AN ECONOMETRIC SUPPLY RESPONSE MODEL FOR COFFEE IN UGANDA

BY

SARAH NAKABO

A Thesis

Submitted to the Faculty of Graduate Studies
in Partial Fulfilment of the Requirements
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ABSTRACT

Supply response models for arabica and robusta coffee were estimated using a supply function and a production function approach. Under the supply function approach a polynomial distributed lag formulation was used. Under the production function approach, a production function and profit function relationship was used. In both approaches it was found that the coffee supply is not affected by relative producer prices *per se* but by other factors. Robusta coffee supply was found to be price elastic and arabica coffee was price inelastic in the long-run.

Coffee pricing policy is being used as an instrument to achieve conflicting government policy objectives. The two conflicting policy objectives directly linked to coffee are maximising government tax revenue and foreign exchange earnings. Results have shown that the government neither maximised tax revenue nor foreign exchange earnings from coffee over the period 1965 - 1989. Moreover, the results suggested existence of a trade-off between maximising government revenue and foreign exchange earnings from coffee production.

Keywords: pricing policy, coffee supply response, government policy objectives.

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Finally, I would like to express the usual thanks to my parents and relatives of the Late Erifazi Mutayanjulwa family. It is they who have endured, not always silently, my absences and preoccupation with my studies for which I will always be grateful.

Dedicated

to my children Andrew and Josephine and
my husband Joseph

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Weights and Measures:

Unless specified otherwise, all quantities are metric.

Abbreviations used embrace:

ha	hectares
kg	kilogram.
km	kilometres.
md	mandays
mm	millimetres.
mt	metric tonnes.
USh	Uganda Shilling.
US$	United States dollar.

Abbreviations used:

APC	Agricultural Policy Committee.
AS	Agricultural Secretariat, Bank of Uganda.
CMB	Coffee Marketing Board.
CRP	Coffee Rehabilitation Programme.
CPSU	Central Processing and Storage Unit, Bugolobi.
EEC	European Economic Community.
ECU	European Currency Unit.
EPC	Effective Protective Coefficient.
GDP	Gross Domestic Product.
ICO	International Coffee Organisation.
IDRC	International Development and Research Council.
MOA	Ministry of Agriculture, Entebbe.
MOCM	Ministry of Co-operatives & Marketing, Kampala.
MOF	Ministry of Finance, Kampala.
MOPED	Ministry of Planning & Economic Development, Kampala.
NPC	Nominal Protective Coefficient.
NRM	National Resistance Movements.
UCA	Uganda Co-operative Alliance.
UCTU	Uganda Co-operative Transport Union.
UNCTAD	United Nations Conference on Trade & Development.

Years: The Uganda fiscal year runs from 1st July through 30th June. Crop years for coffee run from 1st October through 30th September.

Note: Interviews referred to in the thesis were carried out May - August 1990.

INTRODUCTION

Research on changes in agricultural supply improves understanding of the mechanisms of supply response along with the ability to forecast supply changes and competence to prescribe solutions to the problems related to agricultural supply. Supply response analysis is particulary needed because of the severe problems agriculture continues to face in adjusting supplies to market demands and confusion existing with respect to causes of these difficulties. A supply response relation specifies the output to price changes not holding other factors constant. Thus, a supply response may involve both movements along the supply curve and shifts in supply curve.

In Uganda, coffee plays an important role in achieving the objective of economic independence. At present, coffee dominates the economy and accounts for over 95% of the foreign exchange flow from merchandise sources. With over 65% of government revenue from agriculture, coffee accounts for over 90% of that revenue (Background to the Budget, 1989/90).

To increase coffee production to get back to its 1970s production levels, the government is faced with the following:

(a) encourage farmers to maintain average production with their ageing coffee trees below 40 years old through greater attention to cultivation aspects such as pruning, weed control, crop protection, and more complete harvesting; and

(b) encourage farmers to replace their coffee trees above 40 years old with new high yielding varieties.

The problem at hand is the designing of a pricing policy that will provide

incentives to coffee farmers to increase the production of coffee. The problem of 'getting price right' is not simple. Often the constant appeal to get producer prices right is not supported by analytical framework capable of treating the pervasive effects of government intervention in the marketing and pricing of coffee. The pricing policy go awry, not because the intended objectives of the policy are unclear but because their quantitative effects are inadequately understood and measured. To have an effective pricing policy the government must have a "reliable" estimate of the price elasticity of supply.

It is hoped that the results from this thesis will help the policy makers to design appropriate policies towards the coffee industry. To the best knowledge of the researcher policies in the coffee industry have been based on "descriptive" measures. This study may therefore, provide insights in the use of econometric modelling. To accomplish this, two different estimation approaches of the coffee supply response models will be considered, that is, the distributed lag approach and production function approach. Because of the data inadequacies only an aggregated model for each coffee type will be estimated, but if suitable data were available, estimated could be carried out on a more disaggreagated basis.

The pricing policy is being used as a policy instrument in achieving conflicting government policy objectives. With the knowledge of price elasticity of coffee supply the policy makers could identify the likely impact of the recommended pricing policy and the explicit trade-off between these conflicting policy objectives that may be involved.

This thesis presents supply response models for coffee which is mainly grown by small scale farmers. In many respects, coffee presents a rich field of inquiry for supply

analyst because first, there has been considerable variation in coffee prices overtime; second, it is a very important crop in Uganda's economy both as a major foreign exchange earner and source of government tax revenue.

Objectives

The overall objective of the thesis is to estimate the supply responsiveness of coffee. More specifically, the objectives of the thesis will be to:-

(a) Describe the market infrastructure and other aspects of marketing which influence production and the structure of the pricing system.

(b) Estimate the coffee supply response.

(c) Using (b), examine the impact of coffee price policy on foreign exchange earnings, and tax revenues.

This will be the first research of its kind to be carried out in Uganda and will lay a good foundation for further research; which will assist the government to understand the mechanism of supply response, the ability to forecast supply changes and the competence in prescribing solution to the problems related to coffee supply.

Chapter One gives background information. In Chapter Two, a detailed description of the market infrastructure and other aspects of marketing that influence coffee production, and the structure of the coffee pricing system, are presented together with their respective problems. In Chapter Three, the coffee supply response model is estimated using distributed lag and production function approaches. Chapter Four examines the impact of coffee price policy on foreign exchange earnings and tax revenues. Chapter Five presents conclusions.

Chapter One

BACKGROUND INFORMATION

1.1 Geographical Features

Uganda is situated in Eastern Africa, along the equator. It is a land-locked country, and bordered by Sudan in the North, Kenya in the East, Tanzania and Rwanda in the South and Zaire in the West. The distance of Uganda's eastern border with Kenya to the Indian ocean is more than 800 km. Uganda covers 236,000 square km, of which 18% is open water and swamp. Uganda contains large fresh water lakes, of which Lake Victoria, Edward and Albert are shared with neighbouring countries. These lakes and most of the rivers form part of the basin of the Upper Nile river.

Eighty four percent of the land area (excluding open water and swamp) forms a plateau between 900 and 1,800 metres above sea level. The western arm of the East African Rift Valley System accounts for the nine percent of the land area at less than 900 metres. This area includes the lowlands flanking the western lakes (that is, Lakes Edward and Albert) and the course of the Albert Nile river at little more than 620 metres. Mountains over 2,100 metres occupy two percent of the land area and these are above the limit of cultivation. The highest point is Mountain Stanely (which is 5,109 metres), in the Rwenzori group on the border with Zaire, but larger areas of highland are included in the Uganda portion of the volcanic mass of Mountain Elgon, near the Kenyan border. The remaining five percent of the land area lies at an altitude of 1,500 - 2,100 metres in both the eastern and western extremities which form the shoulders to their respective Rift Valley System.

Since Uganda is located between 1^0 30'S and 4^0N, temperatures vary little throughout the year, giving the country an equatorial climate modified by altitude. The areas bordering Lake Victoria and the mountains receive more rainfall than the rest of the country. The high ground of the West, the Central region, and the Eastern and North-Central interior all have over 1,250mm. Only the North-East and parts of the South (East Ankole) have less than 750mm.

1.2 Overview of the Economy

With about two thirds of the land area available for agricultural use, large areas of fertile soils, an equitable climate and adequate rainfall over most of the country, Uganda has a strong base for agricultural development. Most economic activities are closely linked to the agricultural sector which, besides feeding the urban population, contributes raw materials for the main components of the industrial sector; provides more than 65% of government revenue mainly through export duties on coffee, the country's principal export crop; produces most of the country's exports; and provides employment for over 80% of the rural population. Table 1.1 below, indicates that the GDP is dependent on the agricultural sector. Hence the development of the whole country is very much influenced by the performance of the agricultural sector.

Table 1.1

GDP Decomposition by Sectors (%) 1965 - 1985

Period	1965-70	1970-75	1975-80	1980-85
GDP Agriculture	65.9	70.3	72.8	72.8
GDP Services and Other	20.8	21.1	21.5	22.9
GDP Industry	9.7	8.6	5.7	4.3

Source : Venegas, pp30

1.2.1. 1960's and Early 1970's

During its first post-independence decade, Uganda experienced a relatively high rate of economic growth because of a stable political environment. The monetary agricultural sector expanded, in real terms, at an average annual rate of 4.6% and subsistence agriculture was estimated to have grown by an average of 4% per year (Venegas, 1990).

The main reasons for this sustained pace were:

- growth of rural production, in particular in agriculture;
- significant increase in the diversification of rural production characterised by coffee, cotton, tea, tobacco, livestock products and a wide range of food crops;
- growth of the manufacturing industries, especially crop processing, and electricity;
- the base for industrial production was going over the phase of import substitution into that of producing for export; and
- the expansion of social services, economic infrastructure, and supporting servicing.

1.2.2. Period 1975 - 1979

During this period besides the drastic decline in the production of the major export crops[1], the overall productive capacity was reduced by bottlenecks at the transport and processing stages, and by labour shortages. The labour shortage for the rural production especially for crops and livestock production was caused primarily by the presence of

[1] Coffee exports were down by more than 50% while exports of other crops virtually ceased altogether.

more profitable alternative activities in the informal sector of the economy. The departure of migrant labour to their home countries worsened the situation. This led to an increase in the real wage for labour which some farms were not able to afford.

The declining trend was a direct consequence of inappropriate policies which were responsible for: a decline in the major export crops; the overwhelming and increasing dependence upon coffee for Uganda's foreign exchange earnings as cotton abdicated and tea abandoned; the smuggling of large quantities of primary produce especially coffee across the borders[2]; and the switching of agriculture resources from producing for export into food crops in areas with access to urban markets. Owing to the shift in the structure of relative prices, productive resources have been switched into increasing the output of food crops[3] with uncontrolled prices, brewing and distilling activities, supplying the thriving and lucrative "magendo" markets, and smuggling activities.

When the coffee boom ended in 1978, Uganda entered into it's worst crisis in its history and this was intensified by the above enumerated inappropriate policies. This led to a drop in export earnings. Furthermore, public spending increased sharply, generating a deficit which was financed largely by foreign borrowing. In addition deterioration in terms of trade brought about the exhaustion of monetary reserves, and this situation was exacerbated further by higher interest rates in the international markets.

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[2] In the South and East farmers were able to grow coffee which was smuggled profitably across the borders.

[3] It was however, reported that food production declined during 1978/79, due to the impact of the war and subsequent security problems, as well as two successive droughts in the annual crop growing zones.

1.2.3. Period 1980 - 85

In the earlier part of the 1980s some reforms were introduced. However, despite some recovery, the money supply between this period increased at an annual average of 75% per year, the deficit moved from 2.6% to 2.9% of GDP, government expenditure towards the agricultural sector contracted from 6.5 % to 5.8% of GDP, inflation accelerated and the exchange rate became overvalued (Background to the Budget, 1986/87). Moreover, imports expanded more rapidly than exports and the terms of trade deteriorated. The principal use of capital funds was to finance the foreign exchange costs of a significant portion of Uganda's general imports requirements, with emphasis on recurrent inputs, as well as of selected consumer essential goods. The political instability and insecurity in the country led international agencies and individual donors to hold back the assistance they had earmarked to Uganda.

1.2.4. Period 1986 - 1990

The economy registered a remarkable improvement in 1987 compared to previous years. Real GDP rose by 4.1%, with the monetary sector rising by 4.0% and the non-monetary sector by 5.6%. Performance on a sectoral basis was however, very patchy. The agricultural sector grew at 6.2%, with the monetary sector expanding at 5.5% and the non-monetary sector at 6.8%. The latter growth was mainly due to an increase in food production. Coffee production grew at 11%, tobacco at 44% and tea at 9.3%. However, there was a remarkable decrease in cotton production by 40% and this was due to the intermittent insecurity in Northern Uganda (Background to the Budget, 1988/89). From

Table 1.2 below, during the years 1987 and 1988 the rate of imports growth was higher than that of exports growth. In 1989 and 1990 the export growth rate was higher than that of import growth rate. Furthermore, from Table 1.2 the proportion of people engaged in agricultural showed a declining trend - as more people continued to move into the informal sector. In spite of a decline in government spending towards agriculture, Uganda was able to feed its growing population during this period.

Table 1.2

Some Selected Indicators for the Period 1986 - 1990

Indicators	1986	1987	1988	1989	1990
Economic:					
Real GDP growth rates[1]	-6.1	4.1	6.7	6.3	6.0
Per Capita GDP growth	-8.9	1.1	3.7	3.1	3.0
Exports growth rates[2]	16.9	-14.7	-7.3	16.5	15.0
Imports growth rates[2]	11.0	20.3	17.9	7.6	6.3
Terms of Trade[3]	113.8	69.3	79.8	88.3	73.6
Agriculture:					
Food Production	132.8	133.4	133.0	130.2	129.7
Labour force (%)	85.0	85.7	84.9	84.3	84.0
Real GDP growth rate	-3.6	2.9	1.1	1.0	2.5
Food Self-sufficiency ratio (%)	96.3	97.2	98.4	98.2	98.6
Government Expenditure	4.8	5.1	4.5	4.0	4.0

Source : Venegas, pp33
Notes : (1) Index 1980 = 100;
(2) US$ nominal;
(3) Index 1979-81 = 100.

1.3 Overview of the Coffee Industry

From the turn of the century, Uganda was known as a producer of fine quality arabica coffee (now know as the Bugisu arabicas). The Bugisu arabicas are grown at medium altitudes in the Mountain Elgon region, on the Rwenzori mountains in Western Uganda and Nebbi County in Northern Uganda. The Bugisu arabicas, which form the backbone of Uganda's arabica production, are of the "Nyasa" variety of coffee arabica. These mild arabicas were in demand in the quality conscious markets of Europe but never quite achieved the celebrity of the Kenya or Tanzania mild arabicas.

In the 1950's, the increasing popularity of instant coffees created a high demand for robusta coffees. The robusta coffees were preferred by the manufacturers of instant coffee over arabica coffee as a basic starting material. Uganda had a major natural advantage in supplying this new market requirement. Coffea canephora (robusta coffee) was indigenous to Uganda. It required no initial introduction of novel varieties but simply the multiplication of existing native coffee trees (known as "nganda" robusta). Later the introduction of the "erecta" form of robusta coffee, selected by the Dutch for use in their Indonesian plantations, was a response to the increasing commercialization of robusta coffee in Uganda. The "erecta" form of robusta lends itself to more efficient commercial scale harvesting. Ninety three percent of robusta coffee is grown in the "fertile crescent", a belt stretching from Masaka in the South to South Busoga in the North, with an "inward depth" of 40 -70 km. The maximum width of the crescent is achieved in the Mubende - Luwero area.

Before independence and during the 1960's, coffee was grown on coffee estates and by individual small and large scale farmers. Most of the estates were owned by non-Ugandans, especially of Asian origin. When Amin expelled the Asians from Uganda in 1972 (that is, when he declared the Economic War) these estates were abandoned and taken over by the government. Because of the limited managerial capabilities of government appointed managers, the output from these farms declined over time. At present, most of the coffee is grown primarily by more than 1 million small scale farmers. The average farm size per farmer is estimated to be 2.2 ha.

Hectarage and production of coffee expanded rapidly during the 1950s, in response to higher producer prices. By 1962 coffee was Uganda's major export earner (World Bank, 1982). In Uganda, robusta coffee occupies the larger area under coffee compared to arabica coffee. This is illustrated in Table 1.3 below:

Table 1.3

Uganda Average Coffee Hectarage ('000ha) 1965/66-1988/89

Period	Arabica	Robusta	Total
1965/66 - 1969/70	21.18(8.4)	242.64(91.6)	263.82
1970/71 - 1974/75	28.76(11.6)	218.14(88.4)	246.90
1975/76 - 1979/80	32.92(14.7)	190.68(85.3)	223.60
1980/81 - 1984/85	30.60(13.6)	194.00(86.4)	224.60
1985/86 - 1988/89	30.00(12.9)	200.95(87.0)	230.95

Source : Author's calculations based on Appendix I and II.
Note : Figures in brackets indicate the % share for each coffee type.

From Table 1.3, the hectarage under arabica coffee increased until the period 1975/76 -

1979/80 and thereafter started declining. On a crop year basis, it is noted that between 1982/83 to 1988/89 hectarage under arabica coffee remained constant at 30,000 ha (see appendix II and figure 1.1). When the arabica coffee hectarage (% share) was declining, that of robusta coffee started increasing. Arabica coffee is primarily grown along the borders, and when coffee smuggling was escalating it led to an increase in arabica coffee hectarage. The decrease in arabica coffee hectarage afterwards exhibits the government's tightened measures across the borders to control coffee smuggling. The lowest level in robusta coffee hectarage and total coffee hectarage transpired during the period 1975/76 - 1979/80. As already discussed, this is the period when the Uganda economy was hit most due to inappropriate policies.

In an interview with officials in the MOA, it was reported that the new coffee plantings have been very poor since the 1970's. The main reasons for poor new plantings were the low producer prices and inadequate marketing infrastructure. A shift of hectarage from one district to another was also reported. For instance, in Mpigi district which was once one of the major coffee producing districts, the hectarage under coffee decreased because farmers realised that it was more profitable producing food crops which had an already existing domestic market than coffee. At present, districts like Mubende which was once the smallest producer of coffee have come up as the major producers - the reasons being the non-perishable nature of coffee and being located far away from the capital city than districts like Mpigi. This has created problems because the existing coffee physical infrastructure in the traditional major coffee growing areas can not be

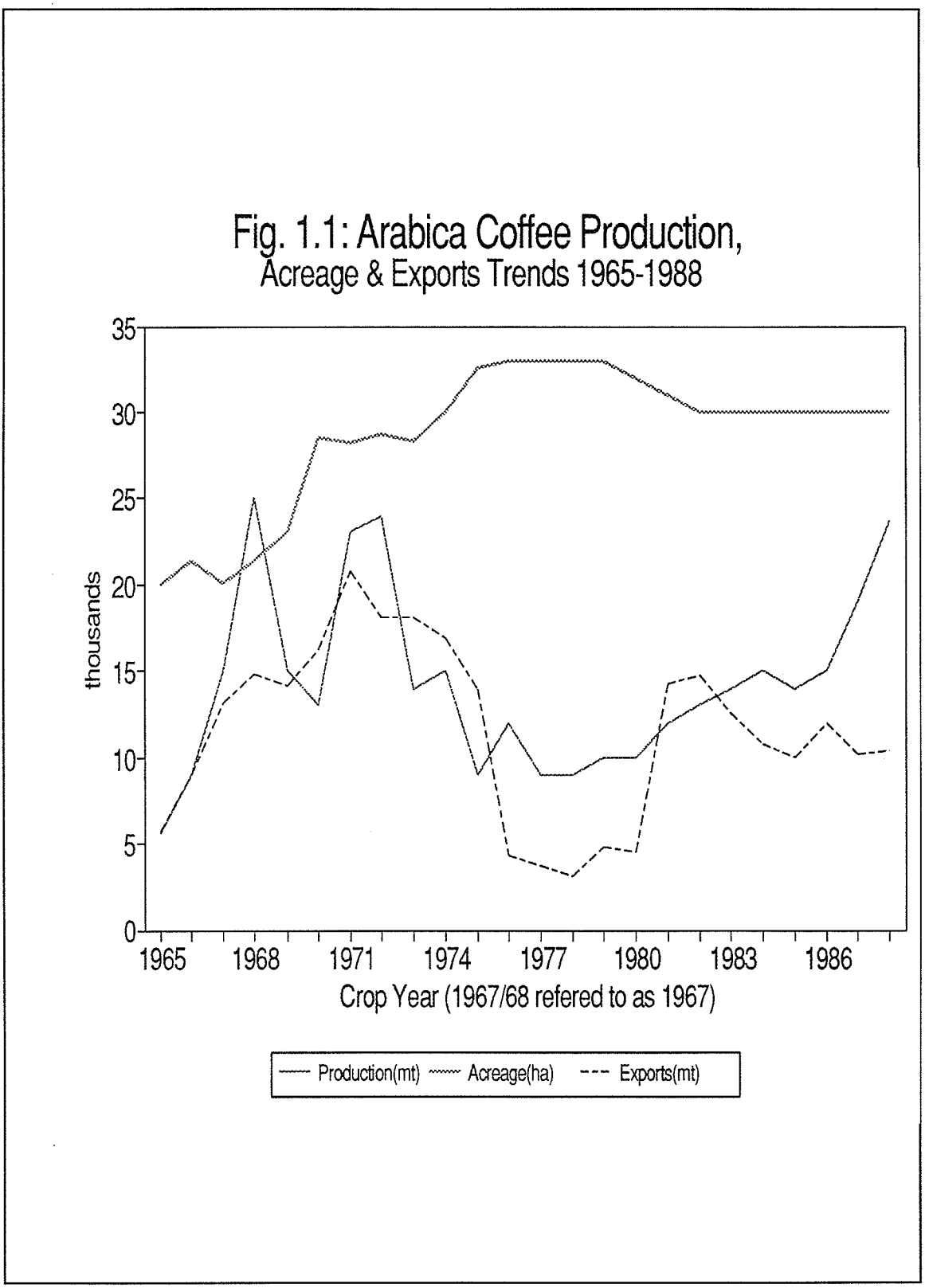


Fig. 1.1: Arabica Coffee Production,
Acreage & Exports Trends 1965-1988
thousands
35
30
25
20
15
10
5
0
1965
1968
1971
1974
1977
1980
1983
1986
Crop Year (1967/68 refered to as 1967)
Production(mt)
Acreage(ha)
Exports(mt)

transferred to the newly coffee growing areas.

Given in Table 1.4 below is average coffee production data based on coffee deliveries to CMB. From Table 1.3, the highest hectarage in arabica coffee transpired during the period 1975/76 - 1979/80 and in Table 1.4 below this is the period when the marketed output was lowest. This reflects the incidence of smuggling rather than any significant decline in production. The trend in robusta and total coffee production exhibited the same trend as the hectarage.

Table 1.4

Uganda Average Coffee Production ('000mt) 1965/66-1988/89

Period	Robusta	Arabica	Total
1965/66 - 1969/70	155.14	13.90	169.04
1970/71 - 1974/75	180.00	17.80	197.80
1975/76 - 1979/80	120.40	9.80	130.20
1980/81 - 1984/85	167.80	12.80	180.60
1985/86 - 1988/89	202.03	17.90	219.93

Source: Author's calculations based on Appendix I and II.

On crop year basis, the highest level in robusta coffee and total coffee production transpired in 1972/73 whereas that of arabica coffee transpired in 1968/69. Since 1973/74 the robusta and total coffee production levels have not been able to maintain their 1972/73 levels (see Figures 1.2 and 1.3). The main factors responsible for the decline in robusta production were related to pricing and marketing policies. However, there were other factors which contributed to the decline in production. These included :

Fig. 1.2: Robusta Coffee Production,
Acreage & Exports Trends 1965 - 1988.

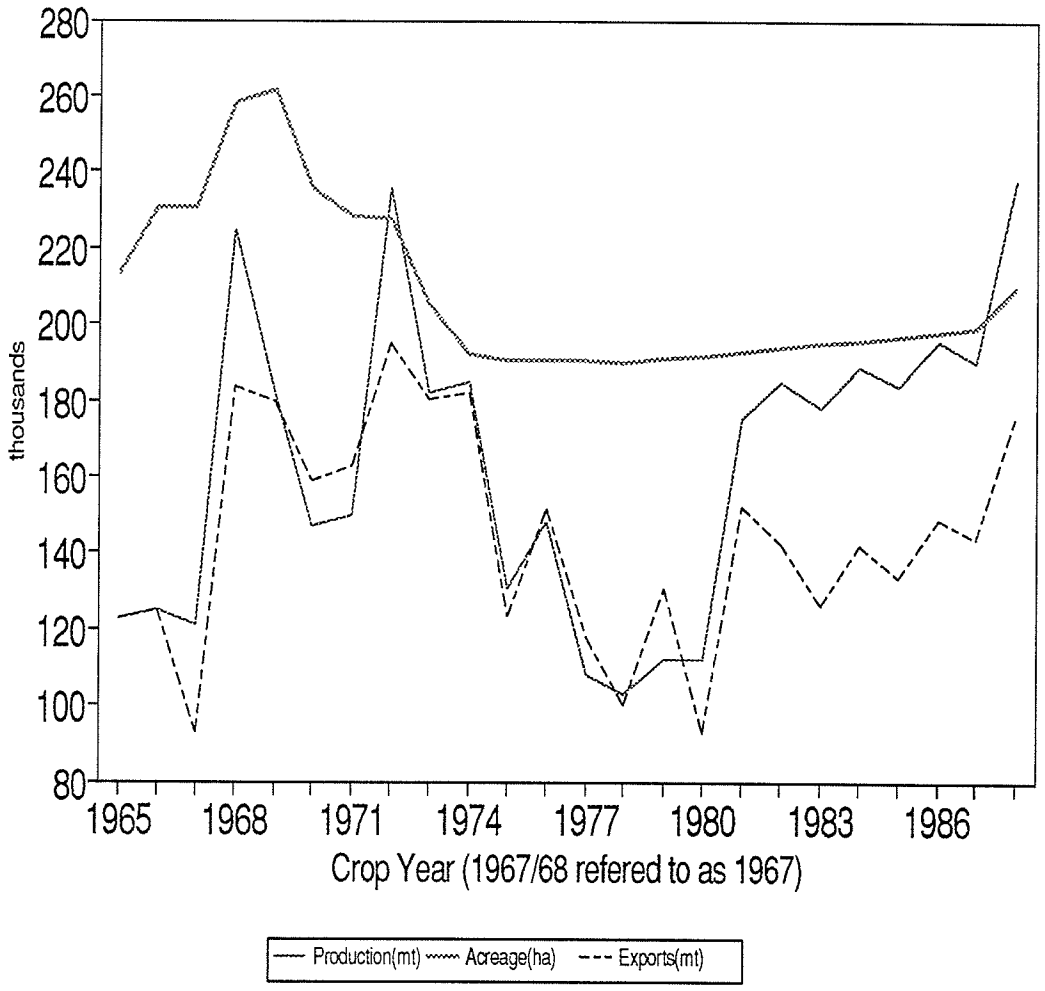
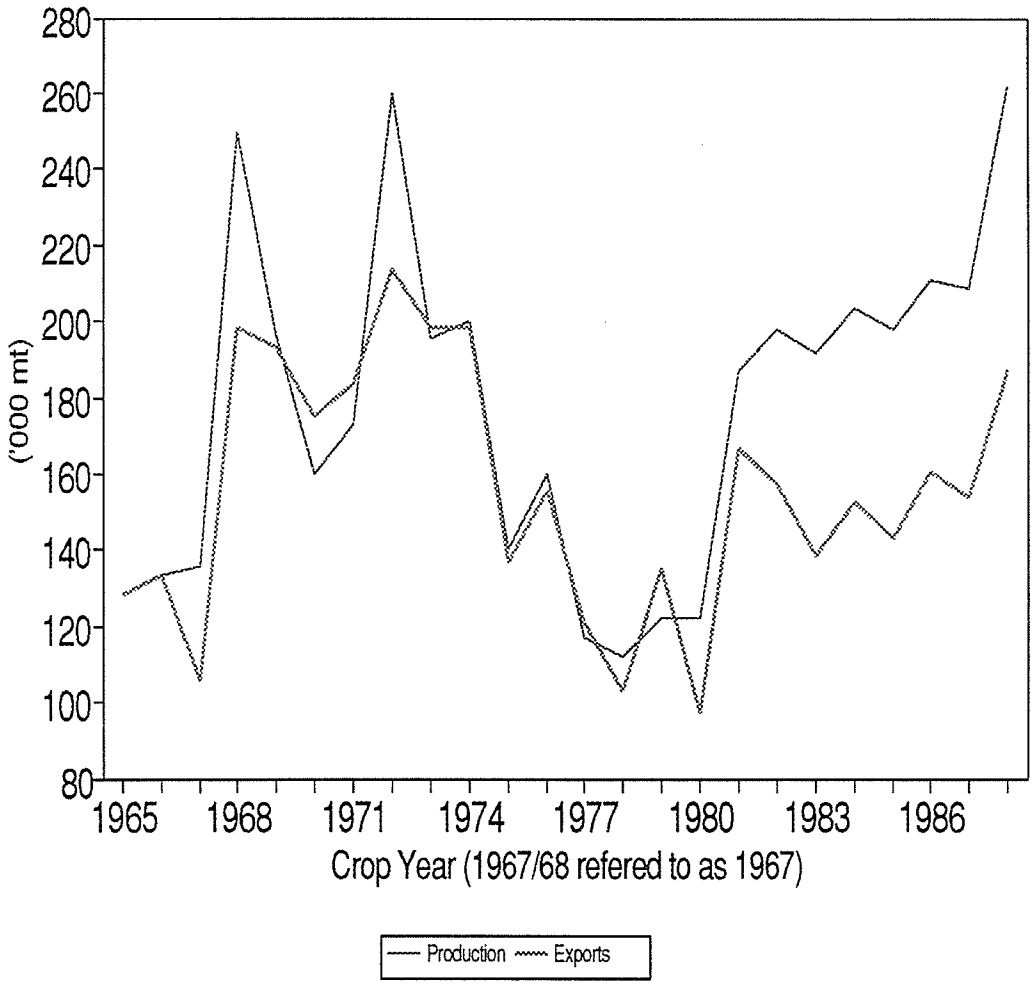


Fig. 1.3: Total Coffee Production And Exports Trends 1965/66 - 1988/89



(a) Shortages of herbicides and hand pumps. These were unavailable due to the foreign exchange constraint, but could otherwise have provided an effective alternative to hand-weeding[4].

(b) Lack of hand tools with which to carry out basic field work.

(c) Lack of improved planting materials to replace abandoned coffee.

(d) Most of the coffee trees are over 30 years old, therefore cost of production is high and has affected coffee yield per tree.

(e) The high opportunity costs have affected care of the crop.

(f) The poor morale and mobility of extension staff to provide advice on herbicide use, pruning and control of pests and disease.

(g) The civil wars especially between 1980 - 1985 caused the trees to be unattended for a long time in some districts as the Luwero Triangle.

(h) A shortage of labour. On the smaller holdings this has resulted in an increased work load for the family. On larger coffee holdings it has led to lower standards of husbandry (especially weeding and pruning) and on some pure coffee farms, partial abandonment of the crop. In an interview with some farmers, it was reported that if labour is available it was too costly for them to maintain.

Officially marketed arabica production showed a declining trend from 1973/74 until 1978/79 (see appendix II and figure 1.1). This would plausibly reflect the incidence of smuggling in Kenya rather than any significant decline in production. The closeness to the Kenya border has also helped the arabica farmers overcome domestic shortages of

[4]Without adequate weeding and pruning, use of other yield improving inputs, such as fertilizers, is unlikely to be economic.

basic tools. Labour shortages have not been a major obstacle as in the robusta growing areas. The major arabica production problems have been:

(a) shortages of essential fungicides, insecticides, and pumps to help control the growing occurrence of coffee rust, coffee berry diseases and insect damage[5]; and

(b) inadequate producer price.

Table 1.5 below shows that domestic coffee consumption in Uganda has been very low compared to total production. This is common in many coffee producing countries in Sub-Saharan Africa. In most cases the reason for low coffee consumption is attributed to the fact that coffee is an expensive commodity in relation to income.

Table 1.5

Uganda Domestic Coffee Consumption (mt)

Crop Year	Quantities Consumed	Consumption as percentage of production
1968/69	960	0.004
1972/73	1,320	0.005
1976/77	1,800	0.011
1979/80	2,460	0.020
1980/81	2,580	0.021
1981/82	2,700	0.014
1982/83	2,760	0.014
1983/84	2,820	0.015
1984/85	2,880	0.014
1985/86	3,000	0.015
1986/87	3,060	0.015
1987/88	3,180	0.015

Source: UNCTAD, 1988

[5] Arabica coffee is more susceptible to diseases than robusta coffee.

From Table 1.6 below, the lowest coffee export peak was during the period 1975/76 - 1979/80. Export trend reflected the production trend (see Figures 1.1, 1.2 and 1.3). Uganda was unable to benefit fully from the high international prices in 1976/77 because of transportation difficulties; the temporary closure of the border with Kenya in 1976; and the lack of foreign exchange, even to buy bags for coffee. Weekly Topic (1992) reported that during the coffee boom in 1976/1977, Kenya exported three times the amount of coffee more than it produced. These coffee exports in Kenya were boosted by the coffee smuggled from Uganda.

Table 1.6

Uganda Average Coffee Exports ('000mt) 1965/66-1988/89

Period	Robusta	Arabica	Total
1965/66 - 1969/70	140.75	11.34	152.09
1970/71 - 1974/75	176.03	18.06	194.09
1975/76 - 1979/80	124.55	5.94	130.49
1980/81 - 1984/85	131.24	11.36	142.60
1985/86 - 1988/89	150.57	10.61	161.18

Source : Author's calculations based on Appendix I and II.

Uganda's share in world coffee exports have also fallen mainly because of low production levels, lack of transport and spare parts, and coffee smuggling activities across the borders. In 1986 when the National Resistance Movement (NRM) came into power, coffee exports were temporarily halted, with the result that Uganda failed to benefit from the then prevailing high prices for coffee on the world coffee market. Although exports were resumed later in the year, the total quantity for the 1985/86 coffee year was 143,280

mt. World coffee prices later declined sharply, and the International Coffee Organisation (ICO) did not reach an agreement on a new quota arrangement until early October 1987. Uganda coffee exports in 1987/88 were only 153,600 mt, the decline being partly attributable to a dispute between Uganda and Kenya and the obstruction by the Kenyan government of Ugandan coffee exports during 1987. The NRM government measures to affect a transfer to rail freight for all Ugandan trade was one of the causes of tension with Kenya during early 1987, owing to loss in earnings that this represented for Kenyan trucking firms. Since early 1988, nearly three quarters of the coffee has been transported by rail to Mombasa and the remainder to Dar es Salaam.

The share of Uganda in total exports and world coffee export market share by coffee type are summarised in Tables 1.7 and 1.8 below respectively :

Table 1.7

Uganda Share in World Coffee Export Markets (%)
1965/66-1988/89.

Period	Robusta	Arabica	Total
1965/66 - 1969/70	16.50	0.40	4.80
1970/71 - 1974/75	18.20	0.73	5.64
1975/76 - 1979/80	13.30	0.23	3.76
1980/81 - 1984/85	13.20	0.39	3.62
1985/86 - 1988/89	14.90	0.34	3.92

Source: Author's calculations based on Appendix I, II and III.

From the Table 1.7, Uganda's average share in the world coffee market for both

coffee types reached a peak in the period 1970/71 - 1974/75, thereafter started declining until when it started rising again in the period 1985/86 - 1988/89.

Table 1.8

World Coffee Export Market Shares(%) by Type
1965/66-1988/89.

Period	Robusta	Arabica	Total
1965/66 - 1969/70	27.2	72.8	100
1970/71 - 1974/75	28.1	71.9	100
1975/76 - 1979/80	26.9	73.1	100
1980/81 - 1984/85	25.3	74.7	100
1985/86 - 1988/89	24.7	75.3	100

Source: Author's calculations based on Appendix III.

From Tables 1.7 and 1.8, Uganda's arabica exports did not keep pace with the expansion in world arabica exports. This was due to smuggling activities across the border which led to a decrease in the quantity of arabica coffee marketed output. The proportion of world robusta coffee exports reached a peak of 28.1% during the period 1970/71 - 1974/75 and a low of 24.7% during the period 1985/86 - 1988/89 - this reflects a general shift in preference of arabica to robusta coffee. Uganda's share in world robusta coffee exports only showed a decline during the war times and civil disorder in the late 1970's. Otherwise Uganda's robusta coffee exports have reflected the pattern of world robusta coffee exports that is, a peak of Uganda's share of 18.2% in 1970/71 - 1974/75.

The coffee industry plays an important role in achieving the objective of economic

independence in Uganda. At present, coffee dominates Uganda's economy and accounts for over 95% of the foreign exchange inflow from merchandise sources and with over 65% government revenue from agriculture, coffee accounts for over 90% (Background to the Budget, 1989/90). This indicates the country's inability to implement successfully an diversification policy[6], either within the agricultural sector or other sectors like tourism, energy and industry to mention a few.

By the latter half of the seventies, the government had realized the need for a major rehabilitation of the coffee industry and discussions were commenced with interested financial donors. The Coffee Rehabilitation Programme (CRP) funded through a 25 million ECU grant from the EEC was mounted in 1982. The major objectives of the CRP were to arrest the decline of coffee production, increase production, and improve the coffee quality. This project ran to 1986, during which the following areas of operation were covered: provision of production inputs, like fertilizers; research support; extension services and training; and processing and/or marketing. Field activities included rehabilitation of coffee factories, pruning and spraying, and some replanting. The replanting programme slightly led to an increasing trend in the area under robusta while that of arabica remained at 33,000 ha (see Appendices I and II; figures 1.1, 1.2 and 1.3). In spite of the rehabilitation efforts, low producer prices and delayed payments to farmers have proved to be negative factors to farmer's motivation.

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[6]This inability to develop other export-competitive activities may be related to the bias in infrastructure towards coffee.

The demise of the ICO in July 1989 and Uganda's weakness in coffee exporting markets, have together had a serious impact on the economy and the government. Robusta coffee, which accounts for the bulk of production and exports, has been especially hit by the slump in prices. However, given that the development of alternative agricultural export crops takes time, coffee will remain Uganda's hard currency earner for some years to come.

Chapter Two

COFFEE MARKETING INFRASTRUCTURE AND PRICING SYSTEM

2.1 Harvesting and Drying Methods

The common harvesting method used by the farmers is to strip the branch of ripe cherries. However, sometimes green and over-ripe beans are picked which results in many defects such as discoloured, shrivelled, and immature beans appearing in the clean hulled coffee - as the equipments in the primary processing factories can only remove a certain proportion of these defects. Robusta coffee harvesting is carried out throughout the year while that of arabica coffee is between October and November of every year.

The robusta drying process involves moving the cherries under the sun and making sure that they are not affected by rain or dew. They have to be stirred regularly until they are fully dry, normally after three or four weeks. The dried cherries (also known as kiboko) are sold to hullers. Kiboko which has been carefully dried has a brown polished appearance free from fungal growth. It is dried to twelve percent moisture content, though in practise it is often more than fourteen percent.

Most common methods used by the farmers to sun dry their robusta coffee[1] cherries are:

(i) Barbecues constructed from dried mud. This is the worst method of drying. After rain, water lies on the barbecue and soaks into the cherry. When this method is employed the dried cherries are invariably covered with white fungal growth, and

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[1]Some wet processed pulped robusta was produced privately during the 1960s, but this is uneconomic at present price differentials.

when liquored the coffee is often found to be tainted. This drying method results in sand and small stones being mixed with dried cherries and this results in consequent high wear and tear of the hulling equipment. This contributes to depressing the throughput and capacity utilisation rates.

(ii) Locally made mats, spread on the ground or raised on wooden tables. This method is better than method (i) above so long as the mat is raised on a wooden structure above the ground.

(iii) Wire bottomed trays or tables. This method is the best of all the three methods mentioned, because of the existence of good-all-round air circulation. Wire bottomed trays lend themselves to easy removal and stacking away at night for security, or when rain is imminent.

Arabica coffee primary processing is mostly done by the wet pulping method, especially in the Mountain Elgon areas. The drying process used for robusta coffee can also be used for arabica coffee, however, this will lead to reduced quality of the arabica coffee. Many of the pulpers are now defunct and lack motors, water supply, and drying tables or pulping discs. At present the arabica coffee farmers have resorted to a labour intensive process of using hand pulpers. The cherries are picked and transported to a hand pulper, and after removal of the skins the pulped beans are taken back to the farm. The owner of the pulper normally takes a fee of pulped beans for his services. Back at the farm the mucilage on the beans is first fermented. The beans are then washed and dried to be ready for sale.

Of all the above robusta coffee drying methods, method (i) is mainly used. The farmers do not have incentives to improve on their harvesting and drying methods. As a result, the kiboko received by the hullers is often of poor quality. This leads to poor quality of coffee not only in the domestic market but also in the world coffee market. This will be discussed in more detail in the next chapter.

2.2 Storage Facilities

Storage of kiboko is much more important as the quantities involved are much larger than those of clean coffee. The kiboko is either stored in bags/sacks or in bulk. Storage facilities at farm levels are exceptionally poor because farmers do not have incentive to improve on these facilities. In a survey of hulling factories carried out by MOCM in 1988, it was found that kiboko storage capacity at hullers was adequate for the current coffee production. Furthermore, the large increases in the number of hullers over the last years has speeded up the throughput and considerably reduced storage capacity requirements.

2.3 Agricultural Extension Services

An important objective of agricultural extension services is to increase the knowledge of farmers about crops and cropping practises. Bibangambah (1982) gives criticisms of extension services in Uganda as follows:

(a) ratio of extension workers is too small to serve effectively the large farm population, given the problems of illiteracy of the farm families, lack of

agricultural supporting services and lack of adequate transport;

(b) these extension workers have often looked down to farmers rather than advising them;

(c) there has been close liaison with research institutions and staff, and because of the narrow technical orientation of the agricultural research, recommendations offered by extension workers are often impractical and of little use;

(d) extension work has had limited results, partly because extension advice has not been integrated with a delivery system for inputs, credit and marketing facilities; and

(e) the effectiveness of the extension service has been greatly restricted by shortage of operating funds.

UCA (1989) reports that given the agricultural potential of Uganda, substantial yield increases could be achieved through improved practises. Improved practises by farmers will be achieved through elimination of constraints facing the provision of agricultural extension services. The efforts to increase productivity in the agriculture sector, in particular the coffee industry, must begin with improving the provision of the above mentioned services, otherwise the yields will remain low even if more machineries are made available to farmers.

2.4 Crop Finance

Crop finance is a new government approach that was set up to buy farmers' coffee on the spot and the government earmarks a certain amount of money in its budget. This

money is lent to coffee unions and primary societies through the commercial banks - guaranteed by the Bank of Uganda - for purchasing coffee from farmers. The problem of crop finance centres around adequacy, timing, institutional arrangement and financial management. At the national level efforts have been made to streamline the arrangement, for instance, the setting up of the Crop Finance Consultancy Committee under the Chairmanship of the Governor, Bank of Uganda. However, no progress has been made in the monitoring of the crop finance utilisation and recovery at the unions and primary society's level. This has resulted into farmers not being paid promptly for the crop delivered.

In the field survey carried out by the AS in 1985 the following were the findings:-

(a) At the union level it was found out that 32.1% of total coffee deliveries by farmers were unpaid and 12.9% of total funds borrowed were diverted to other purposes.

(b) At the primary society's level it was found that 83.8% of total coffee deliveries by farmers were unpaid and 17.5% of the funds borrowed were diverted in other purposes.

As a result of the joint efforts between the UCA, MOCM and the Coffee Desk of the Bank of Uganda, there has been some improvements in timely payment at the top, that is, from CMB to unions (UCA, 1989). However, according to the survey findings reported by UCA, a lot needed to be done to improve payments at low level, that is, from societies to farmers. The benefits of the new crop finance arrangements had not reached these levels. During an interview with some society officials in Luwero and Mukono

districts, it was reported that inadequate crop finance was a major factor for their low turn-over. To increase their turn-over, the primary societies must improve further their payments to farmers. This has a significant implication that prompt payments to farmers may even have stronger incentive than the producer price *per se*. If co-operatives paid more promptly than they are doing now they would handle most of the coffee again. Co-operatives particularly unions must avoid getting unnecessary crop finance from the banking system. For efficiency, unions must put more emphasis on rolling crop finance rather than accumulating the amounts they receive from the banks. Otherwise, it would be a cost to the entire economy to tie up resources unnecessary for long periods.

2.5 Agricultural Credit Facilities

Up to 1987 there was no institutional arrangement to cater for the credit needs of farmers for production inputs and technological development. In 1988, the Uganda Commercial Bank Rural Farmer's Scheme was set up to assist farmers with credit facilities. However, in an interview with some farmers it was reported that this credit scheme was more biased in favour of the rich and livestock farmers. These coffee farmers urged to be assisted on favourable terms from this scheme. The technological development of farms and increase in production can not be achieved unless the farmers are provided with credit facilities.

2.6 Marketing System

Uganda's coffee export market system is a recognisable descendant of the system which operated before 1962. Uganda's coffee sector, like other export-oriented agricultural sectors was created by colonial power. As such, its prime mover was the colonial administration. The system has undergone certain changes since independence; but it is still very much the same as it was.

This system met the needs of the time, and there are elements of the structure which are still useful today; but in all aspects, it is ill-suited to present-day political and economic circumstances. It is essentially a static system, which prevents its participants from responding to changing market needs. It prevents competition and encourages inefficiency. This has resulted into higher export marketing costs in Uganda than among many of its competitors.

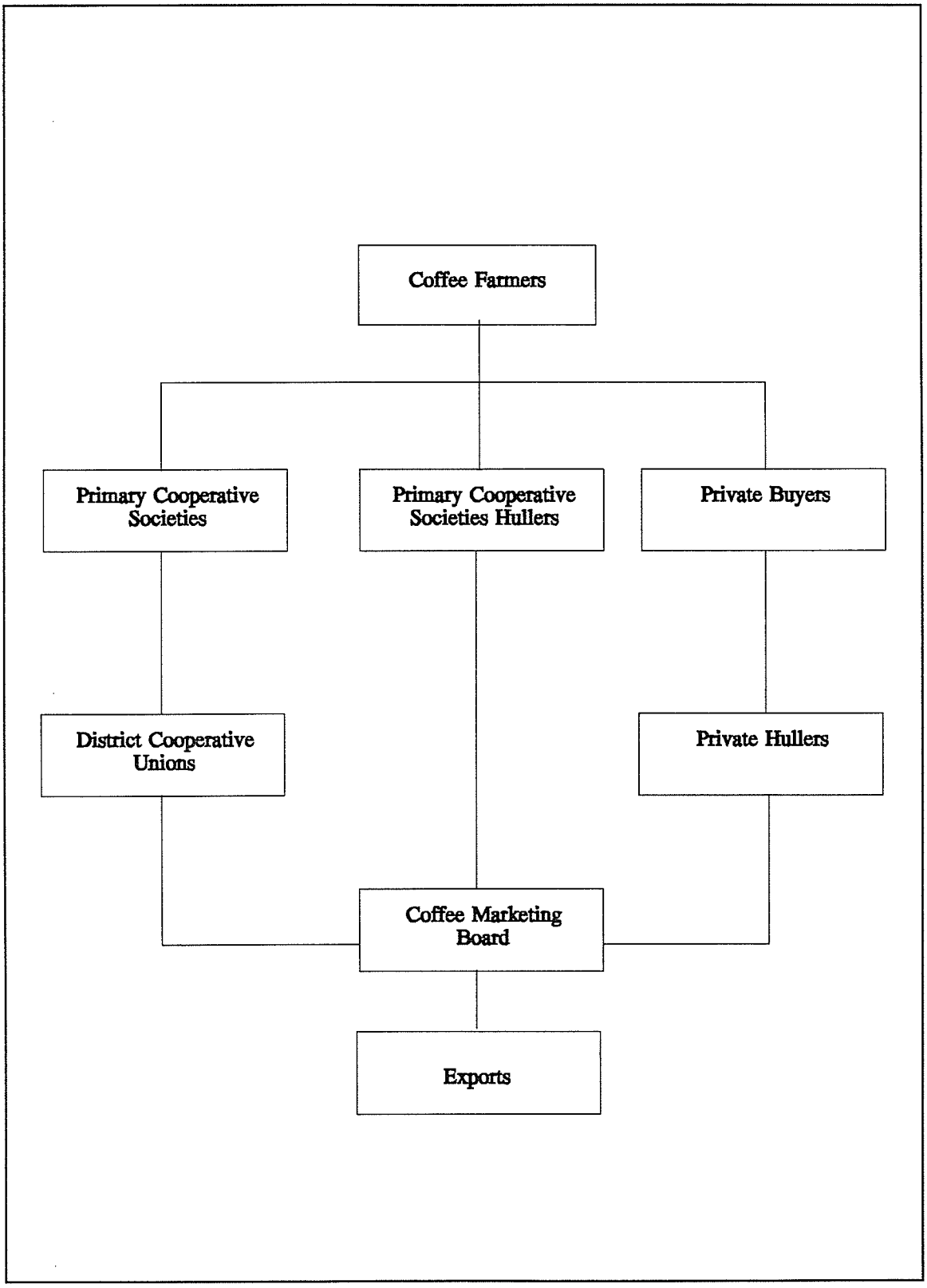
Farmers sell coffee either to primary cooperative societies or to private buyers. Of recent farmers have preferred selling their coffee to private buyers than to primary societies because with the former they are paid cash for their kiboko coffee deliveries on the spot. The affiliated primary cooperative societies sell coffee normally to the district unions. There are, however, also many unaffiliated primary societies with their own hulling facilities. Private buyers sell coffee to private hullers. Some private hullers also purchase coffee directly from farmers. The processors hull the coffee into consignments of fair average quality, and broken and hand picking. Except Bugisu arabica coffee, all hulled coffee is sold to the Central Processing and Storage Unit (CPSU) of CMB at Bugolobi-Kampala for export preparation. Arabica coffee is exported directly by CMB

from Bugisu Curing plant in Mbale.

At the CPSU hulled robusta coffee is graded and the price paid is partly dependent on quality. The hulled robusta coffee is sampled and the proportion of defective hulled robusta coffee determined together with the moisture content and colour assessment. The samples are then roasted, ground and cup tested. On the basis of all these tests a grade for the whole lot is determined. In practice, because the CMB is obliged to buy any coffee offered to it regardless of quality, the range of qualities handled may be very wide indeed. To counteract this a further process is performed to remove dust, stones, and any other foreign matter from the samples. The hulled robusta coffee is cleaned and passed through electronic colour sorters where defective black hulled coffee is eliminated. At this stage the remaining hulled robusta coffee has a green colour.

In Figure 2.1 below is a diagrammatical illustration of the coffee marketing system in Uganda:

Figure 2.1: Coffee Marketing System



There are about 2,100 primary cooperative societies which deal in the primary marketing of coffee. The primary societies are faced with the following marketing problems:

(a) shortages of packing materials, factory spare parts, and lack of storage facilities;

(b) lack of adequate crop finance which results in delayed payments to members for the coffee delivered;

(c) lack of working capital to meet day to day operations and other operating costs; and

(d) lack of transport - many societies are faced with inadequate transport especially at peak periods when members are selling their coffee.

Forty nine coffee factories with 181 hullers are owned by the 33 district cooperative unions. The share of district cooperative unions in the coffee trade is however declining and is being taken over by non-union processors. Based on the production days of 200 per annum and an average operation of two shifts, the processing capacity of district cooperative unions is about 350,000 mt per annum. Against this processing capacity the actual deliveries of coffee to CMB by the district cooperative unions and their capacity utilisation in the last six years has been as follows:

Table 2.1

Coffee Deliveries and Capacity Utilisation by the Unions
1983/84 - 1988/89

Crop Year	Deliveries to CMB (mt)	% Share of total deliveries	% Capacity Utilisation
1983/84	77,538	57.9	22.0
1984/85	77,378	51.0	22.0
1985/86	64,536	45.8	18.0
1986/87	63,947	41.3	18.0
1987/88	60,965	38.5	17.0
1988/89	47,977	28.4	14.0

Source : CMB.

The decline in district cooperative unions' coffee deliveries and deterioration of their economic situation, is the result of a combination of several factors, including:

(a) relatively high costs of hulling because of the costlier new or rehabilitated machinery, low capacity utilisation and higher overhead office costs. The current price structure and quality control practise does not reward quality;

(b) inefficiencies in management;

(c) overstaffing particularly at general levels;

(d) inadequate transport facilities due to looting and destruction during the wars; and

(e) poor financial structure, mainly because of diversification into various enterprises not related to coffee without adequate resources and inadequate transport

margins[2] paid by CMB for the delivery of clean coffee to the CPSU combine to aggravate the situation.

About 265 coffee factories with about 390 hullers are owned by private hullers and unaffiliated primary societies. The non-union processors are not much more efficient than their union counterparts. However, their rising deliveries to CMB have been due to increase in the number of operational factories (see Table 2.2 below) rather than to improvements in efficiency and/or capacity utilisation rates.

Table 2.2

Coffee deliveries by the Private Processors 1984/85 - 1988/89

Crop Year	Coffee Delivered to CMB (mt)	Number of factories	Av. delivery per factory(mt)
1984/85	74,229	146	508
1985/86	76,470	173	442
1986/87	90,978	198	459
1987/88	97,539	209	467
1988/89	122,294	265	461

Source: CMB.

The CMB was established in 1969 and given a monopoly on the export of Uganda coffee. The Coffee Marketing Act 1969 outlines the functions of the CMB as follows:

[2] Some unions like Kigezi, Bunyoro and Busoga have suffered heavily in terms of transportation costs. UCA(1989) suggested that in the pricing structure for the unions, the differences in transportation costs should be taken into account. However, these suggestions have remained on paper up to now. Obviously, it is not fair to keep applying the same transportation rate as if all unions were equidistant from the CPSU.

(a) purchase of all domestically processed coffee;

(b) provide quality incentives by differentiating prices according to quality grades;

(c) processing, washing, screening, bulking and grading coffee;

(d) roasting and selling coffee in the domestic market; and

(e) exclusively exporting coffee to the world coffee market.

The CMB has been cast in the role of a government controlled marketing board. It centrally buys, cleans, stores and packs and sells coffee to international buyers. For some reasons, however, including inadequate financial and managerial resources, it has been unable to achieve its objectives. Consequently, it has handled a fraction of marketed output and the other fraction is smuggled to neighbouring countries. The two reasons that compelled the government to keep control over the coffee industry have been that coffee:

(a) traditionally is a major, and more recently, virtually the only source of foreign exchange; and

(b) until recently, brought in the bulk of government revenue through the taxation of coffee export proceeds.

The government, therefore, has a vital interest in ensuring that its coffee maintains, and where possible, improves both the quality and delivery standards, the two major factors which determine the country's export position in the world coffee markets.

The economic and efficient handling of coffee depend on the efficiency of operations at the primary buying stage, processing and secondary marketing stage, and export marketing which are closely interlinked as already discussed. Any mismanagement at any of these stages will frustrate the objectives of the price incentives by delaying

payments to farmers, increasing unit costs, and delaying the receiving of export proceeds. The overall impact of the processing and marketing inefficiencies on the economy in general, and on the coffee industry in particular, may be summarised as follows:

(a) delays in payment to farmers thus frustrating the objectives of price incentives policy of the government;

(b) under-utilisation of processing and marketing policies resulting in higher processing and marketing per unit costs and low share for farmers in internationally realised prices;

(c) blockage of scarce resources in stocks of processed and unprocessed coffee resulting in heavy crop finance and working capital requirements which are inflationary; and

(d) extension in the period of the coffee marketing cycle, thus delaying the flow of foreign exchange into the country.

In Uganda, the recent fall in the world coffee prices has motivated the government to streamline and cut costs of the CMB. Priorities are given to increasing accountability and efficiency of the existing marketing system and developing a system to monitor the physical and monetary flows associated with coffee. Export sales strategy has always been done on an ad hoc basis without examination of alternative strategies. Most sales have been in form of barter and pre-financing agreements. The beneficiaries of barter sales usually did not reimburse CMB until late (CMB report, 1989).

The government has rejected the option of selling all the exportable coffee through auctions to private exporters. However, it has expressed interest in undertaking partial

privatization. Under partial privatization, only some parts of the marketing network is privatized, leaving the basic structure of the system virtually unchanged. For instance, partial privatization includes the increasing participation of the private sector in domestic marketing and exporting. According to Weekly Topic (1991), the government has so far licensed eleven coffee exporting firms and unions to compete with the CMB. These include Busoga Cooperative Union, Bugisu Coffee Union, Banyankole Kweterana Cooperative Union, Masaka Cooperative Union, Zigoti Cooperative Society, Kyagalanyi Coffee Factory, Kaliro Coffee Factory, Lwanyanga Coffee Factory, Muhamuddu Nsamba and Sons Limited, Okoro Coffee Growers of Nebbi and Sebei-Elgon Cooperative Union. All the licensed firms are to sell coffee through public tenders which are to be issued to all buyers registered with the exporters. Bids/tenders are opened at a fixed time known to the buyers and Uganda Coffee Development Authority. Coffee is offered to the highest bidder. It is hoped that the liberalization of the coffee marketing arrangements will led to an increase in volume and unit value of coffee exports and reduction in the marketing costs. However, the effect of this new marketing system have not been fully realised as the system was implemented only end of 1991.

2.7 Transportation System

Transport constitutes an important area in the processing and marketing of coffee. Transport problems, together with poor or incomplete road infrastructure, has often hampered kiboko collection from buying centres and has frequently caused clean coffee stock holding at the hullers as well. The later results in pressure on storage facilities in

primary processing units and the slowing down of processing turnover. Inevitably profits are eroded due to high financial costs involved in stock financing.

Farmers are responsible for the handling and transportation of coffee to the cooperative societies and private buying centres. Farmers are based in rural areas where the transportation network and local feeder roads to support the system of truck roads are often lacking. For this reason some farmers do carry coffee in baskets on their heads and others who can afford carry it in sacks/bags on bicycles. Unions or private processors on notification of enough kiboko collection send a lorry to load and deliver kiboko loads to the district cooperative unions or private hullers. Some cooperative societies are not affiliated to unions and as such buy and process kiboko for delivery to CMB.

The unions, private processors and private cooperative societies who own and operate processing hullers are responsible for clean coffee deliveries to CPSU. The CMB provides a refund towards transport costs. Though many processing units are located along the main roads, other processing factories are found deep in the rural areas and often are not easily accessible especially during rainy seasons. During the past wars and civil disorders both cooperatives and private processors suffered depletion of their transport fleet in looting and destruction.

The Uganda Co-operative Transport Union (UCTU) is a national union responsible for provision of transport primarily to its share holders, the district cooperative unions. Though at inception it mainly transported cotton and coffee, the UCTU is being operated on a commercial basis. About 50% of the UCTU's transport is deployed in coffee transportation- mostly movement of clean coffee from the union processing factories to

the CPSU at Bugolobi-Kampala. The other 50% of the UCTU lorries is engaged in transportation of food crops like maize, banana and beans to mention but a few. The UCTU like the private and primary processors suffered heavy looses of its lorries during the war periods.

In the past, CMB mainly concentrated on final coffee processing, grading and export of clean coffee as already stated. The CMB had entirely left coffee transport to private transporters, unions and the UCTU. Due to the poor transportation performance of especially UCTU and unions, however, the CMB inevitably had to assist in the movement of clean coffee to the CPSU, and even transportation of kiboko to the primary hullers. In 1987, a big transport operation was mounted to clear coffee stocks from factories to the CMB plant.

As private processors increasingly become dominant in the coffee business, private transportation has gained emphasis especially in the last seven years. A private processor may own a lorry which he devotes to serve his factory in collection of kiboko from buying centres or directly from farmers and delivery of clean coffee to CMB. Without his own lorry, the processor hires transport to move coffee. The private processors are more cost conscious than the cooperatives and manage their fleet better.

Since early 1988, nearly three quarters of the coffee has been transported by rail to Mombasa and the remainder to Dar es Saalam. Before 1986, Ugandan private transporters used to participate in coffee movement to Mombasa as well.

In summary, the following are the major constraints facing the coffee transportation system:

(a) poor rural-feeder roads resulting in high rates of breakdown and low capacity utilization;

(b) poor fleet management of scheduling of journeys especially in case of the unions;

(c) poor workshop facilities to support vehicle maintenance;

(d) lack of vehicle spares and poor maintenance; and

(e) slow off loading and reception rate at the CPSU. Normally delays of up to 3 days are incurred at the plant during the peak periods.

2.8 Pricing System

Pricing system refers to how and by whom prices at each marketing stage are determined and how payments are made. Developing countries intervene in agricultural marketing and pricing without sufficient analysis of problems, policy instruments, and the consequences involved. So long as positive price policy is a rule rather than an exception, analytical input from specialised institutions is necessary to minimize the risk of wasteful intervention. In Uganda, because of the multiplicity of institutions dealing with the agricultural sector and their segmented and uncoordinated responsibilities, the APC and the AS were designed to become the effective institutional machinery for coordinating agricultural policies, plans and resource allocation within this sector. The AS was set up to function principally as the technical and analytical secretariat of the APC in 1983. Among the key roles played by the AS in the main policy areas is Agricultural Pricing Policy. AS has the major responsibility for the analytical work of price determination.

For the AS to function effectively, it is critical that it is staffed by persons trained

in price and policy analysis with easy access to policy makers at the highest level. The AS if institutionally linked to the process of macroeconomic policy formulation, can play a potentially powerful role in protecting the interests of farmers, which are often overlooked in exchange rate, fiscal and monetary policy making.

The AS[3] monitors and reviews coffee producer prices in October/November of every year before the harvesting season. The main objective of reviewing coffee producer price is to make adjustments arising out of changes in domestic and world prices. The AS through the APC makes recommendations to the government of the necessary adjustments in producer prices, margins for processors and CMB.

The methodology and analytical framework for preparing producer price proposals have been developed and adjusted over time, based on the experience gained since the inception of the AS.

The main objective of the price policy is to provide incentives to farmers by way of administered remunerative prices which can stimulate investment and production response. In addition, the price policy is aimed at providing adequate incentives to processors to rehabilitate their factories, operate efficiently and improve the quality of coffee (AS Report, 1990). In any price proposal submitted by the AS, it has always been emphasized that the price policy be in line with other policies affecting developments in other sectors and sub-sectors of the economy. However, these suggestions have always been ignored by the politicians.

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[3]Before 1983, producer prices for coffee were recommended by a pricing committee, comprising of officials from CMB, MOA, and MOCM. After cabinet approval, the minister of Co-operatives and Marketing announces the new producer prices.

The producer price and cost of services at every stage of marketing is fixed by the government at the beginning of the coffee harvesting season. The prices and margins, once announced, become mandatory and are enforceable by law. The actual steps taken by the AS in determining coffee prices are summarised below:

(a) assessment of the average cost of production based on data obtained from cross-sectional sample surveys. The cross-sectional sample surveys are carried out by the AS to establish the following key parameters:-

- average farm size,
- average yield of coffee achieved and seasonality of production;
- levels of input use;
- labour seasonality and requirements;
- current output and input prices; and
- rural labour wage rates and opportunity cost.

These cross-sectional data are checked and adjusted for consistency with farm management data obtained from studies carried out by the MOA and Makerere University;

(b) hired labour is valued at current market wage rates while family labour is valued at opportunity cost. To derive the opportunity cost of family labour, the returns from competing crops are first worked out;

(c) analysis of world parity prices and determination of the appropriate exchange rate conversion;

(d) estimation of the average unit cost of processing and marketing, and calculation

of the margins for processing and CMB as well as collection costs for the primary societies and private processors. The important parameters that are considered are production, procurement and export targets. The processors' margins are worked out on a cost plus basis but related to the average unit cost based on certain performance and efficiency criteria. The performance and efficiency parameters are reviewed every year with the objective of encouraging efficiency and lowering unit cost of processing. In the case of the CMB, export margins are fixed based on actual cost. The necessary data are obtained from cross-sectional sample surveys carried out by the AS with the assistance of the ministries concerned. These surveys cover primary societies, processors and CMB. Prices which CMB will pay to unions/processors are established and fixed. Primary society commissions are also fixed ;and

(e) consultation with the MOPED about budgetary, crop finance, purchasing power and other economic implications. These consultations provide the basis for final adjustments in the share of producers, processors and CMB in the coffee export price.

It is reported that farmers are not paid, especially by the private buyers, the officially announced price. This defeats the very purpose of announcing the minimum price when coffee buyers are free to pay a price less than the official price without fear of legal or administrative actions against them.

The present system of fixed producer price fails to transmit market signals to producers which distorts price incentives among commodities. This is especially the case

when producer prices are determined by political considerations. When producer prices are maintained at fixed level in the domestic market while world market prices of the crop declines for the extended period, the country is effectively encouraging production of a crop whose relative world demand is declining. On the other hand, keeping producer prices fixed well below world prices can prevent the industry from responding to world market opportunities which are signalled by increases in world prices. There is therefore a need to move from a fixed producer price to a more flexible pricing system reflecting marketing signals.

The present structure of prices paid to processors and other intermediaries for coffee delivered to CMB provide inadequate incentives to deliver quality coffee. The present grading system does not reflect the premium/discount on the international markets. Furthermore, the actual cost of processing by cooperative unions have frequently exceeded the established margins because of low capacity utilisation, financial and general mismanagement, low labour productivity, and low stock turnover (UCA, 1989). The higher cost of processing and internal marketing seriously affects producer incentives. On the other hand, the cost of processing tends to go up due to factors beyond the control of the processors such as frequent power cuts, poor rural roads, scarcity of spares parts, inadequate transport and communication network. There is therefore a need for competition among processors without a fixed margin.

From the above it was noted that CMB export marketing margins are fixed based on the actual cost. The operational looses or surplus of CMB are supposed to be reimbursed by or passed on to government on the presentation of audited accounts. This

leaves CMB in a situation of having no incentives either to maximize the volume and unit value of coffee exports or to introduce cost effective measures to reduce cost and increase efficiency.

2.8.1 Coffee Producer Price

Government has increasingly tended to fix prices at a uniform level throughout the country - that is, irrespective of transportation cost differential - in an obvious endeavour to assist farmers who live in remote areas and who often are the poorest. While this may be a desirable social objective, the economic implications of such a uniform pricing policy are often not fully realised. It also distorts the allocation of productive resources in the remote regions by introducing a bias against the production of crops on which transport costs are low in relation to their prices in favour of the production of crops that, owing to their bulk, are costly to transport in relation to the prices they fetch in the market.

Producer prices have been kept low even when the world prices have risen so that the government tax revenue and expenditure can be maintained. In Uganda, as elsewhere, producers have responded to low prices by smuggling, and reducing efforts in production, harvesting and new plantings. During the 1970s and early 1980s smuggled coffee was estimated around 40,000 to 60,000 tons annually (IDRC, 1987) thus, representing a major loss of foreign exchange earnings. According to World Bank report (1988), some 40% of the coffee trees are past their productive life as farmers are reluctant

to replace the old trees due to unattractive price levels[4]. The low coffee producers prices induced farmers in districts like Mpigi to go to the expense of uprooting coffee trees that were still yielding and replacing them with other crops like bananas. Thus there is a slow but steady process of capital erosion through neglect and aging of trees, and uprooting[5] without replacement.

Efforts have been made to provide incentives to producers, unfortunately these incentives have been found to be inadequate to cover the increased cost of production and compensate for the decline in real incomes of the farmers due to inflation (UCA, 1988). Table 2.3 below shows coffee income per kg vis - as - vas a limited basket of consumer goods namely, sugar, salt, soap and paraffin. An increasing trend in the terms of trade until 1984 is noted; between 1985 and 1986 there was a decline in the terms of trade - the reason for this trend was due to a government transition period, whereby the supply of these goods was low and the demand high which led to higher prices. During 1987 - 1988 the terms of trade started increasing again. The reason for this increase was attributed to the increased supply and controlled distribution system for these basic consumer goods. In 1989 a decline was realised again and this was a result of the mini-budget of 7th March 1989 which among other things included a devaluation of the USh

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[4]One would have anticipated the high world coffee prices which prevailed in 1976/77 and 1986/87 to have encouraged new coffee plantings. However, this was not the case since the coffee producer prices set by the government bear no relation to world coffee prices.

[5]The uprooting of coffee trees is undesirable. It is obvious that the consequences of this will be severe to the country since coffee is the major foreign exchange earner and source of government revenue. However, from the farmers' point of view uprooting is rational at least in the short run.

by 21% and substantial increases in petroleum fuel prices. The continuous decline in the terms of trade for sugar from 1985 onwards was a result of higher percentage increase in the prices of sugar than in any of the above mentioned goods. The higher prices of sugar was the result of low supply and high demand. Uganda being solely a sugar importing country and at the same time with foreign exchange constraints, combined to contribute to the low supply of sugar. It can be noted from the above analysis that the relation of coffee prices to non-farm consumer goods has been unfavourable and quite disheartening.

Table 2.3

Coffee Farmers' Terms of Trade 1981 - 1989

Category	1981	1982	1982	1984	1985	1986	1987	1988	1989
Arabica/sugar	0.26	0.44	0.62	0.83	0.86	0.54	0.39	0.38	0.20
Robusta/sugar	0.14	0.23	0.35	0.50	0.49	0.27	0.22	0.23	0.12
Arabica/salt	0.30	0.43	0.68	1.06	0.83	0.61	0.69	0.71	0.34
Robusta/salt	0.30	0.43	0.68	1.06	0.83	0.61	0.69	0.71	0.46
Arabica/soap	0.14	0.17	0.41	0.61	0.54	0.37	0.43	0.45	0.40
Robusta/soap	0.08	0.09	0.24	0.37	0.31	0.18	0.24	0.27	0.24
Arabica/paraffin	2.33	2.23	1.88	2.14	2.81	2.80	3.36	3.28	0.56
Robusta/paraffin	1.25	1.20	1.07	1.29	1.59	1.41	1.88	1.97	0.34

Source: UCA.

Table 2.4

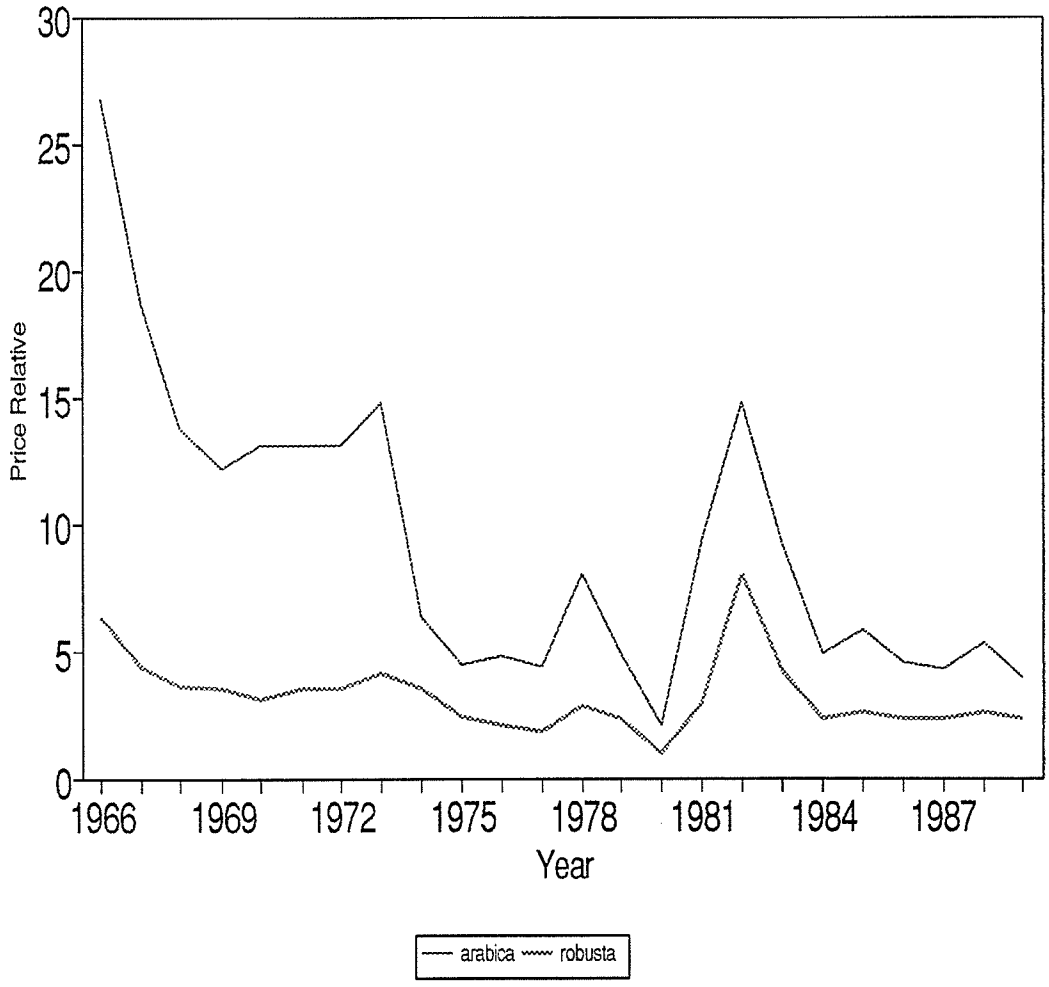
Comparison of Coffee and Banana Producer Price 1966 - 1989

Year	Producer Price (USh/kg)			Producer Price Relative	
(1)	Arabica (2)	Robusta (3)	Banana (4)	Arabica (5)=2/4	Robusta (6)=3/4
1966	3.74	0.88	0.14	26.17	6.29
1967	3.74	0.88	0.20	18.70	4.40
1968	3.30	0.88	0.24	13.75	3.67
1969	3.65	1.06	0.30	12.17	3.53
1970	4.46	1.06	0.34	13.12	3.12
1971	4.46	1.19	0.34	13.12	3.50
1972	4.46	1.19	0.34	13.12	3.50
1973	4.46	1.25	0.30	14.87	4.17
1974	4.46	2.50	0.70	6.37	3.57
1975	4.55	2.50	1.02	4.46	2.45
1976	5.86	2.50	1.22	4.80	2.05
1977	8.50	3.50	1.93	4.40	1.81
1978	10.00	3.50	1.25	8.00	2.80
1979	15.00	7.00	3.05	4.92	2.30
1980	15.00	7.00	7.13	2.10	0.98
1981	65.50	20.67	7.04	9.30	2.94
1982	93.00	50.00	6.26	14.86	7.99
1983	175.00	80.00	18.97	9.23	4.22
1984	350.00	170.00	71.70	4.88	2.37
1985	830.00	370.00	143.00	5.80	2.59
1986	1692.00	850.00	373.00	4.54	2.28
1987	43.00	24.00	10.00	4.30	2.40
1988	100.00	49.67	18.75	5.33	2.65
1989	100.00	60.00	25.25	3.96	2.38

Source : Author's calculations.

From Table 2.4 and Figure 2.2, the price relatives for both coffee types were relatively high in the 1960s and early 1970s. Between 1974 and 1981, the producer price received by the coffee farmers started to decline compared to that of banana. The impact

Fig. 2.2: Relative Producer Price
(i.e coffee/banana prices) Trends



was severe: production fell as some large farm holdings were abandoned[6], and husbandry standards declined and smuggling activities increased. In 1982, there was an increase in coffee producer price as compared to banana producer price. Moreover, this is the time when the producer price relative in case of robusta coffee was highest. The main reason for this increase in producer price relatives was due to an increase in the supply of banana, which led to a decrease in the producer price. From 1983 onwards a decline in the price relatives is noted.

[6] In times of low prices, the large farm holders are more likely to abandon the growing of coffee than the small farm holders.

Table 2.5

Comparison of Uganda Coffee Producer Price[1] and the World Coffee Prices[2] 1971-1989.

Year	World Price (US$/kg)	Producer Price (US$/kg)		Farmer % share	
		Robusta	Arabica	Robusta	Arabica
1971	0.79	0.17	0.64	21.52	81.01
1972	0.74	0.17	0.64	22.97	86.49
1973	0.91	0.18	0.64	19.78	70.33
1974	1.15	0.36	0.64	31.30	55.65
1975	1.06	0.36	0.65	33.96	61.32
1976	1.83	0.36	0.81	19.67	44.26
1977	4.16	0.50	1.21	12.02	29.09
1978	2.78	0.50	1.43	17.99	51.44
1979	2.96	1.00	2.14	33.78	72.30
1980	3.10	1.00	2.14	32.26	69.03
1981	1.95	0.65	2.06	33.33	105.64
1982	1.95	0.53	0.99	27.18	50.77
1983	2.35	0.46	1.02	19.57	43.40
1984	2.87	0.38	0.79	13.24	27.53
1985	2.76	0.40	0.89	14.49	32.25
1986	2.82	0.61	1.21	21.63	42.91
1987	2.02	0.40	0.72	19.80	35.64
1988	2.00	0.40	0.80	20.00	40.00
1989	2.10	0.36	0.61	17.14	29.05

Source : Author's calculations.
Note : (1) Producer Price is divided through by the official exchange rates.
(2) Average world coffee price (for Uganda coffee) based on the New York Spot Market.

World coffee prices were high in the second half of the 1970's, due mainly to reduction in Brazil's production following a severe frost in 1975. But Brazil's production recovered by the early 1980's and world coffee prices declined. The ICA succeeded in keeping nominal US$ prices from declining since 1981. However, they continued to decline in real terms, except for a short period in 1986 following a drought in Brazil. The

Uganda coffee producer prices for both coffee types, in general, did not follow the same trend as the world coffee prices (see Table 2.5 and Figure 2.3).

As shown in Table 2.5 and Figure 2.4, the robusta farmers have historically received less than 40% of the export price, falling below 20% in the boom years, that is, 1976/1977 and 1986/87. From 1982 - 1989 the arabica farmer received less than 50% of the export price and the same applied in the boom years.

In the short-run, coffee is not likely to be neglected because of low producer prices, since both individual farmers and the country as a whole depend heavily on it. Farmers have continued to have their shambas for reasons such as security of income from coffee and little incentive to shift to alternative crops to mention a few. However, in the long-run one would expect the farmers to leave the industry if the country suffers a large fall in export earnings.

Fig 2.3: Comparison of World Coffee Prices & Uganda Producer Prices 1971-89

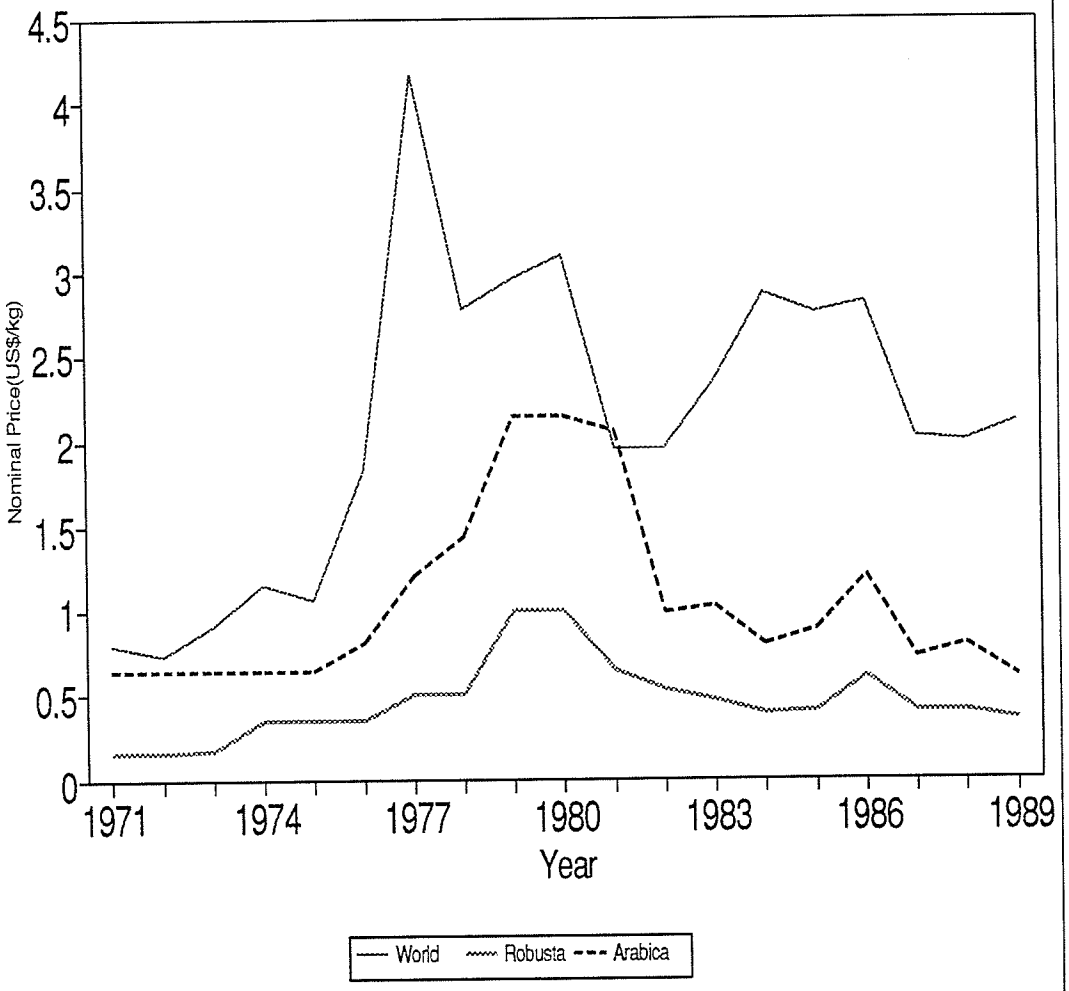
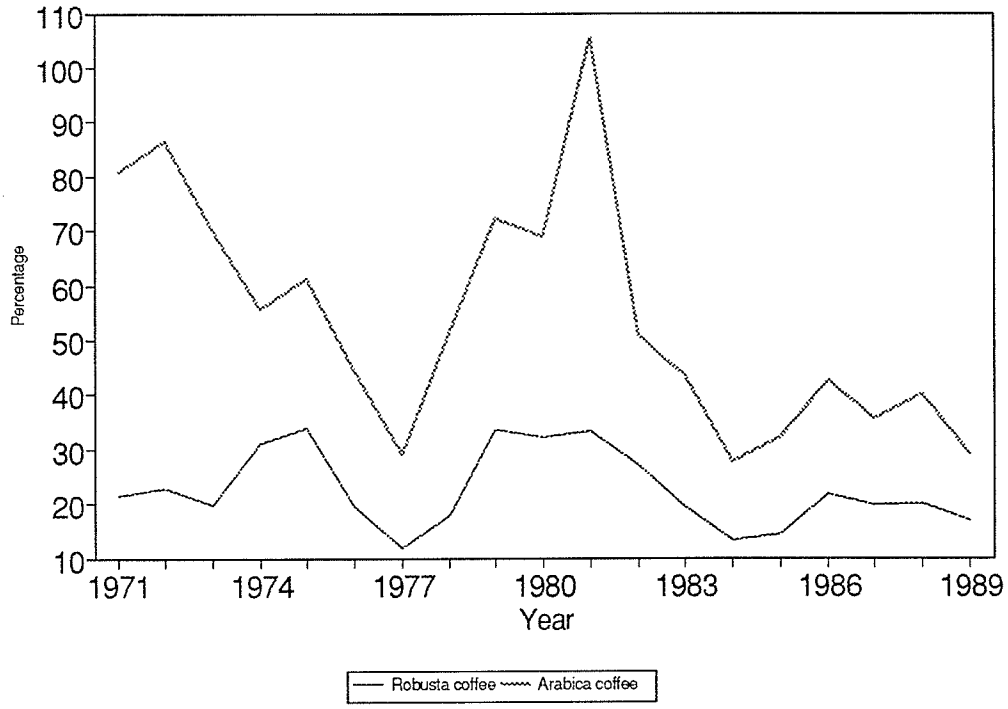


Fig. 2.4: Coffee Farmer's Share (%)
in Exports Price 1971 - 1989



Note on Cost of Production as a Coffee Pricing Criterion

The simple rationale behind the cost of production principle is that farmers ought to receive a fair return on their outlays. In Uganda average cost of production rather than marginal cost is used as a reference point in fixing producer price and processors and CMB margins. Below are some of the criticisms of this criterion:-

(a) the major input in coffee production is labour and the larger share of labour is provided by family labour. This makes cost of production as criterion of pricing less important;

(b) since differences in costs among farmers and regions are very high, the choice of farmer groups and regions whose cost is to be fully covered by administered price will be arbitrary; and

(c) because of the uncertainty involved in any agricultural production, the cost that determine producer decisions is subjective opportunity cost that cannot be measured objectively.

Chapter Three

ESTIMATING THE COFFEE SUPPLY RESPONSE MODELS

3.1 Theoretical Framework

The literature pertaining to agricultural supply response especially for perennial crops is continuing to attract the attention of many researchers. French and Mathews (1971) distinguished a perennial crop from an annual crop in the following manner:

(a) the long gestation period between initial input and first output;

(b) an extended period of output flowing from the initial production or investment decision; and

(c) eventually a gradual deterioration (usually) of productive capacity of the crops.

In developing countries, in particular Sub-Saharan Africa[1], modelling supply response of perennial crops like coffee, rubber and cocoa, has attracted the attention of many researchers. The work which has been done in this area - Bateman (1965); Arak (1969); Maitha (1971); Ghoshal (1974) - has suffered from major weaknesses of in model specification and, inevitably, data problems.

When one considers Bateman's (1965) study, a more complete investigation of the distributed lag pattern of producer price response would have been necessary for coffee and cocoa. In addition the incorporation of rainfall and humidity as exogenous variables raises the problem of multicollinearity.

Another source of specification error results from inaccurate factual *a priori* knowledge of the country being studied, and faulty theoretical exposition. Some

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[1] Perennial crops are important sources of foreign exchange earnings, employment and government revenue in Sub-Saharan African countries.

economists outside Africa still think that farmers grow some crops primarily for cash and others primarily for own consumption. Theoretically any crop can be offered for sale if the price is high enough, and this includes any so-called food crop. Similarly production of any so-called cash crop will cease if the price is sufficiently low. From MacBean (1966), the only reason one could offer as to why he considered coffee and cotton as the production alternatives is because he had in mind the mistaken traditional classification of these crops as cash crops in Uganda.

There are severe limitations on data pertinent to modelling supply response of perennial crops in developing countries and Uganda is no exception. Nerlove (1984) noted that in most developing countries continuous information over time is lacking on new plantings and current age distribution, although such data may be available on an irregular basis. He further observed that data on age distribution, which is a major variable in the analysis of supply response of perennial crops, does not exist.

As noted in Chapter Two, government intervention in the marketing of perennial crops in developing countries, in particular Sub-Saharan Africa, is widespread. This has led to substantial smuggling of crop output to neighbouring countries[2]. The existing marketing boards create substantial spreads between prices paid to farmers and the price at which the crop is sold on the world market. They also hold large stocks which lead to significant problems in formulating appropriate models of price expectations.

The basic concepts leading to the specification of planting, removals, harvesting, replanting and abandonment have been clearly elaborated by French and Mathews

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[2]Data on the amount of output smuggled out in most of these countries do not exist.

(1971,1972) and need not be repeated here. Akiyama and Trivedi (1987) followed a vintage production approach to analyse the supply of perennial crops. Under this approach replanting, planting and abandonment of trees can be taken into account. They further suggested that efforts should be taken to distinguish between harvesting and investment decisions. However, the success in treating harvesting and investment decisions separately is based on data availability. Due to data problems in Uganda, the French and Mathews, and Akiyama and Trivedi approaches will not be considered in this thesis.

3.1.1 A Supply Function Approach

Several studies on perennial crops have adopted variants of the Nerlovian model (Arak (1969); Bateman (1965); Maitha (1969)).. According to this model the relationship between supply and own price is assumed to be such that the response is highest immediately after the price change, then declines geometrically as lag increases. Originally the Nerlovian model was applied to annual crops in which long lags are absent. The success of this model for annual crops is, however, not a sufficient justification for its use for perennial crops where long lags are expected.

Including only one or two lagged price variables in a supply response model, however, seems inadequate because, for certain crops, the entire effect of a price change on output can not be expected to show up only in one or two periods. For perennial crops in particular, the effect of a price change on output is spread over many years. A price increase would probably induce the farmer to grow new plantings which would come into production only after some years. At the same time, the farmer may be

motivated to increase output through greater attention to cultivation aspects such as pruning, weed control, crop protection, and more complete harvesting. Some of the impacts of this better care for mature trees on output are spread over the entire life of the tree. Kulshreshtha (1976) also noted that the farmers' decision making is at times delayed by technical, institutional and psychological factors. These factors give rise to a gestation period. He further noted that in the presence of a gestation period one would not expect the supply to change immediately following a change in price. This leads to the notion of a distributed lag relationship between producer prices and output quantities.

The polynomial distributed lag formulation of price expectations allows the weights assigned to past prices to first increase and then decrease. Such a model specification appears to be more realistic than the Nerlovian model. The polynomial distributed lag model is more flexible than the Nerlovian model, since the shape of the response function is not restricted to any pre-assigned shape. However, it does involve conceptual and statistical problems as will be discussed later.

Hypothesis 1 :

The adjustment in coffee supply is not instantaneous and, in fact, these adjustments will be distributed over time.

Let a polynomial distributed lag model be defined as:

$$(3.1) \quad Y_t = \lambda_0 + \sum_{i=0}^{k} \beta_i P_{t-i} + \sigma_i M_{it} + \varepsilon_t$$

$$(3.2) \quad \beta_i = \phi_0 + \phi_1(i) + \phi_2(i)^2 + \ldots + \phi_n(i)^n$$

are the weights of the lagged price variable which are assumed to lie on the n^{th} order polynomial.

Y_t = production in period t.

M_{it} = ith non-price factor affecting the output in period t.

z_t = error term.

Substitute equation (3.2) into equation (3.1)

(3.3) $Y_t = \alpha_0 + \phi_0 P(1) + \phi_1 P(2) + ... + \phi_r P(r) + \sigma_i M_{it} + \varepsilon_t$

where: $P(0) = P_{t-i}$, $P(1) = iP_{t-i}$, $P(2) = i^2P_{t-i}$, ... , $P(r) = i^rP_{t-i}$.

3.1.2 A Production Function Approach

Suppose the technology of a farm producing a single output can be represented through the following production function:

(3.4) $Y = f(X)$

where : Y = output level; and

X = vector of n input level.

The basic properties of $f(X)$ in equation (3.4) are: monotonicity, concavity, weak essentiality, continuity, and twice differentiability. The implications of each of these properties are well explained by Lau (1976) and Chambers (1988) and need not be repeated here.

Given the assumptions of profit maximisation and price taking behaviour for Ugandan coffee farmers and the concavity of the production function in the variable inputs, the farmers' decisions are the quantities of coffee output and variable inputs. Farmers are price takers in both the input and output markets, that is, there is no production group that is capable of exercising monopsonist behaviour in the input market

or monopolist behaviour in output markets. The long-run static profit function is defined at the industry level, that is, using data on variable inputs and output aggregated over farms. Input and output prices are assumed to be identical over farms.

Let the generalised profit function for a single output be defined as follows:

(3.5) $\Pi(P, W) = Max\ Pf(X) - WX$

where: $\Pi(P, W)$ = profit function;

W = vector of n input prices; and

P = output price.

The basic properties of $\Pi(P, W)$ include : Π is decreasing in W and increasing in P, linearly homogenous in (P, W), convex in (P, W) and differentiability in (P, W) (Chambers (1988) ; Lau(1976)). If $\Pi(P, W)$ is differentiable in P, W everywhere, then by Hotelling's Lemma:

(3.6) $$\frac{\partial \Pi(P, W)}{\partial W_i} = -X_i(P, W) \qquad \text{for i = 1,2,...n.}$$

(3.7) $$\frac{\partial \Pi(P, W)}{\partial P} = Y(P, W)$$

where equations (3.6) and (3.7) are the factor demand and output supply functions respectively. The corresponding properties of $Y(P, W)$ and $X_i(P, W)$ include : linear

homogeneity of degree zero in input and output prices; and the matrix in equation (3.8):

(3.8)
$$\begin{bmatrix} \frac{-\partial X(P,W)}{\partial W} & \frac{\partial Y(P,W)}{\partial W} \\ \frac{-\partial X(P,W)}{\partial P} & \frac{\partial Y(P,W)}{\partial P} \end{bmatrix}$$

is symmetric positive semi-definite. This restriction corresponds to positive semi-definiteness of the Hessian matrix of $\Pi(P, W)$ and in turn $Y = f(X)$ is concave at all optimal values of X (that is, at X^*).

When $f(X)$ and $\Pi(P, W)$ are twice differentiable everywhere, and locally strongly convex, then the relationship between the Hessian matrices of the production function and the profit function may be derived. The derivation of the relationship of the Hessian matrix identities between the production function and the profit function has been well illustrated by Lau(1976) and need not be repeated here. The relationship is given as:

(3.9) $$Pf_{xx}(X^*) = -\Pi_{ww}(P, W)^{-1}$$

Equation (3.9) facilitates the deduction of the supply elasticities of prices under one environment from a knowledge of their values under another environment.

Several studies of supply response for perennial crops have continued to apply linear or log-linear functional forms. These functional forms imply extremely restrictive production functions and behaviourial relations. Use of flexible functional forms for production functions permits the imposition of less restrictive assumptions about the nature of technology than do popular production functions form such as Cobb-Douglas and Constant Elasticity of Substitution (CES).

In estimating the production function econometrically, a quadratic functional form is assumed. The quadratic form is chosen over other flexible functional forms because it enables the Hessian matrices of the profit function corresponding to the same production possibilities set to be constant matrices. Thus given the parameters for the production function, the parameters of the profit function can be computed indirectly using the Hessian matrix identities.

After estimating the above production function, then the value of $-\Pi_{ww}(P, W)^{-1} \equiv [\partial X_i / \partial W_j]^{-1}$ can be calculated from equation (3.9). The value so estimated will facilitate the derivation of price supply elasticities in the following manner:

(a) From above it was stated that the factor demand function in equation (3.6) is homogenous of degree zero in (P, W). This implies the following:

(3.10) $$X_i(\lambda P, \lambda W) = X_i(P, W)$$

$$0.X_i = \frac{\partial X_i}{\partial W_j} W_j + \frac{\partial X_i}{\partial P} P \quad \text{this implies}$$

(3.11) $$\frac{\partial X_i}{\partial P} = \frac{-\partial X_i}{\partial W_j} \frac{W_j}{P} \quad , \text{ but}$$

(3.12) $$\frac{\partial X_i}{\partial P} = \frac{-\partial Y}{\partial W_j} \quad \text{(from the reciprocity property). Then,}$$

(3.13) $$\frac{\partial X_i}{\partial P} \equiv \frac{-\partial Y}{\partial W_j} = \frac{-\partial X_i}{\partial W_j} \frac{W_j}{P} \quad i,j=1,2.$$

(b) The linear homogeneity property of the output supply function from equation (3.14) implies the following:

(3.14) $Y(\lambda P, \lambda W) = Y(P, W)$

$0.Y = \frac{\partial Y}{\partial W_j} W_j + \frac{\partial Y}{\partial P} P$ then,

(3.15) $\frac{\partial Y}{\partial P} = \frac{-\partial Y}{\partial W_j} \frac{W_j}{P}$ j = 1 2.

From equations (3.15), it will be possible to compute the elasticity of output supply with respect to output price (ε) at the mean levels of producer price and output. This is given as follows:

(3.16) $\varepsilon = \frac{\partial Y}{\partial P} \frac{P^*}{Y^*}$

where: P^* and Y^* are the average coffee producer price and average output respectively.

3.2 Empirical Model

The model has a microeconomic structure in that it uses a simple model of farmer behaviour as its building block. The farmers will be assumed to be faced with the same technology, factor and output prices and attempt to maximise their returns from coffee production.

In modelling the supply response of any perennial crop, Akiyama and Trivedi (1987) suggest the following features of the production process be taken into account:

- the existence of a biologically-determined gestation lag between planting and obtaining yield;
- the dependence of current production on previous levels of output;
- the existence of significant costs of adjustment in respect of planting and removal of trees; and
- the constraints on planting and removal resulting not only from past decisions but also from the existence of binding non-negativity constraints related to the adjustment process.

Coffee is first harvested in about three to four years after planting, and it takes two more years before the tree reaches its normal yield. Yield normally starts to decline about fifteen years after planting, but under good management the drop in production is not rapid, and the tree can have an economic life up to fifty years (Singh et al (1977)). According to MacBean (1966), first harvest comes in about two to four years if seedlings are used and four to five years if plantings are from seeds. He further suggested that substantial yield cannot be expected until five to eight years. These differences between the coffee production cycles are due to differences in coffee type varieties.

Coffee producers have control over the amount of coffee harvested and/or marketed[3]. Occasionally coffee producer prices may be so low relative to harvesting costs that a part of the crop is abandoned or the farmers may decide to hold back some coffee in anticipation of a higher price. Hence marketed production will be used as the

[3]Tomek and Robinson (1988), suggested that there are several measures of production which may include total production, harvested production and marketed production.

dependent variable in the analysis of producer's supply response.

A complete investigation of determinants of coffee production decisions in Uganda should consider the existence of substantial coffee smuggling activities into neighbouring countries, coffee producer price, producer price of the competing crop, bearing acreage under coffee, labour wages, fertilizer quantities and prices, age distribution, new plantings, and institutional constraints (for instance, inadequate crop financing, unavailability of credit, delayed payments for coffee delivered by farmers, inadequate marketing infrastructure and inadequate agricultural extension services). Unfortunately, continuous data on fertilizer quantities and prices, age distribution, new plantings and quantities of coffee smuggled out of the country are lacking, that is, for the period under study. If data on the coffee producer price differences between Uganda and the neighbouring countries[4] (that is, to which coffee is being smuggled) were available, they would have been included in the model to take account of the coffee smuggling activities, especially for arabica coffee. It should also be noted that it was not easy to quantify the institutional constraints faced by the coffee farmers.

3.2.1 A Supply Function Model

A polynomial distributed lag model is one in which the weights assigned to lagged price variables follow a polynomial of a given degree. A special type of this model is Almon's scheme which assumes a finite distributed lag whose coefficients follow a polynomial of low order (Almon, 1965). Almon's scheme itself has been extensively

[4]The author was unable to get concrete data on coffee producer prices for Kenya, Zaire and Rwanda where coffee from Uganda is being smuggled.

modified over the years to make it more flexible and computationally less cumbersome. One of the modifications was that suggested by Hall and Sutch (1968) and this has been applied by researchers such as Chen et al (1972) and Olayemi and Olayide (1978). In this thesis, Hall and Sutch's modifications of the Almon's scheme will be applied.

Let a polynomial distributed lag model by coffee type be defined as:

$$(3.17) \quad Y_t = \lambda_0 + \sum_{i=0}^{k} \beta_i P_{t-i} + \sigma_1 W_{1t} + \sigma_2 T + \sigma_3 X_{2t} + \sigma_4 D_1 + \sigma_5 D_2 + z_t$$

Y_t = production ('000 mt) in period t;

P_{t-i} = normalised producer price[5] (US$/kg) in period t - i;

W_{1t} = normalised labour wage (US$/kg) in period t;

X_{2t} = bearing acreage under coffee ('000ha) in period t;

T = time trend;

D_1 = dummy variable to capture the effect of Amin's regime:

$D_1 = 1$ for 1971 - 1979

$D_1 = 0$ for 1980 - 1989 and

$= 0$ for 1965 - 1970;

D_2 = dummy variables to capture the effect of guerilla war:

$D_2 = 0$ for 1965 - 1979 and 1987 - 1989

$D_2 = 1$ for 1980 - 1986;

z_t = error disturbance term in period t; and

k = number of years covered by the lag structure.

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[5]Coffee producer prices and labour wage are normalised by banana producer prices.

Hypothesis 2:

Relative producer prices have an effect on coffee supply over time.

The polynomial distributed lag model, although more flexible than the Nerlovian model, is faced with conceptual and statistical problems. The model contains two parameters: the degree of polynomial and length of the lag. If these two parameters are not known *a priori*, then the estimation of the supply function may be subject to subjective judgement of the researcher.

Most researchers (like Kulshreshtha) tend to rely on some *ad hoc* criterion such as adjusted R^2 when making their choice of length of the lag and degree of the polynomial. Kmenta(1986) suggested that the matter would be relatively simple if the length of the lag (k) is known *a priori* and only the degree of polynomial (r) is uncertain. Then, a sequential testing procedure based on comparing restricted and unrestricted error sums of squares is pursued. The next step is to select the maximum polynomial degree[6], say r^* and test the hypothesis that the degree of polynomial is $r^* - 1$ using an F-test. If the hypothesis is rejected, stop and accept r^* as the appropriate degree. Otherwise one degree lower is tried and tested again. The selected degree of the polynomial is then that corresponding to the last acceptable hypothesis.

Kmenta further suggested that if the length of the lag is not known *a priori* - except for its maximum, say k^* - then a sequence of tests of hypotheses is carried out:

(3.18) $\quad H_0: \beta_{k^*} = 0 \quad H_1: \beta_{k^*} = \beta_{k^*-1} = 0$

using unconstrained estimates and employing the standard F-test until a rejection is

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[6]The selected degree of the polynomial should never be greater than the maximum length of the lag.

encountered. After the length of the lag has been determined, then the degree of the polynomial is selected by the sequential testing procedure described above. However, he pointed out that care should be taken in selecting the length of the lag and the degree of the polynomial following the above procedure, because the true level of significance of the test is unknown. This is a common pre-test estimator problem. However, it is often necessary to examine the underlying assumptions of any estimation approach to see how far it approximates reality. It is on this account that the polynomial lag model seems to be appropriate for supply response studies on perennial crops.

Hall and Sutch (1968) suggested that it is usually advisable to start with a polynomial of degree four and reduce its order if the higher order terms contribute insignificantly to the explanation of the dependent variable[7]. They further suggested that an appropriate test of the significance of the rth degree of the polynomial is a t-test on the coefficient of the P(r) variable, where r=1, 2, ..., n. On choosing the length of lag, Meilke (1975) suggested that if the researcher has knowledge about the production process of a crop under study, it would help in giving an indication of likely length of lag.

To choose the final form of the polynomial function the following scanning procedure is used:

(1) **Choice of the degree of the polynomial.**

For a given lag an equation employing an arbitrary degree of the polynomial with value of r = 2, 3, 4 is estimated without imposing a zero constraint. The

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[7] In their paper, they assumed that a 4-th degree polynomial would be high enough to represent an economic function.

appropriate test of significance for the n-th degree of the polynomial used is a two-tailed t-test on the significance of the coefficient on the P(r) variable;

(2) **Choice of the length of the lag period.**

The choice of this value will be based on Singh et al and MacBean's suggestions on coffee production cycle. For a pre-selected degree of polynomial, varying length of lags are specified (where k= 5, 6, 7, 8, 9). The length of the lag is determined by elimination of terms until the individual price coefficients P_{t-i} are significant using a one-tailed t-test as well as the shape of their distribution;

(3) A last zero constraint (that is, when the polynomial is assumed to be zero during the last period) is imposed and its statistical significance tested using a standard F-test:

$$(3.19) \qquad F_{c,\, m-e} = \frac{(SS1 - SS2)/c}{SS2/m-e}$$

where:

SS1 = sum of squares from a regression imposing a zero constraint;

SS2 = sum of squares from a regression without a zero constraint;

c = number of zero constraints;

m = number of observations; and

e = number of independent variables in the unconstrained regression.

(4) To test the overall significance of the individual parameters included in the model a one-tailed t-test is used. Furthermore, Durbin Watson (DW) statistics at 1% level of significance is used to detect the presence of serial correlation.

3.2.2 A Production Function Model

Let the quadratic production function for coffee be defined as:

$$(3.20)\quad Y_t = \theta_0 + \theta_1 X_{1t} + \theta_2 X_{2t} + \theta_3 X_{1t}^2 + \theta_4 X_{2t}^2 + \theta_5 X_{1t} X_{2t} + u_t$$

where: X_{1t} = labour input quantities ('000md) in period t;

u_t = error disturbance term to take account of other input variable influencing coffee production function not included in the model;

Assume that labour (X_1) is endogenous to the system, where :

$$(3.21)\quad X_{1t} = \alpha_0 + \alpha_1 P_t + \alpha_2 W_{1t} + \alpha_3 X_{2t} + \alpha_4 T + \alpha_5 D_1 + v_t$$

where:

v_t = error disturbance term to take account of other variables affecting the demand for labour in the coffee production.

Let a normalised quadratic production function be defined as:

$$(3.22)\quad Y_t/X_{2t} = \mu_0 + \mu_1(X_{1t}/X_{2t}) + \mu_2(X_{1t}/X_{2t})^2 + \mu_3 X_{1t} + s_t$$

where: s_t = error distrurbance term.

Equation (3.21) and (3.22) are estimated together using two stage least squares (2SLS) and three stage least squares (3SLS) and the results are then compared to come up with more plausible models. The main purpose of estimating the normalised quadratic production function before equation (3.19) is to be able to test for the existence of constant returns to scale.

Hypothesis 3 :

The production function exhibits constant returns to scale. That is to say,

(3.23) $H_0 : \mu_3 = 0$

If the null hypothesis is rejected, then it will imply that (within the framework of a normalised quadratic production function equation (3.22)) the coffee production function does not exhibit constant returns to scale. Then, the next step is to estimate equation (3.20) and (3.21) simultaneously using 2SLS and 3SLS. The standard quadratic production function is tested to see whether it satisfies the concavity property. The elasticity of scale, which is a local measure of the returns to scale, is also calculated in the case of the standard quadratic production function to determine whether the function exhibits increasing or decreasing returns to scale. Since the quadratic production function is not homogenous, the elasticity of scale is derived by summing up all the factor elasticities in the function. Mathematically, elasticity of scale (E) is given as:

(3.24) $E = \Sigma E_i \qquad i = 1 \quad 2$

where: E_i = ith factor elasticity

As in the case of the distributed lag approach, DW statistic is employed to test for the presence of serial correlation.

3.3 Data Source[8] and Limitations

Annual time series data covering the crop years 1965/66 through 1988/89 are used in the study. Time series data are used to ensure adequate variations in prices. The choice of the period is based entirely on the availability of data. Data on production ('000mt), bearing acreage under coffee ('000ha) were obtained from the MOA. Data on prices (USh/Kg), labour[9] wages (USh/kg) and input quantities (md/ha) were obtained from the UCA and AS. World coffee prices (US$/Kg) were obtained from AS and UNCTAD Commodity YearBook various issues; data on foreign exchange rates (US$/USh) were obtained from AS and various issues of IFS. Because of the currency reform which took place on 15th May 1987, it was imperative to have all price data on output and input converted into US$/kg - using the respective official foreign exchange rates.

In Uganda the base of agricultural data is thin[10]. The most recent agricultural census was carried out in 1966 and there is one going on now until the end of 1992. The data available is based on sample surveys which have been carried out between 1967 to the present day.

Unskilled labour is a major input in coffee production. This is due to high labour requirements for weeding, pruning, spraying and harvesting. It should also be noted that more family labour is employed in coffee production than hired labour. When one takes

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[8] It should be noted that there are some discrepancies in the same kind of data obtained from different sources.

[9] Labour wages and input quantities include both family and hired labour.

[10] See Annex 1.

a closer look at the way the labour costs are derived, it is observed that the activities in which labour is involved are not consistent from one year to another and it is aggregated over farms and districts.

Price statistics related to the agricultural sector are very important as price relations play a fundamental role in the formulation of agricultural development plans and related decisions of an economic nature. These relations largely determine the type and volume of productive activity in agriculture. However, Uganda has not accorded the compilation of meaningful and adequate price statistics the same attention as that given to other agricultural statistics.

The production figures reported by the MOA do not include coffee smuggled out of the country. This suggests that coffee production is being underestimated. As already mentioned, this will affect the results especially for arabica coffee. It is also noted that the upheavals of the last 20 years have made it impossible to collect reliable data on new areas planted, the number of farmers by size, age distribution of coffee trees, coffee hectarage abandoned, and movements into or out of coffee farming in the various major coffee growing districts. This thesis deals with Uganda as a whole for each coffee type. While a district level analysis would be preferable, it could not be attempted due to data inadequacies.

3.4 Empirical Results

As pointed out earlier, a range of degree of polynomial from 2 to 4 and a length of lags ranging from 5 to 9 years were tried. With the above outlined scanning procedure, a polynomial of degree 3 and a lag length of 9 years were chosen for robusta, and in case of arabica a polynomial of degree 3 and a lag length of 7 years were chosen. The results for the polynomial lag function are as shown in Table 3.1 and Table 3.2 below:

Table 3.1

Estimated Polynomial Lag Function for Robusta Coffee in Uganda, 1970/71-1988/89

Variable	Without Zero Constraint	With Zero Constraint
Intercept	-1426.75 (-8.22)*	-1463.19 (-10.80)*
W_{1t}	-44.70 (-2.32)*	-50.22 (-3.71)*
X_{2t}	6.65 (6.19)*	7.01 (10.27)*
T	-8.99 (-1.77)**	-10.97 (-4.08)*
P(0)	47.53 (7.10)*	47.17 (8.20)*
P(1)	-3.17 (-0.83)	-4.99 (-6.95)*
P(2)	-5.51 (-1.30)***	-7.40 (-4.90)*
P(3)	-1.43 (-0.41)	-3.11 (-6.11)*
SSE R^2 DW	11.798 0.999 2.862	13.220 0.999 2.849

(* significant at 5% level; ** significant at 10% level and *** significant at 20% level).

Table 3.2

Estimated Polynomial Lag Function for Arabica Coffee in Uganda, 1970/71 - 1988/89

Variable	Without Zero Constraint	With Zero Constraint
Intercept	-	-
W_{1t}	-2.161 (-1.16)	-1.923 (-1.08)
X_{2t}	0.292 (2.22)**	0.292 (2.20)**
D_1	-11.649 (-5.98)*	-11.685 (-6.18)*
P(0)	0.709 (1.98)**	0.536 (1.290)
P(1)	0.519 (3.728)*	0.387 (2.72)**
P(2)	0.206 (1.28)	0.005 (1.03)
P(3)	0.003 (1.81)***	-0.228 (-1.82)***
SSE	40.881	42.364
R^2	0.8054	0.8167
DW	2.921	2.062

(* significant at 5% level; ** significant at 10% level; and *** significant at 20% level).

The values appearing in the parentheses in Table 3.1 and 3.2 are the t-ratios. Variation in signs of P(r) is due to the multicollinearity between these parameters. In this

thesis the interest is in estimating the coefficients of $P_{t-i.}$ Given the values of P(r) and the length of the lag period for each coffee type, the unconstrained and constrained estimated lagged coffee supply response model are as presented below:-

Unconstrained Robusta Coffee Model

$$
\begin{aligned}
(3.25)\ Y_t = {} & -1426.74 - 44.70W_{1t} + 6.65X_{2t} - \\
& (-8.22) \quad (-2.32) \quad (6.19) \\
& 8.99T + 14.38P_t + 15.07P_{t-1} + \\
& (-1.77) \quad (8.38) \quad (9.73) \\
& 15.84P_{t-2} + 16.51P_{t-3} + 16.94P_{t-4} + \\
& (8.22) \quad (7.16) \quad (6.16) \\
& 16.96P_{t-5} + 16.42P_{t-6} + 15.18P_{t-7} + \\
& (5.45) \quad (5.28) \quad (5.75) \\
& 13.06P_{t-8} + 9.93P_{t-9} \\
& (4.69) \quad (1.72)
\end{aligned}
$$

$$R^2 = 0.999 \qquad DW = 2.862$$

Constrained Robusta Coffee Model

$$
\begin{aligned}
(3.26)\ Y_t = {} & -1463.19 - 50.22W_{1t} + 7.02X_{2t} - \\
& (-10.80) \quad (-3.71) \quad (10.27) \\
& 10.97T + 14.94P_t + 15.09P_{t-1} + \\
& (-4.08) \quad (13.56) \quad (11.27) \\
& 15.76P_{t-2} + 16.64P_{t-3} + 17.37P_{t-4} + \\
& (9.50) \quad (8.40) \quad (7.72) \\
& 17.62P_{t-5} + 17.07P_{t-6} + 15.36P_{t-7} + \\
& (7.29) \quad (7.00) \quad (6.81) \\
& 12.17P_{t-8} + 7.17P_{t-9} \\
& (6.67) \quad (6.56)
\end{aligned}
$$

$$R^2 = 0.999 \qquad DW = 2.849$$

Unconstrained Arabica Coffee Model

$$
\begin{aligned}
(3.27)\ Y_t = {} & -2.161W_{1t} + 0.292X_{2t} - 11.649D_1 + \\
& (-1.16) \qquad (2.22) \qquad (-5.98) \\
& 0.003P_{t-1} + 0.074P_{t-2} + 0.052P_{t-3} + \\
& (0.03) \qquad (1.13) \qquad (0.71) \\
& 0.022P_{t-4} + 0.067P_{t-5} + 0.279P_{t-6} + \\
& (0.28) \qquad (0.66) \qquad (2.78) \\
& 0.738P_{t-7} \\
& (6.34)
\end{aligned}
$$

$$R^2 = 0.8054 \quad DW = 2.921$$

Constrained Arabica Coffee Model

$$
\begin{aligned}
(3.28)\ Y_t = {} & -1.923W_{1t} + 0.292X_{2t} - 11.685D_1 + \\
& (-1.08) \qquad (2.20) \qquad (-6.18) \\
& 0.072P_{t-1} + 0.063P_{t-2} + 0.028P_{t-3} + \\
& (1.35) \qquad (1.03) \qquad (0.47) \\
& 0.021P_{t-4} + 0.096P_{t-5} + 0.308P_{t-6} + \\
& (0.27) \qquad (1.06) \qquad (3.60) \\
& 0.712P_{t-7} \\
& (6.80)
\end{aligned}
$$

$$R^2 = 0.8167 \quad DW = 2.062$$

The t-ratios which appear in the parentheses in the above equations (3.25) and (3.26) show that the regression coefficients of P_{t-i} are all positive and statistically significant at the 5% level. It should also be noted that the t-ratios in equations (3.27) and (3.28) are low. This could be due to omission of some relevant factors affecting arabica output supply response such as fertilizer prices and quantities and smuggling activities; or the polynomial distributed lag model may not fully explain the farmers'

production decisions. The next step was to choose between the constrained and unconstrained polynomial distributed lag coffee supply response models.

Hypothesis 4:

The polynomial is equal to zero in the last period.

In the case of robusta coffee, the observed $F^*_{1\ 12}$ was estimated to be 1.446 and the tabulated $F_{1\ 12} = 9.33$. Since $F^* < F$, this implies acceptance at 1% level of significance of the null hypothesis that the polynomial is equal to zero during the last period (that is, $\beta_{10}=0$). Therefore, the final polynomial distributed lag for robusta coffee is the constrained model in equation 3.26. In the case of arabica coffee, the observed $F^*_{1\ 14}$ was estimated to be 0.51 and the tabulated $F_{1\ 14} = 8.86$. Since $F^* < F$, this implies acceptance at 1% level of significance of the null hypothesis that the polynomial is equal to zero during the last period (that is, $\beta_8=0$). Thus the final model should be the constrained arabica coffee model in equations 3.28.

From the chosen models, that is, the constrained robusta and arabica coffee supply response models, it is observed that the signs of the individual parameters are consistent with economic theory. Furthermore, the results suggest the acceptance of hypothesis 2, that relative producer prices affect coffee production. In Uganda, coffee production is based on low-input-output technologies. High yielding seed varieties, fertilizer applications and other improved technologies for higher yields are not currently used by the farmers[11]. This could be the reason why the time trend coefficient is negative in the robusta coffee model.

---

[11] Improvements and technologies which were developing by 1970 have been largely destroyed or neglected by farmers.

In the case of arabica coffee, results suggest that policies of Amin's regime had a negative effect on coffee production. This is not surprising since as already mentioned, arabica growing areas are at the border. This made smuggling activities easier and hence led to a negative impact on the officially marketed output. In both models the dummy variable D_2 capturing the effect of guerilla war was not significant and therefore was excluded. Results also suggest that while the robusta farmers start to respond to prices in the current period, the arabica coffee farmers start their response to prices in the previous period. Moreover, the intercepts in the arabica coffee models were omitted because they were not significant and at the same time affected the signs of other variables. The DW statistics test indicates zero autocorrelation and the adjusted R^2 is very high.

Results suggest that the effect of a price change on coffee output is spread over many years. This implies acceptance of hypothesis 1. In the case of robusta coffee, price change in year t has an increasing effect until about five years later when the effect reaches its peak. A similar result holds in the case of arabica coffee, where the peak occurs at seven years. In subsequent years, the effect gradually declines. For a perennial crop like coffee, this price response appears to make good sense. As mentioned earlier, the effect of price change is two-fold. A price increase, for instance, induces farmers not only to undertake new plantings but also to take more intensive care of the mature coffee trees. For a few years, only the effect of the latter shows up in the output. As seen above, first harvest comes in about three to four years after planting and the normal yield occurs in about five to six years, and these plantings add their effect to the output. This is probably why the price response coefficients for robusta and arabica coffee rise to their

peak in the fifth and seventh year respectively.

From the production function approach, the best labour demand and normalised quadratic production functions for robusta and arabica coffee results are presented in Tables 3.3 and 3.4 respectively. The labour demand and the normalised quadratic production function estimated using 2SLS are chosen. The signs of individual parameters are as expected and there is no autocorrelation. The adjusted R^2 in the robusta labour demand equation is a bit low because not all factors affecting the demand for labour, such as the institutional constraints, were included. In the case of arabica coffee, results suggest that relative producer price, current labour wages, current hectarage and time trend are important variables in explaining the demand for labour. The intercepts for both coffee types were not significant and hence were omitted. The hypothesis that the coffee production function (for both coffee types) exhibit constant returns to scale is rejected. However, results suggest existence of decreasing returns to scale.

Table 3.3

Robusta Labour Demand and Normalised Quadratic Production Functions Results Using 2SLS and 3SLS 1970/71 - 1988/89

Model	Variable	2SLS Estimates	3SLS Estimates
Labour Demand Equation X_{1t}:	Intercept	-	-
	$Log(P_t)$	7.4883 (1.32)***	8.3491 (1.61)***
	$Log(W_{1t})$	-18.1988 (-3.24)*	-18.9317 (-3.62)*
	T	2.2512 (6.99)*	2.1253 (7.06)*
	D_1	8.1657 (1.93)**	7.7306 (1.91)**
	R^2	0.4684	0.4571
	DW	1.872	1.914
Production Function Y_{1t}	Intercept	-	-
	X_{1t}/X_{2t}	3.3510 (179.31)*	3.3436 (190.05)*
	$(X_{1t}/X_{2t})^2$	0.0454 (-1.54)***	0.0566 (1.98)**
	X_{1t}	-0.0002 (-1.52)***	-0.0001 (-1.36)***
	R^2	1.0000	1.000
	DW	2.641	2.645

Note: (* significant at 1% level; ** significant at 5% level; and *** significant at 10% level) and $Y_{1t} = Y_t/X_{2t}$.

Table 3.4

Arabica Labour Demand and Normalised Quadratic Production Functions Results Using 2SLS and 3SLS 1970/71 - 1988/89

Model	Variable	2SLS Estimates	3SLS Estimates
Labour Demand Equation X_{1t}:	Intercept	-	-
	$Log(P_t)$	0.5786 $(1.61)^{***}$	0.8216 $(1.91)^{***}$
	$Log(W_{1t})$	-3.4179 $(-3.66)^{*}$	-3.2462 $(-3.56)^{*}$
	$Log(X_{2t})$	1.0354 $(1.70)^{***}$	0.9002 $(1.53)^{***}$
	T	2.0300 $(2.26)^{**}$	2.0125 $(2.40)^{**}$
	R^2 DW	0.504 1.655	0.4908 1.633
Production Function Y_{1t}:	Intercept	-	-
	X_{1t}/X_{2t}	2.0300 $(48.08)^{*}$	2.0125 $(49.25)^{*}$
	$(X_{1t}/X_{2t})^2$	-0.0179 $(-1.71)^{***}$	-0.0094 $(-1.38)^{***}$
	X_{2t}	-0.0008 $(1.69)^{***}$	-0.0003 (-1.28)
	R^2 DW	1.0000 2.080	1.0000 2.274

Note: (* significant at 1% level; ** significant at 5% level and and *** significant at 10%) and $Y_{1t} = Y_t/X_{2t}$.

Having rejected hypothesis 3 of constant returns to scale for both coffee types, the standard quadratic production function together with the labour demand equations are estimated and the results are presented in Tables 3.5 and 3.6 below. The 3SLS models are chosen for both coffee types. The coefficients of the individual parameters are as expected and there is no autocorrelation. The sign of the interaction term (that is, $X_{1t}X_{2t}$) is positive implying that land and labour inputs are complimentary inputs as expected. The concavity property of the production function is also satisfied, in the case of robusta coffee, since the Hessian matrix of the production function is negative semi-definite. However, in the case of arabica coffee the concavity property is not satisfied. The factor elasticities and elasticity of scale computed at mean levels of the input quantities are presented in Table 3.7. The results in Table 3.7 imply that the production function for both coffee type do exhibit decreasing returns to scale. The labour factor elasticity (E_l) is large and positive for both coffee types.

Table 3.5

Robusta Labour Demand and Standard Quadratic Production Functions Results Using 2SLS and 3SLS. 1970/71-1988/89

Model	Variable	2SLS Estimates	3SLS Estimates
Labour demand Equation X_{1t}:	Intercept	-	-
	$Log(P_t)$	7.4883 (1.32)***	8.3571 (1.61)***
	$Log(W_{1t})$	-18.1988 (-3.24)*	-17.7309 (-3.30)*
	T	2.2512 (6.99)*	2.2196 (7.11)*
	D_1	8.1657 (1.93)**	7.8332 (1.88)***
	R^2	0.4684	0.4643
	DW	1.872	1.876
Production Function Y_t:	Intercept	-31.3300 (-0.98)	-50.8087 (-1.72)***
	X_{1t}	3.2966 (16.36)*	3.0109 (16.97)*
	X_{2t}	0.3123 (0.93)	0.5182 (1.68)***
	$(X_{1t})^2$	-0.0015 (-1.32)***	-0.0018 (-1.66)***
	$(X_{2t})^2$	-0.0009 (-0.94)	-0.0014 (-1.67)***
	$X_{1t}X_{2t}$	0.0009 (0.61)	0.0014 (1.84)***
	R^2	1.0000	1.0000
	DW	3.021	2.812

Note: (* significant at 1% level; ** significant at 5% level; and *** significant at 10% level).

Table 3.6

Arabica Labour Demand and Standard Quadratic Production Functions Results Using 2SLS and 3SLS 1970/71 - 1988/89.

Model	Variable	2SLS Estimates	3SLS Estimates
Labour demand Equation $X_{1t:}$	Intercept	-	-
	$Log(P_t)$	0.5501 (0.65)	0.6892 (1.82)***
	$Log(W_{1t})$	-3.8382 (-4.58)*	-3.8596 (-4.50)*
	$Log(X_{2t})$	1.1767 (2.15)**	1.0893 (2.00)**
	T	0.1446 (1.94)***	0.1505 (2.02)**
	R^2 DW	0.6132 1.560	0.6087 1.559***
Production Function Y_t:	Intercept	-	-
	X_{1t}	1.8710 (15.59)*	1.8639 (15.61)*
	X_{2t}	0.0400 (1.25)	0.0414 (1.29)
	$(X_{1t})^2$	0.0002 (1.12)	0.0028 (1.75)***
	$(X_{2t})^2$	-0.0011 (-1.23)	-0.0011 (-1.82)***
	$X_{1t}X_{2t}$	0.0026 (0.92)	0.0028 (1.80)***
	R^2 DW	0.6132 1.851	1.0000 1.823

Note: (* significant at 1% level; and ** significant at 5% level and *** significant at 10%).

Table 3.7

Factor Elasticities and Elasticity of Scale

Coffee Type	Factor Elasticity		Elasticity of scale E
	E_1	E_2	
Arabica	0.9926	-0.0146	0.9766
Robusta	0.9402	0.0364	0.9780

Source: Author's calculations based on Tables 3.5 and 3.6.

3.4.1 Elasticity Estimates

Supply Function Approach

Price elasticities derived from the disaggregated constrained supply response models using a polynomial distributed lag are presented in Table 3.8. The distribution of the elasticities indicates that the price response increases continuously to about the fifth year for robusta coffee (seventh year for arabica coffee) after a price change and then gradually declines. The aggregated price elasticity is calculated as 2.69 for robusta and 0.93 for arabica coffee. The price elasticities for robusta coffee indicate that, while the production response to price change may appear inelastic when viewed in the context of production change within one or two years, the overall response when all production adjustments are completed is elastic. In the case of arabica coffee, price elasticities are inelastic in the short run and more xlosely approach 1.0 in the long run.

Table 3.8

Estimated Coffee Price Elasticities

Time Period	Elasticity	
	Robusta	Arabica
0	0.27	-
1	0.27	0.04
2	0.28	0.03
3	0.30	0.02
4	0.31	0.01
5	0.32	0.06
6	0.31	0.22
7	0.28	0.55
8	0.22	-
9	0.13	-
Aggregated Elasticities	2.69	0.93

Source: Author's calculations based on equations 3.26 and 3.28.

Production Function Approach

From Table 3.5, derivation of the Hessian matrix for the standard quadratic robusta coffee production function is as follows:

(3.29)
$$P\begin{bmatrix} \frac{\partial^2 Y}{\partial X_1^2} & \frac{\partial^2 Y}{\partial X_1 \partial X_2} \\ \frac{\partial^2}{\partial X_2 \partial X_1} & \frac{\partial^2 Y}{\partial X_2^2} \end{bmatrix} = 3\begin{bmatrix} -0.0036 & 0.0015 \\ 0.0015 & -0.0028 \end{bmatrix}$$

$$\equiv \quad -[\Pi_{WW}(P, W)]^{-1}$$

Then,

$$(3.30) \qquad -\Pi_{ww}(P, W) = \begin{bmatrix} 119.2000 & 63.8570 \\ 63.8570 & 153.2567 \end{bmatrix}$$

From equation 3.30, the following comparative statics for robusta coffee are derived:-

$$\frac{\partial X_1}{\partial P} \equiv -\frac{\partial Y}{\partial W_1} = 66.0300$$

$$\frac{\partial X_2}{\partial P} \equiv -\frac{\partial Y}{\partial W_2} = 123.5887$$

$$\frac{\partial Y}{\partial P} = 101.9459$$

Then, the long run price elasticity of supply $\varepsilon = 1.85$

From the production function approach, the price elasticity of robusta coffee is estimated to be 1.85 in the long-run. However, the long-run price elasticity derived from the production function approach is lower than that derived from the distributed lag approach. For both approaches the long-run price elasticity is elastic. This implies that robusta coffee production is elastic with respect to relative producer prices (that is, robusta coffee/banana prices). Results suggest that robusta coffee producer price response is very sensitive to the banana producer price. No attempts were made to infer the short-run price elasticities from the long-run price elasticities, since policy analysis often requires information on long-run supply response effects of price changes. In case of arabica coffee no efforts were taken to compute the price elasticity

since the concavity property of the production function - which is a necessesary condition for the production and profit function relationship - was not satisfied.

In this Chapter, it has been possible to estimate a coffee supply response model in spite of data inadequacies. Despite these data problems the results obtained are generally plausible and consistent with economic theory. Furthermore, this Chapter has demonstrated how different estimation approaches can lead to different results.

Chapter Four

GOVERNMENT POLICY OBJECTIVES AND THE COFFEE PRICING POLICY

From Chapter Three, the coffee supply response was estimated and it was possible to compute the price elasticity of coffee production. For any pricing policy to be efficacious, it is imperative that the government and the policy makers have a "dependable" estimate of the price elasticity of supply. If the price elasticity is both positive and significant, the government may succeed in achieving its policy objectives. Even if the supply response elasticities are positive but of low magnitude, this has an obvious policy implication that pricing policy as an instrument of achieving increased production may have a limited role to play.

The tools available at present for evaluating the impact of pricing policy in Uganda are inadequate. Among the mostly used tools on which policy advice is often based are descriptive measures of price distortions, including the Nominal Protection Coefficient (NPC), Effective Protection Coefficient (EPC) and Domestic Resource Costs (DRC). The NPC and EPC measure distance between market and shadow prices but they fail to measure the welfare cost of inappropriate pricing policies. Moreover, these measures provide no guidance whatsoever on the effect of changes in policy variables of interest to the government. The government policy objectives include increased food self-sufficiency, export diversification, increased government revenue and foreign

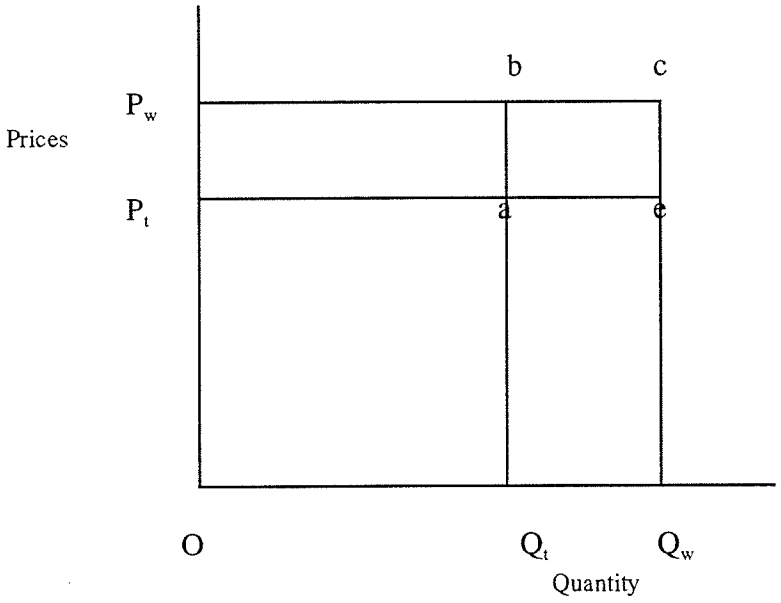
exchange earnings, income generation for farmers and emphasis on equalizing distribution of income between rural and urban areas, increased food and raw materials to support industrial development and enhance exports (Venegas, 1990). One of the outstanding difficulties in using pricing policy as a policy instrument is that it fulfils many conflicting government policy objectives. For instance, the government can not maximise tax revenue and maximise foreign exchange earnings simultaneously from the same crop. And if the government wishes to encourage export crop production it must sacrifice some growth in food self-sufficiency. Perhaps it is because of these conflicting policy objectives set for the pricing policy that most governments in the developing countries, especially Sub-Saharan African countries, are disinclined to leave the determination of prices to market forces. These countries have endeavoured instead to control their effects through a whole range of institutional interventions.

These multiple and conflicting government policy objectives form the basis for policy dialogue in most developing countries. In practise, the policy makers would wish to identify via this dialogue the likely impact of recommended pricing policy on these objectives and the explicit trade-offs that might be involved. To achieve this, it is required to go beyond the above stated descriptive measures by estimating coffee supply response models econometrically as presented in Chapter Three. These models will be capable of providing a link between coffee pricing policy and a set of government policy objectives. Furthermore, with these models it is feasible to examine the consequences of any change in coffee pricing policy on government policy objectives.

Since coffee is considered to be the major export crop and at the same time the

major source of government revenue, the two fundamental policy objectives directly linked to coffee are the generation of government revenue and foreign exchange earnings. It is indisputable that these two policy objectives are often conflicting. It is clear that if the government seeks to maximise foreign exchange earnings from coffee, it should set a different producer price than if it wishes to maximize government revenue. If the government's primary objective is to maximize revenue from coffee marketing, the producer price should be considerably below the world price, where the exact level depends on the characteristics of supply response of coffee. However, if the government is interested in maximising foreign exchange earnings, the producer price should be set equal to the world coffee price. This implies there will be a trade-off between maximising foreign exchange earnings and maximising government revenue from coffee.

Figure 4.1[1]: Expected Foreign Exchange Earnings and Government Revenue Gains Relative to Realised Levels.



where : SS = estimated coffee supply function;

P_w = world coffee price (US$/kg);

P_t = coffee producer price (US$/kg);

Q_t = coffee production by farmers at P_t and resold by CMB at P_w;

Q_w = coffee production if farmers were offered P_w.

If farmers received the world coffee price this would imply that Q_w will be produced and the foreign exchange gain is given by the area Q_tbcQ_w (see Figure 4.1). At P_t the government tax revenue will be given by the area P_tP_wba, however, if farmers

[1]Here we are implicitly assuming that all marketed production is disposed off on the world coffee market.

receive price P_w the tax revenue will be given by the area $P_tP_w$ce. The gain in government tax revenue is given by the area abce. The expected gain in foreign exchange earnings and government tax revenue depends on the distortions P_w-P_t and the elasticity of the long-run supply response curve which will determine Q_w-Q_t . The cost of this foreign exchange maximising policy is the elimination of the surplus collected by the hullers, CMB and government. The maximum government revenue will depend on world coffee prices and the price elasticity of supply for coffee. The more price elastic is supply, the greater will be the revenue maximising producer price.

Assume the government has a revenue maximising objective. This is to say that, it is interested in the effect of its coffee pricing policy on the government revenue both directly through export taxes and indirectly through CMB surpluses and deficits. Before proceeding any further, it is imperative to examine the reasons as to why Sub-Saharan African countries have continued to tax their export crops.

Shalizi and Squire (1989) observed there is a general perception that, because farmers effectively escape income tax, farmers in Sub-Saharan Africa are undertaxed. Suggestions have been made to governments to use land taxes to alleviate this problem. However, in the case of Uganda, the applicability of this kind of tax is controversial because of the land tenure system, the non-existence of data on land quality and variability in productivity from one season to another and from one district to another.

Due to difficulties in taxing farmers' income and implementing land taxes, it is argued that these farmers should be taxed explicitly or implicitly through the export tax. Shalizi and Squire argued that if export taxes are intended as a substitute for an income

tax, it should be possible to compute the rate of tax on exports which would be forthcoming were the farmers subject to income tax. They further argue that even if export taxes are set at reasonable rates, they are a poor substitute for the typical progressive income tax.

In the World Bank Report (1986), four reasons were cited as to why Sub-Saharan African countries tax their export crops:-

(a) To raise revenue for use of either the marketing boards or the central government.

(b) To take advantage of perceived oligopoly power in the world market for a particular commodity.

(c) To encourage the production of domestic food crops in order to attain self-sufficiency.

(d) To encourage agro-industries by taxing, or restricting by quota, the exports of agricultural raw materials.

In the case of Uganda, (a) is the main reason as to why export crops have been taxed. The revenues collected are said to have been used in financing public expenditure in agriculture and elsewhere. However, in Chapter One it was noted that the share of agriculture in public expenditure was very small and at the same time declining over the years. The revenue from coffee (and the funds which were meant for price stabilization) have been used mainly in financing military supplies.

Export crop taxes are a major source of government revenue and some taxation is inevitable for financing public expenditure in agriculture and elsewhere as already

mentioned. The higher the coffee tax, however, the lower the proportion of export parity price that can be passed onto the farmers as an incentive (see Table 2.5). When the high coffee export taxes are combined with the institutional constraints discussed in Chapter Two, little by way of incentives for coffee farmers is left. As a result, high coffee export taxes will imply lower production and procurement levels and lower government revenue.

From Figure 4.1 above, the government revenue[2] collected by the government is given by the rectangle $P_tP_w$ba or alternatively as:

$$(4.1) \qquad GR_t = Q_t(P_w - P_t)$$

where : GR_t = government revenue in period t.

In Chapter One, it was noted that Uganda's share in the world coffee market is too small to influence the world coffee prices (that is, the world coffee prices (P_w) will not vary with the quantity of coffee produced in Uganda). For a given P_w there should be a P_t that will maximise government revenue given as follows[3]:

$$(4.2) \qquad P_t = P_w \frac{\varepsilon}{1+\varepsilon}$$

where: ε is the supply elasticity with respect to producer price.

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[2] Of this government revenue more than 70% goes to the government in form of export tax and contribution to the price stabilization fund, and the rest goes to hullers and CMB as margins.

[3] See Annex II for complete derivation.

Table 4.1

Comparisons Between the Actual and the Revenue Maximising Producer Price (US$/kg) 1971-1989.

Year	World Price	Actual Producer Price		Revenue Maximising Producer Price	
		Robusta	Arabica	Robusta	Arabica
1971	0.79	0.17	0.64	0.58	0.38
1972	0.74	0.17	0.64	0.54	0.36
1973	0.91	0.18	0.64	0.66	0.44
1974	1.15	0.36	0.64	0.84	0.55
1975	1.06	0.36	0.65	0.77	0.51
1976	1.83	0.36	0.81	1.33	0.88
1977	4.16	0.50	1.21	3.03	2.01
1978	2.78	0.50	1.43	2.03	1.34
1979	2.96	1.00	2.14	2.16	1.43
1980	3.10	1.00	2.14	2.26	1.49
1981	1.95	0.65	2.06	1.42	0.94
1982	1.95	0.53	0.99	1.42	0.94
1983	2.35	0.46	1.02	1.71	1.13
1984	2.87	0.38	0.79	2.09	1.38
1985	2.76	0.40	0.89	2.01	1.33
1986	2.82	0.61	1.21	2.06	1.36
1987	2.02	0.40	0.72	1.47	0.97
1988	2.00	0.40	0.80	1.46	0.96
1989	2.10	0.36	0.61	1.53	1.01

Source : Author's calculations based on price elasticities derived from the distributed lag approach.

Table 4.2

Comparisons Between the Actual and the Revenue Maximising Producer Price(US$/kg) 1971-1989.

Year	World Price	Actual Producer Price	Revenue Maximising Producer Price
		Robusta	Robusta
1971	0.79	0.17	0.51
1972	0.74	0.17	0.48
1973	0.91	0.18	0.59
1974	1.15	0.36	0.75
1975	1.06	0.36	0.69
1976	1.83	0.36	1.19
1977	4.16	0.50	2.70
1978	2.78	0.50	1.81
1979	2.96	1.00	1.92
1980	3.10	1.00	2.01
1981	1.95	0.65	1.27
1982	1.95	0.53	1.27
1983	2.35	0.46	1.53
1984	2.87	0.38	1.86
1985	2.76	0.40	1.79
1986	2.82	0.61	1.83
1987	2.02	0.40	1.31
1988	2.00	0.40	1.30
1989	2.10	0.36	1.36

Source : Author's calculations based on price elasticities derived from the production function approach.

Results in Table 4.1 and 4.2 suggest rejection of the objective of maximising government revenue from coffee given the elasticities estimated in Chapter Three. When the actual producer price is compared with the revenue maximising producer price, results suggest that the robusta coffee farmer has been "exploited" over these years (see also Figures 4.2 and 4.3). This has had a disincentive impact on the

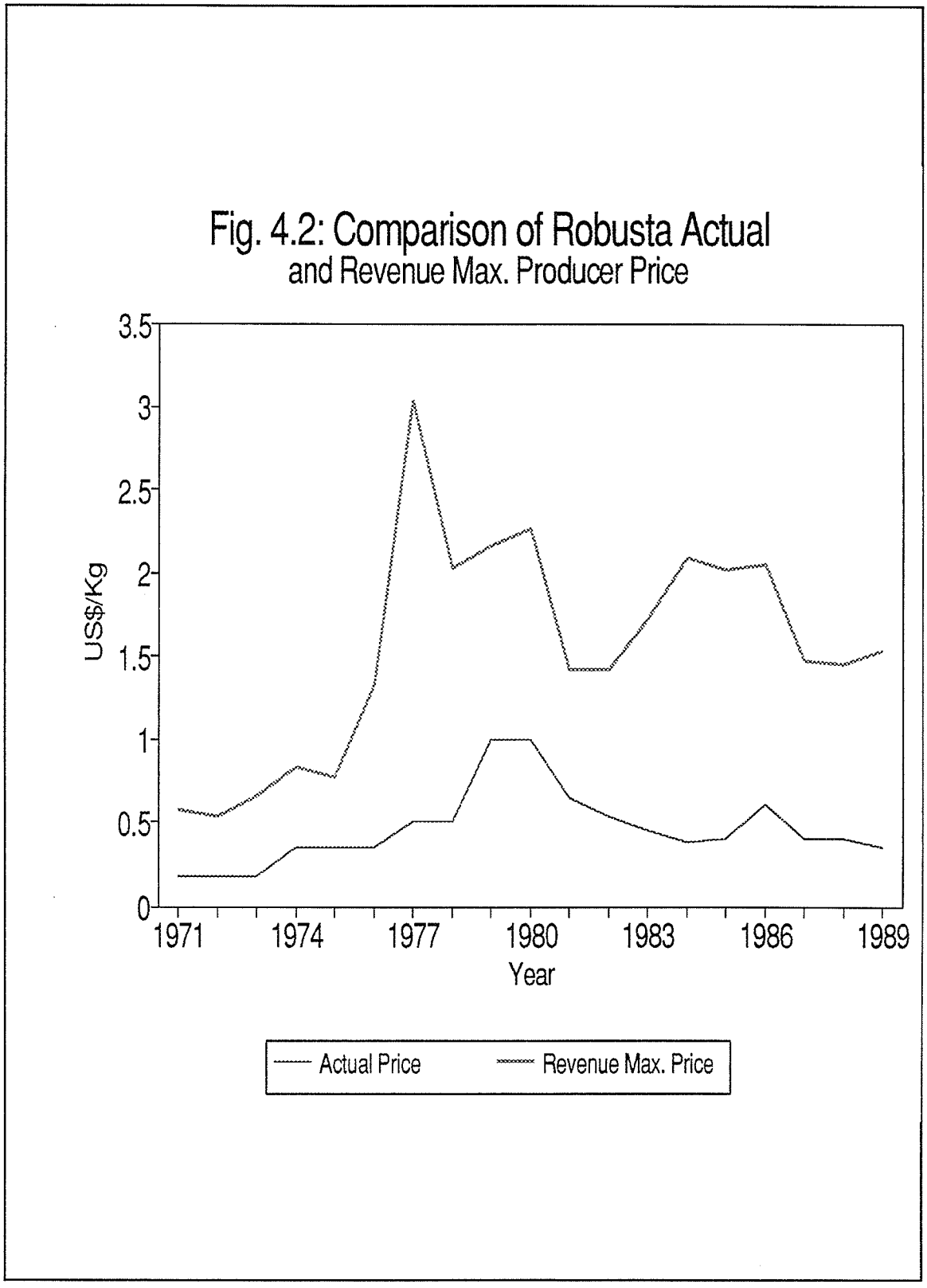
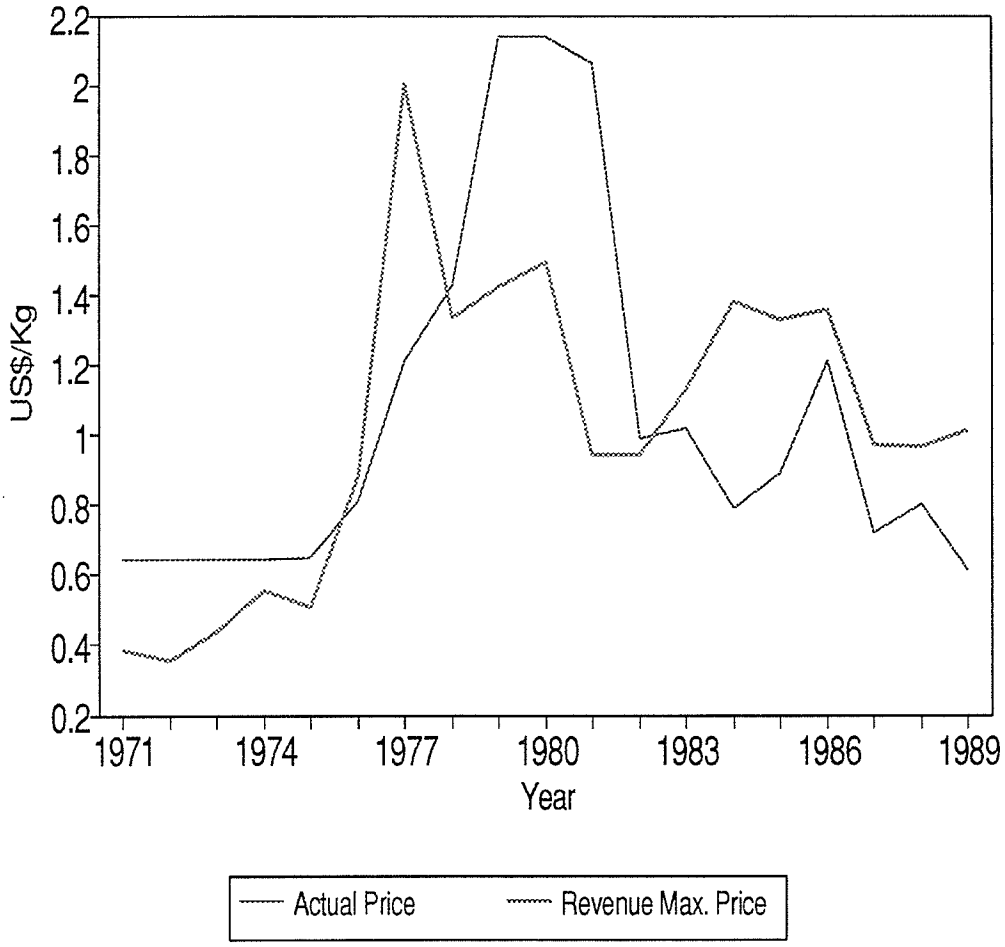


Fig. 4.2: Comparison of Robusta Actual
and Revenue Max. Producer Price
US$/Kg
3.5
3
2.5
2
1.5
1
0.5
0
1971
1974
1977
1980
1983
1986
1989
Year
Actual Price
Revenue Max. Price

Fig. 4.3: Comparison of Arabica Actual and Revenue Max. Producer Price



improvement of the quality of coffee, increasing the marketed output and replanting and/or planting coffee trees. In case of arabica, the revenue maximising producer price was lower than the actual producer price during the 1970s while in the 1980s it was the reverse. With a revenue maximising objective, the rational producer price should be set between the revenue maximising producer price and the world coffee price.

The government should examine public expenditure policies and taxation policies together. Besides exploring the scope for reducing total revenues collected from coffee exports, the government should also be concerned with the form of taxation. At present, coffee export taxes are determined as the excess of export receipts over the sum of the fixed producer prices and processing and marketing margins. This system of levying duty on coffee exports fails to provide incentives for exporters to maximize unit value of coffee sales.

Table 4.3

Increase in Robusta Production ('000mt), Foreign Exchange Earnings (mill. US$), and Revenue (mill. US$)

Year	Increase in Production		Foreign Exchange Earnings Gains		Government Revenue	
	(1)	(2)	(3)	(4)	(5)	(6)
1971	1442.16	497.99	1442.16	393.41	91.40	138.09
1972	1352.91	475.99	1001.16	352.23	85.50	125.54
1973	2574.63	869.77	2342.91	791.50	172.28	272.69
1974	1074.36	423.83	1235.51	487.41	143.78	188.81
1975	967.65	397.10	1025.71	420.93	129.50	167.21
1976	1438.93	485.45	2633.23	888.38	192.57	305.71
1977	2914.24	897.65	12123.23	3734.26	541.68	1178.82
1978	1324.77	437.74	3682.86	1216.94	246.24	411.15
1979	543.06	222.25	1607.45	657.88	201.88	260.91
1980	632.69	253.11	1961.33	784.63	235.20	306.73
1981	602.56	244.94	1174.99	477.64	145.60	188.63
1982	1261.26	469.37	2459.45	915.29	248.50	340.52
1983	2044.69	688.98	4805.03	1619.11	349.65	556.59
1984	3137.53	980.03	9004.71	2812.72	443.22	900.68
1985	2999.62	950.68	8278.95	2623.89	446.04	852.43
1986	1793.22	620.10	5056.87	1748.69	406.64	614.51
1987	2135.32	721.55	4313.35	1457.55	317.52	502.29
1988	2044.40	692.54	4088.80	1385.10	304.00	478.34
1989	3094.40	1012.08	6498.23	2125.39	414.12	711.42

Source : Author's calculations based on the price elasticity derived from the distributed lag approach.

Notes: (1) Increase in production if the farmer received the world coffee price (that is, $P_t=P_w$)[4];

(2) Increase in production if the farmer received the revenue maximising price;

(3) Additional gain to the society in terms of foreign exchange earnings if $P_t=P_w$;

(4) Additional gain to the society in terms of foreign exchange earnings if the farmer received the revenue maximising price;

(5) Coffee revenue at the actual producer price;

(6) Coffee revenue at the revenue maximising producer price.

[4] $P_t = P_w$ is used to assume the coffee farmer received the world coffee price.

Table 4.4

Increase in Robusta Production ('000mt), Foreign Exchange Earnings (mill. US$), and Revenue (mill. US$)

Year	Increase in Production		Foreign Exchange Earnings Gains		Government Revenue	
	(1)	(2)	(3)	(4)	(5)	(6)
1971	1002.54	448.22	783.54	350.31	91.40	164.99
1972	940.50	428.42	688.53	313.64	85.50	150.19
1973	1789.80	782.85	1611.30	704.77	172.28	325.32
1974	746.86	381.47	849.70	434.00	143.78	227.37
1975	672.68	357.41	705.42	374.81	129.50	201.74
1976	1000.29	436.94	1810.96	791.04	192.57	364.67
1977	2025.88	807.95	8337.54	3325.10	541.68	1395.34
1978	920.94	394.00	2532.83	1083.60	246.24	489.67
1979	377.52	200.04	1105.50	585.80	201.88	314.74
1980	439.82	227.81	1348.87	698.66	235.20	369.62
1981	418.88	220.46	808.08	425.31	145.60	227.48
1982	876.78	422.47	1691.44	815.00	248.50	408.79
1983	1421.40	620.12	3304.57	1441.71	349.65	663.87
1984	2181.11	882.09	6192.83	2504.60	443.22	1067.53
1985	2085.24	855.67	5693.70	2336.40	446.04	1011.68
1986	1246.59	558.13	3477.77	1557.09	406.64	734.32
1987	1484.41	649.45	2966.43	1297.85	317.52	599.23
1988	1421.20	623.33	2812.00	1233.33	304.00	570.76
1989	2151.12	910.94	4469.05	1892.52	414.12	846.59

Source : Author's calculations based on the price elasticity derived from the production function approach.

Notes: (1) Increase in production if the farmer received the world coffee price (that is, $P_t=P_w$);

(2) Increase in production if the farmer received the revenue maximising price;

(3) Additional gain to the society in terms of foreign exchange earnings if $P_t=P_w$;

(4) Additional gain to the society in terms of foreign exchange earnings if the farmer received the revenue maximising price;

(5) Coffee revenue at the actual producer price;

(6) Coffee revenue at the revenue maximising producer price.

Table 4.5

Increase in Arabica Production ('000mt), Foreign Exchange Earnings (mill. US$), and Revenue (mill. US$)

Year	Increase in Production		Foreign Exchange Earnings Gains		Government Revenue	
	(1)	(2)	(3)	(4)	(5)	(6)
1971	2.83	7.73	2.24	6.11	1.95	8.49
1972	3.34	12.81	2.47	9.48	2.30	13.73
1973	9.42	16.44	8.57	14.96	6.48	19.07
1974	10.38	12.12	11.93	13.94	7.14	15.57
1975	8.80	11.79	9.33	12.49	6.15	14.71
1976	10.54	9.80	19.29	17.93	9.18	17.82
1977	27.21	19.88	113.19	82.70	35.40	68.71
1978	7.90	8.43	21.97	23.44	12.15	25.11
1979	3.21	6.00	9.49	17.76	7.38	23.00
1980	4.17	6.98	12.93	21.64	9.60	27.27
1981	-0.50	4.56	-0.97	8.90	-1.10	14.71
1982	10.82	11.39	21.10	22.21	11.52	23.63
1983	15.76	14.43	37.05	33.92	17.29	33.40
1984	34.28	24.51	98.39	70.34	29.12	57.26
1985	29.31	22.42	80.90	61.87	28.05	53.50
1986	17.32	15.72	48.85	44.34	22.54	43.43
1987	25.19	20.28	50.88	40.96	19.50	36.92
1988	26.51	22.89	53.01	45.78	22.80	43.41
1989	53.61	39.15	112.58	82.21	35.16	68.28

Source : Author's calculations based on the price elasticity derived from the distributed lag approach.

Notes: (1) Increase in production if the farmer received the world coffee price (that is, $P_t=P_w$);
(2) Increase in production if the farmer received the revenue maximising price;
(3) Additional gain to the society in terms of foreign exchange earnings if $P_t=P_w$;
(4) Additional gain to the society in terms of foreign exchange earnings if the farmer received the revenue maximising price;
(5) Coffee revenue at the actual producer price;
(6) Coffee revenue at the revenue maximising producer price.

Results in Table 4.3 suggest that the low robusta coffee producer prices have caused considerable losses of foreign exchange earnings compared to government revenue. These prices have also been too low to maximise government revenue from robusta

coffee production (comparing column 5 and 6). This is because robusta coffee producer prices are very responsive to banana producer prices. If robusta coffee producer prices are raised, providing higher incentives relative to banana producer prices, robusta coffee production should increase more than proportionately to the price increase. This means that government revenues will increase more than proportionately to the price increase up to the revenue maximising producer price. However, the government should be cautious in providing more incentives to robusta coffee production as it may lead to misallocation of resources.

In the case of arabica coffee, results suggest that the overall loss in foreign exchange earnings was small relative to the government revenue generated (see Table 4.5). This is because arabica coffee producer prices are less responsive to banana producer prices, when the results from the distributed lag approach are considered.

It was discussed above that if the government is interested in maximising foreign exchange earnings or maximising tax revenue from coffee, then the prices should be set at different levels. From Tables 4.3 - 4.5, the results suggest that when $P_t = P_w$ the overall foreign exchange earnings gain would have been more than when the producer price was set between the revenue maximising producer price and the world coffee price. This shows a trade-off between maximising foreign exchange earnings and government revenue from coffee export. Moreover, the results suggest that the coffee export taxes have had a negative impact on coffee production.

Chapter Five

CONCLUSIONS

Given the importance of coffee in the Ugandan economy and the absence of previous studies of supply response, the primary objective of this thesis has been the formulation and estimation of econometric models of supply response for coffee production in Uganda.

In estimating the aggregated coffee supply response models for each coffee type, two approaches were attempted, that is, a supply function and a production function approach. Under the primal approach, polynomial distributed lag models were estimated using Almon's distributed lag. In the case of arabica coffee, the length of the lag and degree of the polynomial were found to be seven and three respectively; whereas for robusta coffee they were found to be nine and three respectively. Unconstrained and constrained polynomial distributed models for each coffee type were estimated. For both coffee types a constrained polynomial distributed lag model was chosen. Results suggested that the coffee supply response was lower during the initial period, then increased and later decreased.

Under the production function approach a production and profit function relationship was used, whereby the production function was estimated directly and the comparative statics for the profit function were derived indirectly. In estimating the production function, labour demand was assumed endogenous in the system, and hectarage and the age distribution were taken to be given. A normalised quadratic production function and labour demand equation were estimated simultaneously using two

stage least squares (2SLS) and three stage least squares (3SLS). The 2SLS estimates yielded the more plausible results for both coffee types. The major reason for estimating these models first was to test for the existence of constant returns to scale in the production function. Rejection of constant returns to scale led to the estimation of a standard quadratic production function and the labour demand equation simultaneously using 2SLS and 3SLS. The 3SLS models for both coffee types were chosen. The robusta coffee production function was found to exhibit decreasing returns to scale and satisfied the concavity property. However, in the case of arabica coffee, the production function did not satisfy the concavity property - which is a necessary condition for the production and profit function relationship - although it exhibited decreasing returns to scale.

In both approaches, all coefficients had the expected signs. Results suggested that coffee production was not affected by relative producer prices *per se* but there were also some other factors. These included labour costs, bearing hectarage, technology, and civil disorders and wars. Robusta coffee supply was found to be price inelastic in the short run and elastic in the long run. Moreover, the robusta coffee was also found to be price elastic in the long run when the production function approach was considered. However, no efforts were taken to infer short run elasticity from the long-run price elasticity, since policy analysis is based on long term basis. Arabica coffee was found to be price inelastic both in the short run and long run when a distributed lag approach is considered.

Coffee pricing policy presumably is being used as a policy instrument in achieving conflicting government policy objectives of maximising government revenue and foreign exchange earnings from coffee. The government raises revenue from coffee through the

export tax. Uganda has relied heavily on export taxes because of the perceived difficulties of administering direct taxes in the rural areas. This kind of taxation has led to lower producer prices. This has discouraged replantings and new plantings, and it has also perhaps decreased the quality of coffee. Results suggested that the low robusta producer prices have caused substantial losses of foreign exchange earnings compared to government revenue. These prices have also been too low to maximise government revenue from coffee production.

In spite of data inadequacies in Uganda, this research has highlighted how inadequate understanding of the quantitative effects of coffee pricing policy has had a negative impact not only on farmers but on the economy as a whole. Before intervening in the pricing policy of any exportable crops, policy makers should analyse the problems, policy instruments and most important the consequences involved. This is especially important at this stage when the government is promoting export sector diversification.

Suggestions for Further Research

This study, because of data inadequacies, had to be carried out on a national basis. An apparent extension of the approach would be to estimate coffee supply response, for each coffee type, on a disaggregated basis. Analysis might concentrate on the heterogeneity of responses to relative producer prices changes among various districts, as well as on the nature of factors determining coffee supply. Such disaggregation could not only provide a deeper understanding of supply behaviour but also assist in fine tuning to the needs and potentialities of different region.

The present study assumed hectarage and age distribution to be given in determining the changes in coffee supply. These assumptions may be relaxed in a further study of the industry.

The quantitative impact of the prevalence of overvalued foreign exchange rates should be examined. Efforts should be made that go beyond the above descriptive measures. Another area of further research is an evaluation of the influence of politics in the coffee pricing policy.

Annex I

Organisation and management of statistical services in Uganda have failed because of a failure of both supply and demand. There is a tendency of collecting data only when it is needed immediately by the government or any international organisation. When this happens then it implies there is no way of having continuous data of any form. On the other hand where continuous data exists, it is found that it may not meet the needs of the users.

The government should increase the resources devoted to data collection. However, before increasing its investment in statistical services, Uganda should consider reappraisal of the role of such statistics plays in decision making. The distinction between data collection and decision making is artificial. Continued separation of data collection activities from policy analysis has resulted in development of statistical organisations that do not meet the needs of government.

Annex II.

(1) GR = $Q_t[P_w - P_t]$

Taking total derivative of equation (1) and equating it to zero we get:-

(2) $0 = \partial GR = Q_t\partial P_w + P_w\partial Q_t - Q_t\partial P_t - P_t\partial Q_t$

(3) $0 = Q_t\partial P_w + (P_w - P_t)\partial Q_t - Q_t\partial P_t$

$\partial P_w = 0$ since Uganda's share in the world market is so small to influence the world coffee prices. Then,

(4) $(P_w - P_t)\partial Q_t = Q_t\partial P_t$

(5) $\frac{P_w}{P_t} - 1 = \frac{Q_t}{P_t}\frac{\partial P_t}{\partial Q_t}$

(6) $\frac{P_w}{P_t} - 1 = \frac{1}{\varepsilon}$

(7) $\frac{P_w}{P_t} = \frac{1+\varepsilon}{\varepsilon}$

(8) $P_t = P_w\frac{\varepsilon}{1+\varepsilon}$

Alternatively, the maximum P_t can be derived in the following manner:

(9) Max $GR(P_t) = Q_t(P_t)[P_w - P_t]$

Taking first order condition of equation (9) with respect to P_t, we get

(10) $$\frac{\partial GR}{\partial P_t} = P_w \frac{\partial Q_t}{\partial P_t} - Q_t - P_t \frac{\partial Q_t}{\partial P_t}$$

(11) $$0 = [P_w - P_t] \frac{\partial Q_t}{\partial P_t} - Q_t$$

(12) $$Q_t \frac{\partial P_t}{\partial Q_t} = P_w - P_t$$

(13) $$\frac{Q_t}{P_t} \frac{\partial P_t}{\partial Q_t} = \frac{P_w - P_t}{P_t}$$

(14) $$\frac{1+\varepsilon}{\varepsilon} = \frac{P_w}{P_t}$$

(15) $$P_t = P_w \frac{\varepsilon}{1+\varepsilon}$$

APPENDIX I:

Robusta Coffee Data Set 1965/66-1988/89

Crop Year	Production ('000mt)	Hectarage ('000ha)	Exports ('000mt)
1965/66	122.80	213.00	122.76
1966/67	124.90	231.00	124.86
1967/68	121.00	231.00	92.88
1968/69	225.00	258.00	183.42
1969/70	182.00	262.00	179.82
1970/71	147.00	236.00	159.24
1971/72	150.00	228.90	162.90
1972/73	236.00	227.80	195.54
1973/74	182.00	205.70	180.48
1974/75	185.00	192.30	181.98
1975/76	131.00	190.60	123.12
1976/77	148.00	190.80	151.62
1977/78	108.00	190.80	117.60
1978/79	103.00	190.00	100.02
1979/80	112.00	191.20	130.38
1980/81	112.00	192.00	93.00
1981/82	175.00	193.00	152.22
1982/83	185.00	194.00	142.68
1983/84	178.00	195.00	126.18
1984/85	189.00	196.00	142.14
1985/86	184.00	197.00	133.32
1986/87	196.00	198.00	149.04
1987/88	190.00	199.00	143.46
1988/89	238.10	209.80	176.46

Source: MOA, CMB, & AS.

APPENDIX II:

Arabica Coffee Data Set 1965/66 - 1988/89

Crop Year	Production ('000mt)	Hectarage ('000ha)	Exports ('000mt)
1965/66	5.60	20.00	5.64
1966/67	8.90	21.40	8.94
1967/68	15.00	20.10	13.14
1968/69	25.00	21.40	14.88
1969/70	15.00	23.00	14.10
1970/71	13.00	28.50	16.20
1971/72	23.00	28.20	20.82
1972/73	24.00	28.70	18.12
1973/74	14.00	28.30	18.06
1974/75	15.00	30.10	16.98
1975/76	9.00	32.60	13.98
1976/77	12.00	33.00	4.32
1977/78	9.00	33.00	3.66
1978/79	9.00	33.00	3.06
1979/80	10.00	33.00	4.80
1980/81	10.00	32.00	4.50
1981/82	12.00	31.00	14.28
1982/83	13.00	30.00	14.70
1983/84	14.00	30.00	12.54
1984/85	15.00	30.00	10.80
1985/86	14.00	30.00	9.96
1986/87	15.00	30.00	11.94
1987/88	19.00	30.00	10.14
1988/89	23.60	30.00	10.38

Source: MOA, CMB, & AS.

APPENDIX III

Total Coffee Data Set 1965/66 - 1988/89

Crop Year	Production ('000mt)	Hectarage ('000ha)	Exports ('000mt)
1965/66	128.40	233.00	128.40
1966/67	133.80	252.40	133.80
1967/68	136.00	251.10	106.02
1968/69	250.00	279.60	198.30
1969/70	197.00	285.00	193.92
1970/71	160.00	264.50	175.44
1971/72	173.00	257.10	183.72
1972/73	260.00	256.50	213.66
1973/74	196.00	234.00	198.54
1974/75	200.00	222.40	198.96
1975/76	140.00	223.20	137.10
1976/77	160.00	223.80	155.94
1977/78	117.00	223.80	121.26
1978/79	112.00	223.00	103.08
1979/80	122.00	224.20	135.18
1980/81	122.00	224.00	97.50
1981/82	187.00	224.00	166.50
1982/83	198.00	224.00	156.84
1983/84	192.00	225.00	138.72
1984/85	204.00	226.00	152.94
1985/86	198.00	227.00	143.28
1986/87	211.00	228.00	160.98
1987/88	209.00	229.00	153.60
1988/89	261.70	239.80	186.84

Source: MOA, CMB & AS.

APPENDIX IV:

World Coffee Exports 1965/66 - 1987/88
('000 bags of 60kg)

Crop Year	Arabica	Robusta	Total
1965/66	36,790	13,378	50,168
1966/67	36,080	14,461	50,541
1967/68	39,072	14,773	53,845
1968/69	39,322	13,824	53,146
1969/70	39,097	14,719	53,816
1970/71	38,419	14,907	53,326
1971/72	42,357	16,208	58,565
1972/73	43,917	16,340	60,257
1973/74	39,119	18,473	57,592
1974/75	42,345	14,625	56,970
1975/76	40,397	17,774	58,141
1976/77	38,883	14,432	53,315
1977/78	37,521	14,459	51,980
1978/79	48,287	16,498	64,785
1979/80	46,449	14,795	61,244
1980/81	44,787	14,678	59,465
1981/82	46,486	17,048	63,534
1982/83	49,431	16,300	65,731
1983/84	52,794	17,224	70,018
1984/85	51,319	17,625	68,944
1985/86	49,998	18,881	68,879
1986/87	57,690	15,841	73,531
1987/88	46,866	16,809	62,675

Source: MOA, CMB & UCA.

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