometric Software.

3.9.4 The Amemiya Information Criteria

Amemiya Information Criteria was also adopted. The criterion however uses the principle of combined hypothesis ratio test. It is a repetitive process that drops insignificant joint lags. Significance is therefore tested for the longest lag only. The process was however easily determined using Econometric Software.

3.9.5 The Final Prediction Error Information Criteria

Final Prediction Error Information Criteria was the last Information Criteria used. The FPE method is similar to AIC and SBIC which balances between goodness of fit, that is (minimizing

$\left|\sum_p est\right|$) and model simplicity (minimizing p). FPE is however statistically close to AIC with just minor difference. The model that was estimated was as follows;

$$FPE_{(p)} = \left(\frac{T+mp+1}{T-mp-1}\right)^m In\left|\sum_p est\right| \ldots\ldots 3.12$$

In this model specification, $\sum_p est$ is the estimated residual variance.

3.10 Determination of the Optimum Lag Length for the Multivariate Model

The econometric model (equation 3.16) was estimated after the determination of the optimum lag length, p. Autocorrelation test was performed to determine any kind of conflict within the variables. The multivariate optimum lag length selection model that was estimated is as follows;

$$Log\,LIC(p) = \log\left(\left|\frac{1}{T}\sum_{t=1}^{P}\hat{\varepsilon}_1\hat{\varepsilon}_2'\right|\right) + (kM^2 + M)\frac{C(n)}{T} \ldots\ldots 3.13$$

In the model above, $C(n) = 2$ which is the regression intercept for the AIC, while log T for the BIC. The two forms of models (AIC and BIC) have the same statistical results.

3.11 Model Specification

The five variables were assumed to have Granger Causality relationships, a rate change in any agricultural sub-sector output results to a change in the Agricultural National Gross Domestic Product Output. Granger-Causality is used to test for null hypotheses for bivariate variables with time series property, and where there are minimal deviations from the assumption that the error term is normally distributed. The assumption is not different for the variables under this study. Due to this assumption between the variables, the study adopted the linearized model with its specification as explained below (see equitation 3.14). However this was clearly brought out later after data analysis results. The model below is used as applied by Elsevier (1987) and later modified by Wooldridge (2001) as they studied the factors affecting government performance, since the variables under consideration have a linear relationship as their study that had government revenue, taxation policies, and inflation and population level dependent variables:

$$INGDP_t = \alpha + \beta_1 INHORT_{t-p} + \beta_2 INCROP_{t-p} + \beta_3 INFISH_{t-p} + \beta_4 INLIVE_{t-p} + \beta_5 INGDP_{t-p} + \varepsilon_t \ldots. 3.14$$

Where $INGDP$ is natural log of agricultural national output; $INHORT$ natural log of Horticultural production; $INCROP$ natural log of total crop production; $INFISH$ natural log of annual fish production; and $INLIVE$ natural log of total livestock production,

α is a constant term.

β_{is} are Regression Coefficients for the Variables where $i = 1, 2, \cdots, T$, T is the number of regressors, p is the optimum lag length determined using multivariate Optimum Lag Length selection criteria. ε_t is white noise process and is assumed to have mean of $E[\varepsilon_t | \varepsilon_{t-i}] = 0$ and variance of δ^2 and t is the time trend. All the variables are endogenous and are measured in terms of Ksh. per annum.

3.12 Stationarity Test

Most time series data have drifts and trends which are increasing in nature (Gujarati, 2007). Also, in long run graph, plotting of variables against time has upward movements meaning a co-movement of the variables. One can therefore draw a suggestion that the variables data are not stationary. For this study, ADF and PP unit roots tests were performed after differencing (to eliminate the presence of non-stationarity) to test for the stationarity statistically.

3.13 Cointegration Analysis and Testing

Many economic or financial time series appear to be of first order. These variables tend to diverge as the observation approach to infinity because their unconditional variances are proportional to number of observation. Thus, it may seem that first order variables could never be expected to obey any sort of long-run equilibrium relationship. It is possible for two (or more) variables to be of first order and yet a certain linear combination of those variables to be stationary. If that is the case, these first order variables are said to be cointegrated. If two or more first order variables are cointegrated, they must obey an equilibrium relationship in the long-run, although they may diverge substantially from that equilibrium in the short run. This has lead to development of the matrix below indicating the rate change of dependent variable depending on every time series variable including their respective last year performance $t-1$. In the matrix T stands for number of observations while Δ indicates the rate change.

$$\begin{bmatrix} \Delta INGDP_t \\ \Delta INHORT_t \\ \Delta INCROP_t \\ \Delta INFISH_t \\ \Delta INLIVE_t \end{bmatrix} = \begin{bmatrix} \alpha_{11}\,\alpha_{12}\,\alpha_{13}\,\alpha_{14}\,\alpha_{15} \\ \alpha_{21}\,\alpha_{22}\,\alpha_{23}\,\alpha_{24}\,\alpha_{25} \\ \alpha_{31}\,\alpha_{32}\,\alpha_{33}\,\alpha_{34}\,\alpha_{35} \\ \alpha_{41}\,\alpha_{42}\,\alpha_{43}\,\alpha_{44}\,\alpha_{45} \end{bmatrix} \begin{bmatrix} 1 & 0 & \beta_1 & \beta_2 & \beta_3 \\ 0 & 1 & \beta_2 & \beta_3 & \beta_4 \\ 0 & 0 & 1 & \beta_4 & \beta_5 \\ 0 & 0 & 0 & 1 & \beta_5 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} INGDP_{t-1} \\ INHORT_{t-1} \\ INCROP_{t-1} \\ INFISH_{t-1} \\ INLIVE_{t-1} \end{bmatrix} + \sum_{i=1}^{p} T_i \Delta INGDP_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots 3.15$$

The study adopted the matrix and examined both long run and short equilibrium of the time series variables. The matrix was adopted from study done by Johansen (1988).

3.13.1 Vector Error Correction Model (VECM)

From the results of Johansen's Cointegration test if there was Cointegration a VECM was estimated. Therefore a VECM was constructed to find out the empirical effects of horticulture, crop production, fish production and livestock production on agricultural national gross domestic product in Kenya, a small open economy with agricultural dependent growth. The model specification can be written as:

$$Y_t = \mu + \sum_{j=1}^{p} \beta_{t-j} G_j + \sum_{j=1}^{p} \beta_{t-j} H_j + \sum_{j=1}^{p} \beta_{t-j} F_j + \sum_{j=1}^{p} \beta_{t-j} L_j + \sum_{j=1}^{p} \beta_{t-j} C_j + \sum_{j=1}^{p} \beta_{t-j} Y_{t-1} + \varepsilon_t \text{.......3.16}$$

The matrices G_j, H_j, F_j, L_j and C_j are parameter matrices and indicates the time series variables Agricultural Gross National Product, Horticulture production (INHORT), Crop production (INCROP), fish production (INFISH), and livestock (INLIVE) respectively and Agricultural Gross National Product as Y_t. The constants β accommodate time series variables relationships. While the vector ε_t contains the residuals. Uncovering dynamic interactions in a small set of macroeconomic variables ANGDP, HORT, LIVE and CROP is often undertaken using the VECM methodology.

Traditionally, the effects of ANGDP shocks on the macro economy were analyzed in such a framework. Examination of significance of relationships still commonly adopts VECM both in long run and short run. One of the key challenges in modeling ANGDP is to extract pure policy shocks from those that are automatic, and to separate dynamics through the economy arising from changes in ANGDP from changes in Agricultural sub-sectors.

3.14 Model Diagnostic Tests

3.14.1 Lagrangian Multiplier Test for Residual Autocorrelation in Model

The Lagrangian Multiplier test for residual autocorrelation, sometimes known as the Breusch–Godfrey test, is based on considering an AR (h) model for the residuals;

$$u_t = \beta_1 u_{t-1} + \cdots + \beta_h u_{t-h} + \varepsilon_t \quad \text{.......3.17}$$

and checking it in the pair of hypotheses;

$$H_0 : \beta_1 = \cdots = \beta_h = 0 \; versus \; H_1 : \beta_1 \neq 0 \; or \cdots or \; \beta_h \neq 0$$

If the original model is an AR (p), of the form;

$$Y_t = \upsilon + \alpha_1 Y_{t-1} + \cdots + \alpha_p Y_{t-p} + u_t \quad \text{.......3.18}$$

Then the auxiliary model of the following form;

$$\hat{u}_t = \upsilon + \alpha_1 Y_{t-1} + \cdots + \alpha_p Y_{t-p} + \beta_1 \hat{u}_{t-1} + \cdots + \beta_h \hat{u}_{t-h} + e_t \quad \text{.......3.19}$$

is fitted. Here $\hat{u}_t$ are the OLS residuals (Dickey and David, 1976) and υ has been used to stand for the initial model constant. It turns out that the LM statistic for the null hypothesis of variables can be obtained easily from the coefficient of determination R^2 of the auxiliary regression model as;

$$R^2 = LM_h = TR^2$$

In the absence of residual autocorrelation, it has an asymptotic $\chi^2(h)$-distribution. The null hypothesis is rejected if LM_h is large and exceeds the critical value from the $\chi^2(h)$-distribution.

3.14.2 Jarque-Bera Test for Normality of the Residuals

Pagan and Persaran (2007), proposed a test for non-normality of the residuals. This model is based on the third and fourth moments or, in other words, on the skewness and kurtosis of a theoretical distribution of the residual. Denoted by u_t^t the standardized true model residuals (that is $u_t^t = u_t / \delta_u$), tests and checks the pair of hypotheses;

$H_0 : E(u_t^s)^2 = 0$ and $H_0 : E(u_t^s)^4 = 3$

This test statistics is tested against;

$H_1 : E(u_t^s)^3 \neq 0$ or $H_0 : E(u_t^s)^4 \neq 3$

That is, it checks whether the third and fourth moments of the standardized residuals are consistent with a standard normal distribution. If the standardized estimation residuals are again denoted by, $\hat{u}_t^s$, the test statistic is;

$$LJB = \frac{T}{6}\left[T^{-1}\sum_{t=1}^{T}(\hat{u}_t^s)^3\right]^2 + \frac{T}{24}\left[T^{-1}\sum_{t=1}^{T}(\hat{u}_t^s)^4 - 3\right]^2 \qquad \text{3.20}$$

In this model $T^{-1}\sum_{t=1}^{T}(\hat{u}_t^s)^3$ is a measure for the skewness of the distribution and $T^{-1}\sum_{t=1}^{T}(\hat{u}_t^s)^4$ measures the kurtosis. The test statistic has an asymptotic $\chi^2(2)$- distribution if the null hypothesis is correct, the null hypothesis is rejected if LJB is large. If H_0 is rejected, the normal distribution is clearly also rejected. On the other hand, if the null hypothesis holds, this does not necessarily mean that the underlying distribution is actually normal but only that it has the same first four moments as the normal distribution. The test is still quite popular in practice because the first four moments are often of particular interest, and deviations from the normal distribution beyond that may not be of equal importance (Green, 2007). If non-normal residuals are found, this is often interpreted as a model defect; however, much of the asymptotic theory on which inference in dynamic models is based, strictly speaking, works also for certain non-normal residual distributions. Still, non-normal residuals can be a consequence of neglected nonlinearities, for example. Modeling such features as well may result in a more satisfactory model with normal residuals. Sometimes, taking into account ARCH effects may help to resolve the problem. An ARCH test was therefore performed in model checking.

3.14.3 ARCH-LM Test for Normality of the Residuals

The ARCH-LM test is a popular test for neglected conditional heteroscedasticity (Verbeek, 2004) or, briefly, for ARCH, is based on fitting an ARCH (q) model to the estimation residuals,

$$\hat{u}_t^s = \beta_0 + \beta_1 \hat{u}_{t-1}^2 + \cdots + \beta_q \hat{u}_{t-q}^s + e_t \quad \text{3.21}$$

This model was to check the null hypothesis below;

$H_0 : \beta_1 = \cdots = \beta_q = 0$ And

$H_1 : \beta_1 \neq 0 or \ldots or \beta_q \neq 0$

More precisely, the LM statistic is;

$$ARCH_{LM(q)} = TR^2 \quad \text{3.22}$$

Engle *et al* (1982) showed that it has an asymptotic $\chi^2(q)$-distribution if the null hypothesis of no conditional heteroscedasticity holds. Large values of the test statistic indicate that H_0 is false and, hence, there may be ARCH in the residuals. In that case, it may be useful to consider fitting an ARCH or ARCH-type model to the residuals.

3.14.4 Granger Causality from the Cointegrated VECM Process

Two ways of causality tests were analyzed in this research, tests for Granger-causality, $Y_{1,t}$ granger cause $Y_{2,t}$ and also the reversed $Y_{2,t}$ granger cause $Y_{1,t}$. For the two ways of tests the vector of endogenous variables is divided in two sub-vectors, $Y_{1,t}$ and $Y_{2,t}$, with dimensions $K1$

and $K2$, respectively, so that $K = K1 + K2$. The sub-vector $Y_{1,t}$ is said to be Granger-causal for $Y_{2,t}$ if it contains useful information for predicting the latter set of variables Lutkepohl *et al* (1991). For testing this property, the following model was estimated;

$$\begin{bmatrix} Y_{1,t} \\ Y_{2,t} \end{bmatrix} = \sum_{i=1}^{p} \begin{bmatrix} \alpha_{11,i} & \alpha_{12,i} \\ \alpha_{21,i} & \alpha_{22,i} \end{bmatrix} \begin{bmatrix} Y_{1,t-i} \\ Y_{2,t-i} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix} \qquad 3.23$$

In this model setup, $Y_{1,t}$ is not Granger-Causal for $Y_{2,t}$ if and only if;

$$\alpha_{21,i} = 0, \qquad i = 1, 2, 3, \cdots, p$$

Therefore this null hypothesis is tested against the alternative that at least one of the $\alpha_{21,i}$ is non-zero. A Wald test statistic, divided by the number of restrictions pK_1K_2, was used in conjunction with an $F(pK_1K_2, KT - n^*)$ distribution for testing the restrictions. Here n^* is the total number of parameters in the system (Peersman, 2005) including the parameters of the deterministic term. The test is problematic. However, if some of the variables are nonstationary (integrated). In that case the usual asymptotic distribution of the test statistic may not be valid under the null hypothesis. Therefore, the test should be performed in the VEC form if there are integrated variables in the system of interest.

3.15 Forecasting from the Cointegrated VECM

The estimated VECM was then used to obtain the optimal forecasts. The forecasts were based on conditional expectations assuming independent white noise process, u_t. The *h*-step forecast at time T was then obtained from the model of the form;

$$Y_t = A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + u_t \qquad 3.24$$

The forecasts are computed recursively for h = 1, 2 . . . 16 starting with $Y_{t-1}|T = Y_{T+1} \,|\, T = Y_{T+2} \,|\cdots| Y_{T+p}$. In this model the values for the exogenous variables have to be supplied for the forecast period. The corresponding forecast errors are:

$$Y_{t+h} - Y_{t(h)} = U_{t+h} + AU_{t+h-1} + \cdots + A^{h-1}U_{t+1} \quad \text{..3.25}$$

According to Lutkepohl (1991), when the forecast errors have zero mean it is unbiased. Moreover the joint forecast error covariance matrix for all forecasts is up to horizon h. Assuming normally distributed disturbances; these results can be used for setting up forecast intervals for any linear combination of these forecasts.

3.16 Limitations of the Study

The data relied on was secondary data. The fact that the data was secondary meant that it might have been altered before documentation. Also, assumption of the Dickey-Fuller test of ignoring the β_0. This is however of minimal effect since the study examines the rate change of the independent variable against the dependent variable.

3.17 Assumptions of the Study

The study was characterized by the following assumptions: One, the secondary data relied on was accurate. Two, there was no significant effect to National GDP and other agricultural sub-sector due to change of external factors such as climate and ignoring β_0 . The coefficient β_0 is not related to the variables under study and even after finding the expectation of the constant, the coefficient doesn't change. Lastly, the data to be relied on was assumed to be affected by the stochastic business cycle. This was indentified as a common external factor but could not be monitored. It's uncontrollable.

CHAPTER FOUR

EMPIRICAL RESULTS AND DISCUSSIONS

4.1 Introduction

This section of the thesis deals with results and discussions. First, it explains the results of time series properties of the dataset and then analysis of the statistical properties of the transformed time series variables.

4.2 Descriptive Statistics Results

In the table 4.1 below, descriptive statistics for the endogenous variables results have been discussed. This description aids in embedding the model in an existing VECM tradition for Agricultural performance and in interpretation for policy purposes. The INGDP variable is defined as log of Total Agricultural Gross Domestic Product, INHORT log of Horticultural Production Output, INCROP log of Total Crop Production, INFISH log of Aggregate National Fish Production, and INLIVE log of the Total Livestock Production per annum. The table also indicate the summary of mean and standard deviation which according the Green (2007) is the beginning and the foundation of all statistical analysis. The aim for this is to get the overall view and picture of the whole analysis procedure.

Table 4.1: Descriptive Statistics of the Endogenous Variables.

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
INGDP	30	11.482	0.0713368	11.33122	11.60471
INHORT	30	10.363	0.1434192	10.16776	10.64578
INCROP	30	10.759	0.0964901	10.49839	10.89629
INFISH	30	09.329	0.7195223	7.626621	10.08703
INLIVE	30	10.230	0.0837252	10.04313	10.38879
d1INGDP	30	00.009	0.0176182	-0.0175886	0.0517797
d1INHORT	30	00.014	0.0665399	-0.08323	0.2401257
d1INCROP	30	00.013	0.0482364	-0.1017113	0.1873531
d1INFISH	30	00.073	0.2156452	-0.5290308	0.8624907
d1INLIVE	29	00.011	0.0482005	-0.5290308	0.0949373

Source: Author's Computation (2014)

From the results above, it's very apparent that there is no much deviation of the time series variables. This indicates that regardless of the cycles that have been experienced in the economy, booms and recessions, the production have always remained the same or in other words there has been a minimal fluctuation. The comparisons of the Maximum and the Minimum with the mean for the 30 years period have also revealed the same. This is of great significance as it describes what is going on in the data and the way logged data is transformed into useful information.

4.3 Autocorrelation Function (ACF) and Correlograms Tests for Stationarity

ACF is one of the most common and simple way of determining the presences of non-stationarity in statistics (Green, 2007). This is the ratio of covariance at lag k to that of variance.

Since the two (covariance and variance) are derived from the same set of data and have the same unit, ACF is therefore unit-less, or simply called pure number and is denoted by, ρ_k.

In Appendix B1, the partial autocorrelation functions (PACFs) are shown for the time series variables. In this case, they all tend to approach small values quickly for increasing number of observations. Visual inspection of the Correlograms gives quick overview whether there is left significant correlation in the residuals.

The constant value of ACF and PACF varies between +1 and -1. A graph of ACF against k is therefore what commonly referred to as Population Correlogram. In statistics however, it's hard to deal with a population of statistics. The study therefore chose to go for four selected agricultural sub-sectors which compare sample covariance with sample variance. This resulted to a sample graph called Autocorrelation Function (AFC**),** Appendix B1.

To determine the presence of autocorrelation, then a graph of estimated ACF ($\widehat{\rho_k}$) against k was drawn. After differencing the pattern of the autocorrelation changes and hovers around zero, see appendix B2. This is the picture of a Correlogram of a stationary time series data. The figure indicated that the data has now become stationary after first differencing.

For stationary processes, partial autocorrelations also approach zero as observations go to infinity; hence, the estimated counterparts should be small for large lags data sets. In appendix B2 the partial autocorrelation functions (PACFs) are shown for time series variables.

4.4 Statistical Properties of the Time Series Data sets in Levels

The first and the foremost step for the analysis of the time series data analysis is plotting of the raw data. This is however the informal method of approach intended to have an overview of the data trend. The study went ahead and examined using more formal way through ADF and PP test. The result is shown in the table 4.2 of the unit root test below.

4.5 Tests for Unit Roots of Time Series Variables in Levels

From all plots in previous sub-section, it is clear that all the time series variables have both stochastic and deterministic trends. Also, all the variables have trends. It was therefore necessary to perform unit root tests to find out if the variables have nonstationary. This was done to avoid spurious regression analysis as plotting alone is not sufficient. According to Green (2007), finding the first difference of the data is the most appropriate method to stationarize the data before doing any analysis. The study began by plotting the variable data against time which indicated an upward trend. Using Authors Computation, Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests indicated the presence of non-stationarity. However the presence of non Stationarity can be eliminated through differencing. For this purpose Augmented Dickey Fuller Test and Phillips-Perron Unit Root Test were used. The results are reported in Table 4.2 below.

Table 4.2 Unit Root Test Results of the Variables in Levels

VARIABLE	ADF TEST	PHILLIP-PERRON	REMARKS
INGDP	-2.616(0.2726)	-1.644(0.6247)	Accept Null Hypothesis
INHORT	-2.579(0.2897)	-1.580(0.8504)	Accept Null Hypothesis
INCROP	-3.042(0.1206)	-5.674(0.0259)	Accept Null Hypothesis
INFISH	-2.054(0.5720)	-1.817(0.3200)	Accept Null Hypothesis
INLIVE	-2.885(0.1674)	-5.830(0.2791)	Accept Null Hypothesis

Source: Author's Computation (2014)

The critical values for ADF Test are -4.343 at 1 per cent, -3.584 at 5 per cent and -3.230 at 10 per cent. The critical values for Phillips-Perron Test are -17.472 at 1 per cent, -12.628 at 5 per cent and -10.280 at 10 per cent. The figures in parentheses are the Mackinnon critical values and all are significantly different from zero.

Both the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests are presented. Both tests indicate that the variables are non-stationary at 1 per cent, 5 per cent and 10 per cent. The non-stationarity suggests the potential presence of Cointegration between these variables.

4.6 Analysis of Variables in First Difference

According to the table 4.2 above both ADF and PP test has shown the presence of unit root. Based on Correlograms plotting (Appendix B) and Augmented Dickey-Fuller test and Phillip-Perron test it is concluded that actually the time series variables under analysis are non stationary. The plots of spectral density function (Appendix C) also show that they are affected by stochastic business cycles. This implies that there is a need to employ a technique to make them stationary. There are three techniques; differencing, seasonal adjustment and de-trending. This research used differencing because Lutkepohl (1991) and Hamilton (1994) recommend that most of the time series variables which are non-stationary, differencing produces stationary series and enables unbiased regression analysis results. The result of the test after differencing is shown in the table 4.3 below.

Table 4.3 Unit Root Test Results of the Variables in First Differences

VARIABLE	ADF TEST	PHILLIP-PERRON	REMARKS
INGDP	-4.939(0.0003)	-24.329(0.0000)	Reject Null Hypothesis
INHORT	-7.641(0.0000)	-39.064(0.0000)	Reject Null Hypothesis
INCROP	-6.494(0.0000)	-33.567(0.0000)	Reject Null Hypothesis
INFISH	-10.151(0.000)	-44.718(0.0000)	Reject Null Hypothesis
INLIVE	-5.498(0.0000)	-27.044(0.0000)	Reject Null Hypothesis

Source: Author’s Computation (2014)

The critical values for ADF Test are -4.343 at 1 per cent, -3.584 at 5 per cent and -3.230 at 10 per cent. The critical values for Phillips-Perron Test are -17.472 at 1 per cent, -12.628 at 5 per cent and -10.280 at 10 per cent. The figures in parentheses are the Mackinnon critical values and all are significantly not different from zero.

The formal statistical unit root test results are reported in Table 4.3 above. It shows that all the time series variables under analysis have become stationary after first differencing of the time series variables since Mackinnon critical values has become not significant different from zero. Also ADF and PP value has become more than their critical values at 1%, 5% and 10%. Therefore it was concluded that the time series variables are integrated of Order one, (I (1)).

4.7 Statistical Properties of Model Variables (Multivariate Relationship)

The model was specified to relate five variables that were assumed to have Granger Causality relationships such that a change in any agricultural sub-sector output results to a change in the Agricultural National GDP Output. Therefore, the next step of the analysis was to examine the dynamic relationships among the variables in the dynamic macro econometric model. To examine this, Cointegration test was performed using Johansen 1995 Cointegration test.

4.7.1 Plot of Log of Differenced Model Variables Combined

The first step was to obtain the plot of the model variables. These plots are reported in Figure 4.3 below.

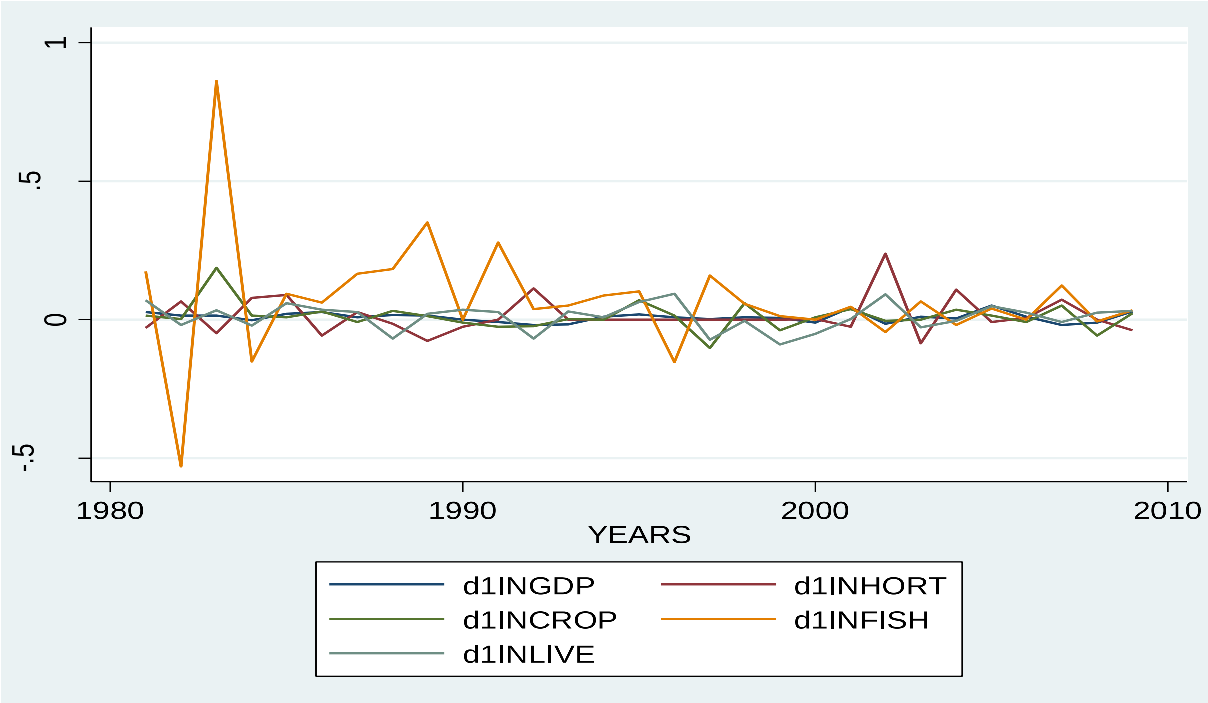


Figure 4.3 Plot of Log of Differenced Model Variables Combined

Source: Author's Computation (2014)

The plot of model variable in Figure 4.3 above discloses significant results among the time series variables. The figure shows that there is a significant dynamic relationship. These show that there is a short run relationship shown by frequent spikes and a long run relationship shown by the long run co-movement. The next step was to find the Cointegration rank of the variables.

4.7.2 Determination of the Optimum Lag Length in Levels.

Before the start of the analysis of the time series variables, there was need to determine the number of the minimum sample observations (n) that could be selected by different selection criteria. This was necessary so that to determine the minimum number of independent coordinates that can specify the position of the system completely without changing or altering the selected criteria. The table 4.4 below indicates the minimum number of the observation selected.

Table 4.4 Results of Optimum Lag Length Selection

Selection Criteria Sample Period 1984-2009; No. of observations = 26								
Lag	**LL**	**LR**	**df**	**P**	**FPE**	**AIC**	**HQIC**	**SBIC**
0	164.025				3.4e-12	-12.2327	-12.163	-11.9908
1	254.672	181.29	25	0.000	2.2e-14	-17.2824	-16.8644	-15.8308*
2	278.214	47.083	25	0.005	3.2e-14	-17.1703	-16.4039	-14.5089
3	314.354	72.281	25	0.000	2.8e-14	-18.0272	-16.9125	-14.1562
4	370.603	112.5*	25	0.000	2.1e-14*	-20.431*	-18.9679*	-15.3502*

Endogenous: INGDP INHORT INCROP INFISH INLIVE Exogenous: Constant

Source: Author's Computation (2014)

From the results above there were a minimum number of observation of 26. Since n (26) < 30, then there was need to determine the degree of freedom (n-1), as used by Gujarati(2007), so as to carry out t-statistics test. 25 were selected as the number of components needed to be known before determining the vector hence the degree of freedom (number of free component).

4.7.3 Co-integration Rank Test Results

Before analysis of Vector Error Mechanism, there was need to determine the number of the Cointegration. The study adopted Johansen's Cointegration Test Analysis and the results are as shown in the table 4.5 below.

The table 4.5 that follows indicates Johansen's Cointegration Test Analysis results. Johansen suggested that to determine the presence of the Cointegration, then one can use any of the two tests depending on the type of data. These are trace statistic and eigenvalue maximum likelihood, and compare their results with critical values at specified confidence level. The null hypothesis is rank (r) cointegrating vector(s) against the specific alternative of $r + 1$ cointegrating vector(s) for eigenvalue. The trace statistic, on the other hand, tests the null hypothesis of no cointegrating vector ($r = 0$) against a general alternative of one or more cointegrating vectors ($r > 0$). However since this study intends to find out the maximum cointegration between two time series variables, the agricultural national output and the agricultural sub-sectors output, then the study explains only the trace statistics. The results are shown in the table 4.5.

Table 4.5 Results of Johansen's Test for Cointegration

Johansen's Test for Cointegration					
Trend: Constant			**Number of Observations = 27**		
Sample: 1983 – 2009			**Number of Lags = 03**		
Max. Rank	**Parms**	**LL**	**Eigen value**	**Trace Statistic**	**5 per cent Critical Value**
0	55	246.269	-	151.512	68.52
1	64	282.555	0.93197	78.939	47.21
2	71	300.541	0.73612	42.968	29.68
3	76	312.078	0.57454	19.894	15.41
4	79	322.013	0.52096	0.023*	3.76
5	80	322.025	0.00086	-	-

Source: Author's Computation (2014)

Using Johansen's Cointegration Test Analysis, results shown above, there are actually a maximum of three Cointegration relationships. Beyond which the critical value remains at a higher value than trace statistic value. The results are not however different when the chi^2 used to explain these results. See table 4.6.

Table 4.6 Summary Statistics Long Run Relationships

Cointegration Equations			
Equations	Parms	Chi 2	P > chi 2
_ce1	2	113.1218	0.0000
_ce2	2	85.37748	0.0000
_ce3	2	79.77756	0.0000

Source: Author's Computation (2014)

At all levels, the X^2 remains to be higher than its probability. The maximum numbers of parameters remain to be two, with three Cointegration Equations, which explains the long run equilibrium relationships of the five time series variables.

According to Johansen (1995), if trace statistics null hypothesis of r=0 is accepted then there is no need to carry out the VEC analysis. But since according to the analysis of this study the null hypothesis is rejected and hence accepted the alternative hypothesis of r>0, then VAR was not done hence study proceeded to carry out VEC analysis.

4.7.4 Determination of Cointegration Rank of the Model Variables

Before carrying out individual VECM, short run relationship, there was need to investigate the relationships that exist between the time series variables. The aim was to have a summary of the total overview of the VECM expected from the study at the maximum lag of 3. This was selected through comparison of the X^2 and its probability. It was also necessary to confirm the number of the maximum Cointegration relationship. The results are shown in the table 4.7 below. This was necessary because the study has shown that the time series data is nonstationary and only becomes stationary after first differencing, I (1).

Table 4.7 Summary Results of VECM

VEC. INGDP INHORT INCROP INFISH INLIVE, Lag (3) Rank (3)

Vector Error-Correction Model

			No. of Observation = 27		
Sample : 1983 – 2009			**AIC**	**= -17.48723**	
Log likelihood = 312.0777			**HQIC**	**= -16.40263**	
Det (Sigma_ml) = 6.2e-17			**SBIC**	**= -13.83969**	

Equation	**Parms**	**RMSE**	**R-sq**	**Chi 2**	**P >chi 2**
D_INGDP	14	0.015547	0.6914	26.88192	0.0199
D_INHORT	14	0.076453	0.3899	7.670104	0.9058
D_INCROP	14	0.017258	0.9443	203.3856	0.0000
D_INFISH	14	0.103809	0.8776	86.02092	0.0000
D_INLIVE	14	0.046665	0.5519	14.7772	0.3936

Source: Author’s Computation (2014)

The table 4.6 above indicates a summary of vector error correction model results at lag 3 with endogenous variables INGDP, INHORT, INCROP, INFISH and INLIVE, and a maximum rank of 3. From the results there were a maximum of five models since at all levels the probability remains higher than chi^2 value. The essence of this was to determine the number of short run equilibrium relationships. Also a rank of 3 indicated actually that there are maximum possible of 3 long run relationships.

4.8 Individual Vector Error Correction Models Short Run Relationships

Table 4.8 (a) VECM results of Log of Kenya Agricultural GDP (INGDP)

	Coef	**Std. Err.**	**z**	**P > [z]**	**[95 % cont.**	**Interval]**
D_INGDP						
_CE 1 L1	-0.7117013	0.2236342	-3.18	0.001	-1.150016	-0.2733863
_CE 2 L1	0.2618038	0.0808449	3.24	0.001	0.1033508	0.4202568
_CE 3 L1	0.1540572	0.1346383	1.14*	0.253	-0.109829	0.4179435
INGDP						
LD	0.2004117	0.2715428	0.74*	0.460	-0.3318025	0.7326259
L2D	0.1831389	0.2851728	0.64*	0.521	-0.3757894	0.7420673
INHORT						
LD	-0.2226222	0.1006892	-2.21*	0.027	-0.4199695	-0.0252749
L2D	-0.1479302	0.0777477	-1.90*	0.057	-0.3003129	0.0044526
INCROP						
LD	-0.1485485	0.1031024	-1.44*	0.150	-0.3506255	0.0535285
L2D	-0.0516245	0.0989704	-0.52*	0.602	-0.2456029	0.142354
INFISH						
LD	-0.0322545	0.0291699	-1.11*	0.269	-0.0894264	0.0249174
L2D	-0.0217786	0.0301227	-0.72*	0.470	-0.080818	0.0372609
INLIVE						
LD	0.0847697	0.0960293	0.88*	0.377	-0.1034443	0.2729837
L2D	-0.0426303	0.0814145	-0.52*	0.601	-0.2021998	0.1169392
_CONTS	0.0161513	0.0073949	2.18*	0.029	0.0016575	0.0306451

Source: Author’s Computation (2014)

*= the value is statistically significance at 95 per cent confidence interval and df = 25

The Cointegrations in INGDP of the logs of Agricultural National GDP with other variables between 1980 and 2010 are shown in the table 4.8 (a) above. All the variables are obviously stationary. Nonetheless, there is a clear relationship between the time series variables. But, it remains to verify whether the series of residuals is stationary. In the case of INGDP (random walk with drift and trend), the lagged value and the lagged first difference, the coefficient on LD is 0.2004117 (0.74*) and that of L2D 0.1831389(0.64*). The analysis shows that in the short run INGDP has significant Autoregressive effect both at lags one and two. Also INGDP is significantly affected for lag one and not lag two in INCROP, LD is -0.1485485 (-1.44*) and significantly L2D -0.0516245 (-0.52*). Still the reverse is true for INFISH. INGDP is significantly affected at lag one LD is -0.0322545 (-1.11*) and L2D of -0.0217786 (-0.72*). The performance of the rest two Agricultural sub-sectors, INHORT and INLIVE, has shown a significance relationship both at lag one and two, LD is 0.0847697 (0.88*); L2D -0.0426303 (-0.52*) for INLIVE and lag one-0.2226222 (-2.21*) and lag two -0.1479302 (-1.90*) for INHORT. These indicate that, in real world situation, these two subsectors (Livestock production and Horticultural output performance) can be used to affect directly the Agricultural GDP performance in short rum equilibrium.

Table 4.8 (b) VECM results of Log of Horticultural Production (INHORT)

	Coef	**Std. Err.**	**z**	**P > [z]**	**[95 % cont.**	**Interval]**
D_INHORT						
_CE 1 L1	1.170996	1.099733	1.06*	0.287	-0.9844415	3.326433
_CE 2 L1	-0.4030779	0.3975589	-1.01*	0.311	-1.182279	0.3761233
_CE 3 L1	-0.4767049	0.6620911	-0.72*	0.472	-1.77438	0.8209699
INGDP						
LD	0.3888341	1.335326	0.29*	0.771	-2.228357	3.006026
L2D	-1.641564	1.402352	-1.17*	0.242	-4.390124	1.106996
INHORT						
LD	0.1596709	0.4951446	0.32*	0.747	-0.8107948	1.130137
L2D	0.1133507	0.3823285	0.30*	0.767	-0.6359994	0.8627008
INCROP						
LD	0.6536415	0.5070115	1.29	0.197	-0.3400827	1.647366
L2D	0.5091894	0.4866923	1.05	0.295	-0.44471	1.463089
INFISH						
LD	0.0474805	0.1434444	0.33*	0.741	-0.2336653	0.3286263
L2D	0.0302265	0.1481301	0.20*	0.838	-0.2601045	0.3205549
INLIVE						
LD	-1.822265	0.4722293	-0.39*	0.700	-1.107779	0.7433259
L2D	0.1066382	0.4003602	0.27*	0.790	-0.6780534	0.8913297
_CONTS	0.0108991	0.036365	0.30*	0.764	-0.060375	0.0821731

Source: Author's Computation (2014)

*= the value is statistically significance at 95 per cent confidence interval and df = 25

Cointegration in INHORT (log of Horticultural Product) with other variables is indicated in the figure 4.8 (b) above. But, it also remains to verify whether the series of residuals is stationary. In the case of INHORT (random walk with drift and trend), the lagged value and the lagged first difference, the coefficient on LD is 0.1596709 (0.32*) and that of L2D 0.1133507 (0.30*) that is lag one and two respectively. The analysis show that in the short run INHORT has a significant Autoregressive effect both at lags one and two meaning that the current performance is dependent of the last year's performance. Also INHORT is having significant relationship with the rest of the variables both in lag one and two apart from INCROP (LD 0.6536415 (1.29) and L2D 0.5091894 (1.05)) meaning horticultural sector is a fully dependent sub-sector to all other sub-sectors except crop production and its output do depend on current performance (LD) or the last year's performance (L2D) of these sub-sectors. Last year performance of the total agricultural GDP sector, the current and last year performance of fish rearing and livestock output has direct effect on the horticultural performance.

4.8 (c) VECM results of Log of Crop Production

	Coef	Std. Err.	z	P > [z]	[95 % cont.	Interval]
D_INCROP						
_CE 1 L1	-0.7437358	0.2482412	-3.00*	0.003	-1.23028	-0.2571919
_CE 2 L1	0.5758005	0.0897404	6.42*	0.000	0.3999125	0.7516885
_CE 3 L1	-0.8927947	0.1494529	-5.97*	0.000	-1.185717	-0.5998724
INGDP						
LD	0.8333276	0.3014214	2.76	0.006	0.2425526	1.424103
L2D	0.7647515	0.316551	2.42	0.016	0.1443229	1.38518
INHORT						
LD	-0.5051548	0.1117683	-4.52*	0.000	-0.7242166	-0.2860929
L2D	-0.3022608	0.0863025	-3.50	0.000	-0.4714106	-0.133111
INCROP						
LD	-0.3695793	0.114447	-3.23	0.001	-0.5938914	-0.1452673
L2D	-0.3206376	0.1098604	-2.92*	0.004	-0.53596	-0.1053152
INFISH						
LD	0.0529404	0.0323795	1.63*	0.102	-0.0105222	0.1164031
L2D	0.0370352	0.0334372	1.11*	0.268	-0.0285005	0.102571
INLIVE						
LD	0.2897814	0.1065957	2.72	0.007	0.0808577	0.4987051
L2D	0.2616828	0.0903728	2.90*	0.004	0.0845555	0.4388102
_CONTS	-0.0024994	0.0082086	-0.30	0.761	-0.018588	0.0135892

Source: Author's Computation (2014)

*= the value is statistically significance at 95 per cent confidence interval and df = 25

The Cointegration in INCROP (log of Crop Production) has shown a insignificant relationship at current year but not the last year's performance since at lag one coefficient is -0.3695793 (-3.23) and lag two the coefficient is -0.3206376 (-2.92*) for LD and L2D respectively. With the rest of the time series variables, results have shown that, to attain short run equilibrium, then INFISH with LD of 0.0529404 (1.63*) and L2D of 0.0370352 (1.11*) can be used to affect the crop production output. The current performance of INLIVE with LD of 0.2897814 (2.72) and the last year's performance of INHORT with L2D of -0.3022608 (-3.50) are insignificant in affecting the crop production performance output. To achieve short run equilibrium therefore, then measure should be adopted based on INFISH, current performance of horticultural output LD -0.5051548 (-4.52*) and the last year's performance of Livestock production, L2D 0.2616828 (2.90*).

4.8 (d) VECM results of Log of Fish Farming (INFISH)

	Coef	Std. Err.	z	P > [z]	[95 % cont.	Interval]
D_INFISH						
_CE 1 L1	2.505677	1.493238	1.68	0.093	-0.4210156	5.43237
_CE 2 L1	-0.216005	0.539813	-0.40*	0.689	-1.274019	0.842009
_CE 3 L1	-0.5624195	0.8989997	-0.63*	0.532	-2.324427	1.199587
INGDP						
LD	-2.77475	1.813131	-1.53*	0.126	-6.328422	0.7789216
L2D	-0.2645811	1.90414	-0.14*	0.889	-3.996627	3.467465
INHORT						
LD	-0.6017882	0.6723166	-0.90*	0.371	-1.919505	0.7159281
L2D	-0.6388272	0.5191328	-1.23*	0.218	-1.656309	0.3786544
INCROP						
LD	-0.0914054	0.6884297	-0.13*	0.894	-1.440703	1.257892
L2D	-0.939538	0.6608399	-1.42*	0.155	-2.23476	0.3556844
INFISH						
LD	-0.5480303	0.1947715	-2.81*	0.005	-0.9297753	-0.1662852
L2D	-0.126376	0.2011339	-0.63*	0.530	-0.5205911	0.2678391
INLIVE						
LD	0.6710466	0.6412018	1.05	0.295	-0.5856858	1.927779
L2D	1.050012	0.5436165	1.93*	0.053	-0.0154569	2.115481
_CONTS	0.0004066	0.049377	0.01*	0.993	-0.0963706	0.0971838

Source: Author's Computation (2014)

*= the value is statistically significance at 95 per cent confidence interval and df = 25

During the Cointegration in INFISH (Log of fish production), the results showed that the fish production is dependent on the other agricultural sub-sectors apart from its current production LD-0.5480303(-2.81) and current livestock production 0.6710466 (1.05) and not its the last year performance L2D-0.126376(-0.63*) and 1.050012 (1.93*) for current performance of livestock. This has been revealed by the significance of their coefficient at 95 per cent confidence interval with agricultural GDP having -2.77475 (-1.53*) at LD and L2D -0.2645811 (-0.14*) and horticulture and crop -0.6017882 (-0.90*) and -0.6388272 (-1.23*), -0.0914054 (-0.13*) and -0.939538 (-1.42*), at LD and L2D respectively. This implies that for us to increase or reduce the performance of the fish output to attain short run equilibrium then horticultural output, and crop production can be used to affect the fish production. This is an indication that majority of what is obtained from fish industry is locally consumed hence not contributing directly to Gross Domestic Product growth.

4.8 (e) VECM results of Log of Livestock Production (INLIVE)

	Coef	**Std. Err.**	**z**	**P > [z]**	**[95 % cont.**	**Interval]**
D_INLIVE						
_CE 1 L1	-1.198649	0.6712531	-1.79*	0.074	-2.514281	0.1169826
_CE 2 L1	0.48914	0.2426613	2.02	0.044	0.0135325	0.9647474
_CE 3 L1	0.2037337	0.404126	0.50*	0.614	-0.5883387	0.9958061
INGDP						
LD	1.379284	0.8150541	1.69	0.091	-0.218193	2.976761
L2D	-0.6761875	0.8559653	-0.79*	0.430	-2.353849	1.001474
INHORT						
LD	-0.3419694	0.3022255	-1.13*	0.258	-0.9343205	0.2503817
L2D	-0.349073	0.233365	-1.50*	0.135	-0.80646	0.108314
INCROP						
LD	-0.188659	0.3094688	-0.61*	0.542	-0.7952066	0.4178887
L2D	-0.152609	0.2970664	-0.51*	0.607	-0.7348484	0.4296305
INFISH						
LD	-0.0056876	0.0875553	-0.06*	0.948	-0.1772929	0.1659177
L2D	0.043746	0.0904154	0.48*	0.629	-0.1334649	0.220957
INLIVE						
LD	0.2157863	0.2882385	0.75*	0.454	-0.3491508	0.7807233
L2D	0.1649691	0.2443711	0.68	0.500	-0.3139895	0.6439278
_CONTS	0.0034585	0.0221964	0.16*	0.876	-0.0400456	0.0469626

Source: Author’s Computation (2014)

*= the value is statistically significance at 95 per cent confidence interval and df = 25

The last short run Cointegration test model was Cointegration in INLIVE (Log of Livestock Production). Livestock production, unlike all the other sub-sectors shows a pure dependent and significance relationship with all variables at lag one and two except its last year's performance. It does depend on other agricultural sub-sectors during short run and both at lag one and two. The coefficient on LD is 0.2157863 (0.75*) and that of L2D is 0.1649691 (0.68). Likewise INLIVE is significant for both lag one and two in INCROP where LD is -0.188659 (-0.61*) and that of L2D -0.152609 (-0.51*), INFISH LD is -0.0056876 (-0.06*); L2D 0.043746 (0.48*), and INHORT LD is -0.3419694 (-1.13*); L2D -0.349073 (-1.50*) for crop, fish, and horticulture respectively. The case is however different in the Agricultural Gross Domestic Product (INGDP) at lag one 1.379284 (1.69) and at lag two -0.6761875 (-0.79*). This means that livestock production in short run is a dependent sub-sector which depends on agricultural GDP at L2D only. The performance of the sub-sector is directly associated with other agricultural sub-sector in short run relationship to attain the short run equilibrium.

From Granger Representation Theorem, if two or more variables Y and X's are cointegrated, then the relationship between the two can be expressed by Error Correction Model (ECM) (Gujarati, 2007). This relationship is as explained and determined in the foregone analysis, and attempts to describe how the agricultural sub-sector models directly estimate the speed at which the agricultural GDP returns to equilibrium after a change in any of the agricultural sub-sector.

4.9 The Long Run Dynamic Relationships of the Model Variables

At the next step of the estimations, the study went for a long run relationship among the time series variables, INGDP, INHORT, INCROP, INFISH and INLIVE. This is a significant improvement over conventional Cointegration tests applied on a single data variable series. While pooling data to determine the common long run relationship, it allows the cointegrating vectors to vary across the members variables. After including previous year Agricultural Gross Domestic Product, the Cointegration relationship model was estimated as follows:

$$E_{It} = \alpha_i + \beta_i R_{it} + \gamma_i GDP_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4.1$$

Where R_{it} is the independent time series variable and GDP_{it} is the gross domestic product from the previous year.

4.9.1 Individual Vector Error Correction Models in Long Run

The results of cointegrating relations show that the model variables are cointegrated with three Cointegration relationships (table 4.6 above). This implies, the long run dynamic relationship among the time series variable can be explained by three long run Cointegrating equations.

The reason behind such a choice is that if we would start straight away with a five variables system, there would be too many candidates for the identified cointegrated relationships which would create confusion..

From the results above (table 4.6) it was therefore necessary to examine the three dynamic relationships of the time series variables. The results are shown by the three Cointegration equations. The essence of this was to bring out clearly, in econometric model form, the variables relationship in long run equilibrium relationship.

Cointegration Relation One

$$\underset{}{INGDP} = -\underset{(.dropped)}{2.536566} + \underset{(.dropped)}{3.47e-17 INHORT} - \underset{(0.0298616)}{0.1092167 INFISH} - \underset{(0.298542)}{0.763303 INLIVE} + \varepsilon_t \ldots\ldots 4.2$$

The first cointegrating relationship is depicted as in Equation 4.2 above. The Cointegration equation showed that the log of Agricultural National Gross Domestic Product (INGDP) depends on INHORT, INFISH, and INLIVE in the long run. The long run relationships showed that INFISH is influencing INGDP significantly with t value of – 3.66. This means that INGDP depends on INFISH in the long run. The long run relationship also revealed that INLIVE is influencing INGDP significantly with t value of – 2.56 which is statistically significant. This means that INGDP depends on INLIVE in the long run as well. Though INHORT is having some effect on Agricultural Gross Domestic Product long run performance, the study has shown that effect is minimal and insignificant.

Cointegration Relations Two

$$INHORT = 19.25862 - 1.11e-16 INGDP + 4.44e-16 INCROP - 0.1385325 INFISH - 2.740799 INLIVE + \varepsilon_t \ldots\ldots 4.3$$
$$(dropped) \quad (dropped) \quad (dropped) \quad (0.0767146) \quad (0.766955)$$

The second cointegrating relationship is as shown in Equation 4.3 above. The Cointegration equation showed that log of Horticultural Production Output (INHORT) depends on INGDP, INFISH INCROP and INLIVE. The long run relationships showed that INFISH is influencing INHORT significantly with t value of – 1.81 which is statistically significant meaning that INHORT depends on INFISH in the long run significantly. The long run relationships also showed that INLIVE is influencing INHORT significantly with a t value of – 3.57 which is statistically significant. This shows that INHORT depends on INLIVE in the long run. However, INCROP and INGDP do not have any significant effect on INHORT in long run as seen in the above equation 4.3 above since they have been dropped.

Cointegration Relations Three

$$INCROP = -4.857069 + 1.11e-16 INGDP - 4.86e-17 INHORT - 0.0867877 INFISH - 0.4918789 INLIVE + \varepsilon_t \ldots 4.4$$
$$(dropped) \quad (dropped) \quad (dropped) \quad (0.0261131) \quad (0.261066)$$

Lastly, cointegrating relationship of INCROP, log of Crop production, is depicted in Equation 4.4 above. The results showed that Crop Production output (INCROP) depends on INGDP, INHORT, INFISH and INLIVE. The long run relationships show that INFISH is influencing INCROP significantly with t value of – 3.32 which is statistically significant. This shows that Crop production output depends on fish production in the long run. The long run relationships also revealed that INLIVE is influencing INCROP significantly with t value of – 1.88 which is statistically significant. This means that INCROP do actually depends on INLIVE in the long run. The other two, INGDP and INHORT, has been dropped in the long run relationship analysis to signify that, Agricultural GDP and horticultural production, their performance in long run is insignificant in affecting crop production performance.

4.10 Stability Test

One of the assumptions of the OLS is that the coefficients of the independent variables remain constant all through the sample period. But these need not always to be the case. Because of the less than impressive results of the multiple regression models above, focus on the analysis of the stability of the coefficients was at the five dependent time series variables.

It is commonly believed that many economic time series variables are tied together even though they are all trending and drifting. When a forecasting model is needed for such time series, a vector autoregressive model in difference is inappropriate. This is because, even though the residuals may appear to be white, such a model suffers misspecification and the forecasts will diverge from each other. However, conventional estimation techniques appear to underestimate the parameters near the unit circle (Banerjee *et al*, 1997). In light of this, all variables were plotted in root of the companion matrix below (Figure 4.4) where by a two units (-1 to +1) circle was drawn. Results revealed that all time series variables being inside the circle (see fig 4.4 below) to mean they are stable.

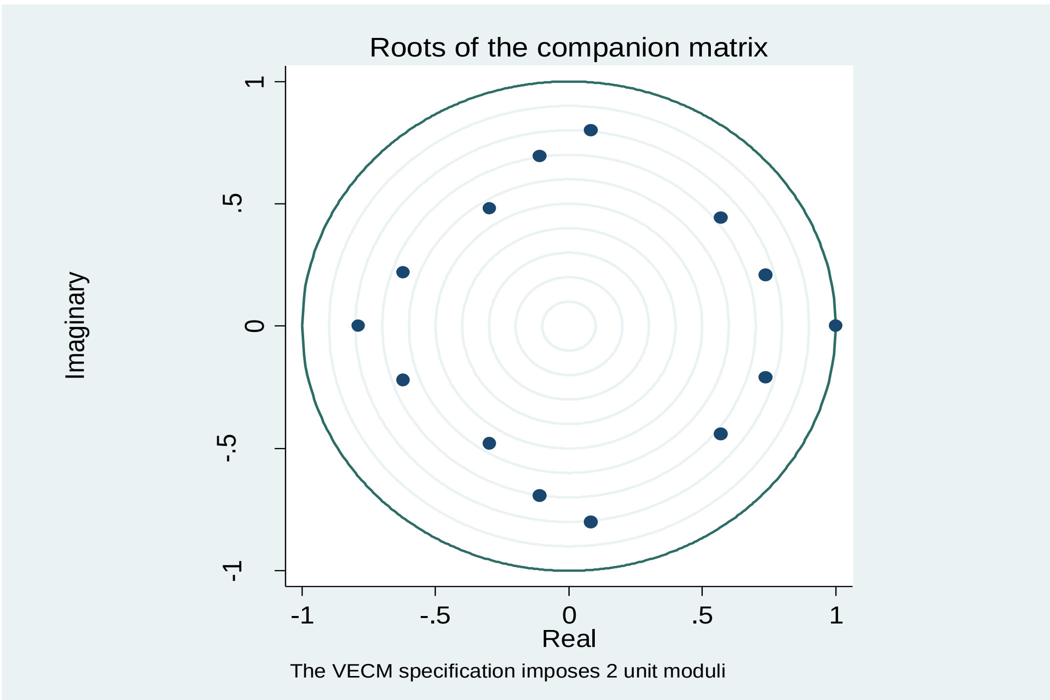


Fig 4.4 Unit Circle for Stability Test of Time Series Variables

Source: Author's Computation (2014)

All lie inside the unit cycle hence the VECM variables are stable.

4.11 Lagrangian Multiplier Test for Residual Autocorrelation

Granger (1986) showed that Johansen's co-integration test is sensitive to the lag lengths used in the VEC models. The study found this to be rather unsatisfactory, since there was no way of knowing whether or not these lag structures are adequate in producing serially uncorrelated error processes. The study also wanted to avoid the inclusion of redundant lags since the correction exacts a heavy toll on those models that have long lags (Hargreaves, 1994) and thus imposes some discipline on the lag selection process. The purpose here was not to find the correct lag length, which was however known, but a more modest goal of finding the minimum lag length that would produce serial uncorrelated residuals. In particular, the study used two Lagrange multiplier tests for residual autocorrelation (see table 4.9 and 4.10 below).

Table 4.9 Lagrange-Multiplier Test

Lagrange-Multiplier test					**Remarks**
Lag	**Chi 2**	**df**	**Prob > chi 2**	**Null hypothesis**	
1	22.0046	25	0.63548	No Autocorrelation at lag order one	Accept Null
2	25.8987	25	0.41302	No Autocorrelation at lag order two	Accept Null
3	25.1081	25	0.45633	No Autocorrelation at lag order three	Accept Null

Source: Author's Computation (2014)

For all lag lengths there was no autocorrelation since the results show that Chi^2 is greater than its probability and hence accepted all null hypotheses of no autocorrelation.

The results are however not different from the Jarque – Bera test of residual (in the table 4.10 below)**.** The residuals followed a multivariate normal distribution. Like in the Lagrange-Multiplier test, the probability is less than the Chi^2. However, this relationship for univariate is not significant in Jarque – Bera test. The main concern is the overall results which showed also no autocorrelation for the multivariate regression VEC model (see table 4.10 below).

Table 4.10 Multivariate Normality Test of Residual

Jarque – Bera test			
Equation	**Chi 2**	**df**	**Prob > chi 2**
D_INGDP	2.030	2	0.36234
D_INHORT	1.906	2	0.38558
D-INCROP	1.697	2	0.42802
D_INFISH	6.299	2	0.04287
D_INLIVE	4.958	2	0.08383
ALL	16.891	10	0.07682

Source: Author's Computation (2014)

4.12 Granger Causality Test

Another test conducted concerning the relationships of the variables was Granger-causality test. Since Granger-causality test is very sensitive to the number of lags included in the regression, both the Akaike (AIC) and Schwarz Information Criteria were adopted in order to find an appropriate number of lags. After these requirements were satisfied, Granger-causality tests were computed. In each case, the null hypothesis is specified in Granger causality test results in the first panel of Table 4.11 below. The probability and Chi^2 shows that the null hypothesis can be accepted or rejected for any of the time series variables INGDP, INHORT, INCROP, INFISH and INLIVE. If probability of Chi^2 is significantly different from zero, the null hypothesis is rejected. If probability of Chi^2 is not significantly different from zero, the null hypothesis is accepted. The intention of Granger causality was to test whether one of the series can be predicted by the history of the other. The results of the Granger causality tests are reported in Table 4.11.

Table 4.11 Granger Causality test

Granger Causality Wald test

Null Hypothesis	**Chi 2**	**df**	**Prob. > Chi 2**	**REMARKS**
INHORT does no Granger Cause *INGDP*	41.993	1	0.000	Accept Null
INCROP does no Granger Cause *INGDP*	0.47631	1	0.490	Reject Null
INFISH does no Granger Cause *INGDP*	5.4023	1	0.020	Accept Null
INLIVE does no Granger Cause *INGDP*	1.3281	1	0.249	Reject Null
ALL do not Granger Cause *INGDP*	44.263	4	0.000	Accept Null
INGDP does no Granger Cause *INHORT*	13.658	1	0.000	Accept Null
INCROP does no Granger Cause *INHORT*	5.2866	1	0.021	Accept Null
INFISH does no Granger Cause *INHORT*	3.1122	1	0.078	Accept Null
INLIVE does no Granger Cause *INHORT*	10.84	1	0.001	Accept Null
ALL do not Granger Cause *INHORT*	35.433	4	0.000	Accept Null
INGDP does no Granger Cause *INCROP*	0.00254	1	0.960	Reject Null
INHORT does no Granger Cause *INCROP*	25.943	1	0.000	Accept Null
INFISH does no Granger Cause *INCROP*	2.0764	1	0.150	Reject Null
INLIVE does no Granger Cause *INCROP*	5.4873	1	0.019	Accept Null
ALL do not Granger Cause *INCROP*	49.498	4	0.000	Accept Null
INGDP does no Granger Cause *INFISH*	2.9453	1	0.086	Accept Null
INHORT does no Granger Cause *INFISH*	0.00503	1	0.943	Reject Null
INCROP does no Granger Cause *INFISH*	0.64895	1	0.420	Reject Null
INLIVE does no Granger Cause *INFISH*	1.0145	1	0.314	Reject Null
ALL do not Granger Cause *INFISH*	13.388	4	0.010	Accept Null

INGDP does no Granger Cause *INLIVE*	1.5533	1	0.213	Reject Null
INHORT does no Granger Cause *INLIVE*	8.72	1	0.003	Accept Null
INCROP does no Granger Cause *INLIVE*	3.0276	1	0.082	Accept Null
INFISH does no Granger Cause *INLIVE*	5.6237	1	0.018	Accept Null
ALL do not Granger Cause *INLIVE*	31.739	4	0.000	Accept Null

Source: Author's Computation (2014)

Granger Causality for INGDP indicates from the test above that horticultural production does not granger cause agricultural gross domestic product (0.000), fish production output (0.020) also do not granger cause the agricultural gross domestic product and the overall test shows that all variables together do not statistically granger cause any change to agricultural gross domestic product (0.000). This is clearly seen by the acceptance of their respective null hypothesis. However, for crop production and livestock performance results have revealed that the null hypothesis is rejected implying some relationships between the estimated variables. These indicate that the two, INCROP and INLIVE do granger cause the INGDP. The two time series variables, INCROP and INLIVE, can therefore be used to the impact the performance for INGDP.

Granger causality for INHORT test also revealed that horticultural production sector is an independent sub-sector that does not depend on any other sector's performance. This is revealed by the acceptance of the null hypothesis at all time series variables. There is no causal relationship for INGDP (0.000) to INHORT, INCROP (0.021) to INHORT, INFISH (0.078) to INHORT, INLIVE (0.001) to INHORT, and the overall causality (0.000).

Granger causality for INCROP shows that it is possible for crop production performance to be predicted by the historical performance of INGDP (0.960) and INFISH (0.150). However the relationship between the crop production, with horticultural and livestock output shows that the latter two, can not be used to predict the crop performance and there is no significance causal relationship between them since their probability is not significantly different from zero, INHORT (0.000) and INLIVE (0.019).

Granger Causality for INFISH revealed that it is possible to forecast the fish production output using horticultural, crop and livestock performances. This is because, with a normal distribution and at 95 per cent confidence interval, the null hypothesis, that states *INHORT*, *INCROP* and *INLIVE* does not Granger Cause *INFISH* has been rejected implying that the three do statistically Granger Cause fish production. But with the inclusion of the agricultural gross domestic product (INGDP), the null hypothesis is accepted and implying that the performance of the combined variables cannot be used to predict the fish performance as a sub-sector for agricultural GDP. Granger Causality test resulted to INGDP (0.086) and the overall results of 0.010 which are not statistically different from zero. But for the other sub-sectors, INHORT had 0.943, INCROP (0.420) and INLIVE (0.314) their probability is significantly different from zero implying some granger causality.

Granger causality for INLIVE, also showed a similar pattern of mixed results like other sub-sectors results. This means that with a normal distribution and at 95 per cent confidence interval the null hypotheses, that state *INHORT* (0.003), *INCROP* (0.082) and *INFISH* (0.018) do not Granger Cause *INLIVE* have been accepted implying that the three do not statistically Granger Cause livestock performance hence they cannot be used to predict livestock performance. The result is also not different for the conjoint variables prediction performance which can’t also be used for the prediction. However, the results for the test showed that actually past performance of Kenya Agricultural GDP do granger cause INLIVE with probability of 0.213.

4.13 Forecast of Variables

This was done so as to estimate the value performance of a variable at some future point in time, and in this study forecasts were done for the next 16 levels. In this section however, plotting of forecasted data forms the main core. This was necessary to aid in decision making and planning for the future. The section was found relevant to help in policy implication. This is guided by the core principle that, if we can predict what the future will be like based on previous years performance analysis, we can modify our behavior now to be in a better position, than we otherwise would have been, when future arrives. All forecasting methods are very involving and tedious repetitive calculations. This increases the probability of erroneous results. So the study ideally chose to use Econometric Software for forecasting and plotting the results. Below is however the forecasted results in graph followed with their explanations. All the plotting was done at 95 per cent confidence interval on each variable with its upper and lower limits.

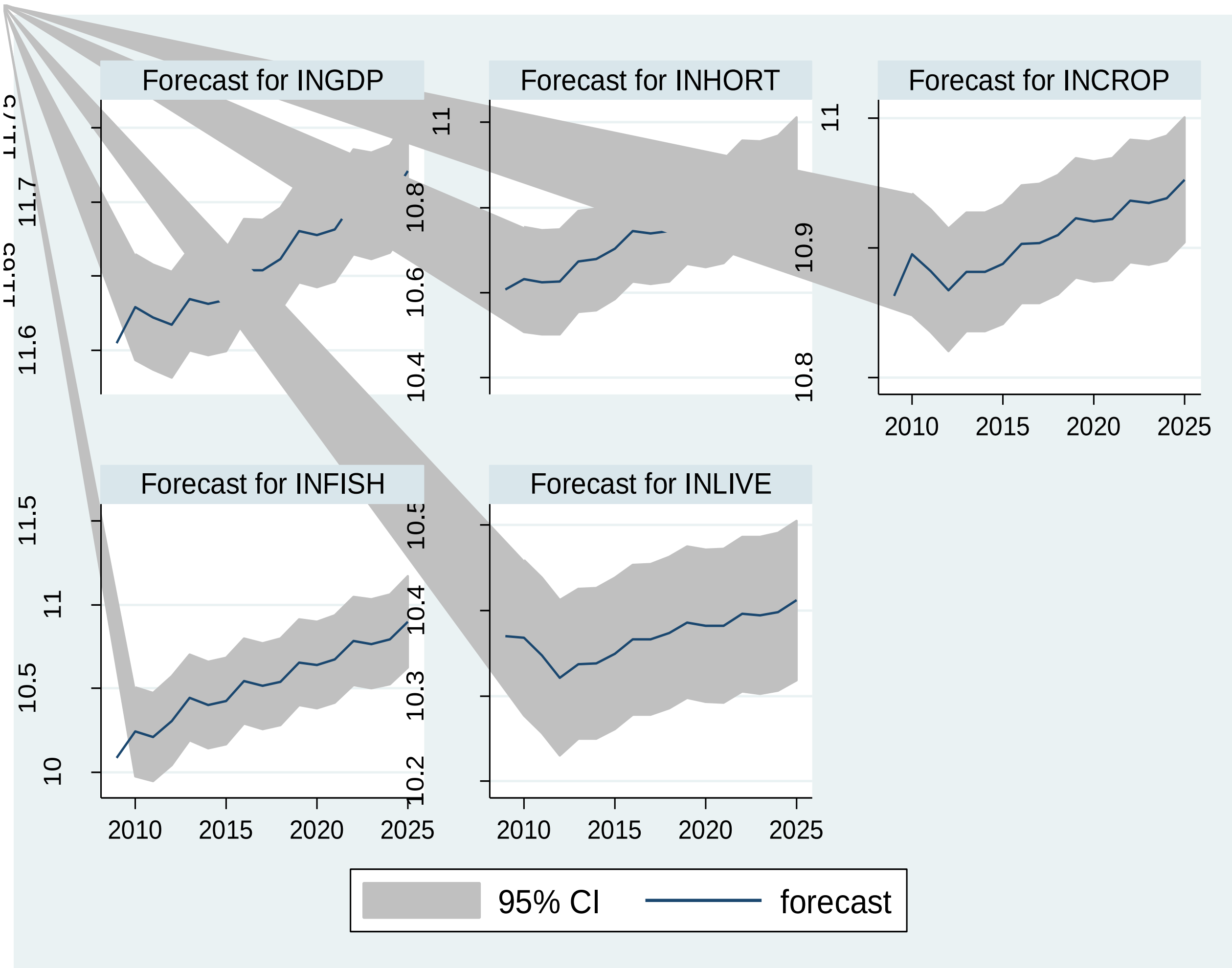


Fig 4.5 Graphics for the Forecasts

Source: Author's Computation (2014)

The forecast of the variables shows that the entire sector is significantly trending upwards. The co-movement of the variables indicates that the five time series variables have a tendency of trending together positively for the next 16 years, from 2010 to 2025. This has however taken the assumption that all the exogenous factors affecting the agricultural sub-sectors shall remain constant such as community conflict, drought and so on. The implication of this statement is that, Kenya has the potential of performing better since majority of its resources lie unexploited, the probability of this positive trending depends heavily on other factors such as goodwill of the government and those in power. The government should therefore put measures to avoid some drifts and support trends. The support of public-private partnership for example forms the main channel of developing the sub-sectors to impact the Kenya Agricultural GDP. This also is supported by the fact that Kenya is a growing economy heavily depending on the agricultural sector as the main backbone of its economy. Below is an overview of individual variable analysis.

4.13.1 Agricultural Gross Domestic (INGDP) Product Forecast

The trend for the INGDP indicates an upward movement. This is an indication of continuous positive performance which reveals the probability of better future performance. However, the results are characterized with drift and trend all along the period indicating the presence of other exogenous factors affecting the Agricultural Gross Domestic Product output.

4.13.2 Horticultural Production Forecast

Horticultural product has also revealed drifts and trends but which are minimal compared to the Agricultural gross domestic product forecast. This can be interpreted to mean that the sector is really affected by other external factors. With some minimal government support, the sector can be independent. The indication is very significant since majority of the horticultural products are mainly for export market and what is left for the domestic consumption doesn’t reflect significantly to national account.

4.13.3 Crop Production Forecast

Crop production also revealed an upward trending with minor drift. The results showed that the crop production has a tendency of performing better than what is currently being produced.

There is a possibility of continued increase in crop output, other factors being held constant or being controlled to have minimal effect.

4.13.4 Fish Production Forecast

There is also a tendency of increase in what marine sub-sector produces to the national account. This is however determined by the behavior of the external factors such as market and encouragement of fish pond creation by those in leadership to local farmers.

4.13.5 Livestock Production Forecast

Livestock production like all other sub-sectors showed that there is the probability of future increase in the output. The performance forecast however has some minor drift but a positive trend. This is a good indication for good future performance of output.

There is an overall co-movement of the entire variables under the study. Focus should therefore be on the policy makers to make policies that ensure that drifts are minimized while encouraging the positive trend.

CHAPPTER FIVE

SUMMARY OF THE STUDY, CONCLUSIONS AND POLICY IMPLICATION

5.1 Introduction

The chapter discusses the outcome of the study, the author's view of the results on the solution to knowledge gap that was indentified in previous studies discussed in the literature review. The chapter concluded on results use on policy making. Also included in the chapter is the author's suggestion on the further area of study that was found necessary based on this study.

5.2 Summary of Study

The results indicated that despite a stable Agricultural gross domestic production, the effectiveness of development in it stimulating economic activity has increased over time. Short-run interaction of the variables has revealed a mixed reaction with some sub-sectors depending on others while others being independent such as horticultural sub-sector. The results are not much different in the Long-term either. The results also suggest that other components operating outside agricultural sector can have a significant effect on output performance of agricultural sector. This is clearly seen by the huge drifts of the individual plotting graphics and sometime constant production.

With respect to the driving forces over a time variation, the study found evidence to point out the presence of co-movement of the variables. This finding lends to empirical support to the view that the variables under study actually do move together regardless of some not having significant relationship to each other. The results didn't change whether in the short run or in the long run. Furthermore, lack of government good will, corruption, and community conflict might be associated with the drifts which are experienced. These findings support the argument that government support and investment may have an additional positive aggregate trend effect in addition to the Agricultural Gross Domestic Product.

Finally, the results generally showed that there is still the possibility of continued increase in the production. This is consistent with the policy analyses and previous studies that indicate that the agricultural sector has shown a continuous increase in the output overtime though there is reduction in commodity price and rapid rise in population, hence demand. For the growth of the economy agricultural sub-sectors can not therefore be ignored or assumed whether in short term or long term.

5.2 Conclusion

The first objective of this research was to determine whether horticulture sub-sector has a significant effect on Kenyan Agricultural Gross Domestic Product. The results of the analysis showed that in the short run horticulture does not Granger cause, Kenyan Agricultural Gross Domestic Product. The results show that there is no directional causality from horticultural production to Agricultural Gross Domestic Product and vice versa. The results are not different from the other sub-sectors neither except for the horticultural production that granger cause fisheries. The long run relationship also shows that in the long run, growth rate of horticulture insignificantly contributes to growth in Kenyan Agricultural Gross Domestic Product. This is a significant and practical result because Horticultural sub-sector is purely export oriented. Basing on these results, the first hypothesis stating that Horticultural sub-sector has no significant effect on Kenya Agricultural Gross Domestic Product is accepted in the short run and in the long run dynamic relationships.

The second objective of this research was to find out if livestock rearing has significant relationship with Kenyan Agricultural Gross Domestic Product. The results of the analysis revealed that in the short run, livestock production does significantly Granger cause Kenyan Agricultural Gross Domestic Product and fish production. The results show that there is also directional causality from Agricultural Gross Domestic Product to livestock production and vice versa. Still in the long run relationship, the long run growth rate of livestock production is significantly contributing to growth in Kenyan Agricultural Gross Domestic Product. This is a significant and consistent result that indicates that almost every community has a single kind of livestock that it depends on for its livelihood. Majority of Kenyan households rely on livestock for their livelihood. Basing on these results, the second hypothesis stating that there is no significant relationship between the livestock production and Kenya Agricultural Gross Domestic Product is therefore rejected in both short run and in the long run dynamic relationship.

The third objective of this research was to examine whether crop production impacts significantly on Kenyan Agricultural Gross Domestic Product. The results of the analysis showed that in the short run there is Granger causality between Kenyan Agricultural Gross Domestic Product and crop production. The result doesn’t change for the vice versa; that there is directional causality from crop production to Agricultural Gross Domestic product and vice versa. The long run relationship however changes. In the long run Agricultural Gross Domestic product is independent from livestock production. There is no granger causality between the two time series variables. Basing on these results the third hypothesis stating that crop production does not significantly impact Kenya Agricultural Gross Domestic Product is rejected in the short run and maintained in the long run dynamic relationship.

The fourth objective was to indentify whether fish farming output has significant relationship with the Kenyan Agricultural Gross Domestic Product. The results of the analysis showed that in the short run, fish production does not Granger causes Kenyan Agricultural Gross Domestic

Product. The results show that there is no directional causality from fish production to Agricultural Gross Domestic Product and vice versa. The long run relationship however shows a significant contribution, that is the long run growth rate of fish production output has a significant relationship with the Kenyan Agricultural Gross Domestic Product performance. This is a significant and practical result because fish and its product is gaining a significant demand both domestic and export. Basing on this result the forth hypothesis stating that fish farming has no significant relationship with Kenya Agricultural Gross Domestic Product is maintained in the short run and rejected in the long run dynamic relationship.

5.3 Policy Implications

5.3.1 Policy Implications from the First Objective

The results of analysis of the VECM show that in the short run there is significant relationship between horticultural sector and the Kenyan Agricultural Gross Domestic Product. Therefore the policy recommendation is that the government should design policies that would increase domestic production of horticultural output. It is clear that the sector is useful in the short run for employment creation. It is also evident that domestic revenue from the horticulture is used for Local consumption. Also, there is a insignificant relationship between horticultural production and Kenyan Agricultural Gross Domestic Product in the long run. Therefore in the long run the government should design policies targeting ease of domestic consumption because horticultural production is export oriented therefore for the achievement of long term development goal such as millennium development goals; horticultural sector is a key sector that must be incorporated in the long run domestic macro economic setup.

An interesting direction for future research would be to investigate the tendency of increasing of horticultural export effects to the Kenyan Agricultural Gross Domestic Product with dimension of time variation to the economic growth, how and which product has sufficient potential and ability to improve economic growth. Such an investigation would contribute to the present study by adding information to policymakers at macro level.

5.3.2 Policy Implications from the Second Objective

The results from the analysis of the VECM reveal that in the short run there is a strong significant relationship between livestock production sector and the Kenyan Agricultural Gross Domestic Product. These are empirical results since most of livestock product is used domestically. Actually Kenyan's economy consumes more livestock products that it produces meaning that at least yearly there must be some livestock crossing the boarder. Therefore the policy implication for this is that the government should design policies that would increase and encourage more domestic production of livestock output. It is clear that the sector is significantly useful both in the short run and long run. It is evident that domestic revenue is reflected in the national account whether in long run or short run. Therefore the government policy maker should design policies targeting ease of production both in long and short run. This reveals the reason why the long-term development goals for the government should not exclude livestock sector.

The study leaves a direction for future research to investigate the tendency and probability effect of increasing livestock production either at small scale or large scale. How such production should be done with the common denominator of ensuring that the output reaches at national level and be accounted for.

5.3.3 Policy Implications from the Third Objective

The results of analysis revealed that in the short run there is a significant relationship between crop production sector and the Kenyan Agricultural Gross Domestic Product. In either way the two have revealed a strong relationship at lag two. However, there is an insignificant relationship between crop production and Kenyan Agricultural Gross Domestic Product in long run. Therefore the policy recommendations will depend whether the government is looking to solve a short term or a long term goal. The fact that the crop production sector does granger cause Kenyan Agricultural Gross Domestic Product in the short run indicated that to raise the Kenyan Agricultural Gross Domestic Product in short run then crop production is very crucial. It is very important for the policy makers to therefore ensure that small scale market and industry are promoted. In the long run however, the results have revealed that there is a probability of large export of crop production by individual private sector or that the sector is dominated by private foreign traders who sell their product outside the Kenyan boundary. This is indicated by the insignificant effect of the sub-sector to the Kenyan Agricultural Gross Domestic Product. Restriction of export from the sub-sector should be encouraged or export only those crop product that earn great exchange rate.

The study leaves room for future research to investigate the net effect of individual crop to the Kenyan Agricultural Gross Domestic Product. Such an investigation would contribute to the present study by adding information to policymakers at macro level and determine the individual crop net output.

5.3.4 Policy Implications from the Forth Objective

Out of the analysis of the VECM results showed that in the short run there is significant relationship between fish production sector and the Kenyan Agricultural Gross Domestic Product. The opposite is true however in the long run. The sector has shown a significant relationship in the long run. Therefore the policy recommendation is that the government should design policies that would increase domestic private production and consumption. It is clear that the sector is useful in the short run and long run for unemployment solution. The results also indicate that the domestic revenue from the sector is used for local consumption. The insignificant relationships between fish production and Kenyan Agricultural Gross Domestic Product indicate the necessity to design policies targeting increase domestic consumption and export. Fish production sector is therefore a key sector that must be incorporated in the long run domestic macro economic setup.

In future research, it would be necessary to investigate the tendency of increasing of fish pond education rather than dealing with the natural waters alone as the only source of marine products. Such a study would contribute to the present studies by adding information to decision makers on how to advise the government and farmers at large on fish farming.

REFERENCES

Banerjee, Anindya & David F. Hendry eds. (1997). *The Econometrics of Economic Policy*. Oxford: Blackwell Publishers

Chibber, D. C. (1988). The Aggregate Supply Response in Agriculture. In S. Commander (eds), *Structural Adjustment in Agriculture: Theory and Practice.* London: James Currey.

Dickey, David A. (1976). *Estimation and Hypothesis Testing for Non-Stationarity Time Series,* (Unpublished PhD Thesis), Lowa State University, Ames.

Granger Clive (1986). *Forecasting Economic Time Series*. 2nd edition. New York: Academic Press.

Elsevier Science Econometrics (1987). *Forecasting and Testing in Co-intergrated Systems,* North- Holland, p143-159

Engle, Robert F., David F. Hendry, and J. F. Richard (1983). Exogeneity Econometrica Basic *Econometrics,* 51, 277-304

FAO (2007). *National Economic Survey 2006*: *Fishery Country Projectile.* Kenya.

FAO (2012). *The state of World Fisheries and Aquaculture: FAO Fisheries Department.* Rome, Italy.

FAO (2003). *National Agriculture Sector Overview*, Kenya.

Government of Kenya (2005). *Resource allocation and utilization in Kenya's Agricultural Sector: A public Expenditure Review:* Nairobi, Government Printers.

______ (1997). *Explaining Africa Economic Growth Performance: An Economic Survey*. Nairobi: Government Printers.

______ (2007). *Kenya Vision 2030: A globally Competitive and Prosperous Kenya*. Nairobi: Ministry of Planning and National Development.

______ (2006). *Development Plan 1997-2000.* Nairobi: Government Printers.

______ (2012). *Kenya Economic Survey Diary 2012.*Nairobi: Government Printers.

______ (2010). *Agricultural Sector Development Strategy 2010-2020.*Nairobi: Government Printers.

______ (1995). *Kenya Economic Survey 1995*. Nairobi: Ministry of Planning and National Development.

______ (2001). *Kenya Economic Survey 2001*. Nairobi: Ministry of Planning and National Development.

______ (2003). *Kenya Economic Survey 2003*. Nairobi: Ministry of Planning and National Development.

______ (2000). *Kenya Economic Survey 2000*. Nairobi: Ministry of Planning and National Development.

Gujarati, N. D. (2007). *Basic Econometrics, Fourth Edition.* New Delhi: McGraw-Hill Companies

Greene, William (2007). *Basic Econometric Analysis.* Fifth Edition. New York, USA: McGraw-Hill Companies

Hamilton, James D. (1994). *Time Series Analysis.* Princeton: Princeton University Press

Hargreaves, C.P., (1994). A review of methods of estimating cointegrating relationships. In: Hargreaves, C.P. (Ed.), *Nonstationary Time Series Analysis and Cointegration.* New York: Oxford University Press Inc.

IGAD & LPI (2010). *The contribution of livestock to the economies of IGAD Members state: IGAD/LPI working paper NO. 02-11,* Addis Ababa, Ethiopia.

IGAD (2011). *New Study on drivers of the economy in Kenya. Retrieved in August 1, 2013 from http://www.farmbizafrica.com*

Johansen, S. (1995). *Likelihood-based inference in cointegrated vector autoregressive Models.* Oxford: Oxford University Press

Johansen, S., (1988). Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control*, 12 (2–3), 231–254.

Kenya National Bureau of Statistics (2009). *Kenya Population Census: Animal Production Division.* Nairobi: Government Printers

Kimenyi Mwangi (2013, 1, June). Kenya growth landscape, 1963-*2012 Daily Nation, p. 17+*

KPMG (2013). *KPMG Budget Brief.* Retrieved on August 1, 2013 from http://www.kpmg.com/east africa

Lutkepohl, Helmut (1991). *Introduction to multiple time series analysis.* (2nd ed). Heidelberg: Springer-Verlag.

Magister of Electrical Enginieering (2011). Research Design. *In C. R. Kothari (Eds), Research Methodology: Methods and Techniques, Second Edition.* New Delhi: New Age International Publishers.

Ministry of Agriculture (2013). *Agricultural policy in Kenya: Department of Horticulture*. Nairobi: Government printer

Ministry of Agriculture (2010). *National Horticulture policy*. Nairobi: Government Printer

Mosley, P. & Smith, L. (1989). Structural Adjustment and Agricultural Performance in Sub-Saharan Africa 1980-1987. *Journal of International Development*, 1, 321-355.

Nyonje, B. M., Karisa, C. H., & Macharia S. K. (2011). *Aquaculture Development in Kenya status, potential and challenges.* Department of Fisheries, Kenya.

Pagan, A.R. and M.H. Persaran (2007). On the Econometric Analysis of Structural Systems with Permanent and Transitory Shocks and Exogenous Variables. *Journal of Economic Dynamics and Control*, 32(10), 3376-3395

Peersman, G. (2005). What Caused the Early Millennium Slowdown? Evidence Based on Vector Autoregressions. *Journal of Applied Econometrics*, 20, 185-207.

Pena, D, G. Tiao, and R. Tsay, (2001). *A course in time series analysis.* New York: New York Publishers.

Phillips, P. C. B. & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika*, 75, 335-346.

Robert, F. Eagle & Granger, C. W. (1987).*: Co-Integration and Error Correction, Econometrica*, 55(2), 251-276.

Republic of Kenya (2005). *Economic Survey 2005*. Nairobi: Government Printers.

Simon C. K. & David T. (2009). *Agriculture and Livelihood diversification in Kenya.* Nairobi: Tegemeo Institute of Agricultural Policy and Development. Retrieved on August 1, 2013 from: http://www.tegemeo.org

The Investor Word Home Page (2013). *Online Investors Group.* Retrieved on August 1, 2013 from http://investorwords.com

USAID/KENYA (2010). *Update on Kenya Horticulture.* Kenya: USAID

Verbeek, Marno (2004). *A Guide to Modern Econometrics*. India: John Wiley & Sons Ltd

Wooldridge, J. M. (2001). *Introductory Econometrics: A Modern Approach.* Boston: MIT Press

World Bank (1981). *Accelerated Development in Sub-Saharan Africa*. Washington DC: World Bank Publications

APPENDICES

APPENDIX A: DEFINITION OF THE ENDOGENOUS TIME SERIES VARIABLES

A1 Data Definitions

The study period begins in 1980 and extends to 2010; all data were collected in form of Kenya pound (K£) and transformed to Kenya shillings (Ksh) with a base year of Ksh. 100.

A2 Endogenous Variables

A2 (i) Agricultural Gross Domestic Product: Logged Agricultural Gross Domestic Product was the total contribution of the entire agricultural sector as a sector contributing to the Kenyan National Account. It is abbreviated as INGDP for ease of analysis.

A2 (ii) Horticultural Production: Logged Horticulture was data gathered and accounted for at the national account. This however was divided into two sections. From 1989 to 1999 the data was a combination of fruits and other temporary crops, whereby the term temporary crop stood for a combination of cut flowers and vegetables. From 2000 to 2010 the data was very categorical and divided within the three products (Cut flowers, Vegetables and Fruits). The division was however immaterial to results and never had effects between the two periods. It was abbreviated as INHORT for ease of analysis.

A2 (iii) Crop Production: Logged Crop Production abbreviated as INCROP. This was a combination of three sub-main productions: Cereals which included a summation of Wheat, Maize, Barley, Rice (Paddy) and other minor products such as peas and beans; Temporary Industrial Crops which was a combination of Pyrethrum, Sugar-Cane, Cotton and Tobacco; and the lastly Permanent Crops which was made up of Coffee, Sisal and Tea.

A2 (iv) Livestock Production: The logged livestock production was abbreviated as INLIVE and was a combination of seven main livestock produce traded in Kenya. These are Cattle and Calves for slaughter, Sheep, Goats and Lambs for slaughter, Pig for slaughter, Poultry meat and eggs, wool, Hides and Skins, and Dairy products.

A2 (v) Fisheries Production:

Fish production was the aggregate of all the marine output recorded at the national account annually. The variable was logged and abbreviated as INFISH.

APPEDIX B: CORRELOGRAMS OF THE TIME SERIES VARIABLES

B1 Correlograms before Differencing

B1 (i) Correlogram of INGDP

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.8338	0.9374	23.015	0.0000		
2	0.7077	0.0138	40.185	0.0000		
3	0.5816	0.1168	52.211	0.0000		
4	0.4551	0.2620	59.857	0.0000		
5	0.3088	-0.2869	63.519	0.0000		
6	0.2198	0.1044	65.452	0.0000		
7	0.1565	0.1886	66.475	0.0000		
8	0.1083	-0.0098	66.986	0.0000		
9	0.0548	0.0667	67.124	0.0000		
10	0.0512	-0.2510	67.249	0.0000		
11	0.0324	-0.1035	67.303	0.0000		
12	0.0074	0.1835	67.305	0.0000		
13	-0.0257	0.4506	67.343	0.0000		

Source: Author’s Computation (2014)

B1 (ii) Correlogram of INHORT

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.8177	0.9150	22.132	0.0000		
2	0.6813	0.3730	38.045	0.0000		
3	0.5239	-0.0053	47.804	0.0000		
4	0.3746	-0.0998	52.985	0.0000		
5	0.2834	0.2269	56.068	0.0000		
6	0.1938	0.2172	57.57	0.0000		
7	0.1420	0.1349	58.412	0.0000		
8	0.0677	0.6383	58.611	0.0000		
9	0.0697	0.2973	58.834	0.0000		
10	0.0533	0.8569	58.97	0.0000		
11	-0.0279	-0.4185	59.009	0.0000		
12	-0.0883	0.1592	59.425	0.0000		
13	-0.1310	-0.3472	60.394	0.0000		

Source: Author’s Computation (2014)

B1 (iii) Correlogram of INCROP

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.7252	0.7599	17.409	0.0000		
2	0.5058	0.1883	26.182	0.0000		
3	0.2515	0.0950	28.431	0.0000		
4	0.1573	−0.0948	29.345	0.0000		
5	0.1167	0.1678	29.867	0.0000		
6	0.0580	−0.0089	30.002	0.0000		
7	0.0059	−0.1301	30.004	0.0001		
8	−0.0414	−0.0727	30.078	0.0002		
9	−0.0243	0.2265	30.105	0.0004		
10	0.0089	0.0886	30.109	0.0008		
11	0.0609	0.1077	30.296	0.0014		
12	0.0619	0.0420	30.501	0.0023		
13	0.0062	−0.2027	30.503	0.0040		

Source: Author's Computation (2014)

B1 (iv) Correlogram of INFISH

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.8717	0.9101	25.156	0.0000		
2	0.8005	0.5630	47.125	0.0000		
3	0.6465	0.1670	61.985	0.0000		
4	0.5701	−0.0571	73.986	0.0000		
5	0.4631	−0.1107	82.219	0.0000		
6	0.3636	0.0834	87.509	0.0000		
7	0.2422	−0.1474	89.956	0.0000		
8	0.1525	0.1681	90.971	0.0000		
9	0.0524	−0.0484	91.097	0.0000		
10	−0.0086	0.1334	91.101	0.0000		
11	−0.0788	−0.0421	91.414	0.0000		
12	−0.1249	−0.0724	92.247	0.0000		
13	−0.1746	0.1656	93.968	0.0000		

Source: Author's Computation (2014)

B1 (v) Correlogram of INLIVE

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	0.6973	0.7789	16.094	0.0001		
2	0.4925	0.0076	24.411	0.0000		
3	0.2982	0.0095	27.573	0.0000		
4	0.2003	0.2149	29.054	0.0000		
5	0.0801	-0.0201	29.3	0.0000		
6	0.0744	0.1866	29.522	0.0000		
7	0.0539	-0.0111	29.643	0.0001		
8	0.0556	0.1326	29.778	0.0002		
9	0.0857	0.3814	30.114	0.0004		
10	0.1097	0.2245	30.691	0.0007		
11	0.1222	0.3230	31.445	0.0009		
12	0.0737	0.1827	31.735	0.0015		
13	-0.0545	0.2785	31.903	0.0025		

Source: Author's Computation (2014)

B2 Correlograms of First Difference Variables

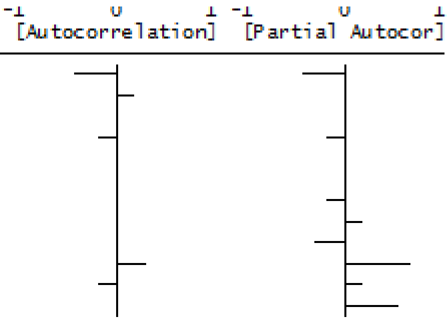
B2 (i) Correlogram of INGDP

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	0.0003	-0.0014	2.6e-06	0.9987		
2	-0.1069	-0.1173	.3807	0.8267		
3	-0.2238	-0.2722	2.112	0.5495		
4	0.2255	0.2796	3.9405	0.4141		
5	-0.0497	-0.0866	4.0332	0.5446		
6	-0.0563	-0.1863	4.1572	0.6554		
7	-0.0699	0.0073	4.3569	0.7379		
8	0.0395	-0.0721	4.4237	0.8170		
9	-0.0419	-0.0458	4.5026	0.8753		
10	0.0168	-0.1040	4.5159	0.9211		
11	-0.0750	-0.5817	4.797	0.9406		
12	-0.2018	-0.7341	6.9496	0.8609		

Source: Author's Computation (2014)

B2 (ii) Correlogram of INHORT

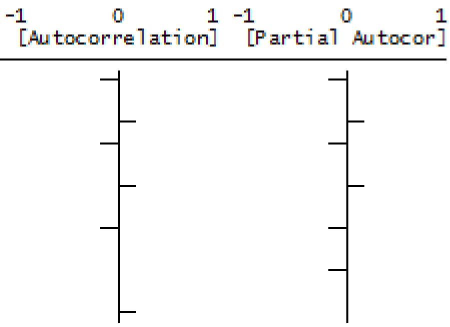
LAG	AC	PAC	Q	Prob>Q
1	-0.3906	-0.4003	4.8994	0.0269
2	0.1414	-0.0157	5.5654	0.0619
3	-0.0102	0.0532	5.569	0.1346
4	-0.1980	-0.2243	6.9788	0.1370
5	0.0668	-0.1115	7.1458	0.2100
6	-0.0705	-0.0341	7.3401	0.2905
7	-0.0525	-0.1734	7.4528	0.3833
8	0.0748	0.1261	7.6923	0.4641
9	-0.0871	-0.2579	8.0333	0.5308
10	0.2534	0.7089	11.072	0.3520
11	-0.1303	0.2119	11.92	0.3697
12	0.0494	0.5462	12.049	0.4418



Source: Author's Computation (2014)

B2 (iii) Correlogram of INCROP

LAG	AC	PAC	Q	Prob>Q
1	-0.1975	-0.1979	1.252	0.2632
2	-0.0137	-0.0570	1.2583	0.5330
3	0.1358	0.1447	1.8964	0.5942
4	-0.2036	-0.1521	3.3865	0.4953
5	0.1002	0.0435	3.7626	0.5841
6	0.1274	0.1564	4.3969	0.6231
7	-0.0747	0.0796	4.6248	0.7056
8	-0.1608	-0.2376	5.7311	0.6773
9	0.0358	-0.1115	5.7886	0.7609
10	-0.1153	-0.1317	6.4181	0.7790
11	0.0243	-0.0650	6.4477	0.8419
12	0.2112	0.1164	8.8065	0.7194



Source: Author's Computation (2014)

B2 (iv) Correlogram of INFISH

LAG	AC	PAC	Q	Prob>Q	[Autocorrelation]	[Partial Autocor]
1	-0.5648	-0.5653	10.24	0.0014		
2	0.2582	-0.0579	12.46	0.0020		
3	-0.0211	0.1311	12.475	0.0059		
4	0.0940	0.1668	12.793	0.0123		
5	-0.0669	-0.0434	12.96	0.0238		
6	0.2056	0.2205	14.613	0.0235		
7	-0.2504	-0.2476	17.174	0.0163		
8	0.1962	0.1051	18.821	0.0158		
9	-0.1314	-0.1080	19.597	0.0206		
10	0.0310	0.0682	19.643	0.0328		
11	-0.0461	0.0785	19.749	0.0489		
12	0.0533	-0.1269	19.899	0.0690		

Source: Author’s Computation (2014)

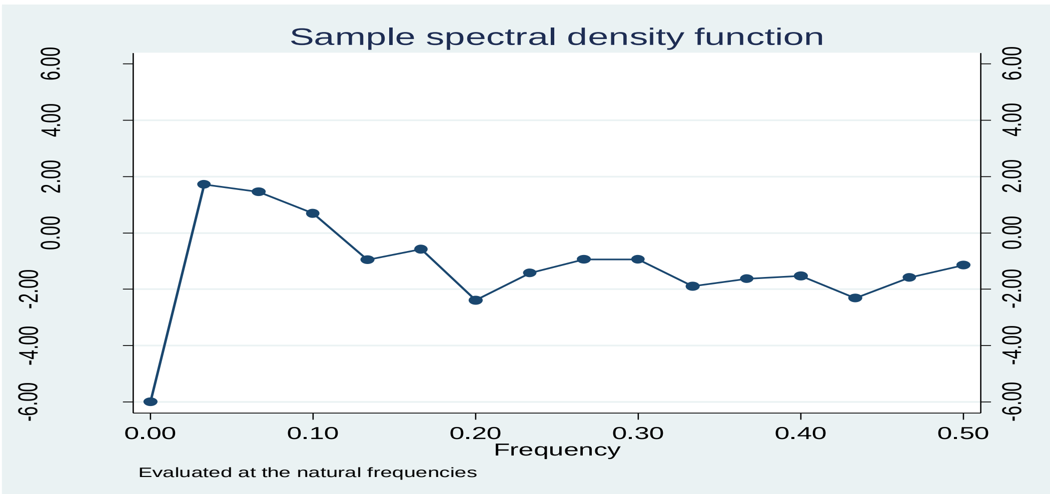
B2 (v) Correlogram of INLIVE

LAG	AC	PAC	Q	Prob>Q	-1 0 1 [Autocorrelation]	-1 0 1 [Partial Autocor]
1	-0.0716	-0.0728	.16473	0.6848		
2	-0.0734	-0.0791	.34419	0.8419		
3	-0.2564	-0.2750	2.6167	0.4546		
4	0.0290	-0.0160	2.6469	0.6185		
5	-0.0982	-0.1946	3.0083	0.6987		
6	0.1287	0.0198	3.6555	0.7232		
7	-0.0674	-0.1342	3.841	0.7979		
8	-0.0984	-0.2765	4.2556	0.8334		
9	0.0759	0.0098	4.5148	0.8744		
10	0.0165	-0.0888	4.5277	0.9204		
11	0.0531	0.0331	4.6687	0.9461		
12	0.0026	0.0386	4.6691	0.9681		

Source: Author’s Computation (2014)

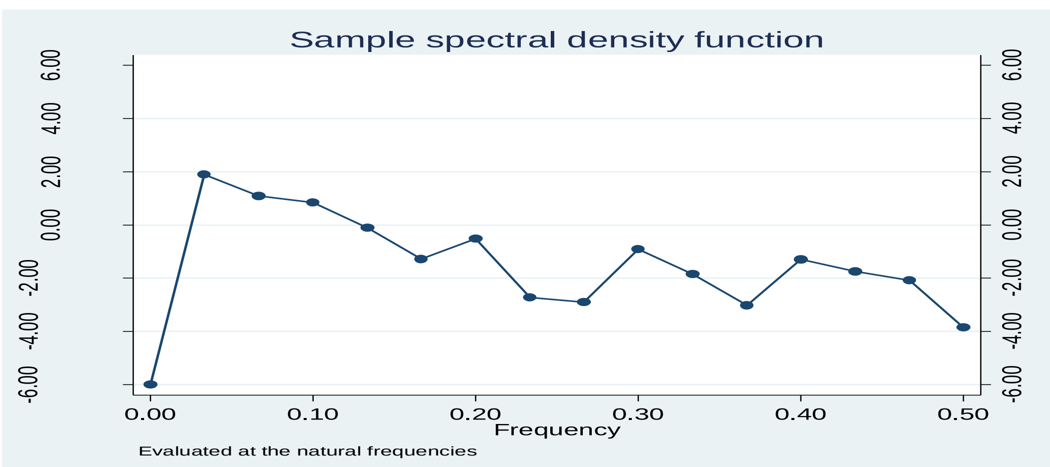
APPEDIX C: SPECTRAL DENSITY FUNCTION

C (i) Plot of spectral density function of INGDP



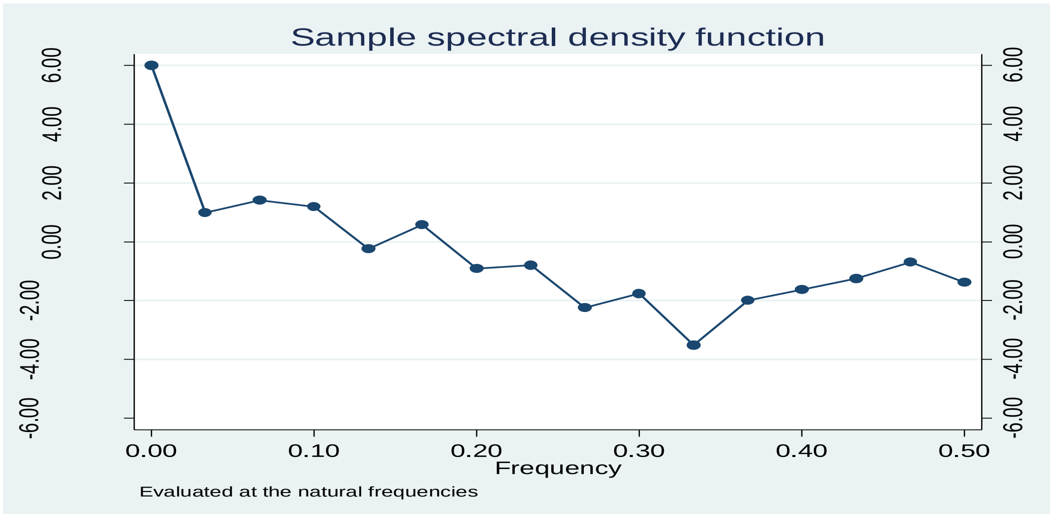
Source: Author's Computation (2014)

C (ii) Plot of spectral density function of INHORT



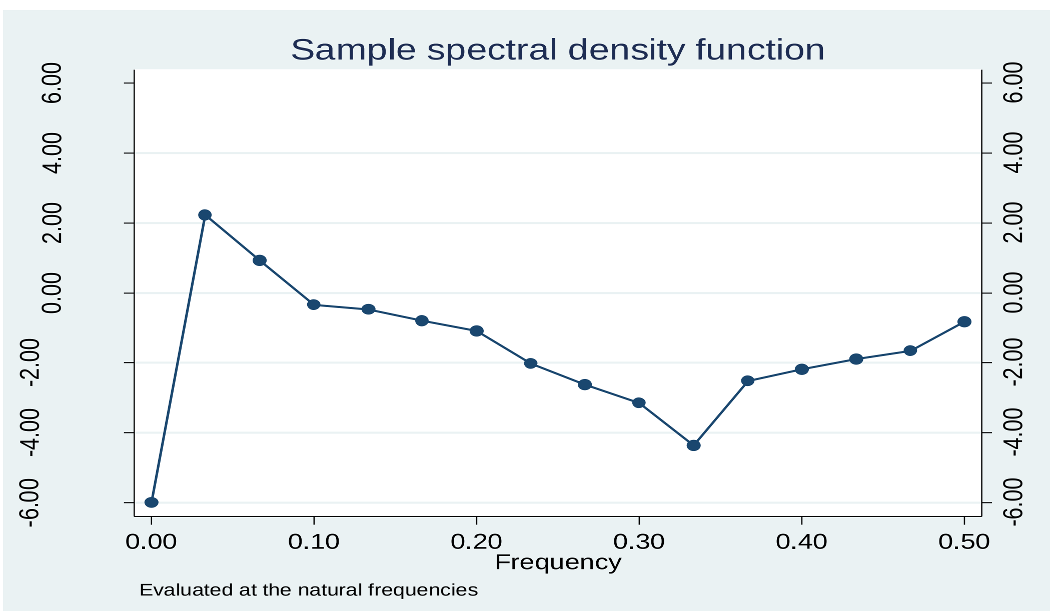
Source: Author's Computation (2014)

C (iii) Plot of spectral density function of INCROP



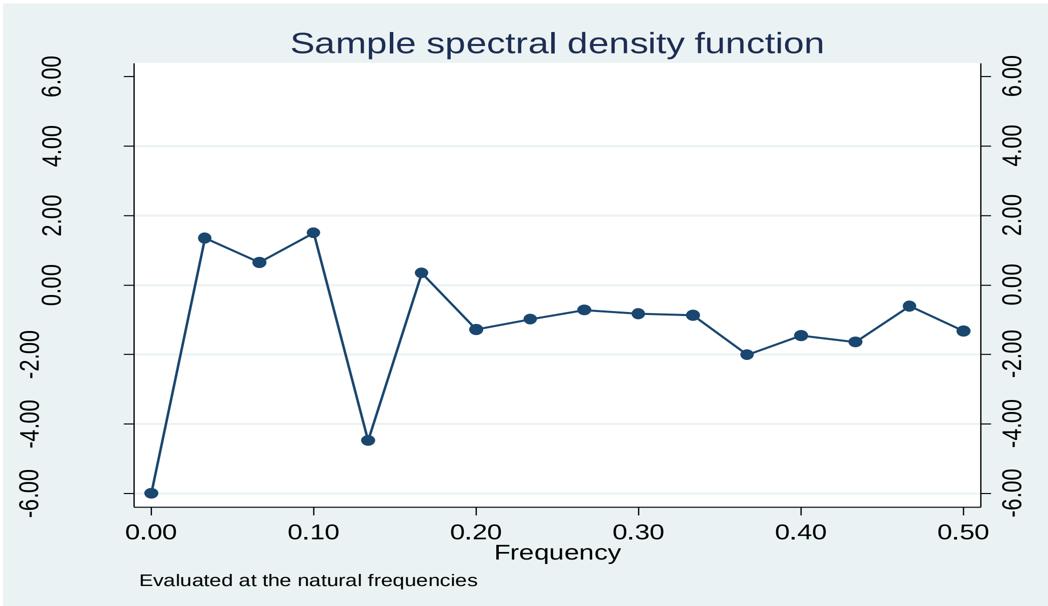
Source: Author's Computation (2014)

C (iv) Plot of spectral density function of INFISH



Source: Author's Computation (2014)

C (v) Plot of spectral density function of INLIVE



Source: Author’s Computation (2014)

APPEDIX D: COINTEGRATION RESULTS OF VECTOR ERROR CORRECTION MODEL

D (i) Cointegration relation one

Identification: beta is exactly identified
Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
INGDP	1	.	.	.	.	.
INHORT	3.47e-17	.	.	.	.	.
INCROP	(dropped)					
INFISH	-.1092167	.0298616	-3.66	0.000	-.1677445	-.050689
INLIVE	-.763303	.298542	-2.56	0.011	-1.348435	-.1781715
_cons	-2.536566	.	.	.	.	.

Source: Author's Computation (2014)

D (ii) Cointegration relation two

_ce2						
INGDP	-1.11e-16	.	.	.	.	.
INHORT	1	.	.	.	.	.
INCROP	4.44e-16	.	.	.	.	.
INFISH	-.1385325	.0767146	-1.81	0.071	-.2888904	.0118253
INLIVE	-2.740799	.766955	-3.57	0.000	-4.244003	-1.237595
_cons	19.25862	.	.	.	.	.

Source: Author's Computation (2014)

D (iii) Cointegration relation three

_ce3						
lnGDP	1.11e-16	.	.	.	.	.
lnHORT	-4.86e-17	.	.	.	.	.
lnCROP	1	.	.	.	.	.
lnFISH	-.0867877	.0261131	-3.32	0.001	-.1379684	-.0356069
lnLIVE	-.4918789	.261066	-1.88	0.060	-1.003559	.019801
_cons	-4.857069	.	.	.	.	.

Source: Author's Computation (2014)