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ESTIMATING THE SUPPLY RESPONSE OF KENYA'S SMALL-SCALE COFFEE PRODUCTION TO REAL PRODUCER PRICES

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DECLARATION

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

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DEDICATION

I dedicated this research work to my Family and to my Dad, Peter Owango, Mum, Rael and Brothers, Timon and Joshua who inspired me to study hard until I achieve the ultimate degree attainable.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACP – African Caribbean and Pacific Countries

ARIMA – AutoRegressive Moving Average

CBK – Coffee Board of Kenya

CBD - Coffee Berry Disease

CDF – Coffee Development Fund

CPI – Consumer Price Index

CRF – Coffee Research Foundation

D(LOG(AVR)) Average Rainfall

D(LOG(PRB)) Price of Beans

D(LOG(PRC)) Price of Coffee

D(LOG(PLY)) Government Policy

D(LOG(TECH)) Technological Advancement

EAC – East African Community

ECM – Error Correction Model

FAO – Food and Agriculture Organisation of the United Nations

GB - Great Britain

ICO – International Coffee Organisation

IMF – International Monetary Fund

GDP – Gross Domestic Product

GoK – Government of Kenya

KPCU - Kenya Planters Cooperative Union

KIPPRA – Kenya Institute of Public Policy Research and Analysis

MoA – Ministry of Agriculture

OLS – Ordinary Least Squares

SMI - Supplier-Managed Inventory

UNCTAD – United Nations Conference on Trade and Development

USA – United States of America

WTO – World Trade Organisation

ABSTRACT

Continued economic growth and reliance on small scale coffee productions has come under threat owing to the numerous fluctuations in price of coffee and marketing difficulties farmers face through the various marketing organizations. Coffee production in the country has also been observed to be on the decline. Estimating the supply response to real producer price is important in finding a solution to the problem of reduced coffee production. An understanding of coffee farmers' responsiveness to price and non prices factors is sought in this study so as to come up with appropriate policy formulation.

A review of literature was undertaken to serve the purpose of informing the extent of relationships between variables and previous studies evaluating small scale coffee farmers' responses to these factors. The study used secondary data to gather information that was analysed using the Nervlove model with the help of Eviews.

The analyses observed that all the OLS assumptions were met in order to carry on with interpretation of the findings. From the data analysed it was established that price of coffee, price of beans, technological advancements, and the amount of coffee production achieved had a positive impact on coffee output while, annual average rainfall and the changes in government policy were observed to have a negative influence on the area allocated for coffee production.

This study recommends that policy formulation be directed towards training the small-scale farmers to improve their skills. Adopting improved farming technologies and government support to farmers in terms of input subsides is also recommended as necessary policy measures in order to increase the small-scale farmers' responsiveness to price and non-price factors in their production process.

CHAPTER 1.0: COMMODITY TRADE: ESTIMATING THE SUPPLY RESPONSE OF KENYA'S COFFEE TO REAL PRODUCER PRICES

1.0 Introduction

This Chapter looks at the background of the coffee industry in Kenya and the policy context in which the industry operates. It includes description of the agricultural sector in general, the coffee sub-sector in particular in terms of production trend, export trend, aggregate performance of the sub-sector, the sector's role in the economy, coffee as a traded commodity, and policy developments that impact on the industry.

1.1 Kenya's Agriculture Sector

Kenya like most developing countries depends largely on the agricultural sector as the driving force behind its economic growth and the place of the coffee sub-sector in the economy cannot be fully understood without appreciating the wider agricultural sector. Kenya's agricultural sector performed satisfactorily during the early post-independent period up to around 1974 when it declined as a result of the 1973 international oil crisis and the drought of 1973/1974 (Republic of Kenya, 1975). This dismal performance by the sector was reversed around 1976/1977 when there was overall improvement in local whether conditions which favoured both livestock and crop production, including coffee. The terms of trade for coffee, particularly improved as a result of frost in Brazil which led to reduced supply and resulting increases in the international price as a result of excess demand. No significant improvements were observed in the 1990s in the backdrop of generally poor overall economic performance. Empirical evidence shows that there is a strong correlation between growth in agriculture and that of the GDP whereby

proportionate growth in the sector similarly results in proportionate growth of the economy.

Currently, the agricultural sector contributes about 24 per cent of the country's GDP and 60 per cent of export earnings (Republic of Kenya, 2007). Agricultural commodity exports alone, contributes about 24 per cent of the country's GDP and 60 per cent of export earnings (Republic of Kenya, 2007). The principal commodity exports of tea and coffee alone provided 21 per cent of domestic exports revenue in 2005 while the combined revenue from coffee and tea was KShs 51.993 billion compared to KShs 43.016 billion in 2004.

Additionally, through links with manufacturing, distribution and the service sector, agriculture indirectly contributes a further 27 per cent to the country's GDP while about 45 per cent of government revenue is derived from the sector as well. The sector contributes over 75 per cent of industrial raw materials and its contributions to the achievement of national food security, livelihood security and employment of the rural population at 80 per cent. From the foregoing, the importance of the agricultural sector in the domestic economy cannot be over-emphasized. However, despite the important role the agricultural sector plays in the economy, it faces a number of constraints and challenges chief, among them is the declining prices that affect production at the farm level. This situation similarly affects the coffee sub-sector, locally and internationally.

1.2. Coffee industry Kenya

As in most of Sub-Saharan African countries, the export structure of Kenya's export sector is predominantly composed by primary commodities, particularly coffee, tea and

horticulture. Indeed, these commodities have been historically the mainstay of the economy. Such structural composition of exports has made the sector to be more vulnerable to fluctuations in world prices (Were *et al,* 2002).

Coffee was introduced in the country in 1893 by the Scotland Missionaries in Bura in Taita Hills in Coast Province. Kenya largely produces mild Arabica type that is uniquely of high quality, largely attributed to inherent genetic characteristics of tree varieties, good agro-climatic and proper field and post harvest management practices. At independence (1963) production stood at 43,778 metric tonnes from a total acreage of 45,538. The industry experienced a phenomenal growth after independence, courtesy of Government and donor-supported programmes. Coffee is produced by small-scale growers and plantations estimated at 700,000 and 3,411 respectively with approximately 60 per cent of all the mild coffee produced coming from smallholders and 40 per cent from estates. Kenya coffee industry is highly dependent on external market. Over 95 per cent of the Kenya's coffee is exported. Domestic consumption of coffee is about 1,500 tonnes. Coffee growing therefore is an important economic activity impacting directly on the well being of millions of people. Coffee terms of trade have declined over the long-run and are currently less than half of what they were in 1963.

The importance of coffee as one of the main exported commodities is measured by its contribution to foreign exchange earnings, farm incomes, employment opportunities and food security. It is also the major source of livelihood security in the highly populated agro-ecological zones of the country where it is produced mainly by small-scale farmers. From available statistics, the crop is grown by approximately 600,000 small-scale farmers and 1,300 large-scale farmers spread across the country. Many households,

therefore, depend on coffee for employment and income as the sub-sector is not so capital-intensive like other sub-sectors. It is recognized that growth in coffee income has contributed immensely to the development in the coffee producing areas. In these areas, income derived from coffee sales have been re-invested in other farm activities such as stocking of farm inputs, food and grocery retail business, agro-processing and even informal activities that have provided the important link of agriculture to the rest of the economy. Thus the contribution of coffee to the provision of the basic needs of the rural population could be seen in terms of use of the accrued income to purchases of food and farm inputs geared towards increasing food production. Efforts towards promoting food production in the coffee growing areas have been traditionally enhanced by farmers' cooperative societies and unions in terms of providing inputs such as seed maize, fertilizers and pesticides.

Since the early years of independence, earnings from coffee helped to educate many of Kenyans. Thus coffee has played an important role in community capital formation (schools and colleges built with "harambee" contribution from coffee). Coffee growing is an important economic activity impacting directly on the well being of about 3 million people (coffee growers and their families).

1.2.1 Coffee in the National Economy: Economic importance of Coffee

Coffee has made significant contribution to foreign exchange earnings over the years since its introduction. The industry was the leading foreign exchange earner since independence until 1987/89 period when it was overtaken by tea before it was finally relegated to the fourth place by horticulture and tourism though it still as the third leading

export crop after tea and horticulture at 20 per cent of total agricultural foreign exchange earnings. In terms of overall foreign exchange earning, the industry currently contributes about 8 per cent of the country's foreign exchange earnings, a drop from a 40 per cent contribution in the good years. For instance, in 1978 when the Country's coffee sector was booming, coffee accounted for 9.5 percent of GDP at US $ 500 million in exports. This declined to a revenue level of US $ 75 million – a mere 0.6 percent of GDP (World Bank, 2005). Because coffee occupied a central place in the national economy, it was for many years referred to as "the black gold" for Kenya (Republic of Kenya, 2005). The dismal performance by industry has resulted in loss of jobs and income to families and consequently resulted to escalating poverty and insecurity in the coffee growing areas.

The coffee industry is dualistic in nature. There are both large and small-scale producers. The smallholders process and market their coffee through 330 co-operative societies while the estate farmers process their coffee in their own factories. Smallholder coffee production has declined persistently in the last decade. The industry has been a major employer, absorbing 400,000 permanent and 350,000 seasonal jobs but today it hardly can afford only about 210,000 workers. But because of its forward and backward linkages supports about 5 million Kenyans. At the household level, a large number of smallholder farmers directly engaged in coffee production and income from coffee accounts for a major proportion of total farm income in the coffee growing areas. These incomes have important multiplier effects in the national economy and more so in rural areas. The decline in coffee incomes therefore has a direct bearing on poverty in most coffee growing areas. Furthermore as coffee incomes are normally used to finance major household expenditures such as school fees, investments and health care which have

direct and indirect impact on child poverty and any decline in coffee production has consequences on rural poverty, particularly in the coffee growing areas as well as on the national economy.

It is considered therefore that the industry is still an important sub-sector of agriculture and coffee production has remained a highly emotional economic issue in the country. It is these contexts that it is considered a source of livelihood to many Kenyans as it plays a central role in the fight against poverty and as a source of food security.

The importance of the commodity is further emphasized by the fact that the country's fiscal budget depends on its export earnings. The industry also serves an important role in terms of equity a feat that cannot be matched even by the capital-intensive service sectors such as tourism.

1.2. 2 Production trend

Up to 1988, coffee production has been on a general downward trend. The industry recorded an all time high production of 128,926 metric tones in 1987/88 from an estimated acreage of 160,000 hectares (Coffee Board of Kenya, 2007) but the subsequent period was marked by a declining trend in production. The decline in production has been more pronounced in smallholder farms where it declined by 47 per cent during the period 1980 to 2005. Indeed, the smallholder average yields during the last one-decade were only half those realised in 1987/88. Again, smallholder coffee production declined by 66 per cent from 69,483 metric tonnes in 1990 to only 23,800 metric tonnes in 2000 (Republic of Kenya, 2005) while the estimated yield declined from 0.6 tonnes to 0.21 tonnes per hectare. For the same period estate production declined by 22 percent from

34,356 metric tonnes to only 26,743 metric tonnes and the estimated yield declined from 0.9 tonnes to 0.7 tonnes per hectare. The sub-sector, however, seem to be on a rebound. During the period 2005/2006, coffee production increased by 7 per cent from 45,200 tons in 2005 to 48,303 tons in 2006 as shown in Table 1 below. The increase was mainly attributed to increased production by smallholders whose share rose from 24,500 tons in 2005 to 27,046 tons in 2006 (Republic of Kenya, 2005). During the same period, the estates also increased production from 20,745 tons in 2005 to 21,257 tons in 2006. During the same period, exports of coffee increased by 2.6 per cent to reach 43,302 tons in 2006 from 42,196 tons in 2005, with the USA, Sweden and Germany being the major destinations. The export earnings also increased by 6 per cent from Kshs. 8.225 billion in 2005 to Kshs. 8.704 billion in 2006 representing the highest coffee export-earnings over a 5-year period (Republic of Kenya, 2007).

Overall, increase in production was attributed to improved crop husbandry following planned introduction of the Coffee Development Fund (CDF) from where farmers can now access credit for coffee development.

1.3 Coffee in the International Commodity Market

At the international level, coffee forms an important and integral part of the global economy and the international commodity markets represent a major outlet for developing country total sales. It is estimated that about 20-25 million families-mostly small-scale farmers-in more than 50 developing countries produce and sell coffee (Lewin *et al*, 2004). Integration into the world economy through commodity trade is important to the growth and development of the domestic economy. But commodity markets are

among the most volatile of markets and poor countries often suffer from this volatility most, first because of their heavy reliance on these markets, and secondly, because they are less able, due to shortage of finance and poverty, to adapt their sales to changes in demand and to vicissitudes of prices so as to maximize revenue and minimize losses. Furthermore, long-term demand for primary products expands less fast than the demand for manufactures and services, while supply shows a persistent tendency to over-production because of shortage of alternative employment opportunities in developing countries and in primary production (agriculture) generally, and because of insufficiency of skills for diversified production. Hence there has been a persistent tendency for prices of most primary products to fall in relation to prices of most manufactures, and this adverse movement in the terms of trade is one of the key unfavourable features with which developing countries have had to cope in the past seven decades.

Downward fluctuation and adverse trend have been fully at work since 1989, the year when the International Coffee Agreement also collapsed, and the developing world is now experiencing another collapse of commodity prices, which has brought them down, in real terms, to the lowest level since 1950, and, according to the Economist and World Bank analysts, over the last 100-150 years.

There was commodity slump between 1990 and 1991 and export commodity prices of developing countries fell about 20 per cent, according to UNCTAD, The World Bank and IMF indices, a speed of decline only slightly lower than during the slump in 1980-82, which triggered the international debt crisis and ushered "the decade lost for development." The Economist's index shows a decline of about 30 per cent between 1988 and 1991. In any case, prices of primary products in real terms are very much lower now

than they were in the early 1980s, and therefore any additional fall is felt with ever greater hardship.

As shown by available literature, in the context of international commodity trade, depressed prices have been common to most commodities, but unlike other commodities much attention has been focused on coffee. Being the single most important tropical commodity, accounting for almost half of total net exports of tropical products, coffee has become a symbol of the many problems faced by all developing country agricultural commodity exports (FAO, 2003). A key feature of the world coffee market has been the substantial short-term fluctuations in coffee prices, both at the level of international markets as well as markets relevant for coffee producers. This exposes producers to high levels of price risk. For example, price falls for coffee have been particularly dramatic in early 2000s: after a brief recovery in the mid-1990s when buffer stocks were finally cleared, real coffee prices had fallen by 2001 to levels lower than ever recorded. Indeed, in real terms coffee prices today are less than one third of their 1960 level, and for many producers less than the cost of production (FAO, 2003). This is what impacts on the 20-25 millions households in coffee producing countries, and indirectly upon up to a further 100 million engaged in upstream and downstream activities (Gresser *et al*, 2002).

In the international coffee trade, the International Coffee Organisation (ICO) operated a quota-regulation system until 1989. Since then production has risen dramatically and has remained over 100 million (60 kilogram) bags every year (Agritrade, 2007). From the available literature prices fell sharply to their lowest level in the period from 2002-2004, and recovered only partially thereafter. The price fall was not fully attributed to the over-supply but also due to subsequent move in the control of stock of coffee beans from

producer countries' coffee agencies to international traders based in consumer countries. Moreover, coffee trade is also becoming concentrated. According to Agritrade (2007), only two companies controlled 29 percent of the global market and six controlled over a half and by 2007, probably only three controlled around 45 percent. Coffee roasting is even more concentrated with two groups controlling 57 percent of the market for roasted and instant coffees, and the top five controlling 87 percent. This is further exacerbated by the implementation of SMI (supplier-managed inventory) which has meant tighter integration of international traders with private exporters, and the threat of marginalisation of small-scale producers in the developing countries, Kenya among them.

These arguments for the dramatic declines in the in coffee prices have been further reinforced by FAO (2003). These include the emergence of Viet Nam as a major producer and exporter, the depreciation of the Brazilian Real, "under-consumption", exploitation of market power by roasters and retailers, technological change in roasting, domestic market liberalization, and abolition of parastatal marketing agencies, among others. The collapse of the International Coffee Agreement and the policies implemented by the World Bank, the International Monetary Fund (IMF) and the World Trade Organization (WTO) has also been blamed for the coffee price crisis, too. However, the basic explanation lies in the market fundamentals of supply and demand. According to the Food and Agriculture Organization of the United Nations (FAO) price determination models, the operation of market fundamentals has not changed though it might be tempting to assume that such dramatic fall in prices must be due to some new factor or some change in market behaviour. It is specifically the recent rapid growth in global

supplies against sluggish demand growth which has led to falling prices, and the low price elasticity of demand means that these price falls are severe.

1.4 Challenges and Constraints Faced by the Industry

The coffee industry in Kenya has faced many problems. A key feature of the world coffee market has been the substantial short-term fluctuations in coffee prices as well as low prices that has a consequences on the producer price and production. Coffee growers in Kenya, like in other developing countries, have historically received a very small share of the export price of green coffee. One reason often mentioned in the literature is heavy government intervention in the sector (Krivonos, 2004). Coffee prices, for example, sharply declined from a high of about US $300 per 60kg bags to about US $60 per bag in 2001/02 and US $132 (2005/06) forcing the growers to either neglect or uproot their coffee bushes, or replacing them with more profitable enterprises. This, coupled with the volatility in international coffee prices has also made coffee earnings unpredictable. Price fluctuations are deemed to expose producers, especially the small-scale ones, to high levels of price risk. Though recent improvements in the international price of coffee provide some relief to small-scale coffee farmers and farm workers, the dynamics of the coffee market have not shifted in ways that guarantee long-term stability for those at the bottom of the supply chain.

Other major challenges and constraints facing the industry include, among others, are the escalating cost of production associated with the high cost of inputs, labour, transport, energy, exchange rate, inflation, rainfall and technology applied in the production process.

Lack of affordable credit, including lapses of Government programmes, negatively impacted on production of coffee due to small-scale farmers' inability to afford inputs such as fertilizers, pesticides and also to meet labour costs.

Poor infrastructure is an important factor in coffee production and marketing. The coffee producing areas, like many agricultural areas in the country, suffer from inadequate infrastructure in the form of electricity, clean water, roads and telephone, among, others. These infrastructures are vital to the efficiency in coffee production and marketing and without which, production and quality are negatively affected.

Weather conditions affect growth of the crop and yield. Excessive rains have been known to predispose coffee crop to certain diseases such as the coffee berry disease which not only reduce the yields but also destroy the bean quality. The effect of droughts is to reduce yields and bean quality as a result of the coffee rust disease which is more prevalent during the dry spells.

Inadequate extension service is particularly a big challenge to coffee production among the small-scale farmers. Training of agricultural extension workers by the Government has declined in the recent years as a result of progressive liberalisation of the agricultural sector since 1992 and limited funding, among others. Furthermore, the available training is not specialized and focuses more on general agricultural extension and not coffee extension.

Poor Governance in the cooperative societies which provide the institutional infrastructure, especially for coffee marketing, is regarded as one of the major dis-incentives to coffee production in the recent years. Allegation of corruption among the

management staff of such societies is partly blamed for the declining returns to farmers as un-necessary deductions are made on the earnings in the face of reduced societies' capital base which affect credit availability to farmers.

High industry's indebtedness is another major challenge. The indebtedness is closely associated with the mismanagement in the industry as individual societies accumulate debts arising from poor investment decisions and alleged outright theft by management.

1.5 Recent Reforms in the Coffee Industry

1.5.1 Introduction

Various policy reforms have been undertaken to revitalise the coffee industry in Kenya. The reforms targeted improvements in farmers' incentives and their control of the industry's affairs. The reforms were also aimed at adressing specific challenges facing the coffee indusry and more so the small scale farmers. Some of the reforms targeted include intensification of production in high potential areas in the wake of diminishing land availability, enhancement of yields in small-scale farms and diversification of coffee production through introduction of new yielding varieties and increasing quality in the production process.

1.5.2 National Level

To address some of the challenges and constraints at the national level, the government has been implementing different policy reform measures in the coffee sub-sector since 1992 at the advent of liberalization of the agricultural sector with the principal objective increasing incentives for the beneficiaries – the farmers, especially the small-scale ones- and also to deepen ownership among the stakeholders. The Coffee Act (Cap 333) is the

overall legal framework guiding the coffee industry and which provides for its regulation and control over production process, marketing and export of coffee and associated issue through the supervision of the Coffee Board of Kenya (CBK). Within the framework of the Act, the reforms in production, processing and marketing have been implemented gradually in phases to avoid unnecessary disruption in the supply chain (Karanja *et al*, 2002). In 1992, for example, the government mandated the Coffee Board of Kenya to undertake coffee auction at the Nairobi Coffee Exchange using dollars, which gradually gave way to payment of farmers in US dollars. Subsequent reforms led to the licensing of three more millers in 1993 in order to engender competition in the milling of locally produced coffee by breaking the monopoly status of the Kenya Planters Cooperative Union.

Implementation of the reforms has since reduced the role of Government in the management of coffee co-operative societies through the enactment of the Cooperative Act (1998) and which has since been amended further as Co-operative Act (2002).

However, the reform programme for the sub-sector was put on the right path when the government formulated the policy on *"Liberalisation and Restructuring the Coffee Industry"* through the *Sessional Paper No. 2 of 2001* and the enactment of the Coffee Act, No. 9 of 2001 which came into force on the 25th March 2002. The policy envisaged a vibrant, efficient and effective industry, by addressing various policy measures that would lead to, among others, increased production, higher returns to the growers, sustainable credit facilities, effective research and extension services, and privatization of coffee marketing.

But a major concern in the liberalization of the coffee industry, however, was the need to harmonize the legal framework with the policy reforms (Nyangito, 2001). In the course of implementation of the Act, it was realised that it was not in harmony with the policy. Specifically, some sections of the Act were found to be restrictive and contradictory to the spirit of a liberalized coffee industry thus limiting the achievement of the policy objectives as were envisaged. In broad terms, the need for the legal framework to allow institutions hitherto involved in controlling and regulating the industry to fit in well with the new policy changes, became self-evident. The new Act (2002) was thus intended to harmonize the policy reforms, legal and institutional frameworks within the sub-sector.

Institutional reforms led to the restructuring of the Coffee Board of Kenya to encourage all beneficiary participation, especially the private sector, to encourage competition not only in milling but also in the provision of extension services, marketing and making payments to farmers (Nyangito, 2001). It was in this context that the direct coffee sales were introduced to complement the central auction where coffee is sold to the highest bidder (as provided for in the Coffee Act, 2001). The direct coffee sales provided the second window for coffee marketing where, individual growers, cooperative societies, estates and millers can sell their coffee directly to buyers abroad or exporters without going through the auction (MoA, 2005). It was anticipated that through this new arrangement cooperative societies and estates would be able to realize better prices.

As part of the harmonisation of the reforms, the Government supported strengthening of extension services and capacity building in cooperative societies and coffee research through recruitment of additional staff as well as allocation of additional funds to increase extension outreach and methods in order to increase production. Furthermore,

increased funding for capacity building in coffee cooperative societies to improve management was also a major aspect of the harmonisation process. Strengthening research through additional funding to the Coffee Research Foundation (CRF) to provide high quality planting materials in collaboration with the Kenya Plant Health Inspectorate Services (Kephis) was also integral to the reforms in the industry.

The reform train also envisaged the establishment of Coffee Development Fund (CDF) under the Coffee Act, 2001, to finance the industry. Under the Act, the CDF is to be managed as a revolving fund to finance farm development, farm operations, price stabilization, capacity building in the cooperative societies, and factory modernization.

The harmonization process also called for the restructuring of the Coffee Board of Kenya (CBK) and the Kenya Planters Cooperative Union (KPCU), the key institutions in the coffee industry. It was envisaged that the success in revitalizing the coffee sub-sector will depend on how efficiently and effectively these institutions will provide the services. The CBK is the industry regulator, formulating coffee policies in close consultation with the Ministry of Agriculture. Additionally, the CBK is also charged with promotion of production, processing, marketing and provision of advisory services related to production and quality improvement. On the other hand, KPCU is a farmers' organisation initially established to undertake bulk purchasing and stocking of essential agricultural inputs for reselling at competitive prices to its members. The Union also receives and mills coffee parchment on behalf of farmers. KPCU's range of services, however, has since diversified to marketing, auctioneering, dealing, roasting, warehousing and export. The challenges and demands of liberalization have affected the provision of these

services by the two institutions which calls for their strengthening in order to enable them play their roles effectively.

Amendment to the Coffee Act, 2001, thus became one of the most important measures to effective harmonization of the industry's operations. According to the industry stakeholders, the amendment of the Act was necessary in order to accommodate changes such as direct sales, collection of statutory levies, operationalisation of the Coffee Development Fund (CDF), and to preclude any farm-gate trade of any form of coffee and to provide for sufficient safeguard measures for the farmers coffee. The Act was published as the Coffee (Amendment) Bill 2006, which is still with the Attorney General's office and is therefore yet to be enacted.

The government introduced more policy measures such as direct sales of coffee beans alongside the time-tested coffee auctions, establishment of the Coffee Development Fund to provide sustainable and affordable credit to farmers, particularly the smallholder farmers, debt relief to cooperative coffee farmers to the tune of Kshs. 3.2 billion (about US $ 48,500,000 million), and revamping of farmers' institutions such as the agricultural training centres, the Agricultural Finance Corporation (AFC) and the Kenya Farmers Association (KFA) in order to address them. The development of CDF organizational structure and staff establishment, including recruitment of management staff; development of Coffee credit administration policy; and the publication of the Coffee (Amendment) Bill, 2006 Gazettment of Coffee (General) (Amendment) Rules, 2006.

Under the direct sales, the Coffee Board of Kenya (CBK) initially licensed forty three (43) marketing agents out of which twelve (12) were commercial while thirty one (31)

are grower marketing agents. The introduction of the direct sales injected some competition in the marketing of coffee which led to a noticeable improvements in prices offered at the auction. Through direct sales better prices are being realized than under the Auction system.

Despite the positive outcomes of the reform measures, particularly in the processing and milling, there is still concern by some of the industry stakeholders that Coffee Board of Kenya remains a regulatory agency that also controls export marketing by appointing coffee brokers at the auction market while regulating the activities both the brokers and buyers at the same time. The Board also receives the farmers' proceeds from exported coffee which it later remits to them through the farmers' marketing agents. Despite the initial benefits, the direct sales came with its new challenges, including the organizational time lags by the newly licensed marketing agents in terms of logistics and finances, time requirements for the marketing agents to identify appropriate overseas markets and to address challenges of development of negotiation skills, identification, development and consolidation of markets and market access opportunities, among others. The expectation of the in industry is that the direct sales would properly pick up after some concerted efforts on overseas marketing to get buyers are undertaken by the key industry stakeholders.

1.5.3 The Global Scene

At the global level, various responses have been suggested to stem the price crisis facing the coffee industry. In the past, chosen policies in response to price declines and variability relied on market interventions to maintain prices within agreed ranges. The

interventions were essentially in the form of export supply management through regulations or buffer stock schemes. For their impact on producer welfare, the policies are in general regarded as unsuccessful. The cost of reduced volatility seemed too high, given that the administered prices usually were far below the certainty equivalent that would be accepted by producers (Krivonos, 2004). From time to time there is talk about producer cartels as a solution to low and variable coffee prices, but too many sources of supply negate the scope for successful supply control (Maizels et al., 1997). Nevertheless, interest in supply management shall persist, but mainly for the purpose of raising prices rather than as a solution for price variability.

Other suggested solutions to the crisis have included demand promotion, guaranteed prices, product differentiation, support for diversification(and trade liberalization to provide opportunity for diversification, vertical integration through the value chain, raising the profile of commodity problems in international for a, fair trade initiatives and even grower support funded by a windfall tax on roasters. However, very little attention has been paid to the effects that measures suggested to solve the international "coffee crisis" as reflected by price will have on the supply side, despite the fact that microeconomic theory predicts that a reduction in demand will lead to a lower equilibrium price for a given level of coffee output. The difficulty with many demand side approaches is that they ignore their impact on the farmers whose livelihoods depend on coffee.

The objective of this paper is to estimate the supply response of Kenya's small-scale coffee production to real producer price which takes care of the international price

variable. Specifically, the study covers the period 1971 to 2005, and estimates the supply elasticities of coffee using the Nerlovian Partial Adjustment model.

1.6 Problem Statement

Real producer price received by coffee farmers (farm-gate price) is known to be one of the major factors affecting coffee production. High short and medium-term price expectations can lead to higher coffee production from existing coffee bushes. The converse happens when the prices decline. The planting of new coffee bushes and/or the rehabilitation/substitution of existing crops is related to the long-term price expectations as long as land is not a binding constraint. Low prices can induce resource poor farmers to forego investments in such husbandry practices as prunning, weeding, spraying aginst pests and diseases thus compromising future production potentials. According to Branchi et al (1999), "the relevant price for the producers' decision to increase or decrease their supply of coffee is the real price they receive, that is the purchasing power that can be be obtained by the sale of one unit of coffee".

Thus estimating the supply response to real producer price would be important in finding a solution to the problem of reduced coffee production. Further, this might provide crucial information for policy.

1.7 Objectives and Hypothesis of the Study

1.7.1 Objectives

Commodity related sectors carry a greater weight in Kenya's trade balance. The general objective of this study is to assess the implication of real producer price on Kenya's small-scale coffee sub-sector.

The specific objectives of the study objectives of the study are:

(i) To estimate the long run hectarage (supply) under coffee production by small-scale farmers to real producer prices;

(ii) To examine the influence of non-price factors (whether/rainfall, output, policy and technology) to changes in area under coffee cultivation;

(iii) To make policy recommendations based on the results of the Study.

1.7.2 Justification of the Study

Understanding how coffee respond to real producer prices (transmitted from the international market to the farm-gate) and how factors (both price and non-price) such as input prices and rainfall influence farmers decisions on the total land they put under production cannot be over-emphasized if policy reforms must have effect on the aggregate quantity of coffee produced by the small-scale coffee farmers. Given the importance of coffee exports to the country, the decline seen in the coffee industry dictates the need to examine the real producer price factor in influencing local supply. Coffee is now ranked fourth at 8 per cent of the total foreign exchange earnings after tea,

tourism and horticulture in terms of foreign exchange earning to the country, a drop from a 40 per cent contribution in the good years. With a crop of such significance for the country, the destabilizing effect of the price crisis sparks concern on decreases in acreage under coffee production as well as falls in export revenues will reduce the country's ability to meet its fiscal needs. Moreover, the industry directly supports a significant number of people, estimated at approximately 5 million.

Whilst studies have analysed the supply elasticity of agriculture in several countries, for example, in Tanzania (McKay *et al*, 1997), tobacco in Zimbabwe (Leaver, 2003), Grains in USA (Ray, 2000), beef in South Africa (Ogundeji, Oyewumi and Jooste, 2007), and Australia, among others, limited similar studies have been conducted using lagged acreage response or co-integration analysis, with respect to the coffee industry in Kenya.

Furthermore, the ever changing policy environment and the limited studies on supply response of coffee farmers to price and non-price incentives in their production process, this study attempts to fill the information gap and add value to the existing body of evidence on supply response of export crops in the country.

As a result, the questions being addressed are:

1. What is the nature of response of coffee farmers to changing real producer price factor in Kenya from 1971 to 2005?

2. How does substitute crops affect expansion of coffee production, given that the need to grow alternative crops in order to address food/and or financial security could already be competing with coffee production?

3. How do the non-price factors such agro-climatic conditions and policy measures affect expansion of land under coffee production?

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

This chapter reviews literature on previous studies on supply response with respect to coffee and other agricultural commodities. Sources of literature include books, periodicals, journal articles, conference papers, unpublished papers – working papers, discussion papers – and book chapters. This is to bring about understanding how the previous studies on supply response relate to this study, for example, in terms of similarities and differences in approaches, findings and methodologies, inadequacy of evidence, apparent contradictions or inconclusive evidence or unsatisfactory methods of analysis.

2.1 Review of Theoretical and Emperical Literature

Agricultural response represents the agricultural output response to changes in agricultural prices, generally understood best as agricultural incentives. In this respect, supply response measures the degree to which the level of production and/or marketed surplus changes in response to stimuli provided by changes in some important variables, mainly prices (Nkang *et al,* 2006). Such response attempts to explain the behaviourial changes of producers with respect to the production, consumption and exchange decision of a certain product or set of products due changes in economic incentives. In this context, therefore, the size of agricultural supply gives clue on the effect of policy on agriculture sector – whether a policy of taxing agriculture through lower farm prices or through over-valued exchange rates and industrial polices will generate resources for investment in other sectors of the economy or whether such policies will retard

agricultural growth and create food and input bottlenecks which eventually brings down the rate of growth of the economy (The World Bank, 1996). From different studies, the vexing question that arises from the foregoing is: to what extent is the discrimination against agriculture hampers economic development given that the sector accounts for a significant share of total GDP in developing countries such as Kenya? Invariably, the answer to this question depends largely on whether a dynamic response of agricultural supply can be expected with positive incentives.

A basic assumption underlying agricultural policy measures is that both supply and demand are responsive to changes in commodity prices. Others argue that when prices are high, we expect crop acreage to increase and consumption to eventually decline. Conversely, when prices are low, we would expect planted acreage to decline and usage to be stimulated (Ray, 2000). Furthermore, in estimating the price elasticity of supply, the real value added is the most comprehensive price variable as it captures changes in producer prices, intermediate costs, real exchange rates, and world market prices (Thiele, 2003). Thus in many public policy debates price signals are seen as key to sufficiently overcome market disturbances.

From purely a theoretical standpoint, supply response assumes that economic agents, notably, farmers respond to the relevant price and non-price factors or variables and could be categorized in three different groups (Nkang *et al*, 2006). The notion of the first group is founded upon the neoclassical theory that postulates that there is perfect competition in the market; prices are the most efficient means of information; and that adjustment is fairly smooth through price signals. The second group views the unavailability or poor non-price incentives associated with structural rigidities in less

developed economies as the cause of irrational response of the agents to price signals. Quoting the World Bank, Nkang *et al* (2006), cites inadequate infrastructure, poorly functioning markets, rudimentary industrial sector, and severe institutional weaknesses in the public and private sectors as the key non-price factors that impede smooth supply response of agricultural commodities to economic reforms in Sub-Saharan Africa with the consequence of policy bias against agriculture in many developing countries.

Finally, the third category concurs that the simultaneous nature of response pattern of economic agents is due to price and non-price factors as is affirmed by the Nerlove model of adaptive price expectations and partial adjustment which make use of both price and non-price factors as important determinants of farmers supply response.

Agricultural supply response can be analysed empirically in different forms. In most studies, aggregate output/supply, sub-sectoral output (such as crop output and livestock output) and individual crop output, for example, coffee or based on time-series data, and mostly use the Nerlove (1958) devised for single commodities or the method developed for aggregate supply response (McKay *et al*, 1997). Agricultural output can also be captured in terms of (a) acreage or area under cultivation; (b) yield or product per acreage unit; and (c) product of acreage and yield. Over time, alternative time series approaches have been developed such as co-integration analysis, dynamic general equilibrium models and cross-country regressions.

The Nerlove model has been variously described as famous and the most successful econometric model (Michael Braulke, 1982). The model hypothesizes that farmers react in terms of price expectations and/ or partial area (or production) adjustments (Askari *et*

al, 1977). The model accommodates delays in response to price movements (Ogundeji *et al*, 2006). However, it is worth noting that the Nerlove model (1958) was devised for single commodities. The model is also a partial equilibrium as it does not model the non-agricultural sector and thus implicitly assume that the interactions between the two sectors are insignificant although sometimes a non-agricultural relative price may be included. The model has extensively been used in empirical analysis of dynamic supply responses, especially in agriculture (Rudaheranwa *et al*, 2003). The model involves a one stage procedure and directly regresses production on prices and other relevant variables. It describes the dynamics of agricultural supply by incorporating price expectations and/or adjustment costs. The model makes some basic assumptions that: (1) the dynamics of supply is driven by price expectations only and price expectations are generally assumed to be adaptive; and (ii) adjustment costs can also cause lags in the supply response of output to price and non-price changes.

It should be noted that most studies on aggregate supply response ignore farmers' price expectations and concentrate on the partial adjustment hypothesis, where actual change in output, say $\mathbf{A_t}$ from $\mathbf{A_{t-1}}$, is only some fraction of the actual change required to achieve the optimal level (say $\mathbf{A_t}^*$). Here, the expected price is the lagged price.

But the adaptive price expectations and the partial adjustment hypothesis result in the same dynamic specification. This is one difficulty of the model: when both partial adjustment and adaptive expectations are present, it becomes impossible to distinguish between their respective coefficients, and, unless certain (arbitrary) restrictions on one or other are imposed.

The supply function of the Nerlove partial adjustment model has a general form:

$$\mathbf{Ln\ A^{*}_{t} = a_0 + a_1 \log P^{R}_{t-1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where A^{*}_{t} denotes the desired output/hectarage at time t and P_{t-1} the output price at time t-1. The dynamics of the supply are captured by the following equation:

$$[\ln A_t - \ln A_{t-1}] = \delta\ [\ln A_t^{*} - \ln A_{t-1}] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where A_t is actual output/hectarage and δ is the partial adjustment coefficient. From equation (2), adjustment costs imply that the actual change in output/hectarage between two periods is only a fraction of the change required to achieve the optimal output level/hectarage A_t^{*}. Substituting (2) into (1) and rearranging gives:

$$\ln A_t = \delta a_1 + \delta a_2 \ln P^{R}_{t-1} + (1-\delta)\ln A_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Where δa_2 and a_2 are the short-run and long-run price elasticities of agricultural supply, respectively. Variants of function (8) are normally estimated in the applications of the Nerlove method. From Thiele (2000), additional control variables such as a time trend serving as a proxy for the impact of technological change on output are included.

The Nerlove has faced a number of criticisms. Considering the issues of application of the method, certain authors have argued against using time-series data in estimating long-run elasticities, because only short-run year to year fluctuations are observed. The output response to annual fluctuations is likely to be small (even after full adjustment) because farmers will respond strongly to price changes if they are perceived to be permanent. The studies which have employed it found low values, or zero long-run price elasticities of agricultural supply, ranging between 0.1 and 0.30 as shown by other previous studies for

a number of countries (McKay *et al*, 1997). The method is seen as assuming that the difference between current and long-run planned outputs is eliminated, thus implying that farmers are not forward looking in their production decisions. The method is also seen as lacking capacity to measure the effect of non-price factors such as rural infrastructure and credit (Ogundeji *et al*, 2006). This implies that the long-run elasticity estimates from time series data are biased downward. Similarly, Schiff and Montenegro (1995) argue that the long-run supply response to prices is properly evaluated when the transition to a new price regime is detected. Therefore, even though empirical results with the Nerlovian models have been regarded as satisfactory, the theoretical basis, in particular, the idea of fixed targets, is not strong (Ogundeji *et al*, 2006). Any permanent change in price policy affects the decision rules and thus any results drawn from past observations become obsolete. In other words, the values of the parameters estimated from time series data are specific only to a given policy regime, so one cannot forecast the impact of a policy reform. But while this is strictly true, the view is taken that long-run elasticities derived from a time series analysis are at least indicative and, while we do not forecast, we infer that if there is evidence of a long-run response, reforms that enhance the ability of farmers to respond may increase the long-run price elasticity further, so promoting increased growth in agricultural output.

In a study on sugar supply response to world price dynamics (Ramulu, 2005) in Andhra Pradesh, India, using the Nerlove lagged adjustment model, the results indicate that the level of responsiveness of exports to price changes is positive and significant for prices expressed in national currency and US Dollars. The influence of relative price is significant in affecting acreage under sugarcane production. This positive price-acreage

relationship means that with positive price changes, the production of sugarcane might increase considerably. The study also found that changes in sugar production that could result from a variety of reasons such as weather variations, use of cane, domestic production structure, are four times more important in determining the level of exports than changes in export prices.

Leaver (2003) in measuring the supply response function of tobacco in Zimbabwe, using the logarithmic form of the Nerlove model with ordinary least squares (OLS) found that price lagged one period and output lagged both one and two periods, and the simple time trend exert a positive influence on tobacco production. Using the sales quota dummy, rainfall dummy and quadratic time trend variable, she found out that these variables exert a negative influence on tobacco output. According to the study, the negative coefficient of the quadratic time trend variable implies that unspecified effects were causing tobacco output to increase, although at a decreasing. According to the study, about 96 percent of the variation in Zimbabwean tobacco output is explained by these variables. However, both the short-run and long-run supply elasticity fell in the inelastic range, indicating that Zimbabwean tobacco farmers are relatively unresponsive to output prices. The study attributes this to the extent of the domination of the tobacco industry in the national economy which raises the likelihood of policy intervention changing the entire structure of the economy. Specifically, the study identifies the high fixed capital costs of infrastructure necessary for tobacco production as the reason why Zimbabwean tobacco farmers are so unresponsive to price. This means that the tobacco farmers would keep growing tobacco even with significant price decreases because of the perceived lack of viable alternative.

Many other similar studies have been done elsewhere on different crops. Ray (2000) in the study, "Agricultural Price Experiment: What have We Learned in Four Years?", with respect to the 1996 United States Farm Bill, commonly known as Freedom to Farm whose main objective was to determine price responsiveness of farmers argues, like others before him that indeed, in the case of grains, production response to grain price changes is really acreage response. While the yield portion of the production identity is affected by price-induced changes in input application per acre, the major near term factor influencing yield is weather, which is out of the hands of the farmer. Therefore the farmers' greatest opportunity to change production levels is via acreage decisions.

In understanding agricultural supply response, Ogundeji *et al* (2006) used the error correction approach to study the beef supply response in South Africa on economic (price), climatic (rainfall), and demographic (population) time series. The estimated long-run supply elasticities were found to be significant at 1 per cent level as was expected. The cattle farmers' response to economic factors was captured by the producer price. The result showed that farmers, being rational in economic decision making, are aware of and respond to changes in economic environment. The long-run producer price elasticities were found to be significant at 5 per cent level. This was explained by the study that cattle farmers respond to change in climatic conditions and the period of dry spells coincides with increased slaughtering of animals to avoid the high cost of keeping them due to poor conditions of pasture. However, the short-run effect of both cattle population and producer price were found to be insignificant using the error correction model. The study aptly attributed this to the breeding system of cattle and age distribution of the cattle population which cause slow rate of biological reproduction. The short-run effect

of rainfall was found to be significant at 1 per cent level confirming the high rate of responsiveness of beef production to climatic factors. The policy effect was also found to be significant meaning that, for South Africa, deregulation policy implemented affected beef production in the short term.

Agricultural supply response using co-integration analysis has also been used by McKay *et al* (1997) in a study on the aggregate export and food crop supply response in Tanzania. They pointed out in their study the inherent theoretical and empirical problems in traditional supply response models such as the Nerlove and Griliches techniques which seem unable to give an adequate clear distinction between short-run and long-run elasticities while the use of OLS produce spurious results. For the Tanzanian case the McKay's study, based on the econometric estimates, suggests that the potential for agricultural sector response to liberalization of agricultural prices and marketing may be quite significant: the performance of export crop production (measured as official purchases), in both the long-run and short-run, could be fully explained by secular downward trend. The dominance of the trend prevented estimation of price elasticities, although the trend in production was in line with that in prices. According to the study, the failure to find a short-run response is consistent with the time lags inherent in export crop response, as many of the major crops are perennials. Indeed, the results indicated higher price elasticities of supply than suggested by previous studies. The results suggested that Tanzanian farmers were quite responsive to prices with a short-run elasticity of aggregate output of 0.35.

According to the same study, the behaviourial assumptions of the Nerlove model were by no means satisfactory while estimating supply response using the Griliches model was

considered not feasible given the data requirements. For food crops, McKay *et al* (1997) obtained a high price elasticity of supply close to unity (most ranging between 0.1 and 0.50) while demonstrating that the dynamics of supply are, indeed, more complex than suggested by the Nerlove method by estimating significant coefficients for some differenced variables. But Thiele (2000) quoting Krueger *et al*, argues that the relatively high long-run supply elasticity for food crops does, however, not necessarily reflect a high aggregate agricultural supply response which would lend support to the hypothesis that appropriate (direct and indirect) price incentives alone would not foster agricultural development, that is, the price elasticity of supply is high. The high long-run supply elasticity may be the result of a substitution between food crops and export crops. But employing error-correction approach, Alemu *et al*, (2003) estimated long-run price elasticities for grains in Ethiopia and found these to be positive and highly significant though inelastic (the long-run elasticities ranged between 0.05 to 0.51) and comparably low like for the estimates for other Sub-Saharan countries as with the McKay study.

Employing the ARIMA estimations of expected prices and yields, Narayana *et al* (1984) used the Nerlovian response to estimate the supply response for large and small farms in Kenya. Results of their analysis show that (expected) yield levels, rather than expected prices affect small farms, whereas large farms react more strongly to prices.

The model has also been used in another empirical analysis of Kenya's export performance which examined broadly the factors that have influenced Kenya's export volumes by disaggregating total exports of goods and services into three categories of traditional agricultural exports (tea and coffee) and other "goods and services" where exchange rates are used but only as a proxy to relative prices (Were *et al*, 2002). In this

study, however, the supply response to price incentive (real exchange rate depreciation) for exports of goods and services was found to be significant. Investment as a proportion of GDP used as a proxy for supply constraints had a positive and significant impact on the export volumes of coffee but for export volumes of other goods and services.

In looking at the African coffee exports in a comparative perspective, Branchi *et al* (1999) analyses the impact of price policies on coffee production and exports in a selected group of developing countries, with particular focus on a select group of Sub-Saharan coffee exporting countries. The study argues that due to the dependency of coffee producers on the vagaries of the international market, direct crop taxation and exchange rate policies in these countries are found to be only partially endogenous. But when the long-run impact of policies on producers' behaviour is tested by means of a cross-country linear regression model, about one third of cross-country variability in planted areas was found to be attributable to exchange rate and, to a lesser extent, taxation policies. However, price policies do not appear to exert any significant impact on yields. No parametrically significant difference between sub-Saharan Africa and the rest of the world emerges from the analysis. The results show that, in the case of coffee, the weight of domestic price policies in determining production and exports is relevant, but should not be exaggerated, as most of the cross-country variability in performance in the coffee sector is in fact related to non-price factors, some of which can be modified by strategic non-price policy interventions.

2.2 Overview of Literature

The importance of the issue of agricultural supply response in the developing countries like, Kenya lies on its impact on economic growth, poverty and the environment. Since Lewis in 1954 (Kirkpatrick *et al*, 2004), one of the most influential policy prescriptions for the low-income countries ever given by development economists has been to foster industrialization by withdrawing resources from agriculture (Thiele, 2000). There is, indeed, evidence that the majority of policy makers followed this prescription at least until the mid-1980s. Quoting the results of a comprehensive World Bank study (Krueger *et al*, 1992), the study indicates that for most countries studied in the period 1960-1985 taxed agriculture both directly via interventions in agricultural markets and indirectly via over-valued exchange rates and import-substitution policies. Such policies have since been considered as acting as disincentives to agricultural production hence the sector's growth and development. As a response, most developing countriesadopted structural adjustment programmes which were aimed at removing the direct and indirect discrimination against agriculture. Kenya adopted the programmes from 1992 starting with the agricultural sector.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter introduces the basic estimation for agriculture supply response in this study using the partial equilibrium framework known as the Nerlovian partial adjustment model/mechanism with a co-integration analysis.

3.1 Conceptual Framework

Majority of the studies on the aggregate supply response have applied the Nerlove model which involves the estimation of a partial adjustment model for a particular country (Thiele, 2003). From literature, it has been found that the majority of such estimates result in low, or even zero long-run price elasticities of agricultural supply with potential of the estimates being downward-biased due to the restrictiveness of the specification of the dynamics of supply in a restrictive way. The limitations posed by the Nerlove method have resulted in different options of estimating supply response. One option involves estimating the supply elasticity for a cross-section of countries rather than single country over time. The other option is to use the co-integration analysis to overcome the restrictive nature of the Nerlove method.

Co-integration analysis does not impose on the short-run behaviour of variables and only requires a stable long-run equilibrium relationship. This implies that there exists a linear combination of variables that is stationary even though each single variable may be non-stationary. Testing of co-integration, quoting Thiele (2003), normally involves two main

approaches, that is, (i) the estimation of a static model where all variables enter in levels and (ii) the estimation of an error correction model (ECM).

For the purpose of this study both the Nerlove Partial Adjustment Model and the Co-integration analysis with error correction model will be employed.

3.2 Definition of Variables

Dependent Variable:

The dependent variable is the area in hectares cultivated for coffee production in time ***t***. Time (t) will capture the production period from 1971 up 2006, the two years inclusive.

The Independent variable

The variables that will be considered in the long-run supply function will be as follows:

i. *Real producer price of coffee*

From literature, in estimating price elasticity of supply, the real value added price is the most comprehensive price variable. It captures the real exchange rate and real international (world) market price of coffee which are important parameters, coffee being a traded commodity. In this case, it represents the real price paid to local coffee farmers. The real producer price is invariably important as it is the variable that influences the farmers' decision with respect to area that should be allocated to coffee production.

ii. *Producer price of maize*

Maize as a staple food crop with similar agro-ecological requirements competes for land with coffee in the coffee producing zones and therefore could be grown as a

substitute crop to coffee. On the other hand, maize and the price can also be used as a proxy for other staple food security crops which grow in similar agro-ecological zones.

iii. *Coffee output*

iv. *Rainfall Dummy*

Rainfall, like other factors, is an important in determining the yield levels and consequently profitability in coffee production. Adequate amount of rainfall in the coffee producing zones will induce farmers to engage in the production of the crop. The dummy for rainfall in this case is used to capture agro-climatic conditions represented by W_t in the estimation equation.

v. *Dummy for Government policy*

The dummy for government policy shifts is represented by $\mathbf{D_t}$ in the estimation equation. Policy reforms are implemented from time to time to take care of changes in both the domestic and external environment in order to improve the performance of the industry. External and internal price shocks, for example, are known to affect the decision-making process of the Government and the farmers.

vi. *Time trend*

Trend variable is used to capture technology change and government investment in the coffee sub-sector over time. It is represented by T_t in the estimation equation.

vii. Stochastic Variable, e_t

The stochastic variable, e_t, represents other variables related to farm production that are treated as fixed factors in the model and are as such considered as stochastic.

3.3 Hypothesis

Hypothesis I: A negative relationship exists between price of coffee and area under coffee production. This will be tested against a null hypothesis that there is a positive relationship between the area under coffee production and the price of coffee.

Hypothesis II: A negative relationship exists between price of maize and output of coffee. This will be tested against a null hypothesis that there is a positive relationship between the area under coffee production and the price of maize.

Hypothesis III: A positive relationship exists between the output of coffee and the area allocated to coffee production. This will be tested against its null hypothesis that there is no relationship between output of coffee and the area allocated to coffee production

Hypothesis IV: A positive relationship exists between the amount of rainfall and the level of production hence total area under coffee. This will be tested against the null hypothesis that no relationship exists between the amount of rainfall and the area allocated to coffee production.

Hypothesis V: The changes in government policy are expected to have an impact on the total area under coffee production since the coffee inductry is regulated under government policy. The impact of the changes in government policy is difficult to determine a priori because the sign that its coefficient would assume is mixed for policies which give the farmers incentives to produce and negative for policies which are a disincentive to increasing coffee production.

3.4 Model Specification

In order to estimate the long-run supply response function, the Nerlovian Partial Adjustment Model (Mechanism) is used. The model accommodates delays in response to price movements (*Ogundeji* et al, 2006). The Nerlove model involves a one stage procedure and directly regresses production on prices and the other specified variables.

3.4.1 Assumptions

1. The dynamics of supply is driven by price expectations and non-price factors. Price expectations are generally assumed to be adaptive.

1. Adjustment costs can also cause lags in the supply response of acreage/output to price changes.

The actual adjustment of hectarage in one time period is specified as some proportion (δ) of intended full adjustment to the desired or equilibrium hectarage, A_t^*.

$$[A_t - A_{t-1}] = \delta\,[A^*_t - A_{t-1}]; \qquad 0 < \delta \leq 1 \qquad (4)$$

Therefore, $$A_t = \delta A^*_t + (1-\delta)\,A_{t-1} \ldots\ldots\ldots\ldots\ldots \qquad (5)$$

Since farmers base their production decisions on expected prices, equation (12), the change in price expectation is also specified as some proportion of the error made in formulating expectations in the previous year as follows:

$$P^*_t - P^*_{t-1} = \alpha\,(P^R_t - P^*_{t-1}); \qquad 0 < \alpha \leq 1 \ldots\ldots\ldots\ldots\ldots\ldots \qquad (6)$$

Therefore, $$P^*_t = \alpha\,P^R_t (1-\alpha) P^*_{t-1} \ldots\ldots\ldots\ldots\ldots\ldots \qquad (7)$$

But the desired/equilibrium (A^*_t) area can be specified as a function of expected real price (P^*_t) and other exogenous variables which influence supply. This can therefore be represented in equation form as follows:

$$A^*_t = a_0 + a_1 P^*_t + a_2 Z_t + U_t \text{ ....} \quad (8)$$

But since (P^*_t) is unobservable, we assume that farmers make their decisions based on their knowledge about real prices that prevailed immediately in the preceding year or period, meaning $P^*_t = P^R_{t-1}$. Therefore P^*_t is taken as the lagged real price. Including other variables that affect supply in the equation above, we specify the long-run linear response function as follows:

$$A^*_t = a_0 + a_1 P^R_{t-1} + a_2 PM_{t-1} + a_3 W_t + a_4 O_t + a_5 D_t + a_6 T_t + U_t \text{ ....} \quad (9)$$

In order to estimate the long-run supply (acreage) response function, we substitute equation (16) into (12), to obtain the short-run supply response function (<u>the **estimation equation**</u>) as follows:

$$A_t = a_0 \delta + a_1 \delta P^R_{t-1} + a_2 \delta PM_{t-1} + a_3 \delta W_t + a_4 O_t + a_5 \delta D_t + a_6 \delta T_t + (1-\delta) A_{t-1} + e_t \text{ ....} (10)$$

The reduced form of equation (7) can now be represented as follows:

$$A_t = b^*_0 + b^*_1 P_{t-1} + b^*_2 PM_{t-1} + b^*_3 W_t + b^*_4 O_t + b^*_5 D + b^*_6 T + b_7 A_{t-1} + e_t \text{ ....} (11)$$

Where, $b^*_0 = \delta a_0$; $b^*_1 = \delta a_1$; $b^*_2 = \delta a_2$; $b^*_3 = \delta a_3$; $b^*_4 = \delta a_4$; $b^*_5 = \delta a_5$; $b^*_6 = \delta a_6$; $b^*_7 = (1-\delta)$; $\delta = 1 - b^*_7$

A_t = Actual area under the crop in the current year, t

A_{t-1} =Area under the crop in the lag year

δ = Coefficient of hectarage adjustment [speed of readjustment], whose value will generally be more than zero and less than unity

A_t^* = Desired equilibrium level of the area under crop [which is not observable]

$[A_t - A_{t-1}]$ = Actual change in the area

α = Coefficient of price expectation

P_{t-1} = Lagged real producer price

PM_{t-1} = Average annual price of maize (used as a proxy to food security in the coffee growing areas because of the substitution effect of maize on coffee).

W_t = Dummy representing agro-climatic factors such as rainfall.

O_t = Ouput in kilograms by small scale famers

D_t = Dummy to capture government policy shifts

T_t = Trend variable to capture technology change over time

e_t = Error term to satisfy normal regression assumptions

b_1^* is the rate of change off in area under cultivation per a unit change in the lag year prices.

i.e., $\partial A_t / \partial P^R_{t-1} = b_1^*$

Estimation of Supply Elasticities from the Autoregressive Distributed Lag Function (Equation 8):

The responsiveness of the area under cultivation with respect to the changes in lag year prices will be evaluated at the mean values [$\bar{p}^{R}_{t-1}$ and $\bar{A}_t$] as follows:

$$\partial A_t / \partial p^{R}_{t-1} \; / \; A_t / p_{t-1}$$

$$= \partial A_t / \partial p^{R}_{t-1} \cdot \bar{p}^{R}_{t-1} \; / \; \bar{A}_t$$

$$= b_1 * \bar{p}^{R}_{t-1} \; / \; \bar{A}_t$$

This is known as the short-run average price elasticity of acreage as it will be estimated at the mean values. The short-run elasticity reflects the time period that is not long enough for farmers to adjust completely to the changes in prices. If the mean value is more than unity, then the short run price elasticity will be relatively more elastic. If it is less than unity, then the price elasticity will be relatively inelastic. If it is unity, then there will be unitary price elasticity. Given the assumption that famers are rational economic agents and gtheir expectations are that prices will remain high then they will increase land under coffee cyultivation. This is in lieu of these famers response to higher prices is expected to be positive. The long run price elasticity will be evaluated as follows:

Short run price elasticity/coefficient of partial adjustment

$$[\delta] = b_1 * P^{R}_{t-1} \; / \; A_t / \; \delta$$

$$= b_1 * \bar{p}^{R}_{t-1} \; / \; \bar{A}_t * 1 / \delta$$

The long run price elasticity will be relatively higher than the short-run price elasticity as the value of coefficient of adjustment [∂] will generally be less than unity. The long run price elasticity refers to the situation where the farmers have more time to adjust the desired area to the changes in prices. The long-run price elasticity shows the cumulative effect of the changes in prices on the area under cultivation. The coefficient of adjustment (∂), shows the speed of adjustment between the desired change in acreage [$A_{t^*} - A_{t-1}$] and actual change in acreage [$A_t - A_{t-1}$]. If the value is unity, then there will be an instantaneous adjustment in that year between the desired change and actual change in acreage. If it is less than unity, then the actual change in acreage will be lower than desired change in acreage. Thus the desired value of coefficient of adjustment (∂) shows the speed of adjustment between actual change and the desired change in the area under cultivation. The above equation of supply (acreage) response function would be appropriate, if there is a linear relationship between the area under cultivation in current year and price in lag year. If it is not linear, then other forms of supply response functions will be attempted, for example, the log linear supply response function.

Estimating the Acreage Response from the Log form of the Autoregressive Distributed Lag Function

A log linear function of the autoregressive distributed could also be estimated by fitting a log-linear form of supply response function to the time-series data. In this case, the regression coefficients of the price in a lagged year directly gives the value of the short run elasticity of the acreage under the coffee crop with respect to changes in price in that lag year.

The study thus uses the lagged model to take in to account the delayed effects of famers' responses and output increases due to the price of coffee.

Specification of the autoregressive log linear supply response function

The specification of the log linear supply response function for the crop (coffee) will be as follows:

$$\text{Log } A^*_t = a_0 + a_1 \log P^R_{t-1} + a_2 \log PM_{t-1} + a_3 \log W_t + a_4 \log O_t + a_5 \log D_t + a_6 \log T_t + U_t \quad \text{.....(12)}$$

This is known as the long-run supply response function. Since the desired level of area [A_t^*] is not observable, the following partial adjustment mechanism will be adopted to estimate the function:

$$[\log A_t - \log A_{t-1}] = \delta [\log A_t^* - \log A_{t-1}] \quad \text{.....(13)}$$

$$\log A^*_t = \delta[\log A_t^* - \log A_{t-1}] + \log A_{t-1} \quad \text{.....(14)}$$

Substituting equation (21) into equation (19), we get the following short-run supply response function:

$$\text{Log } A_t = \delta [\log a_0 + a_1 \log P^R_{t-1} + a_2 \log PM_{t-1} + a_3 \log W_t + a_4 \log O_t + a_5 \log D_t + a_6 \log T_t - \log A_{t-1}] + \log A_{t-1} + U_t \quad \text{.....(15)}$$

$$\text{Log } A_t = \delta \log a_0 + a_1 \delta \log P^R_{t-1} + a_2 \delta \log PM_{t-1} + a_3 \delta W_t + a_4 \delta O_t + a_5 \delta D_t + a_6 \delta T_t + (1-\delta) \log A_{t-1} + e_t \quad \text{.....(16)}$$

$$\text{Log } A_t = b^*_0 + b^*_1 \log P^R_{t-1} + b^*_2 \log PM_{t-1} + b^*_3 W_t + b^*_4 O_t + b^*_5 D_t + b^*_6 T + b_7 \log A_{t-1} + e_t \quad \text{.....(17)}$$

Where, $b_0^* = \delta \log a_0$; $b_1^* = \delta \log a_1$; $b_2^* = \delta \log a_2$; $b_3^* = \delta a_3$; $b_4^* = \delta a_4$; $b_5^* = \delta a_5$; $b_6^* = \delta a_5$;

$b_6^* = [1 - \delta] \Rightarrow 1 = a_7^* + \delta \Rightarrow \delta = 1 - a_7^*$

The short- and long-run elasticities will be derived the autoregressive distributed lag equation (24) in this case. Specifically, the short- and long-run elasticities for the linear form of equation (8) will be taken as follows:

a_1^* is the constant short-run elasticity of the area under coffee with respect to the changes in lagged prices.

$a_1^* = \partial \log A_t / \partial \log p^R_{t-1}$

The long-run elasticity of acreage with respect to lagged prices will be estimated as follows:

$$SRE/\ \delta = \partial \log A_t / \partial \log p^R_{t-1} / \delta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

$$= b_1^* / \delta$$

The numerical value of the long run price elasticity of acreage would normally be higher than the short-run price elasticity as the coefficient of Partial adjustment would be less than unity.

From previous studies, the Nerlove model accommodates delays in response to price movements (Ogundeji *et al*, 2006). The model also involves a one stage procedure and directly regress production on prices and other relevant variables which attests to the fact, among others, that the dynamics of supply is driven by price expectations and non-price factors with the price expectations generally assumed to be adaptive.

3.5 Issues of Application

Selecting the correct Data:

In time series analysis of single commodity, the main difficulty lies in selecting the correct data. A part from identifying the correct output measure (planted area, marketed production, crop yields, etc.) researchers must determine which (relative) price variable to use: the choice of deflator (consumer price index, input prices, etc.) is essential in formulating price response. For example, if farmers formulate their price expectations using relative prices and yet an absolute price is used in estimation, results may incorrectly present farmers as being not responsive to prices. Some of these problems are alleviated by addressing aggregate supply response.

Ogundeji (2006), citing Langley identifies some other important problems experienced when using the time series data for supply response analysis. The problems cited include: vagueness in expectation, flexibility of fixed factors over time, technological changes and the measurement of impact of weather.

The model is also considered weak for a number of reasons: Firstly, its inability to give an adequate distinction between short- and long-run elasticities. Secondly, it uses integrated time series data, which is subject to danger of spurious regression.

Multi-collinearity:

Furthermore, it is to be noted that in the use of time series data such as in this case, the independent variables move either in the same direction or opposite direction thus creating the problem of multi-collinearity between the independent variables in the

supply response function. The presence of multi-collinearity between the independent variables breaks the precision of the estimates of elasticities. This problem can be rectified by having a large sample size (1970-2006) and leaving out other independent variables which might not be statistically significant and which might bring about serial correlation between the independent variables from the supply response function.

Autocorrelation:

Another potential problem that will be faced is the autocorrelation. This problem can be reduced by taking the variables in first difference form and also by using the log linear function form to ensure normal distribution of the estimates.

The theoretical assumptions used in the models are also often considered inadequate as modeling the dynamics of supply comes down to an ad hoc assumption that each period a fraction of the difference between the current position, and the long-run position is eliminated. Furthermore, the adaptive price expectations and the partial adjustment hypothesis result in the same dynamic specification. Thus, when both partial adjustment and adaptive expectations are present, it becomes impossible to distinguish between their respective coefficients, and, unless certain (arbitrary) restrictions on one or other are imposed.

3.6 Data

The study uses secondary time series as follows:

a. ***Land under coffee production (hectares):*** This was measured by the volume of land under coffee production and the changes observed in the land held for coffee cultivation by small scale famers.

b. ***Output of coffee:*** by small scalle famers: this is measured in tonnes. The cumulative coffee production per year by small scale farmers is used.

c. ***Producer price of maize:*** The price of maize used is the value of maize paid to famers in US Dollars per Kilogram. Famers upon facing low price for coffee are expected to neglect the coffee bushes in terms of husbandry even if they don't uproot them. They will instead devote more time and resources to maize production on the same land which would seem more profitable give the comparable prices.

d. ***Average annual rainfall figures:*** Theses are chosen to represent agro-climatic conditions such as quality of soil in the coffee growing areas. The variable is estimated using annual average rainfall. The amount of precipitation in a particular year is expected to influence quality of harvest in a period.

e. ***Technology:*** Simple time trend variable, T_t, was used as a proxy for the technical progress and government investment in the coffee sub-sector in the empirical analysis. This variable was captured by a dummy variable where investments by the government and changes in innovative coffee production are indicated by 1 in that particular year and by 0 otherwise.

f. ***Government policy shift*** is captured by a dummy variable, D. Policy shift was captured by the changes in governement policies in cases which government made efforts to streamline the coffe industry through various incentives to coffee famers.

To capture the real measure of value of coffee to farmers the real price is decomposed into its components parts as follows:

$$P^R = P^N/CPI = NPC.RER.P^*$$

Where P^R is the real producer price, P^N is the farm gate producer price, NPC is the nominal protection coefficient, RER is the real exchange rate, and P^* is the real world price (the nominal world market price P^* deflated by an index of aggregate world market price).

$RER = e.WPI/CPI^{US}$, where e is the official nominal exchange rate measured in domestic currency units per US$, and WPI is the US wholesale price index,

The above equation can bere-written as follows:

$$P^R = P^N/CPI = (P^N/CPI).[(P^*.e)/(P^*.e)].[WPI^{US}/WPI^{US}] = (P^N/P^*.e)(WPI^{US}.e/CPI).(P^*/WPI^{US}) = NPC.RER.P^*$$

3.7 Data Sources

The study used secondary data. The data used was obtained from publications by; Government of Kenya (Economic Surveys, Agricultural data compendium), International Coffee Organization, The World Bank Data, International Financial Statistics of the International Monetary Fund and Financial Statistics, The Food and Agriculture Organization of the United Nations (FAO), United Conference on Trade and

Development (UNCTAD), Coffee Board of Kenya, Kenya Institute for Public Policy Analysis and Research (KIPPRA) and Tegemeo Institute of Agricultural Policy and Development of Egerton University.

3.8 Limitations of the Study

The model used, the Nerlove partial adjustment model, is criticized for many reasons as given in the literature under issues of application. Suffice it to say that it results in low estimates of coefficients, among others, and may results in unrealistically high coefficients of determination. The ECM model is used in this case to address the inherent lack of dynamism in the Nevelove Model.

Another limitation is on the data variables. First, the data used was secondary data with inherent errors in terms how they were used in collecting them. Secondly, the data variable on real producer price was calculated again from the international prices of coffee, real annual exchange rates, consumer price indices (CPI) and nominal local producer prices. This resulted in more accumulated errors in the variables. The study used large sample to minimise errors of estimation and averaging.

3.9 Estimation Method

The Ordinary Least Squares (OLS) method was used to estimate the parameters using E-Views statistical package. Using the criterion of consistency (asymptotic efficiency), the OLS technique has been criticised on the basis that the estimates of the structural parameters using the OLS method are generally inconsistent as compared to other methods such as Instrumental Variables (IV), Two-stage Least Squares (2SLS) and the

Limited information Maximum Likelihood (LIML), Three-stage Least Squares (3SLS) and the Full Information Maximum Likelihood methods. Ranking on the basis of the small sample properties, the OLS method fails on the criterion of root mean square error. OLS yields the estimates with the greatest bias. However, according to Koutsoyiannis (2003) the most serious disadvantage of OLS is that there is greater danger of drawing wrong inferences concerning the significance of the various parameters , that is, there is greater danger of incorrectly accepting coefficients as significant as explained by the low variance of its estimates as compared to other methods.

The various weaknesses of the OLS method can be improved by improvement in data collection, including the use of large samples and by employing improved processing techniques. Accurate estimates of structural parameters depend on the sample and correctness of the specification of the model.

3.10 Error Correction Models with Co-integration Analysis

Due to the inherent weaknesses of the Nerlove method, alternative time series approaches have been identified to address its limitations. The most important of such techniques are the Error Correction with Co-integration analysis and dynamic general equilibrium models. For the purpose of this study, the co-integration analysis was employed further as it is also a straightforward way to overcome the restrictive dynamic specification of the Nerlove method.

Co-integration analysis does not impose any restrictions on the short-run behaviour of prices and quantities/area. The method only requires a co-movement of the two variables in the long-run. This implies that there is a linear combination of A_t and Pt which is

stationery even though both A_t and P_t may be non-stationery. The long-run equilibrium relationship is specified as follows:

$$\mathbf{Ln\ A_t = \beta\ ln\ P_t + \varepsilon_t} \quad \text{.....} \quad \mathbf{(21)}$$

Where the coefficient β measured the long-run supply elasticity, and where ε_t is the residual which is stationary if, and only if, A_t and P_t are co-integrated.

Unit Root test

The stationarity of ε_t, and thus the existence of equilibrium relationship can be tested by means of the **Augmented Dickey-Fuller (ADF) test**.

If prices and hectarage (quantities) are co-integrated, then there exists an error-correction representation which incorporates both short-run and long-run behaviour. The error correction model (ECM) is given by the following equation:

$$\mathbf{\Delta ln\ A_t = \sum^{p}_{1=0}\ \alpha_i\ \Delta ln\ A_{t-p} + \sum^{q}_{j=0}\gamma_j\ \Delta\ ln\ P_{t-q} - \mu\varepsilon_{t-1} + \nu_t} \quad \text{.....} \quad \mathbf{(22)}$$

With $\varepsilon_{t-1} = \ln A_{t-1} - \beta \ln P_{t-1}$.

The expression $\sum^{p}_{1=0}\ \alpha_i\ \Delta ln\ A_{t-p} + \sum^{q}_{j=0}\gamma_j\ \Delta\ ln\ P_{t-q}$ captures the short-run dynamic adjustment of quantities and prices.

The expression $\mu\varepsilon_{t-1} + \nu_t$ (the error correction mechanism) measures the speed at which the system gets closer to the long-run equilibrium relationship, with the residual of the co-integrating regression (4) representing the divergence from equilibrium.

If all coefficients α_i and γ_j of the differentiated variables turn out to be insignificant, the ECM reduces to a partial adjustment model, that is, the partial adjustment model is nested within the error correction model.

3.11 Diagnostic Tests

To determine whether any of the classical linear regression are violated, four diagnostic tests, that is: Histogram normality; heteroscedascity; serial correlation; and mis-specification.

Histogram Normality test: This test was conducted using the Breusch Godfrey test. The test check whether the error term is normally distributed with Kutosis of 5.4 a null hypothesis used is that errors are normally distributed

Heteroscedascity: The test seeks to check whether the variance of the residuals is constant. The null hypothesis is that there is homoscedasticity.

Serial Correlation: This test check the high order autocorrelation of the error term with the null hypothesis being that there is no correlation between any two error terms. The null hypothesis is that there is no auto correlation among residuals.

Mis-specification: checked using the Ramsey RESET specification. The null hypothesis to the test is that coefficients on the forecast are zero (0) this means that insignificant F-statistic shows that the model is well specified

Advantages of ECM

The main advantage of ECM over the partial adjustment model is that it is consistent with the forward-looking behaviour of farmers. Another reason is that with all the variables

being stationery, an estimation of the ECM avoids the problem of spurious correlations which may occur in the OLS-regressions of the Nerlove model if variables are non-stationery. Spurious regression possibilities arise because most economic time series exhibit tendencies of non-stationarity. Such situations give rise to high R^2 that may only indicate correlation trends and not true economic relationships. The technique confronts the spurious regression by attempting to identify conditions for which relationships are not spurious. If time series variables are co-integrated, then their long-run trends adjust according to an equilibrium constraint and the cyclical components of the series fit into a dynamic specification in the class of error-correction models.

3.12 Expected Output

This Study is expected to have the following outcomes:

(i) Estimates of long-run elasticities of area allocated for coffee production with respect to lagged real producer prices coffee, lagged producer prices of maize and non-price factors represented by dummy variables.

(ii) Report of the Study

CHAPTER 4: DATA ANALYSIS AND RESULTS

4.0 Introduction

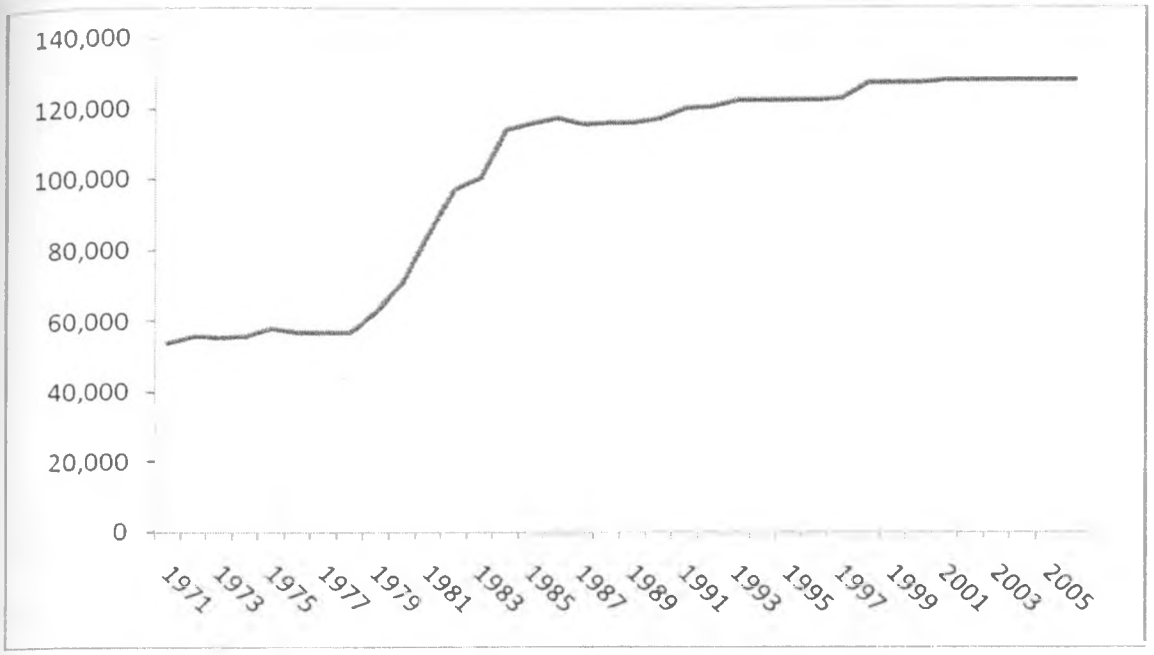
This chapter provides a discussion of the data collected from the secondary sources. The data discussion is carried out by first explaining the trend observed in the average changes, then the variable are tested for time dependence through a unit root test, the regression or the variable is then determined and the subsequent tests to ascertain that the OLS assumptions are met are undertaken.

4.1 Data Analysis

The analysis begins with outlining the trend of various economic variables that are under investigation. The trend runs from 1971-2006. To show the trend of the variables, line graphs have been used. The variables under investigation include area under cultivation (hectare), average rainfall, price of coffee, price of beans, government policy, technological change and coffee output. To capture government policy and technological change dummy variables have been used.

4.1.1 Trends of Variables

Figure 4.1.1 Trend in hectare



The area under cultivation for coffee production by small-scale farmers was almost constant in the period between 1971 and 1978 at just above 55,000 hectares. In the period between 1979 and 1982 area under coffee cultivation increased steadily from 60,000 hectares to 120,000 hectares. This increase was attributed to coffee failure due to frost in Brazil, global supply management through quarters under the International Coffee Agreement and the positive government regulations and policy to support coffee farming in the country. More land was allocated to coffee production in the country subsequently. From the 1985 to 2005 the average area under coffee production by small-scale farmers has remained more or less constant owing to the low returns realized from coffee production. This situation mirrored the fluctuating trend of the international cofee prices over the same period as indicated in figure 4.1.2 below.

Figure 4.1.2 Trend in Price of coffee

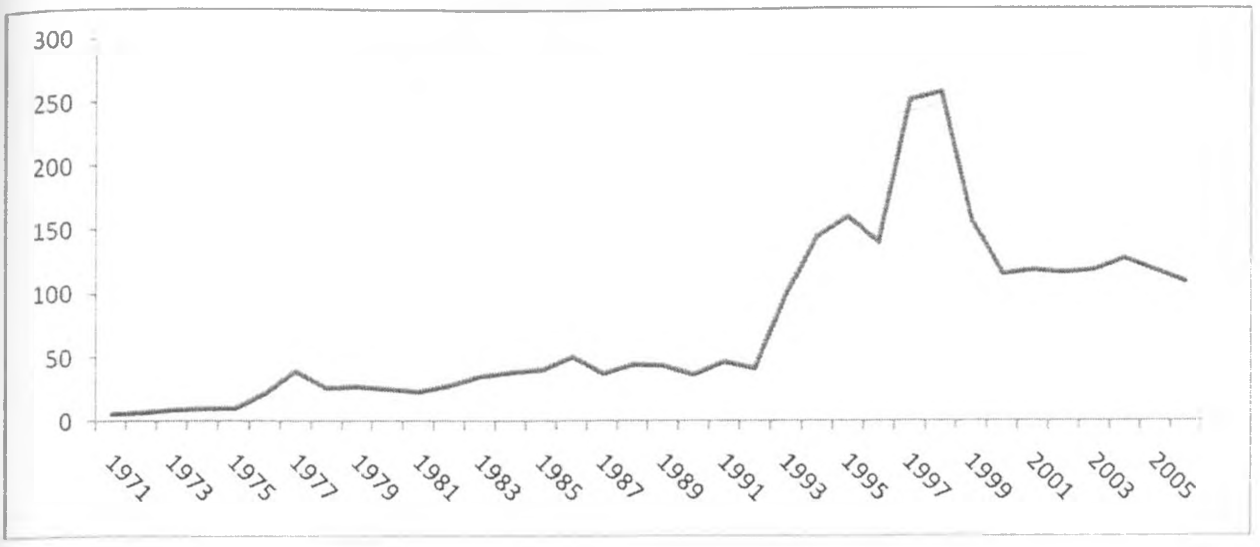


Figure 4.1.2 above shows the trend of coffee prices in Kenya shillings between 1971 and 2005. In the early 1970 the price of coffee average Kshs.5.68 per kilogram owing to few external markets in Europe which was the leading importer of coffee at the time. The price of coffee continued in a gradual upward trend as popoulation increased and discovery of new markets in Asia. The period 1975-1979 witnessed a coffee boom in prices owing to frost attacks on Brazilian coffee during this period. These factors resulted in a considerable increase in average prices from Kshs. 9.00 per Kilogram in 1975 to Kshs.39.52 per kilogram in 1977. Thereafter the prices normalised in 1979 - 1991 period with the prices falling back to between Kshs.26.00 and Kshs. 36.00 per kilogram. However, the early 1990's also witnessed a change in coffee prices as a result vigorous marketing campaign by the Coffee Board of Kenya and the liberalisation of the foreign exchange market. But the decrease in average rainfall coupled with the collapse of the International Coffee Agreement that ended global supply management through quotas reduced the production of coffee in the country as prices declined further. This forced most of the coffee farmers to turn to alteranative crops to maintain their incomes and

livelihood. This trend was briefly reversed in the period between 2000 and 2003 when there was stability in the price of coffee. The price averaged at Ksh. 116.00 per kilogram.

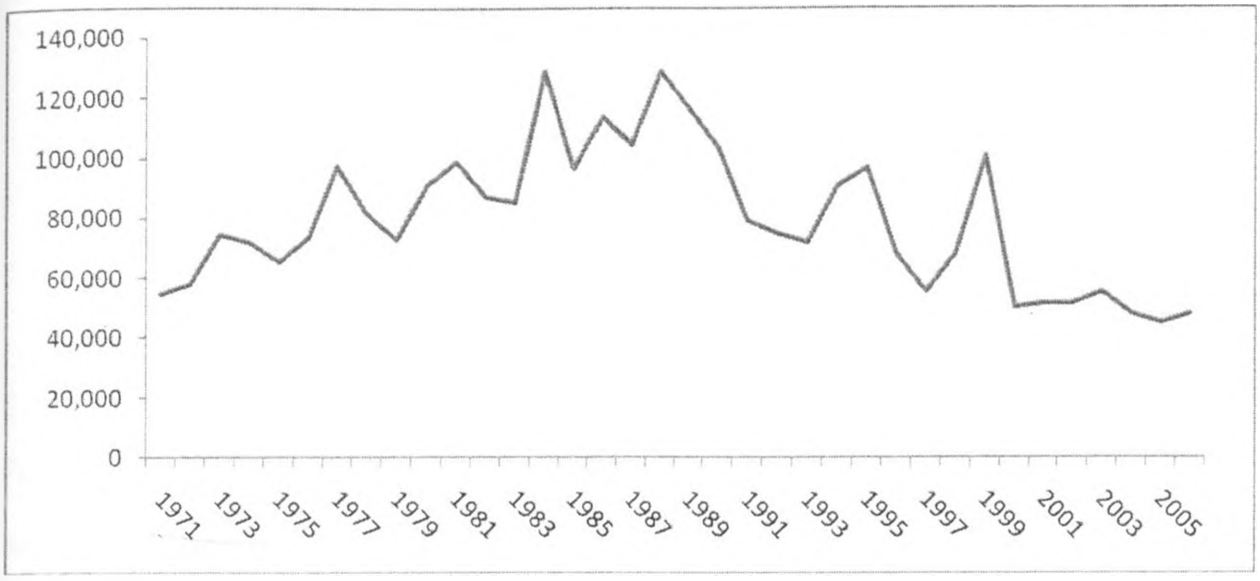
Figure 4.1.3 Average rainfall

From figure 4.1.3 above, the annual average rainfall received in the Country shows that there was considerable fluctuation in the amoount of rainfall received between 1971 and 2005. For exanmple, the average of rainfall received decreased by over 100 per cent between 1971 and 1972 at about 600 millimeters. Exceptionally good amounts of rainfall were received between 1975 and 1978 which also concided with the period of the coffee boom in the Country. The Country, however, experienced severe decline in the average rainfall received between 1979 and 1987 causing a considerable economic and social stress with a large segment of the population suffering famine. As expected, this period witnessed reduced levels of productivity in coffee farming as most parts of the country were hit with drought.

In 1997-1998 the Country experienced El-Niño raifall which caused severe floods that also damaged crops, including cash such as coffee. From 2000-2006, the average rainfall

fluctuated with some parts of the country experiencing low levels of rainfall while some parts received higher levels of rainfall.

Figure 4.1.4 Trend in Coffee production



Coffee is one of the main sources of foreign exchangeearnings to the country. Figure 4.1.4 above shows that average production of coffee was in upward trend from about 60,000 in 1971 and peaking at about 130,000 metric tonnes in 1988. Production took a declining trend since 1988. This has largely been attributed to the collapse of the International Coffee Agreement in 1989 that led to a glut in the international coffee market with the attendant price decline. This caused a serious blow to the small-scale coffee producers who are generally poorly cushioned against the market risks. Many of the farmers opted to neglect their crops and in some cases uprooting the crop altogether, replacing them with alternative cash or food crops. Occasional peaks of production improvements have been there, for example, between 1996 and 1998 production increased from its initial low of about 55,000 metric tonnes to 100,000 metric tonnes.

Figure 4.1.5 Price of beans

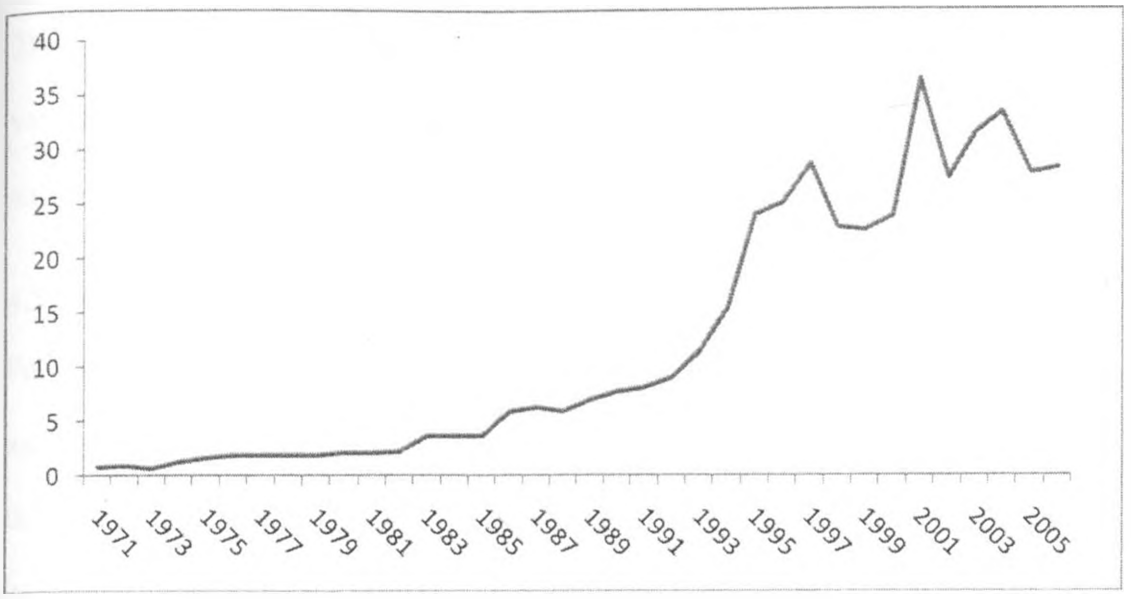


Figure 4.1.5 above shows that between 1971 and 1973, the average price of bean was between Ksh. 2.00 to Kshs 4.20 per kilogram. The constant price of beans during these periods was attributed to low costs of production. The price of beans continued a gradual upward trend with a sharp increase experienced between 1991 and 1996. It is noted, however, that this followed the 1982/1983 drought that coincided with the increase in the prices of beans from about Ksh.4.00 in 1991 to over Ksh.10.00 per kilogram in 1996. A sudden decline in prices followed up to 1998. Between 1998 and 2005, price fluctuated but eventually peaked at about Kshs. 37.50 during the first half of 2000. Price increase trend continued thereafter until late 1990's but with declines in between as can be seen in figure 4.1.5 above. The average price was above Kshs.20.00 per kilogram. This was due to increased demand for beans across the world as most countires sought to improve on their strategic food reserves.Thereafter the price of beans has been fluctuating from one price level to another.

4.2 Discussion of Results

4.2.1 Introduction

The variables used for the study were time series and to determine the fitness for use, various tests were performed. These tests included the test to check for OLS assumptions and model specification. .

4.2.2 Unit Root Test

For the purpose of the analysis the Augmented Dickey Fuller test was employed to ascertain the variables stationarity status. This is to determine whether the variable were time dependent. The test uses the Null hypothesis that the variable being tested is time invariants. It uses 3 test significance values which are the critical values at 1%, 5% and 10%. The desirable status to ascertain a stationary variable is excess negativity compared to any of the critical values.

Null hypothesis $\rho = 0$

Thus $\rho = \alpha - 1$

In $\Delta Y_t = (\alpha - 1) Y_{t-1} + \sqrt{t}$ ..... (4.2.1)

$\Delta Y_t = \rho Y_{t-1} + \sqrt{t}$..... (4.2.2)

Where: Δ is Difference operator

Table 4.2.1 UNIT ROOT TESTS

Variables	Test in levels					Test in first difference		
	ADF Test	Critical values			ADF Test	Critical values		
		1%	5%	10%		1%	5%	10%
HA	**-2.831520**	-4.2505	-3.5468	-3.2056	**-3.648733**	-7.705129	-3.5514	-3.2081
PRC	**-1.921910**	-4.2605	-3.5514	-3.2081	**-2.871039**	-2.6369	-1.9517	-1.6213
PRB	**-2.063988**	-4.2412	-3.5426	-3.2032	**-6.740625**	-4.2505	-3.5468	-3.2056
AVR	**-0.336253**	-2.6300	-1.9507	-1.6208	**-7.622723**	-1.6209	-1.9510	-2.6321
PLY	**-1.891349**	-4.2605	-3.5514	-3.2081	**-4.643815**	-4.2712	-3.5562	-3.2109
TECH	**-1.006175**	-2.6344	-1.9514	-1.6211	**-4.226019**	-2.6369	-1.9517	-1.6213

All the variable used in this study were observed to be non-stationary implying that they were all time dependent and as such there was need to difference them Once. This is in order to account for the time influence upon them. Upon the first differencing the variables were observed to be stationary.

4.2.3 ECM Test

ECM stands for Error Correction Model. This model is used to determine the speed of adjustment of the dependent variable. The model uses a stationarity test. The ECM (Error Correction Model) was tested for stationarity and was observed to be stationary in level thus it is fit to be used in determination of the speed of adjustment of area in hectares cultivated for coffee production.

Table 4.2.2 ECM Unit Root Test

ADF Test Statistic	-3.725903	1% Critical Value*	-3.6289
		5% Critical Value	-2.9472
		10% Critical Value	-2.6118

ECM is the error correction model that is given by:

ECM = LOG(HA) – LOG(HAF)

The ECM (Error Correction Model) was tested for stationarity and was observed to be stationary in level thus it is fit to be used in determination of the speed of adjustment of area for coffee production cultivation in hectares.

4.3 Diagnostic Checks

To ascertain that all the Ordinary least square (OLS) assumptions are fulfilled and the model (ECM) is fit for forecasting purposes diagnostic checks were conducted. For the purposes of carrying out the checks the study undertook Multicollinearity test; to check for correlation between the explanatory variables, Residual test; serial correlation, normality distribution of the error term and stability test to check for specification of the model and its confident stability over time.

The OLS assumptions hold that the explanatory variables are independent of each other. This assumption has however been critisised by Gujarati (1994) who argues that Multicollinearity is not a serious problem and can be allowed up to a level as high as 0.85. In other cases multicolinearity can be resolved with large sample sizes. Table 4.2.1 below shows the observed Multicollinearity matrix.

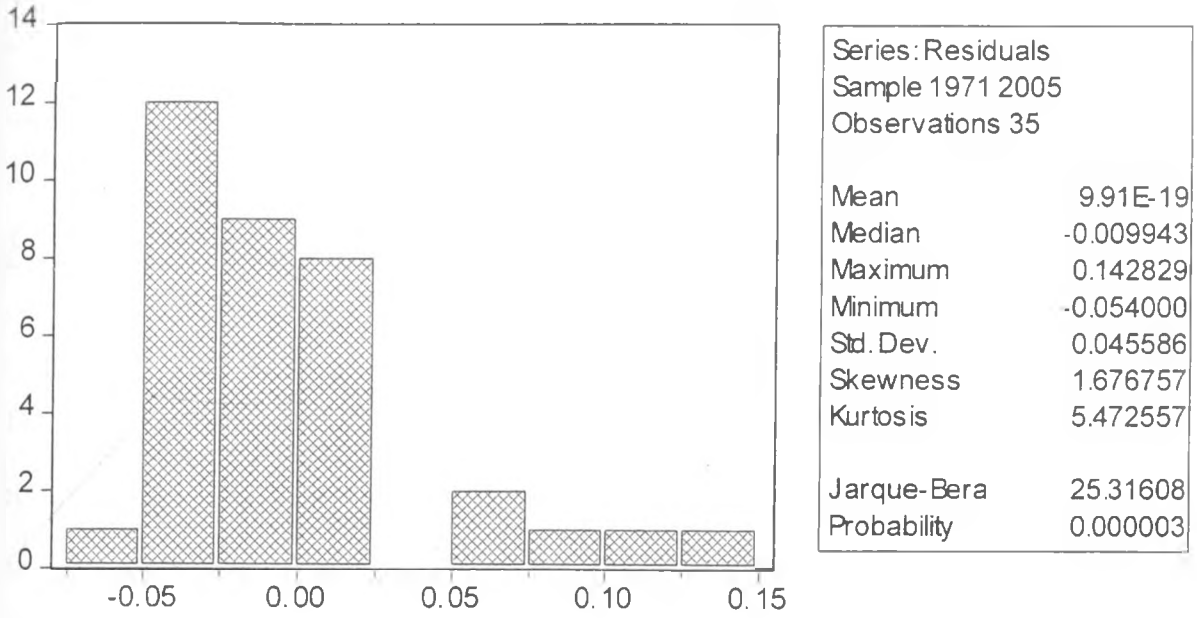
Table 4.3.1 Correlation Matrix

	D(LOG(PRC))	D(LOG(PRB))	D(LOG(AVR))	D(LOG(PLY))	D(LOG(TECH))	D(LOG(CPRD))
D(LOG(PRC))	0.00104					
D(LOG(PRB))	-0.00021	0.002				
D(LOG(AVR))	-0.00021	-0.0001	0.0003			
D(LOG(PLY))	2.132	-1.945	0.0002	0.002		
D(LOG(TECH))	5.959	0.0002	6.045	0.0001	0.0007	
D(LOG(CPRD))	-6.845	0.0004	-3.238	0.0001	0.0003	0.001

The correlation matrix tests for multicollinerity. It seeks to establish whether there is a correlation between the explanatory variables.Correaltions up to 0.5 whether positive or negative indicate that there is no multicollinaerity. The variables used in the study showing correlation between each other included governemnt policy with the price of coffee and price of beans which in economic thory this is to be the case where the govement participates in price controls indirectly or directly. The dummy variable of technology as was used in the study showed correlation with price of coffee (PRC) and average rainfall (AVR). Coffee producation (CPRD) is correlated with price of cofee (PRC), and the avarage rainfall (AVR). This case is also support in economic theory that the amoun of coffee will be dependent on the pric of coffee in the market and the volume amount of precipitation received. Despite the multicollinerity observed among the variables of the study we carry on with futher tests for analysis taking the correlations observed as acceptable for the study.

Histogram Normality Test was conducted using the Breusch Godfrey test to check whether the error term is normally distributed with Kutosis of 5.4 a null hypothesis used is that errors are normally distributed. The test observed that the errors are not normally distributed upon the observation of an insignificant Jacque – Bera Statistaic.

Figure 4.3.2 Histogram



The test seeks to establish whether the stochastic variables are normally distributed. The null hypothesis for the test is that the residuals are normally distributed. The probability is 0.000003 which is insignificant. We therefore accept the null hypothesis that the variables are normally distributed.

The Serial Correlation LM Test was done to check high order auto-correlation of the error term with the null hypothesis being that there is no correlation between any two error terms. The null hypothesis is that there is no auto-correlation among residuals. It is necessary that individual error terms be a result of a stochastic process otherwise, spurious regression result would be realized. Observance of correlation in the error term

compromises the reliability of the results and forecasting is compromised thus unreliable in policy formulation and guide for further study. The test indicated non existence of serial correlation between the error terms since the F – statistic value of 16.37446 has a probability value of 0.000029. This says that there are 0.0029 per cent chance of occurrence of correlation between the error terms.

Table 4.3.2 Breusch-Godfrey Serial Correlation LM Test:

F-statistic	16.37446	Probability	0.000029
Obs*R-squared	19.84820	Probability	0.000049

The White Heteroskedasticity was used to check whether the variance of the residuals is constant. The null hypothesis holds that there is homoscedasticity. We accept the alternative hypothesis because the p-value is 0.974353 is significant hence we conclude that there is there is heteroskedasticity.

Table 4.3.3 White Heteroskedasticity Test:

F-statistic	0.353825	Probability	0.974353
Obs*R-squared	6.947878	Probability	0.936702

The Stability Tests undertaken included general model specification using Ramsey RESET test and the CUSUM tests for stability of the model. To determine the stability over time of the model, Recursive coefficient test was done. This is by testing for mis-

specification errors, omission of variables, incorrect functional form of the model and correlation between explanatory variables and residuals.

The Ramsey RESET tests to check the general specification of the model was done. The null hypothesis to the test is that coefficients of the forecast are zero (0) which means that insignificant F-statistic shows that the model is well specified.

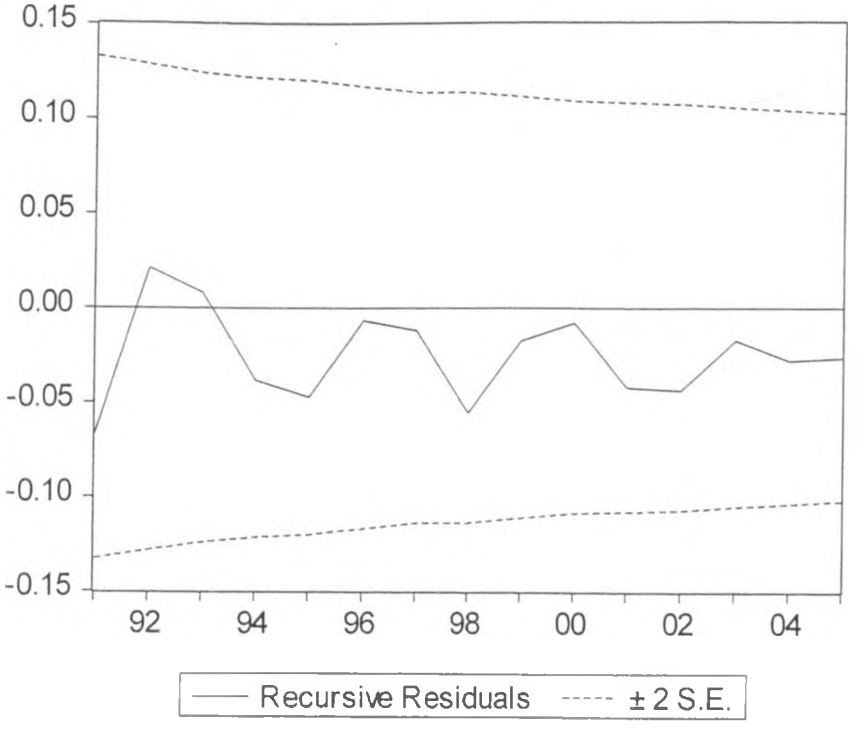
The test was done shows whether the model used in the study was well specified. The null hypothesis was that the model is well specified. The probability of 0.152731 observed is insignificant. It therefore means that the model was well specified and the all relevant variable to the model were included.

Table 4.3.4 Ramsey RESET Test

F-statistic	1.564212	Probability	0.222188
Log likelihood ratio	2.044760	Probability	0.152731

The result of the Recursive Residuals test to check for stability over time of the coefficient used in the study is presented in figure 4.3.3 below.

Figure 4.3.3 Recursive Residual



The result shows stability of the variables at 5% level of significance indicating that the residuals are stable as they are within the margin.

Cusum Test was done to check the stability of the model at 5 per cent level of significance. Figure 4.3.4 below shows that the model is not sensitive to changes in sample size. This means that the variables will behave in the same manner in the present as in the future. They can therefore be used for forecasting. Above 5 per cent significance level the model is sensitive to changes in sample size since line showing the trend of variables has crossed the broken line margins.

Figure 4.3.4 Cusum Test

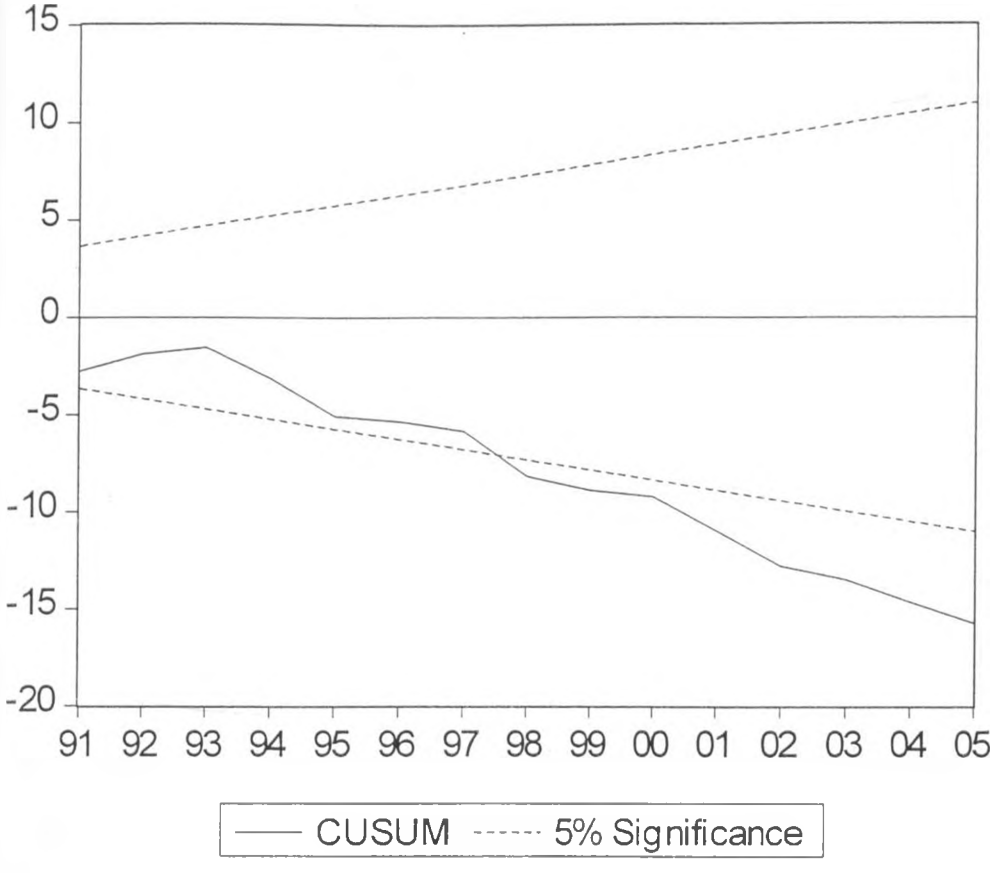
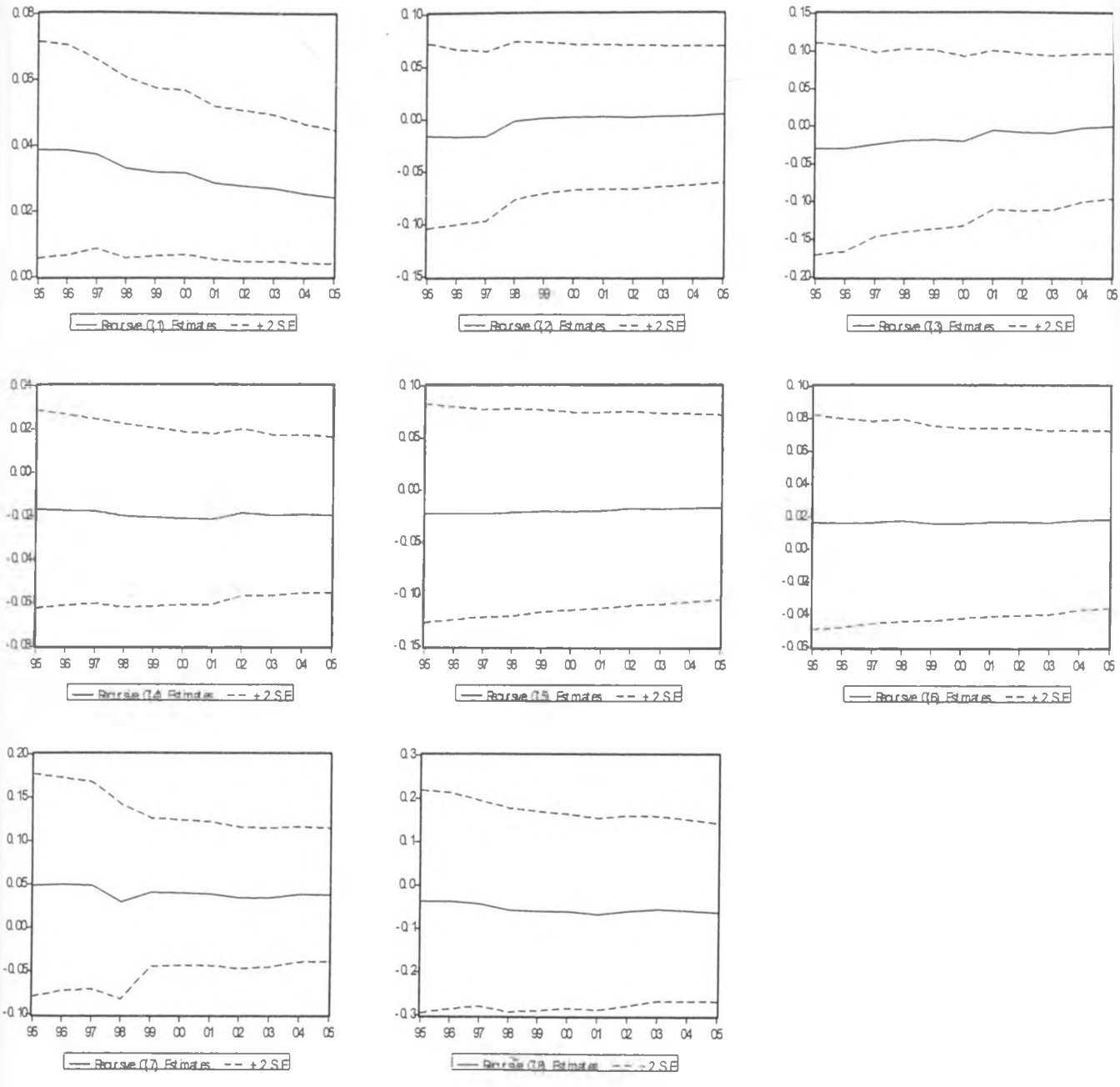


Figure 4.3.5 Recursive Co-efficients



The recursive test sought to find out whether the coefficients of the model are stable at 2 per cent levels of significance. Results as indicated in Figure 4.3.5 above show that all the curves of the coefficients are within the test boundaries. Therefore based on the result the coefficients are stable.

4.7 Regression Results and Discussions

Table 4.7.1 Regression

Dependent Variable: D(LOG(HA))				
Method: Least Squares				
Sample(adjusted): 1972 2005				
Included observations: 34 after adjusting endpoints				
Convergence not achieved after 100 iterations				
Backcast: 1971				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.020696	0.024162	0.856546	0.4002
D(LOG(PRC))	0.052003	0.013514	3.847975	0.0008
D(LOG(PRB))	0.014493	0.037995	0.381446	0.7062
D(LOG(AVR))	-0.037775	0.005918	-6.383022	0.0000
D(LOG(PLY))	-0.007623	0.017635	-0.432259	0.6694
D(LOG(TECH))	0.028205	0.009171	3.075419	0.0052
D(LOG(CPRD))	0.072229	0.021121	3.419729	0.0022
ECM(-1)	-0.381351	0.138007	-2.763261	0.0108
AR(1)	0.548597	0.190760	2.875845	0.0083
MA(1)	0.989944	4.32E-05	22928.45	0.0000
R-squared	0.699516	Mean dependent var		0.024549
Adjusted R-squared	0.586835	S.D. dependent var		0.048508
S.E. of regression	0.031180	Akaike info criterion		-3.858176
Sum squared resid	0.023332	Schwarz criterion		-3.409246
Log likelihood	75.58899	F-statistic		6.207919
Durbin-Watson stat	1.968918	Prob(F-statistic)		0.000163
Inverted AR Roots	.55			
Inverted MA Roots	-.99			

4.7.1 Auto Regressive and Moving Averages

The regression result shows that the land under cultivation for coffee production is influenced heavily by the land previously held under coffee cultivation and the land that is currently held available for the same purposes. The auto regressive and moving averages coefficients were observed as 0.548597 and 0.989944 both having a positive influence on the land under cultivation. They also have significant probabilities asserting a high probability of occurrence of the same.

The Adjusted R-Squared which is the measure of the cumulative influence of the independent variables on the dependent variable realized a positive value of 0.586835 with a significant probability of 0.000163. The result goes to show that the independent variables accounted for 58.7 percent of the variation in the dependent variable with a 99.9998 chance of occurrence.

The regression result indicated that the logarithm price of coffee accounted for 0.052 variations in the area under coffee production. The coefficient was observed to be significant with a significant probability distribution 0.0008. The price of coffee has a positive relationship with the area under coffee production. This means that as the area under coffee production will increase by 0.5 per cent with a unit increase in the price coffee.

Prices of beans have a positive significant relationship with the area under coffee production. This means that the area under coffee production will be increased subsequent to the increase in the price of beans by 0.14 per cent. The relationship was observed to be significant with the observation of probability of 0.008. This is an indication that the price of beans is likely to have this influence in the area under coffee production 0.9992 times. This relationship negates the theoretical expected sign.

The area under coffee plantation by small scale farmers will reduce with increases in the amount of rainfall received. This is observed from the regression table above indicating a coefficient of -0.037775 influence of rainfall with a significant probability indication this is to be the case 100 per cent of the times. A unit increase in the amount of rainfall will

yield to a 3.7 per cent reduction in the area under coffee cultivation by small scale farmers.

Government policy has a negative impact on the supply response of coffee farmers. Area under production of coffee will be reduced after a shift in government policy that directly affects coffee production following from the observation of negative value. Government policy will account for -0.7623 variation of area under coffee cultivation by small scale farmers. This is only to be the case in 34 per cent of the times according to the observation of 0.66 probability value of significance.

The advancement of technology in the country was measured as a Dummy variable whose influence on the area under coffee production held a coefficient of 0.028205 with a 0.0052 probability of non–occurrence. The changes in technology will thus be responsible for 2.8 per cent variations in the change in the land under coffee cultivation by small scale farmers. The relationship has a 99.9 per cent chance of occurrence. The supply response for coffee farmers in this case is observed as positively related to

CHAPTER 5: CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Introduction

This chapter makes a summary of the study, including core findings, conclusions and policy recommendations. The objective of the study was to estimate the supply elasticities of coffee using the Nerlovian Partial Adjustment Model.

5.2 Conclusion

Kenya started production of coffee back in the 1893 and with time coffee growing has emerged to be an important economic activity impacting directly on the well being of millions of people. The contribution made by coffee industry in the country has been more synonimous with exchange earning and income generation for many households over many years. The viscicitudes of international commodity markets and domestic policy regimes have, however, contributed to the diminished contribution the industry has made to the Country's economy. Price volatility in international coffee market, low producer prices, and the vagrancies of non-price factors such as government policies and weather conditions have significantly affected local coffee production, especially production by the small-scale farmers.

Understanding small-scale farmers' behaviour by estimating supply response in this case is vital, given the contribution of the small-scale coffee production to economic growth, rural income stability and poverty reduction in the country. This Study provides information on policy direction which should be adopted on the basis of the challenges small-scale coffee farmers face and on the basis of economic justification for continued support to small-scale coffee farmers in the country. Moreover, this study on the agricultural supply response is also useful in terms of informing the potential impacts on

the local environments as farmers have the recourse to change to alternative crops in the present coffee growing areas with potential adverse impacts on the natural environment.

The study in its analysis established that coffee production by small-scale farmers in Kenya is significantly influenced by the amount of land available for expansion. The other factors that influence supply responses by farmers include the real producer price of coffee and technological advances while annual average rainfall and government policy have a negative influence on the farmers' decision on land allocated for coffee production.

5.3 Summary

Supply response measures the degree to which the level of production and/or marketed surplus changes in response to stimuli provided by changes in some important prices and non price variables. The study sought to estimate the supply response of Kenya's small-scale coffee producers to real producer price and to non-price factors that act as stimuli to coffee production in the Country. The behavioral change of small-scale farmers to the variables was hypothesized in the first chapter as;

i) The long run acreage (supply) under coffee production by small-scale farmers changes with changes in the real producer prices.

ii) Area under coffee production will be influenced with a changes in non-price factors (whether/rainfall, policy and technology);

(iii) Policy adopted by the government has an impact on small-scale farmer's decisions about the area under coffee production.

The first chapter of the study looked at the trend of coffee production among small-scale farmers evaluating the output of coffee against the climatic, policy and price changes over the years. The study came up with three research questions which acted as the guided to scope of the study. The objectives of the study were: To estimate the long run acreage (supply) under coffee production by small-scale farmers to real producer prices; examine the influence of non-price factors (whether/rainfall, policy and technology) to changes in area under coffee production; and identify policy recommendations for the coffee industry in Kenya.

An understanding of how coffee farmers responds to real producer prices (transmitted from the international market to the farm-gate) and how factors (both price and non-price) such as input prices and rainfall influence farmers decisions on the total land they put under production was observed necessary for growth of coffee sector and effective policy reforms in the sector. Given importance of coffee productions as given by various research studies and economic reports the study was observed timely to come up with counter measures for the declining levels of coffee production and stagnated acreage in coffee production.

Literature on previous studies looking at agricultural output supply response to price and non-price factors was reviewed in the second chapter. The review indicated that the agricultural supply response to real long run prices and other non-price factors was significant. The response of agricultural output is, however, delayed by the period it takes to adjust and attain a change in output in response to the explanatory variables.

The study employed the Nerlove Model which involves the estimation of a partial adjustment model. It attempts to explain the behavioural changes of producers with respect to the production, consumption and exchange decision of a certain product or set of products due to changes in economic incentives.

5.3.1 Findings of the Research

It was observed that the amount of land under coffee cultivation by small-scale farmers is a function of the land that is currently held which holds a major influencing factor. The amount of land held currently for coffee cultivation has one year lagged positive response to the price of coffee, price of beans and technological advancements. The statistical coefficients influence observed on these variables were significant but below 10 per cent indicating that farmers though responsive to these variables will do so reluctantly. For the price variable, the reason for this observation could be that the land held by small-scale coffee farmers play the major role. Other than this reason, farmers will restrain from increasing the amount of land under cultivation since they are not sure whether the favorable conditions observed for coffee production are sustainable for a longer period.

It could also be that the coffee growing areas in the country already experiencing land pressure as a result of high population density and generally suffer land shortages because of fragmentation beyond economic sizes. This has an influence on land allocation whether or not real producer prices of coffee increases. Price incentives might well be reflected in form increased yields as opposed to increased land allocation as farmers intensify production within the existing holdings already devoted to production.

Furthermore, it also takes a longer period to prepare land for coffee cultivation and more so a longer period to develop the crop to start yielding output that would be sold and take advantage of the favourable conditions realized.

The result also reflects what has been confirmed by the Study by Branchi *et al* (1999) while analysing the impact of price policies on coffee production and exports in a selected group of developing countries, with particular focus on a select group of Sub-Saharan coffee exporting countries. According to the study price policies do not appear to exert any significant impact on yields/production. The results show that, in the case of coffee, the weight of domestic price policies in determining production and exports is relevant, but should not be exaggerated, as most of the cross-country variability in performance in the coffee sector is in fact related to non-price factors, some of which can be modified by strategic non-price policy.

Nyangito (2001), in the reviewed literature pointed out that the main reason for the general decline in coffee production in Kenya is that coffee farms have been neglected because they face production and marketing constraints and because of low payments for coffee delivered. The findings of this Study concur this assertion.

Average Rainfall in a year and the changes in government policy were observed to have a negative influence on the farm under coffee production in the year. The coefficients were also below 10 per cent though significant. Small scale coffee farmers supply response to average rainfall and the government policy were observed to have similar effects in the reviewed literature where it was observed that the weather conditions affect growth of the crop and yield. Excessive rains have been known to predispose coffee crop to certain

diseases such as the Coffee Berry Disease (CBD) which not only reduce the yields but also destroys the bean quality. For the case of a study undertaken by Nyong et al (2004) it is a common criticism of conventional supply response that the exclusion of non-price incentives weakens the strength of response of economic agents. This group finds the basis of its proposition on the basic Nerlove model of adaptive price expectations and partial adjustment, which makes use of both price and non-price factors as important determinants of farmers' supply response. This reinforces the findings of the study by Rudaheranwa *et al* (2003) which asserts that the non-price factors, if adequately addressed could be more significant in terms of raising the incentives of farmers to increase production.

The non-price factors in the case of our study average rainfall and government policy will have a contributing effect on the supply response of small-scale farmers in the country. Other studies on small scale farmers supply response to the amount of precipitation in the year have asserted that droughts reduce yields and bean quality as the coffee rust disease is more prevalent during the dry spells. Thus from these effects the land under coffee cultivation will decline with prolonged dry spells.

Inadequate extension services are particularly a big challenge to coffee production among smallholders. Training of agricultural extension workers by the government has been far in between in the recent years. Furthermore, training has not specialized, focusing more on general agricultural extension and not coffee extension.

Poor Governance in the cooperative societies which provide the institutional infrastructure, especially for coffee marketing, is regarded has one of the major dis-

incentives to coffee production in the recent years. Corruption among the management staff of such societies contributes declining farmers' returns as un-necessary deductions are made on their earnings while at the same time, reduced societies' capital base affect credit availability for farmers to purchase inputs. These are the reasons attributed to the negative relationship between the coffee farmer supply response and government policy.

5.4 Policy Recommendation

It is admissible that a solution to the crisis faced by coffee farmers, especially the small-scale producers, in expanding production cannot be deemed to be easy. The solutions need to combine elements of economic diversification, supply management, market regulation and other measures. Indeed it is apparent from cross-country growth differences is that most of the countries pursuing growth successfully are also the ones that have taken most advantage of international trade. The supportive evidence in favour of export-led growth and global trend towards trade liberalisation and which Kenya has adopted requires that the coffee sub-sector becomes competitive to be able to curve a niche in the world coffee market. This requires a combined effort to develop the coffee industry's production potential and move away from mere primary processing of beans towards product brand in coffee exports.

Policy Support

This study recommends that greater emphasis be placed on coffee production support policy. There are numerous factors hindering the expansion of coffee production in the country and the extensive reliance on coffee production as a major income earner is being diluted over time. The farmers are faced by price volatilities and inefficient price control systems to shield them from such volatilities.

Training on farming and marketing be provided to farmers and the coffee marketing boards so that the sector can embrace stability in income and productivity. The government should also review its farmer's input support to cushion them from the rising cost of production. This will help farmers' be more responsive to the changes in price by increasing their coffee yield through better and improved coffee production mechanisms.

Promote technology development and adoption

Technology advancements in the country have been observed as slow or slack. The government and coffee boards of Kenya should help small scale farmers to adopt the new technology through provision of loans and grants to help in the production activities of coffee.

Provide incentives to farmers

The study has established that small scale farmers' response to real producer prices and non-price incentives are positive but is small. Thus the factors that would influence increases in coffee production and greater responsiveness (elasticities) will need to be determined. It appears that this calls for well thought-out policy measures that provide for greater incentives to farmers, albeit within the context of a liberalised production and trade regimes. Studies on selected export commodities such as coffee shows that the "demand driven approach" to access of agricultural inputs by small-scale farmers seems to have reduced production incentives that should have accrued to farmers after liberalisation. Some peasant farmers are too poor to demand sufficient levels of agricultural inputs. Without reversing the policy of liberalisation, the Government should take consistent efforts to make farm inputs available to the small-scale coffee producers in the country.

Enhance institutional /regulatory regime

Proper institutional and regulatory regimes should be put in place to implement policy measures. Additionally facilitating farmer participation in policy debate should be an integral part of policy formulation process.

Enhancement of quality and Consistency

One area of structural change in the coffee supply chain which affects profitability hence the potential amount of land devoted to coffee production is in quality and consistency. The high value placed by consumers on consistency underscores the coffee industry's preference for steady and predicable quality given the costs and risks of sourcing from new suppliers. Kenya's coffee is known worldwide to be superior in quality which derives from its genetic origin of being the mild Arabica and climate of production which is the cool mountain areas of the Central Highlands and Highlands west of the Rift Valley. Farmers should therefore be supported in production to ensure consistency in quality of seedlings planted and inputs used. Equally, it is important to enhance efficiency in processing, storage and marketing of the processed product to ensure quality. The Coffee Research Foundation, the coffee regulatory agency, that is the Coffee Board of Kenya, millers, farmers, farmer cooperatives and other stakeholders should work together and institute measures that would ensure consistency in quality in the locally produced coffee.

Diversification of markets and product differentiation

Emerging markets in Asia, Eastern Europe, and the former Soviet Union which are not traditional coffee consumers are posting rapid growth in consumption (Levin *et al,* 2004).

Kenyan coffee exporters have opportunity to explore these markets. Moreover, product differentiation could also be an avenue for expanding market for local producers. Differentiated markets require that producers distinguish their products by distinct origin, defined processes, or exceptional characteristics such as superior taste or a few defects and include: geographical indications of origin (appellations); gourmet and specialty; organic; fair trade labelling; eco-friendly or shade grown; and other certified coffees. The Levin *et al* (World Bank 2004), however, observes that these differentiated can provide some producers with competitive advantages and added value; they are not necessarily easy to access and relatively small. But these markets are important because of their growth rates and potential to provide better social, economic, or environmental benefits to the local farmers. It is also observed these markets are breaking the pattern of declining producer share of revenue (World Bank 2004) which can be a boon to the local producers. By 2004, the differentiated markets imported 6-8 million bags of green coffee which represented about 9-12 percent of the total developed markets in North America, Western Europe and Japan.

Diversification of production to other crops

Diversification of some farmers away from dependence from coffee as a means of livelihood is a means of shielding them from lose of income associated with low producer prices. This is feasible in some geographic areas in Kenya, especially in the Central Highlands where horticultural farming has gained a lot of currency as an alternative to coffee production and due to its nearness to Nairobi which provides a ready market and also onward connection to the international markets.

Market Information

While the conditions of the coffee farmers could improve for a period as global supply aligns itself to the global demand to bring some recovery to the international prices, this might not bring to an end to their problems because the economic causes of the historic cycles in the global coffee marketing chain are likely to repeat themselves regardless. But given the cyclical nature of the current global coffee market, any price recovery is likely to be temporary while social, environmental and economic sustainability will remain. Again, structural changes in the ability to manage and finance global supplies and the perennial high weather-related risks also lower the potential of early price recovery to the previous reached highs. Furthermore, the structural changes in the global coffee industry in the recent times will have strong influence on the nature of these markets. Understanding theses changes is important and there is a compelling need for information flow to coffee farmers to make them understand the characteristics and nature of these structural changes and to also make appropriate decisions. The Government must then provide an enabling environment to alloy the farmers to successfully adapt to the new demands of the market place and to help them adapt.

Research and extension services

Fostering the necessary research and extension is required together with accompanying measures such as long-term programs to strengthen extension services through training and other capacity building measures.

Provision of Credit

The small-scale farmers should be empowered by supporting efforts to minimise price swings and expanding commitment to rural finance.

Risk Management

In the current situation of liberalised markets and diminished support state support to agriculture, it will be incumbent upon farmer and trade organisations to actively engage in the provision of necessary services. These organisations will also need to forge closure relationship and direct linkages with buyers and roasters to adequately respond to the demand of the market and to also form an integrated value chains that would assist in ensuring sustainability of these players in the value chain.

Focusing in Rural Development

The Government need to focus more on rural development that will increase competitiveness of agriculture, reducing dependency on coffee by farmers in the coffee growing areas and widening the range of products produced by the agriculture sector, improving production and marketing systems and supporting non-farm activities to broaden the income base.

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Appendix I: Data Used

obs	LOG(HA)	LOG(PRC)	LOG(PRB)	LOG(AVR)	LOG(TECH)	LOG(PLY)	LOG(CPRD)
1970	10.89303	1.736951	-0.174353	7.083388	0.000000	0.000000	10.17740
1971	10.92513	1.948763	-0.061875	6.791221	0.000000	0.000000	10.25281
1972	10.92029	2.199444	-0.328504	6.428105	0.000000	0.000000	10.45547
1973	10.92594	2.284421	0.285179	6.779922	0.000000	0.000000	10.61800
1974	10.96450	2.240710	0.512824	6.505784	0.000000	0.000000	10.47627
1975	10.94368	3.105035	0.636577	6.726233	0.000000	0.000000	10.49502
1976	10.94376	3.676807	0.636577	7.288928	0.000000	0.000000	10.77185
1977	10.94376	3.260785	0.636577	7.295056	0.000000	0.000000	10.77361
1978	11.04411	3.280911	0.636577	6.776507	0.000000	0.000000	10.73811
1979	11.17285	3.212053	0.746688	6.866933	0.000000	0.000000	10.85707
1980	11.34699	3.117065	0.788457	7.026427	0.000000	0.000000	11.06675
1981	11.48733	3.325036	0.797507	6.895683	0.000000	0.000000	10.86916
1982	11.52255	3.551914	1.297463	6.648985	0.000000	0.000000	10.86798
1983	11.64601	3.649099	1.297463	5.214936	0.693147	0.000000	11.22099
1984	11.66417	3.681855	1.297463	6.508769	0.693147	0.000000	11.12309
1985	11.67570	3.916015	1.771557	6.388561	0.000000	0.000000	11.13291
1986	11.66183	3.600595	1.840550	6.432940	0.693147	0.000000	11.12589
1987	11.66438	3.798854	1.781709	7.245655	0.000000	0.000000	11.34280
1988	11.66210	3.763987	1.954445	7.340836	0.000000	0.000000	11.26881
1989	11.67384	3.593469	2.045109	7.145984	0.000000	0.000000	11.14884
1990	11.69723	3.840312	2.093098	6.770789	0.693147	0.693147	10.64488
1991	11.69993	3.724729	2.197225	5.771441	0.693147	0.693147	10.65552
1992	11.71717	4.593705	2.437990	7.145196	0.693147	0.000000	10.59029
1993	11.71717	4.971756	2.736962	7.504942	0.000000	0.693147	10.86406
1994	11.71717	5.073047	3.178887	7.237778	0.693147	0.693147	10.94879
1995	11.71717	4.935481	3.221273	6.289716	0.000000	0.693147	10.55216
1996	11.71766	5.527443	3.354804	7.032624	0.000000	0.693147	10.42181
1997	11.75407	5.549776	3.125005	7.180831	0.000000	0.693147	10.59878
1998	11.75407	5.051905	3.113515	6.956545	0.000000	0.693147	11.03915
1999	11.75407	4.745714	3.169686	6.734592	0.693147	0.693147	10.07744
2000	11.75979	4.768649	3.591818	7.076654	0.693147	0.693147	10.12663
2001	11.75979	4.756947	3.306887	7.010312	0.693147	0.693147	10.26889
2002	11.75979	4.770091	3.449352	6.452049	0.693147	0.693147	10.43488
2003	11.75979	4.843872	3.506458	7.090077	0.693147	0.693147	10.30755
2004	11.75979	4.772716	3.324316	6.807714	0.693147	0.693147	10.10643
2005	11.75979	4.696107	3.340031	6.771363	0.693147	0.693147	10.20529
2006	NA	NA	NA	NA	NA	NA	NA

Appendix II: Authors Compilation of Secondary Data Collected

Years	Hectares	Nominal Producer price of coffee (US$/Kg)	Real Producer Price (US$/Kg)	Real Prod. Of Maize(US $/Kg)	Ave. annual rainfall	Output (tonnes)
1971	53,800	5.68	2.61	0.13	1192	26,302
1972	55,555	7.02	2.98	0.14	890	28,362
1973	55,287	9.02	3.63	0.16	619	34,734
1974	55,600	9.82	3.27	0.13	880	40,864
1975	57,786	9.4	2.32	0.11	669	35,464
1976	56,595	22.31	4.97	0.16	834	36,135
1977	56,600	39.52	8.15	0.16	1464	47,660
1978	56,600	26.07	5.10	0.17	1473	47,744
1979	62,574	26.6	4.90	0.14	877	46,079
1980	71,172	24.83	3.90	0.14	960	51,900
1981	84,710	22.58	2.33	0.10	1126	64,007
1982	97,473	27.8	1.88	0.07	988	52,531
1983	100,967	34.88	1.92	0.06	772	52,469
1984	114,235	38.44	1.69	0.07	184	74,682
1985	116,328	39.72	1.52	0.07	671	67,717
1986	117,677	50.2	1.77	0.07	595	68,385
1987	116,056	36.62	1.15	0.06	622	67,907
1988	116,353	44.65	1.11	0.05	1402	84,356
1989	116,087	43.12	0.81	0.04	1542	78,340
1990	117,459	36.36	0.53	0.03	1269	69,483
1991	120,238	46.54	0.50	0.03	872	41,977
1992	120,563	41.46	0.30	0.02	321	42,426
1993	122,660	98.86	0.27	0.01	1268	39,747
1994	122,660	144.28	0.32	0.02	1817	52,264
1995	122,660	159.66	0.38	0.02	1391	56,885
1996	122,660	139.14	0.27	0.02	539	38,260
1997	122,720	251.5	0.43	0.02	1133	33,584
1998	127,271	257.18	0.40	0.02	1314	40,086
1999	127,271	156.32	0.20	0.02	1050	62,265
2000	127,271	115.09	0.12	0.01	841	23,800
2001	128,000	117.76	0.11	0.01	1184	25,000
2002	128,000	116.39	0.11	0.01	1108	28,822
2003	128,000	117.93	0.11	0.01	634	34,026
2004	128,000	126.96	0.10	0.01	1200	29,958
2005	128,000	118.24	0.09	0.01	904.8	24,500