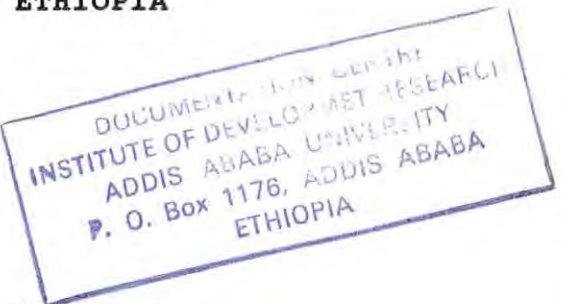


**STATISTICAL MEASURES OF EXPORT INSTABILITY
WITH REFERENCE TO SUDAN AND ETHIOPIA**

By

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**A THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE
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Title of Research: Statistical Measures of Export
Instability with Application to
Sudan and Ethiopia.

Name of Candidate: Fathia Saeed

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Examiners' Decision

1. External Examiner:

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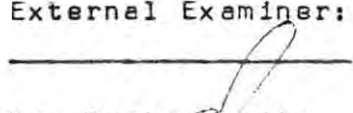
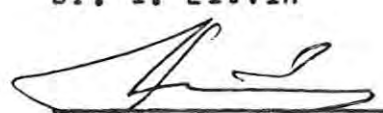
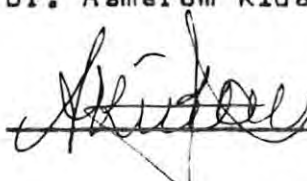
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ABSTRACT

The aim of the study is to measure the extent of export instability for Ethiopia and the Sudan. Various statistical methods of measuring export instability have been investigated. The data were collected from United Nations reports, Direction of Trade Statistics and International Financial Statistics (year book) for the years 1960 to 1989.

Four different statistical methods of export instability namely, graphical, coefficient of variation, turning point test, indices derived from regression estimate of various functional form have been applied. Also the Box - Jenkins models have been used. Based on computed results, some conclusions are made. The results suggest that the four methods showed similar and consistent results. The overall conclusion shows that export instability during the 1980's was higher than pre 1980.

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their import needs. In the case of Africa this dependency is further accentuated and reflected in dependence on a single or few export products. For instance commodities provide between 85 and 95 percent of the total export income. Furthermore about eleven African countries depend on one single commodity for around 75 percent or more of their export income. (UNCTAD 1990)

Economic development theories have emphasized the need to expand export and documented the virtues of export lead economies as the main engine for growth and development. These theories stated that; there are strong relationship between export and economic growth. Exports are a key factor in promoting economic growth. There are many direct benefits from a high export growth rate that help in promoting general economic growth. An increasing level of exports generally means that the country can increase level of imports. These imports include capital goods which are especially important in contributing to growth. Export development also tends to concentrate investment in the most efficient sectors of the economy, such as industrial sector, by increasing technology and managerial skills. The country also gains from economies of scale, since the international market added to the domestic market obviously permits large-scale operations than does domestic market alone.

Profitable export industries, also tend to expand both domestic and foreign investment. Expanding export of primary products stimulates domestic investment in the existing industries associated with the products in its different stages of production . Profitable exports also encourage foreign investment to grow at a steady state.

In addition to stimulating domestic and foreign investment, a growing export sector encourages an increased flow of technological and market innovations as well as managerial skills. Seeking of international market competition and desire to continue expanding foreign sales, foreign techniques and methods are imported to further improve productivity and quality.

All these theories tend to work together leading to further development and growing of exports revenue, increasing foreign exchange earnings, growing in investment sector ,and growth in real gross national product.

The above theories have dominated the development thinking in the developing countries and the international financial institutions. Indeed the latest World Bank study "Sub-Saharan Africa": From Crisis To Sustainable Growth advocates the export growth model as the road for reviving Africa's economic growth (World Bank, 1989). A major problem

with the model is its classical economic assumptions of free trade, perfect competition, perfect knowledge, mobility of resources and comparative advantages. Furthermore the model did not take into account political and social considerations.

Chapter 2

Export Instability

Export instability is the degree of fluctuations in export revenue. Since developing countries are highly dependent on export revenue for their growth, any fluctuations in it effects investment, growth of real income, growth of gross domestic product(GDP) and hence economic growth.

Export instability and the declining revenue of African countries from their export earnings, with exception of African oil exports, have been the concern of African policy makers and academicians and indeed the whole international community. Africa's revenue from export of commodities in 1988 was \$18 billion. This was 26 percent lower, in real terms than 1980 and 35 percent lower than 1970 (UNCTAD, 1990). The major contributing factor to this decline has been the deterioration of Africa's terms of trade and weakness in commodity markets which fell by 40 percent between 1980 and 1988. Taking 1980 as base year Africa's terms of trade and purchasing power of exports were respectively 59 and 52 in 1988.(Appendix 1)

In Africa's case the issue is not only of instability and fluctuations but rather of a continuous decline in export earnings. This is a direct result of two factors; the first is the continuous decline in the price per unit of export of

African commodities while the second is the result of the declining in the market share of Africa in the international market of its major exports. With respect to the first factor, the export prices of African commodities continued to decline as a result of two factors; first the increase in the world supply of commodities above the international demand, thus creating an imbalance which forced the equilibrium price down. This trend is still continuing since developing countries continue to expand their production of the above commodities for lack of other products to diversify as well as the shortage of capital necessary for investment for diversification projects. The second factor which lead to the decline in prices is the substitution effect. By this we mean the development of substitutes by the developed countries to many African and developing countries export commodities. As a result of the development of science and technology new products are replacing traditional ones. Plastic and synthetics are replacing steel, copper and fibers in many manufactured products. In automobile industry, for instance, plastics are drastically reducing the amount of steel used in car production. Optic fibers are replacing copper in telecommunications and electronics industries. Synthetics are replacing natural fibers such as sisal and cotton in the textile, robe and other industries.

The development of bio-technology is also adding to the

downward pressure of the prices of African commodities. Substitutes are being developed every day to African commodities. Already most of the candy chocolates bars are essentially artificial chocolate. The same applies for other products such as Vanella and hides and skins. The development of technology also lead to the use of less raw materials in the production of manufactured products.

With respect to African share of the international market, statistics show that Africa's total exports of non-fuel primary commodities as percentage of world exports decline from 9.1 percent in 1970 to 5.3 percent in 1980 and to 4.1 percent in 1987. (Appendix 2)

The respective Africa's share in coffee declined from 33.6 percent in 1970 to 24.1 and 19.9 in 1980 and 1987 respectively. In the case of cotton the percentage share fell from 11 percent to 8.3 and 7.9 for the same years. (Appendix 2) The above figures reflect two factors, first that in some cases Africa's volume of exports actually declines. Secondly the figures indicate that Africa is not capturing its adequate share in the growth of demand for commodities i.e. stagnation of Africa's export volume or a very low of volume growth.

In addition to the above, structural factors of Africa's exports are subject to large annual price fluctuations. These

fluctuations can in some cases depart as much as 80 percent of the mean price of a certain commodities.

These fluctuations create serious problems for African countries. High prices create expectation which lead to pressure on governments to spend on infrastructure and other projects. However these investments could not be kept up when prices decline or fluctuate downwards leading African countries to go into debt. The net effect is to create an environment not conducive to medium and long term planning.

For all the above reasons it is important to study the relationship of export instability and economic growth as export earnings are the main source of foreign exchange for African countries. It is therefore important to develop a method of measuring export instability. This study is a case study of two African countries namely Ethiopia and Sudan. Both countries are dependent on the export of a narrow range of commodities for their export earnings. Ethiopia is dependent on coffee, hides and skins for about 80 percent of its export earnings with coffee accounting for 68 percent of the earnings in 1977/81. For Sudan dependency rate of cotton and oil seeds was 66 percent with the farmer account for 46 percent of this dependency for the years 1977/81. (Appendix 3)

Chapter 3

Ethiopia's Export Performance

3.1 Introduction:

With an estimated Gross National Product (GNP) per capita of around US \$ 120, Ethiopia ranks among the poorest countries in the world. It is Sub-Saharan Africa's most populous country after Nigeria. Its population was estimated to be around 43.5 millions in mid-1986. (World Bank, 1988)

Ethiopia, as many other developing countries, is highly dependent on producing and exporting agricultural products as a source of foreign exchange earnings. Agriculture accounts almost about half of Gross Domestic Product (GDP), (table 3-1). It generates some 90 percent of the export earnings and provides about 85 percent of the employment.

Total export constitute a relatively minor share of GDP (9 percent). The major export commodities are coffee, hides and skins, oil seeds, pulses meat products, fruit and vegetables, sugar, oil cakes, live animals, chat, petroleum products, bee's wax and others.

Table 3-1
Gross Domestic Product By Sector
At Current Factor Cost
(1980/81-1988/89)

in millions

Sector	80/81	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89
Agri.	4072	4062	4389	4070	3916	4355	4318	4327	4595
Other commod.	1258	1297	1402	1476	1495	1596	1737	1775	1900
Distrib. services	1218	1337	1504	1562	1576	1754	1770	1789	1903
Other services	1549	1601	1789	1835	1924	2013	2175	2356	2732
GDP at current factor	8097	8297	9083	8944	8944	9718	9999	10247	11129
Agri. as % of GDP	50.3	48.9	48.3	45.5	43.8	44.8	43.2	42.2	41.3

Source: Derived from Annual Report,

National Bank Of Ethiopia (1988/89)

Table 3-2
Percentage Share Of Export In GDP

	71/72-73/74	74/75-77/78	78/79-82/83	83/84-84/85
Merchandise Exports	9.0	9.1	9.4	8.4
Exports of Goods & Non-factor service	12.9	12.3	12.4	12.1

Source: The World Bank: An Export
Action Program (June 1987)

3-2 Ethiopia's Export:

Commodities that trade internationally can be divided into two categories; coffee and non-coffee products. Coffee constitutes about 60 percent of total export earnings of Ethiopia.

The study of structure of Ethiopia's export during the period 1971/72- 1988/89, reveals that, since 1974 there has been an increase on coffee export. During the three years 1971/72-73/74 coffee exports constituted about 40 percent of

total export earnings, while non-coffee exports' share was almost 60 percent. Recently, non-coffee share declined to about 40 percent of total earnings, while coffee share increased to 60 percent (table 3-3).

On the other hand, in the years 1974 coffee exports declined almost by 20 thousands tons in volume compared to 1973. In 1979, coffee exports recovered significantly to reach 86 thousands tons. In 1983 it reached a high of 90 thousand tons, but it declined to 68 thousands tons in 1985. (Appedix 4 table 3). This may be due to the decline in production. Except sugar and petroleum products; most of non-coffee exports showed a clear downward shift after 1974. Annual exports of pulses, oil seeds and oil cakes, the second largest group of exports before 1974, declined from about 250 thousands tons to almost 25 thousands tons in recent years. Meat and live animal dropped in volume by about 70 percent in the years 1978/79-82/83 .However they show a significance increase. Hides and skins which rank second in Ethiopia's foreign trade earnings seemed to fluctuate a little in volume after 1974.(table 3-4).

Table 3-3

Annual Average and Share of Ethiopia's

Exports for 1971/72-1988/89

Commodity	Values in millions of Birr					Percent of The Total				
	71/72- 73/74	74/75- 77/78	78/79- 82/83	83/84- 85/86	86/87- 88/89	71/72- 73/74	74/75- 77/78	78/79- 82/83	83/84- 85/86	86/87- 88/89
Coffee	177.0	334.2	535.8	573.8	530.1	38.5	57.3	63.8	66.3	65.8
Hides & skins	47.2	50.9	101.1	102.9	121.6	10.3	8.7	12.0	11.9	15.1
Meat & live animals	27.1	15.8	16.3	22.2	27.9	5.9	2.7	1.9	2.6	3.5
Pulses, oil seeds & oil cake	130.9	133.0	49.9	40.0	29.1	28.5	22.8	5.9	4.6	3.6
Petroleum products	4.4	17.9	60.6	61.3	27.3	1.0	3.1	7.2	7.1	3.4
Other Exports	73.4	31.3	76.1	65.6	69.6	16.0	5.4	9.1	9.1	8.6
Total Exports	460.0	583.1	839.8	865.8	805.6	100	100	100	100	100

Source: Derived from Annual Report.

National Bank Of Ethiopia.

Table 3-4

Annual Average Quantities of Major

Exports for 1971/72-1988/89

Commodity	Quantities in thousands of Tons					Quantity Index(1971/72-73/74=100)				
	71/72- 73/74	74/75- 77/78	78/79- 82/83	83/84- 85/86	86/87- 88/89	71/72- 73/74	74/75- 77/78	78/79- 82/83	83/84- 85/86	86/87- 88/89
Coffee	73.3	56.7	84.6	78.3	81.8	100	77.4	113.2	106.8	111.6
Hides & skins	13.6	8.9	9.9	10.6	9.3	100	65.4	72.8	77.9	68.4
Meat & live animals	16.2	11.8	5.1	7.9	12.4	100	72.8	31.5	48.4	76.5
Pulses, oil seeds & oil cake	252.6	167.8	64.9	56.2	24.7	100	66.4	25.7	22.2	9.8
Sugar	21.3	9.0	31.4	42.5	29.7	100	42.2	147.4	199.5	139.4
Fruits & vegetables	23.8	19.6	8.1	8.7	13.7	100	82.3	34.0	36.6	57.6
Petroleum products	98.4	64.8	200.2	194.6	197.1	100	65.8	203.4	153.3	200.3

Source: Derived from Annual Report.

National Bank Of Ethiopia

Chapter 4

Sudan's Exports Performance

4.1. Introduction:

Sudan; the biggest country in Africa (about 2,506 thousands square kilometer); lists among the low-income countries. Gross National Product (GNP) per capita was estimated to be US \$ 320 in 1986, with average annual growth rate -0.2 percent for the period 1965-86. On the other hand, Gross Domestic Product (GDP) showed a little growth between 1975/76 and 1985/86; population grew at about 2.8 percent a year for same period with the result that real per capita GDP declined by about 2.3 percent a year.(table 4-1). Like Ethiopia, agriculutre sector plays an essential role in Sudanese economy.It contributes about 90 percent of the total export and provides more than 80 percent of the employment. Despite,its important role its contribution to GDP declined from 55 percent in 1966 to 34 percent in 1989/90.(table 4-2). This decline was due to the drought of 1982/83-84/85.

Table (4-1)
Some Selected Macroeconomic Indicators
1975/76-85/86

Item	75/76	81/82	85/86	Annual Growth %	
				75/76-85/86	81/82-85/86
Real Gdp(Lsd.M) (At constant 81/82 market prices)	5965.00	6721.00	6247.00	0.5	-1.8
Population (millions)	16.6	19.7	21.9	2.8	2.7
Real per capita GDP(Lsd)	359.3	341.2	285.3	-2.3	-4.4

Source: Problems Of Economic Adjustment

World Bank, Report No.6491-SU, June 19, 1987

Table (4-2)
Sectoral Contribution To GDP
1966-89/90

Sector	1966	69/70	75/76	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Agri.	54.9	34.5	38	39.4	35	34.8	32.4	36	35.4	31.6	36.2	34
Manufacturing	7.4	8.4	7	7	7.5	7.7	8.6	7.3	7.3	7.4	6.7	7
Construction	4.8	3.9	5	5.8	6.7	5.9	5.8	6.2	5.6	5.6	5.6	5.3
Energy & Water	3.3	2.7	2	1.2	1.4	1.6	1.9	2.1	2	2.1	2	2.1
Services	29.6	50.5	48	46.6	49.4	50	51.33	48.4	49.7	53.3	49.5	51.6
GDP	100	100	100	100	100	100	100	100	100	100	100	100

Source: Economic Survey Ministry Of Finance,

Republic Of Sudan, 1989/90.

4-2 Sudan's Exports:

Sudan's export has declined steadily over the period 1980-1987. Export value declined by 16.9 from 1986-1987, and export unit value showed negative annual growth rate(-13.7) from 1985-1986. Terms Of trade for the same period fell by 19.7 from 1985-1986 putting 1980 as the base year. (table 4-3). Sudan's exports are mainly agricultural products; namely cotton, gumhashab, groundnuts and sesame. Besides, Sudan exports live

animal and their products plus other exports.

4-2-1 Cotton:

Sudan is the second producer country for cotton in Africa after Egypt. Its average share in Africa's production was 18 and 10 percent for the group years 1969-71 and 1979-81 respectively. (World Bank, 1986)

Cotton is the most important cash crop and agricultural product. It represents about 40 to 50 percent of export earnings, supplies raw materials to local textile factories, and provides employment to hundreds of thousands of people who work in production, harvesting, ginning, processing and marketing. Sudan produces long, medium and short staple cotton. Long staple represents more than 80 percent of production and exportation.

Cotton exports showed a substantial decline during the 1980s. Its share to total export earnings fell from 50 percent for the period 1960-79 to 28 percent during 1980-82. In 1986-89 it showed a little improvement, by increasing to 41 percent. Several factors contributed to this decline. International prices, diversification policy in Gezira Scheme reduced the area under cotton cultivation; also marketing,

transportation and stock facility problems are other reasons for this decline.

4-2-2 Gum Hashab:

Gum hashab is the second cash crop that Sudan exports. Its share to the total export earnings fluctuated little during the period 1960-1985; as the result of its international prices, drought and desertification in the beginning of the 1980s, and devaluation of the currency.

However; its exports recovered significantly and reached 15 percent in 1986-89. (table 4-4).

4-2-3 Groundnuts and Sesame:

Export of groundnuts grew up during 1975-79 and reached 13 percent of the total export value. The increase is due to an increase of 42 percent in the area cultivated during the same period. In 1986-89 it fell to 1.5 percent of the total export. This decline is caused by fall in the production cotton seed.

Sesame's share to the total export values during 1960-1982 ranged between 7 to 9 percent. In 1983-1989 its share was between 10 to 11 percent. (table 4-4).

In general, Sudan's exports consisted of primary products and were dominated by one agricultural product. Thus any fluctuations in cotton prices will affect Sudan's balance of payment and foreign exchange earnings considerably.

Table (4-3)
Some Indicators Of Sudan's Exports
1980-1987

Item	YEAR								Average annual growth rate		
	1980	1981	1982	1983	1984	1985	1986	1987	80-85	1986	1987
Exports value(US \$)	594	538	432	581	722	595	497	482	595	497	482
Export unit values (1980=100)	100	97.1	83.6	92.4	88.8	76.6	66.1	77.2	-4.2	-13.7	16.8
Term of Trade	100	95.8	88.3	99	96.2	86.6	69.5	83.3	-1.7	-19.7	19.8
Exports Value	594	554	517	629	813	776	752	625	8	-3.2	-16.9

Source: African Economic and Financial Data

United Nations Development Program

Table (4-4)
 Percentage Share of Sudan's Export Commodities
 to the Total Export Value
for 1960-64 & 1986-1989

Commodity	60-64	65-69	70-74	75-79	80-82	83-85	86-89
cotton	54	55	54	57	28	48	41
Gumhashab	9	11	8	7	8	8	15
Ground nuts	9	9	9	13	10	3	1.5
Sesame	7	8	8	7	9	11	10
Others	21	17	21	16	45	30	32.5
Total	100	100	100	100	100	100	100

Source: Economic Survey
 Ministry Of Finance,
 Republic Of Sudan,
 1989/90.

CHAPTER 5

Measurements of Export Instability

There are several methods of measuring the extent of instability of export earnings. They range from the simplest method (the coefficient of variation) to a more sophisticated one such as the one derived from the Box Jenkins Models. The aim here is to compare the various indices and choose the one that represents instability indices in an objective manner. It should be noted that the main aim is to compare the indices and not to discuss the determinants or the consequences of export instability. In this paper we will confine our studies to five methods namely

1. Graphical
2. Coefficient of Variation
3. Turning Point Test
4. Indices derived from regression estimate of various functional forms
5. Indices derived from Box Jenkins Models

5.1 Graphical Method

Under this method we will plot various components of exports; compare the various graphs and identify some characteristics.

5.2 Coefficient of Variation

This is the simplest, commonly known and easy to understand index. It is given by

$$C = \frac{S}{\bar{X}} \quad \dots\dots\dots (5.1)$$

where S and $\bar{X}$ are standard deviation and mean, respectively.

5.3 Turning Point Test

This is another measure of extent of export instability. The test assumes that observations are random and compares this randomness with either seasonal or trend component. In this study Turning Point will compare randomness with trend.

$$Z = \frac{P - E(P)}{S(P)} \quad \dots\dots\dots (5.2)$$

where P = number of turning points

E(P) = expected number of turning points

S(P) = standard error

$$E(P) = \frac{2}{3} (n-2) \quad \dots\dots\dots (5.3)$$

$$var(p) = \left[\frac{16n-29}{90} \right] \quad \dots\dots\dots (5.4)$$

A small or large value of P is expected to suggest either

decreasing or increasing trend while a value of $E(P) = \frac{2}{3}(n-2)$

tends to suggest randomness. With respect to export earnings a value of $P=E(P)$ suggests lack of regularity.

5.4 Indices Based on Regression

The fourth method is the standard error of the estimate of a regression after linking exports to time. We will only consider our regression estimates, linear and non-linear

$$Y_t = \beta_1 + \beta_2 t + e_t \quad \dots\dots\dots (5.4.1)$$

$$\ln Y_t = \beta_1^1 + \beta_2^1 \ln t + e_t \quad \dots\dots\dots (5.4.2)$$

where Y represents exports; t represents time; and e is the disturbance term. After fitting various trends of the deviation of exports from trend, normalized by the projected exports according to trend, and divided by the number of years in the time series. The formula is :

$$I = \frac{\sum_{t=1}^n \frac{|Y_t - \hat{Y}_t|}{\hat{Y}_t}}{n} \quad \dots\dots\dots (5.4.3)$$

5.5 Box-Jenkins Models

The fifth method of measuring export instability would be the application of Box Jenkins Models. This method is believed to have wide application in several natural and social science disciplines. The Box Jenkins approach as applied in this study deals with time domain and discrete data. A class of stable linear statistical models, commonly known as ARIMA are presented and their properties briefly considered. Before considering the ARIMA models we will briefly discuss its components; namely, the autocorrelation and partial autocorrelation.

Autocorrelation

Given a stationary series (not affected by any change in time origin, Chatfield (1975)) $Y_1, Y_2, \dots, Y_n$ we can estimate the mean μ and the autocorrelation coefficient of order K .

$$\mu = \bar{Y} = \frac{1}{N} \sum_{t=1}^N Y_t \quad \dots\dots\dots (5.5.1)$$

$$r_k = \frac{C_k}{C_0} \quad \dots\dots\dots (5.5.2)$$

where
$$C_k = \frac{1}{N} \sum_{t=1}^N (Y_t - \bar{Y}) (Y_{t-k} - \bar{Y})$$

one should note that C_k is autocovariance of K and whenever $K=0$ we get C_0 which is the variance. The variance of autocorrelation coefficient r_k is given by:

$$\text{var}(r_k) = \frac{1}{N} \left(1 + 2 \sum_{i=1}^k r_i^2 \right) \dots\dots\dots (5.5.3)$$

$$i = 1, 2, \dots, k.$$

Thus the variance of an autocorrelation function increases with the value of k .

Partial Autocorrelation

The partial autocorrelation function is estimated from an autocorrelation matrix where an autocorrelation matrix is given by:

$$P = \begin{bmatrix} 1 & \rho_1 & \dots & \rho_{n-1} \\ \rho_1 & 1 & & \\ \cdot & & & \\ \cdot & & & \\ \rho_{n-1} & \rho_{n-2} & \dots & 1 \end{bmatrix} \dots\dots\dots (5.5.4)$$

Thus the partial autocorrelation coefficient is given by:

$$\phi_{kk} = \frac{|P_k^*|}{|P_k|} \dots\dots\dots (5.5.5)$$

where P_k^* is P_k with the last column replaced by:

$$\begin{bmatrix} \rho_1 \\ \rho_2 \\ \cdot \\ \cdot \\ \cdot \\ \rho_k \end{bmatrix} \dots\dots\dots (5.5.6)$$

The variance of ϕ_{kk} is given by:

$$\text{var}(\phi_{kk}) = \frac{1}{N} \quad \dots\dots\dots (5.5.7)$$

We apply the autocorrelation and partial autocorrelation function to the study of the three components of Box Jenkins ARIMA models namely:

- a) Autoregressive Process (AR)
- b) Moving Average Process (MA)
- c) Mixed Process (ARIMA)

a) Autoregressive Process

The general form of autoregressive process of order P;
AR(P) is given by:

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \dots + \phi_p Y_{t-p} + a_t \quad \dots\dots\dots (5.5.8)$$

A special case of AR(P) are AR(1) and AR(2) that is:

$$Y_t = \phi Y_{t-1} + a_t \quad \dots\dots\dots (5.5.9)$$

where $a_t \sim \epsilon(0, \sigma_a^2)$ and $-1 \leq \phi \leq 1$

The autocorrelation and partial autocorrelation function of AR(1) is :

$$\mu_k = \phi \mu_0 \quad \dots\dots\dots (5.5.10)$$

$$\phi_{11} = \rho_1 \quad \dots\dots\dots (5.5.11)$$

$$\phi_{11} = 0, K > 1, \sigma_z^2(1 - \phi^2) = \sigma_a^2 \quad \dots\dots (5.5.12)$$

For AR(2) the function is:

$$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + a_t \quad \dots\dots\dots (5.5.13)$$

The autocorrelation and partial autocorrelation function of AR(2) is:

$$\rho_k = \phi_1 \rho_{k-1} + \phi_2 \rho_{k-2} \quad \dots\dots\dots (5.5.14)$$

$$\phi_{11} = \rho_1 = \frac{\phi_1}{1 - \phi_2} \dots\dots\dots (5.5.15)$$

$$\phi_{22} = \frac{\rho_2 - \rho_1^2}{1 - \rho_1^2} = \phi_2 \dots\dots\dots (5.5.16)$$

$$\phi_{kk} = 0 \quad \text{for } k > 2$$

$$\sigma_z^2 \left[1 - \frac{\phi_1^2}{\phi_2^2} - \phi_2 \left(\frac{\phi_1^2}{1 - \phi_2} + \phi_2 \right) \right] = \sigma_a^2 \dots\dots (5.5.17)$$

Interpretation

If r_k is significant for all or most value of K while ϕ_{kk} is non significant for $K > 1$ then the time series data be best fitted by AR(1). Also if r_k is significant for all or most values of k while ϕ_{kk} is non significant for $k > 2$ then the time series data may be best fitted by AR(2). The value of σ_a^2 will later be used as measures of export instability.

b) The Moving Average Process

The general process of moving average of order q , $MA(q)$, is given by:

$$Y_t = a_t + \theta_1 a_{t-1} + \theta_2 a_{t-2} + \dots + \theta_q a_{t-q} \quad \dots\dots\dots (5.5.18)$$

$$\text{where } a_t \sim IN(0, \sigma_a^2)$$

A special case of $MA(2)$ namely $MA(1)$ and $MA(2)$ are briefly considered. $MA(1)$ is given by:

$$Y_t = a_t + \theta a_{t-1} \quad \dots\dots\dots (5.5.19)$$

The autocorrelation and partial autocorrelation functions are given by:

$$\rho_1 = \frac{\theta}{1 + \theta^2} \quad \dots\dots\dots (5.5.20)$$

$$\rho_k = 0, \quad k > 1$$

$$\theta_{kk} = \frac{(-1)^{k-1} \theta^k (1 - \theta^2)}{1 - \theta^{2(k-1)}} \quad \dots\dots\dots (5.5.21)$$

and $\sigma_a^2 = \frac{\sigma_z^2}{(1 + \theta_1^2 + \theta_2^2)} \quad \dots\dots\dots (5.5.22)$

$MA(2)$ is given by:

$$Y_t = a_t + \theta_1 a_{t-1} + \theta_2 a_{t-2} \quad \dots\dots\dots (5.5.23)$$

where θ_1 and θ_2 are estimated from the following formulae:

$$\rho_1 = \frac{\theta_1(1+\theta_2)}{(1+\theta_1^2+\theta_2^2)} \dots\dots\dots (5.5.24)$$

$$\rho_2 = \frac{\theta_2}{(1+\theta_1^2+\theta_2^2)} \quad \text{where } \rho_k=0, k > 2 \dots (5.5.25)$$

Interpretation

Whenever ϕ_{kk} is significant for large values of K, while r_k is non significant for $K > 1$, then MA(1) will best fit the model. Whenever ϕ_{kk} is significant for large values of K and r_k is non significant for $K > 2$ then MA(2) is good fit.

One should note that in both MA(1) and MA(2) the values of θ_1 and θ_2 can only be estimated for limited or permissible values of r_1 and r_2 .

Finally, one may be able to show that a long AR(p) equation may be replaced by short MA(q), equation and vice versa.

If any one of the models do not fit the series then a mixed process may be introduced. Below, we introduce the simplest form of mixed process, namely the ARIMA(1,1) process.

Mixed process ARIMA(p,q)

A mixed process is given by:

$$Y_t = \phi_1 Y_{t-1} + \dots + \phi_p Y_{t-p} + \theta_1 a_{t-1} + \dots + \theta_q a_{t-q} + a_t \quad \dots (5.5.26)$$

A special case of ARIMA(p,q) is ARIMA(1,1) which is given by:

$$Y_t = \phi_1 Y_{t-1} + \theta_1 a_{t-1} + a_t \quad \dots (5.5.27)$$

This value of ϕ and θ may be estimated from the following equations:

$$r_0 = \frac{(1+2\theta\phi+\theta^2)}{(1-\phi^2)} \sigma_a^2 \quad \dots (5.5.28)$$

$$r_1 = \frac{(\theta+\phi)(1+\theta\phi)}{(1-\phi^2)} \sigma_a^2 \quad \dots (5.5.29)$$

Chapter 6

EMPIRICAL RESULTS

6-1 Graphical Presentation and Turning Point Test

Figures 1 to 3 as well as 4 to 6 show the extent of export instability for Ethiopia and Sudan respectively. One observes the existence of upward trend over the entire study period (1960-1986); but the extent of fluctuation seems to be more pronounced in the eighties compared to the sixties. This is true for graphs based on value. When the two countries export performance is compared one observes less instability in Sudan compared to Ethiopia.

6.1.1. Ethiopia

By Commodity

Values:-

Using turning point test we found that the exports of hides and skins showed a little fluctuations, while those of coffee showed much higher fluctuations or irregularities (Table 1).

Table (1)Turning Points by Value of Commodity

Ethiopia:

Commodity	No. of turning points	Expected value	S.Error	Z.Values
Coffee	8	16.6	2.1	-4.09524
Hides & skins	5	16.6	2.1	-5.52381
Others	3	16.6	2.1	-6.47619
Total	10	16.6	2.1	-3.14286

The extend of fluctuations was more pronounced in the latter period of the study than in the earlier. Others exports' fluctuations was some where in between the two.

Total exports' earnings fluctuations tend to show the same trend. This is because coffee contributes more than 60 percent of Ethiopia's exports.

Quantity:-

Applying the same test (turning point test) to quantities exported by Ethiopia during 1969-1989, we found out that more instability appeared, particularly quantities of coffee exported after 1974.

Table (2)Turning Point by Volume of Commodity

Ethiopia:

Commodity	No. Turning points	Expected Value	S.Error	Z.Values
Coffee	10	11.3	1.7	-0.76471
Hides & skins	7	11.3	1.7	-2.52941

6.1.1.2 By Destinations:

To study the extend of Ethiopia's exports by country destinations we found out that there were more than ten partners countries, thus we have to group them into four sub-groups namely: United States, European Communities, Japan and others.

Table (3)Turning Points by Value of Destination

Ethiopia:

Destination	No. of turning points	Expected Value	S.Error	Z.Values
United States	14	16	2.07	-0.96618
European communities	8	16	2.07	-3.86473
Japan	4	16	2.07	-5.7971
Other	6	16	2.07	-4.83092
Total	11	16	2.07	-2.41546

A simple comparison showed that there were more fluctuations of export to United States, followed that to European communities. Japan showed a little fluctuations. Same was true for exports to other countries except for 1978.

Unlike fluctuations of exports by commodity, trend of total exports did not seem to follow those of individual country specially in the later part of the study period. In the earlier part, fluctuations of total exports and those exports to United States seemed to show the same pattern. The divergence started after 1972. This period when the world resorted to floating exchange rates.

6.1.2: Sudan

6.1.2.1 By Commodity:

Values:

Similarly, turning point test was applied to Sudan's exports by commodity group: In general, it seemed to be a little fluctuations in exports for Sudan compared to Ethiopia. Still cotton seemed to show more fluctuations while sesame seemed to the least. Gum hashab and other commodities can be somewhere in between.

Table (4)Turning Point by Value of Commodity

Sudan:

Commodity	No. of turning points	Expected Value	S.Error	Z.Values
Cotton	7	16.6	2.1	-4.57143
Gumhashab	2	16.6	2.1	-6.95238
Groundnut	3	16.6	2.1	-6.47619
Sesame	1	16.6	2.1	-7.42857
Other	4	16.6	2.1	-6
Total	4	16.6	2.1	-6

Like Ethiopia the fluctuations of total exports seemed to follow that of cotton. This because in most of the observations cotton earnings turns to constitute the largest portion of total exports (more than 60 percent). Again, like Ethiopia the extent of fluctuations seemed to be more in the later part of the study period.

Quantity:

Unlike values trends, quantities exported showed much higher fluctuations during the whole period of the study. This is true for all major commodities. Cotton and groundnut appeared to be more unstable comparing with sesame and gum hashab.

Table (5)Turning Points by Volume of Commodity

Sudan:

Commodity	No. of turning points	Expected Value	S.Error	Z.Values
Cotton	14	15.3	2.03	-0.64039
Gumhashab	11	15.3	2.03	-2.11823
Ground nuts	13	15.3	2.03	-1.133
Sesame	11	15.3	2.03	-2.11823

6.1.2.2. By Destinations:

Also, Sudan's different customers were grouped to: United States, European Communities, Japan and others.

Table (6)Turning Point by Value of Destination

Sudan:

Destination	No. of turning points	Expected Value	S.Error	Z.Values
United States	9	16	2.07	-3.38164
European Communities	10	16	2.07	-2.89855
Japan	9	16	2.07	-3.38164
Other	7	16	2.07	-4.34783
Total	9	16	2.07	-3.38164

Turning point test, showed that exports to United States, Japan and other countries appeared to have a little fluctuations, while that to European Communities was highly fluctuated showing more unstable performance at the later part of the study period.

Total exports trend followed that to European Communities. This is due to the big share of these countries to Sudan's exports earnings.

6-2 The Instability Indices:

6-2-1 Coefficient Of Variation:

6-2-1-1 Ethiopia:

This index is estimated for values by commodity group and values by destinations; as well as by quantities.

As a point of reference, 0.25 is taken as a boarder line between stability and instability. A value greater than 0.25 implies a higher standard deviation and therefore higher degree of instability. Based on this the coefficient of variation for Ethiopia exports values by commodity group shows higher irregularities. As expected the extent of irregularities for coffee is higher in the second half of the study period than in the first one (table 7). For hides and skins the extent of irregularity is slightly lower.

Table (7)
 Coefficient of Variation
 For Ethiopia
(By Commodity Value)

Commodity	Coefficient of Variation		
	1960-1973	1974-1986	1974-1986
Coffee	0.23	0.36	0.65
Hides & Skins	0.43	0.37	0.63
Others	0.45	0.42	0.55
Total	0.29	0.19	0.52

Table (8)
 Coefficients of Variation
 For Ethiopia
(By Destination Value)

Country	Coefficient of Variation		
	1964-1973	1974-1989	1974-1989
U. States	0.16	0.35	0.33
U.Kingdom	0.32	0.32	0.51
Germany	0.55	0.46	0.8
France	0.4	0.46	0.74
Italy	0.4	0.37	0.59
Netherlands	0.72	0.93	1.23
Japan	0.54	0.32	0.68
Others	0.42	0.96	1.28
Total	0.26	0.24	0.48

Table (9)
Coefficient of Variation
for Ethiopia
(by Commodity Volume)

Commodity	1969-1987
Coffee	0.16
Hides & Skins	0.51

Similar indices were applied to the exports by destination . In this case exports to United States show less stability while those to the Netherlands show a very high degree of instability . Again later period stability indices seems to show higher coefficient of variation than the earlier period (table 8).

On the other hand, (table 9) shows that quantity of coffee exported during 1969-1987 seems to be more stable than hides and skins exported in the same period.

6-2-1-2 Sudan:

Coefficients of variation given in (table 10) and (table 11) show that the instability measures for Sudan's exports earnings

by commodities and by destinations are increased in the later period (1974-1986), suggesting a change in the character of exports instability. Exports to United States, Italy and Netherlands show higher instability indices in the later period of the study compared with the first period.

Tables (10)

Coefficient of Variation

For Sudan

(By Commodity Value)

Commodity	Coefficient of Variation		
	1960-1973	1974-1986	1974-1986
Cotton	0.35	0.73	1.02
GumHashab	0.19	0.96	1.34
Groundnuts	0.33	0.66	0.92
Sesame	0.29	0.80	1.22
Others	0.38	0.81	1.3
Total	0.31	0.68	1.05

Table (11)
Coefficients of Variation
For Sudan
(By Destination Value)

Country	Coefficient of Variation		
	1960-1973	1974-1986	1974-1986
U.states	0.27	0.61	0.65
U.Kingdom	0.16	0.3	0.25
Germany	0.24	0.3	0.29
France	0.58	0.41	0.61
Italy	0.26	0.57	0.57
Netherlands	0.24	0.52	0.46
Japan	0.52	0.33	0.44
Others	0.19	0.68	0.82
Total	0.23	0.25	0.33

Table (12)
Coefficient of Variation
for Sudan
(by Commodity Volume)

Commodity	1969-1987
Cotton	0.35
GumHashab	0.4
Groundnuts	0.77
Sesame	0.33

Quantities exported during 1969-1987 also show some degree of instability using this approach, especially groundnuts which shows a very high degree of instability among others commodities exported. (table 12).

6-2-2 Regression Results and Indices:

6-2-2-1 Ethiopia:

The approach of simple linear and non-linear regression trend equations was to fit to the whole data set on various commodities values as well as to the destination values for the period (1960-1986). Separate trend equations were also fitted for the two periods (1960-1973) and (1974-1986).

A non significant slope or intercept would imply high rate of instability. It is also possible that the slopes may be significant while at the same time one may observe instability. In this study we estimated linear and non-linear equation for first period (1960-1973) and for second period (1974-1986). In a period which the absolute value of t for the slope is high one may conclude more stability than when the t value is low. This is because of the inverse relation between the value of t and the standard error of regression coefficient.

In most cases the slope was significant; however, when the t values are compared between the first and second periods, there exists higher instability in the second than in the first. This is true for both functional forms. On the other hand when one compares t values by destination for each of the two periods, one can not draw a definite conclusion. (tables 13 and 14)

We do not confine ourselves to measuring instability by a significance of the slope; a better method which we discussed earlier is to estimate the standard error of the estimates and then calculate an index based on equation (5.4.3) given on page 24. Thus, an index of a deviation from the trend line (curve) was estimated and the results which are based on this equation are given in table 15 and 16.

Most of the indices are below 0.5 suggesting that there is an instability in the exports earnings from the various commodities. The instability from coffee which constitutes more than 60 percent of Ethiopia's exports earnings, showing the highest degree of instability compared to hides and skins. Further more, the latest period (1974-1987) seems to show high degree of instability compared to earlier period. (table 15) This result is similar to the estimates based on the coefficient of variation.

On the other hand indices by destination values suggest that export to United States, France and Netherlands are more instable at the later period compared to the earlier period.(table 16)

Table 13
Preliminary Results

Ethiopia (By Commodity Value)

Functional Form	Commodity	1960 - 1973					1974 - 1986					1960 - 1986				
		Intercept	Slope	R(SQ)	St.Err	t.value	Intercept	Slope	R(SQ)	St.Err.	t.value	Intercept	Slope	R(SQ)	St.Err	t.val
Linear	Coffee	96.42	7.19	0.73	1.26	5.689	-186.87	30.93	0.53	8.72	3.545	-4.24	21.780	0.78	2.33	9.342
	H & S	14.84	2.06	0.43	0.68	3.041	-31.16	5.43	0.46	1.75	3.097	2.28	3.810	0.73	0.46	8.321
	Others	41.71	8.04	0.53	2.19	3.672	364.45	7.92	0.14	5.91	1.340	70.19	5.580	0.30	1.77	3.254
	Total	152.98	17.30	0.76	2.79	6.189	146.42	28.44	0.59	7.05	4.036	68.23	31.170	0.90	2.08	15.00
Non-linear	Coffee	4.59	0.05	0.73	0.01	5.680	4.15	0.09	0.52	0.03	3.451	4.42	0.077	0.84	0.01	11.59
	H & S	2.93	0.06	0.49	0.02	3.384	2.66	0.08	0.57	0.02	3.793	2.82	0.072	0.83	0.01	11.09
	Others	4.07	0.07	0.66	0.01	4.789	5.81	0.03	0.06	0.04	0.834	4.29	0.041	0.40	0.01	4.123
	Total	5.17	0.06	0.84	0.01	8.100	5.74	0.04	0.60	0.01	4.104	5.14	0.067	0.93	0.04	18.83

Table (14)
Preliminary Results

Ethiopia (By Destination Value)

Functional form	Country	1964 - 1973					1974 - 1989					1964 - 1989				
		Intercept	Slope	R(SQ)	St. Er	t.val	Intercept	Slope	R(SQ)	St. Er	t.val	Intercept	Slope	R(SQ)	St. Er	t.Val
Linear	U.states	46.77	1.466	0.25	0.89	1.642	104.47	1.757	0.11	1.33	1.322	57.13	0.611	0.046	0.57	1.072
	U.kingdom	3.77	0.085	0.036	0.15	0.551	0.55	0.524	0.57	0.12	4.290	1.79	0.456	0.75	0.05	8.547
	Germany	1.12	1.469	0.77	0.29	5.131	-34.12	4.677	0.87	0.48	9.700	-11.92	3.534	0.90	0.24	14.79
	France	2.03	0.334	0.43	0.14	2.477	1.85	0.803	0.25	0.37	2.162	-0.48	0.908	0.63	0.14	6.397
	Italy	5.29	0.768	0.37	0.36	2.153	6.19	1.152	0.29	0.48	2.393	3.10	1.296	0.67	0.19	6.934
	Netherlan	1.04	0.418	0.28	0.24	1.749	-28.98	2.679	0.44	0.80	3.336	-7.50	1.589	0.50	0.32	4.897
	Japan	0.49	1.044	0.87	0.14	7.362	-4.54	1.907	0.83	0.23	8.235	-3.57	1.843	0.94	0.10	19.17
	Other	2.21	0.199	0.19	0.15	1.353	20.18	0.172	0.001	1.26	0.137	0.14	1.149	0.19	0.48	2.389
	Total	62.72	5.783	0.51	1.98	2.918	65.60	10.158	0.65	1.97	5.163	38.68	11.38	0.88	0.84	13.5
Non-linear	U.States	3.85	0.026	0.24	0.02	1.599	4.71	0.027	0.11	0.02	1.347	4.03	0.007	0.29	0.01	0.854
	U.kingdom	1.37	0.005	0.003	0.04	0.147	1.41	0.047	0.55	0.01	4.187	1.14	0.059	0.74	0.01	8.225
	Germany	1.20	0.162	0.88	0.02	7.742	2.05	0.097	0.83	0.01	8.437	1.45	0.128	0.94	0.01	20.28
	France	0.91	0.071	0.44	0.03	2.493	1.52	0.064	0.37	0.02	2.863	0.87	0.096	0.79	0.01	9.643
	Italy	1.85	0.063	0.32	0.03	1.933	2.24	0.054	0.40	0.02	3.055	1.85	0.073	0.77	0.01	8.913
	Netherlan	0.64	0.076	0.19	0.05	1.385	0.58	0.113	0.397	0.04	3.037	0.45	0.118	0.70	0.02	7.503
	Japan	0.76	0.171	0.95	0.01	12.49	2.25	0.061	0.84	0.01	8.680	1.17	0.116	0.91	0.01	16.10
	Other	0.92	0.039	0.13	0.04	1.079	2.34	0.031	0.059	0.03	0.936	0.79	0.107	0.64	0.02	6.504
	Total	4.23	0.054	0.55	0.02	3.127	4.69	0.044	0.63	0.01	4.869	4.22	0.067	0.88	0.01	13.58

Table (15)

Ethiopia Indices
(By Commodity Value)

Functional form	Commodity	1960-1973	1974-1987	1960-1987
Linear	Coffee	0.099	0.221	0.469
	H & S	0.217	0.198	0.365
	Others	0.214	0.305	0.304
	Total	0.092	0.088	0.175
Non-linear	Coffee	0.021	0.0434	0.034
	H & S	0.053	0.0.0431	0.050
	Others	0.007	0.068	0.058
	Total	0.015	0.014	0.018

Table (16)

Etiopia indices
(By Destination Value)

Functional form	Country	1960-1973	1974-1987	1960-1987
Linear	U.states	0.113	0.272	0.256
	U. Kingdom	0.205	0.006	0.242
	Germany	0.201	0.188	0.102
	France	0.178	0.323	0.543
	Italy	0.236	0.221	0.252
	Netherlands	0.490	0.934	0.205
	Japan	0.195	0.108	0.963
	Other	0.252	0.587	0.558
	Total	0.139	0.107	0.160
Non-linear	U.states	0.027	1.162	0.063
	U. Kingdom	0.150	0.068	0.117
	Germany	0.075	0.045	0.069
	France	0.125	0.119	0.133
	Italy	0.096	0.067	0.083
	Netherland	0.343	0.214	0.296
	Japan	0.058	0.0255	0.090
	Other	0.196	0.143	0.199
	Total	0.026	0.0205	0.030

Similarly, linear and non-linear regressions forms were applied to the quantities exported during the period(1969-1987).

Regression results and indices suggest that volumes of coffee and hides and skins exported during this period seem to be more stable than their values. (table 17 and 18).

The overall conclusion is that export instability is due to price fluctuation than quantity.

Table (17)

Preliminary Results

Ethiopia (By commodity Volume)

Function al Form	Commodity	1969 - 1987				
		Intercept	Slope	R(SQ)	St.Err.	t.value
Linear	Coffee	71.95	0.31	0.02	0.51	0.600
	H & S	14.36	(0.22)	0.04	(0.85)	0.260

Table 18

Ethiopia Indices

(By commodity Volume)

Functional Form	Commodity	1969 - 1987
Linear	Coffee	0.129
	H & S	0.300

6-2-2-2 Sudan:

Similar approaches were applied to Sudan's exports values by commodities and by destinations for the same periods. When the t values are compared for first and second period, there seems to be less trend compared to those of Ethiopia. While for cotton, ground nuts and sesame show more instability in the second period, the opposite is true for total exports as well as other exports. (table 19)

Also there exists more instability for export based on destination than for commodities. (table 20)

Indices calculated from standard error based on equation (5.4.3) given on page 24 suggest that there is an instability in Sudan's exports earnings.

Table (19)
Preliminary Results

Sudan (By Commodity Value)

Function al Form	Commodit y	1960 - 1973					1974 - 1987					1960 - 1987				
		Intercept	Slope	R(SQ)	St. Er.	t.val	Inter cept	Slope	R(SQ)	St. Er.	t.val	Inter cept	Slope	R(SQ)	St. Er.	t. Val
Linear	Cotton	-432.003	29.620	0.69	6.01	4.932	21.88	3.620	0.76	0.59	6.136	-45.83	11.628	0.60	1.90	6.108
	G.Hashab	-135.200	8.330	0.71	1.59	5.249	5.46	0.257	0.58	0.06	4.072	-15.68	2.762	0.50	0.55	5.034
	G.nuts	42.90	0.851	0.039	1.26	0.674	4.86	0.322	0.32	0.14	2.382	2.72	0.936	0.30	0.32	2.963
	Sesame	-101.62	6.710	0.69	1.36	4.934	3.53	0.388	0.78	0.06	6.451	-14.47	2.623	0.59	0.44	5.960
	Others	-408.81	25.760	0.86	3.17	8.131	9.62	0.961	0.38	0.35	2.743	-59.13	9.405	0.63	1.45	6.478
	Total	-1035.05	69.590	0.86	8.45	8.236	45.37	5.554	0.76	0.91	6.106	-132.6	27.358	0.68	3.78	7.244
non- linear	Cotton	1.61	0.161	0.71	0.03	5.161	3.31	0.070	0.75	0.01	5.988	3.11	0.092	0.80	0.01	10.174
	G.Hashab	-1.2267	0.216	0.89	0.02	9.662	1.70	0.037	0.55	0.01	3.825	1.18	0.103	0.79	0.01	9.726
	G.nuts	4.60	0.079	0.12	0.06	1.249	1.64	0.040	0.30	0.02	2.249	1.68	0.053	0.30	0.02	3.033
	Sesame	-0.34	0.177	0.67	0.04	4.763	1.39	0.058	0.81	0.01	7.192	0.98	0.113	0.83	0.01	10.957
	Others	-0.78	0.249	0.83	0.03	7.434	2.43	0.045	0.34	0.02	2.469	1.80	0.127	0.78	0.01	9.449
	Total	2.15	0.175	0.94	0.01	12.95	3.98	0.059	0.81	0.01	7.098	3.62	0.106	0.90	0.01	15.392

Table (20)
Preliminary results

Sudan (By Destination Value)

Functional form	country	1964 - 1973					1974-1989					1964 - 1989				
		Intercept	Slope	R(SQ)	St. Err	t.val	Intercept	Slope	R(SQ)	St. Err	t. Val	Intercept	Slope	R(SQ)	St. Err	t. Val
Linear	U.state	6.52	0.426	0.28	0.24	1.773	22.24	0.312	0.022	0.56	0.560	8.57	0.368	0.10	0.22	1.658
	U.kingdom	18.34	0.423	0.24	0.27	1.591	20.43	0.251	0.065	0.25	0.985	17.15	0.094	0.033	0.10	0.909
	Germany	18.44	1.736	0.60	0.50	3.489	25.66	0.310	0.024	0.53	0.588	25.27	0.357	0.10	0.22	1.644
	France	5.32	0.958	0.22	0.64	1.504	57.11	1.586	0.44	0.48	3.321	12.72	0.625	0.14	0.32	1.972
	Italy	17.85	2.129	0.68	0.51	4.174	124.1	4.154	0.54	1.02	4.059	38.80	0.122	0.002	0.62	0.198
	Netherlands	10.78	0.387	0.14	0.34	1.144	28.18	0.660	0.14	0.43	1.545	14.31	0.035	0.001	0.18	0.195
	Japan	3.74	3.264	0.76	0.64	5.097	30.09	0.336	0.018	0.66	0.508	16.35	1.062	0.36	0.29	3.670
	Other	11.42	0.044	0.003	0.26	0.166	-28.6	3.309	0.50	0.89	3.723	-1.34	1.919	0.52	0.37	5.160
	Total	92.41	8.520	0.64	2.23	3.820	279.2	3.007	0.067	2.98	1.008	131.8	4.394	0.29	1.41	3.107
Non-Linear	U.states	1.84	0.056	0.37	0.03	2.175	3.03	0.018	0.040	0.02	0.762	2.09	0.029	0.22	0.01	2.624
	U.kingdom	2.89	0.024	0.21	0.02	1.447	3.028	0.016	0.08	0.01	1.115	2.84	0.007	0.057	0.01	1.211
	Germany	2.96	0.063	0.61	0.02	3.547	3.18	0.012	0.04	0.02	0.754	3.21	0.012	0.111	0.01	1.736
	France	1.94	0.056	0.12	0.05	1.057	4.30	0.057	0.39	0.02	3.025	2.26	0.044	0.26	0.01	2.903
	Italy	2.98	0.069	0.75	0.01	4.903	5.59	0.104	0.55	0.03	4.111	3.59	0.003	0.002	0.01	0.203
	Netherlands	2.41	0.022	0.10	0.02	0.959	3.54	0.048	0.22	0.02	1.982	2.65	0.003	0.003	0.01	0.283
	Japan	2.14	0.150	0.82	0.02	6.093	3.16	0.020	0.056	0.02	0.911	2.72	0.044	0.43	0.01	4.229
	Other	2.44	0.001	0.000	0.02	0.037	1.73	0.086	0.49	0.02	3.661	2.06	0.068	0.66	0.01	6.875
	Total	4.60	0.057	0.71	0.01	4.448	5.65	0.015	0.07	0.01	1.038	4.86	0.025	0.33	0.01	3.451

Table (21)
Sudan Indices
(By Commodity Value)

Functional Form	Commodity	1960-1973	1974-1987	1960-1987
Linear	Cotton	0.169	0.491	2.468
	Gumhashab	0.096	-0.263	0.240
	Groundnuts	0.199	0.481	0.430
	sesame	0.110	-0.012	-0.018
	Others	0.194	0.594	-0.089
	Total	0.129	1.238	0.526
Non-linear	Cotton	0.507	0.806	0.058
	Gumhashab	0.982	0.072	0.128
	Groundnuts	0.547	0.223	0.184
	Sesame	0.739	0.092	0.122
	Others	0.877	0.076	0.134
	Total	0.0234	0.024	0.046

Table (22)
Sudan Indices
(By destination Value)

Functional Form	Country	1960-1973	1974-1986	1960-1986
Linear	U. States	0.174	0.331	0.336
	U. Kingdom	0.106	0.041	0.175
	Germany	0.105	0.241	0.218
	France	0.388	0.272	0.450
	Italy	0.104	0.344	0.440
	Netherlands	0.158	0.307	0.287
	Japan	0.226	0.283	0.289
	Other	1.237	0.4596	0.138
	Total	0.0897	0.193	0.200
Non-linear	U. States	0.074	0.105	3.031
	U. Kingdom	0.040	0.077	1.603
	Germany	0.033	0.066	0.062
	France	0.159	0.083	0.157
	Italy	0.027	0.101	0.125
	Netherlands	0.057	0.121	0.111
	Japan	0.054	0.091	0.095
	Other	0.056	0.101	0.095
	Total	0.016	0.037	0.038

Again, as Sudan's exports by volume instability of cotton and sesame exported during the period (1965-1989) seem to be better than their values, while quantities of gumhashab and groundnuts show more instability during the same period. This result is similar to that of Ethiopia. (tables 23 & 24)

Table (23)
Preliminary Results

Sudan (By Commodity Volume)

Function al Form	Commodity	1965 - 1989				
		Intercept	Slope	R(SQ)	St.Er.	t.values
Linear	Cotton	197.2600	(2.056)	0.06	1.65	(1.247)
	G.Hashab	54.6432	(1.442)	0.54	0.28	(5.228)
	G.nuts	151.7586	(4.978)	0.30	1.60	(3.117)
	Sesame	84.9406	(1.137)	0.13	0.61	(1.858)

Table (24)

Sudan Indices

(By Commodity Volume)

Functional Form	Commodity	1965 - 1989
Linear	Cotton	0.265
	Gumhashab	0.198
	Groundnuts	0.554
	Sesame	0.243

Indices Based on Box Jenkins Models

The estimation of indices based on Box Jenkins Models were only applied for commodity values. For Ethiopia table 25 shows lagged autocorrelation coefficients while table 26 shows the corresponding variances.

Table 25: Correlations Coefficients for Ethiopia
(Lagged 5 Years)

	Coffee	Hide & skin	others	Total
Et-1	0.9022	0.8406	0.8060	0.9487
Et-2	0.8576	0.7011	0.4017	0.9434
Et-3	0.7824	0.6477	0.0483	0.9236
Et-4	0.7073	0.5858	(0.1156)	0.8898
Et-5	0.6327	0.6291	(0.0513)	0.8500

Table 26: Variance of Autocorrelation coefficients

	Coffee		Hide & skin		Others		Total	
	Var.r	Se.r	Var.r	Se.r	Var.r	Se.r	Var.r	Se.r
r^1	0.09733	0.31197	0.08937	0.29896	0.08515	0.29181	0.10370	0.32205
r^2	0.15181	0.38962	0.12578	0.35466	0.09711	0.31162	0.16963	0.41186
r^3	0.18884	0.43456	0.15686	0.39606	0.08394	0.28973	0.23282	0.48251
r^4	0.23421	0.48395	0.18228	0.42694	0.09827	0.31348	0.29146	0.53987
r^5	0.26386	0.51367	0.21159	0.45999	0.09846	0.31379	0.34498	0.58735

Based on the above table a first order moving average process was applied and the indices are given in table 27.

Table 27

Commodities	Indices
Coffee	0.268
Hides & Skins	0.346
Others	0.421
Total	0.276

The above table shows that the extent of fluctuation does not vary very much among the commodities even though the results are above 25 percent.

The corresponding autocorrelation coefficients along with the standard errors for the Sudan are given in tables 28 and 29.

Table 28: Correlation Coefficients for Sudan (Lagged 5 Years)

	Cotton	Gum Hashab	Ground nuts	Sesame	Others	Total
Et-1	0.8759	0.8842	0.4172	0.8926	0.9569	0.9678
Et-2	0.6904	0.8959	0.1389	0.7781	0.8998	0.9183
Et-3	0.5805	0.9523	0.2524	0.7454	0.8212	0.8617
Et-4	0.6629	0.9183	0.1654	0.7526	0.7141	0.9103
Et-5	0.7252	0.9551	0.1286	0.5776	0.6908	0.9165

Table 29: Variances of Autocorrelation Coefficients

	Cotton		Gum Hashab		Groundnuts		Sesame		Others		Total	
	Var.r	Se.r	Var.r	Se.r	Var.r	Se.r	Var.r	Se.r	Var.r	Se.r	Var.r	Se.r
r^1	0.0939	0.3064	0.0949	0.3081	0.0499	0.2234	0.0961	0.3100	0.1049	0.3239	0.1064	0.3262
r^2	0.1292	0.3594	0.1544	0.3929	0.0514	0.2267	0.1409	0.3754	0.1648	0.4060	0.1689	0.4110
r^3	0.1541	0.3926	0.2216	0.4707	0.0561	0.2369	0.1821	0.4267	0.2148	0.4635	0.2239	0.4732
r^4	0.1867	0.4321	0.2840	0.5329	0.0581	0.2410	0.2240	0.4733	0.2526	0.5026	0.2853	0.5341
r^5	0.2256	0.4750	0.3516	0.5930	0.0593	0.2435	0.2487	0.4987	0.2879	0.5366	0.3475	0.5895

The above tables also suggest that first order moving average is the approximate fit. Based on this the derived indices are given in table 30.

Table 30

Commodities	Indices
Cotton	0.261
Gum Hashabs	0.279
Groundnuts	0.631
Sesame	0.248
Others	0.219
Total	0.207

The above indices show more fluctuation for groundnuts while for the others the indices are quite low. When Box Jenkins based indices were applied the indices for Ethiopia and Sudan show more similarity.

Conclusion

The aim of the project is essentially statistical. It compares various indices to the same data set. It also estimates indices by classifying export by quantity value and destination. The data which is of 26 year length is also classified into earlier and later parts. While one observes several differences or variations, the following conclusions may be made.

- a) Whether indices are simple (coefficients of variation), intermediate (standard error of regression estimate) or advanced (Box Jenkins) the results seem to be more or less similar.
- b) All indices showed higher export instability between 1974-1989 compared to 1960-1973.
- c) Fluctuations differ by destination; whenever export is made to countries whose currency fluctuates more, the indices of the two countries (Ethiopia and Sudan) tend to be mor unstable.

In general one need not resort two indices that are quite sophesticated; approximate results may be obtained by applying simple measures. When one compares indices by quantity with those by values for Ethiopia, (tables 7 and 9) there is more fluctuation of major export commodities as being more responsible for higher

fluctuation. Also when the extent of fluctuation is compared by destination export to the United States tends to show more fluctuation. Over the past 15 years there was more up and down in the performance of the American economy compared to other Ethiopian partners. This suggests that the performance of the partner's own economy tends to affect export earnings of Ethiopia.

Similar conclusion may also be observed for Sudan when one compares export instability by value and quantity (tables 10 & 12). In other words it is again price fluctuation and not quantity of exports that affects instability of export earnings. On the other hand the extent of fluctuation as measured by destination (table 11) is smaller.

The above comparison is based on the index of coefficient of variation. Similar conclusion may be drawn when one considers other measures.

The results reported in this study could be interpreted by economists and their impact on the overall performance of the two countries' economy could be elaborated further. We could not do this because our objective was statistical measurement not economic interpretation.

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Appendices

Appendix 1

Africa's Terms of Trade and Purchasing Power
of Exports, 1962-1988
(1980 = 100)

Year	Terms of Trade	Purchasing Power of Exports
1960	49	23
1965	37	31
1970	36	47
1975	67	64
1980	100	100
1985	95	74
1988	59	52

Source: Derived from table 7, United Nations,
Africa's Commodity Problems Towards a solution,
Report of the UN Secretary General.

Appendix 2

African's Exports of Individual Non-fuel Primary
Commodities
As a Percentage of World Exports

Commodity	1970	1980	1987
Total Non-fuel Commodities	9.1	5.3	4.1
Coffee	33.6	24.1	19.9
Cotton	11.0	8.3	7.9

Source: Derived from table 4, United Nations,
Africa's Commodity Problems Towards a solution,
Report of the UN Secretary General.

Appendex 3

Dependency on Individual Primary Commodities

Including Feul

Country or Area/ Commodity	1982- 1986	1977- 1981	1972- 1976	1967- 1971
Ethiopia				
Coffee	66	68	40	58
Hides & Skins	12	12	10	9
Petroleum Products	8	5	1	1
Vegetable Oil	2	2	12	9
Livestock	2	1	3	1
Sudan				
Cotton	42	46	51	60
Vegetable Oil	14	20	29	19
Livestock	12	5	2	6
Sereals	7	9	2	1
Groundnuts	6	15	18	8
Roots & Tubers	3	1	-	-
Hides & Skins	2	2	3	2
Petroleum Products	1	2	2	-

Source: Derived from table 2, United Nations,
 Africa's Commodity Problems Towards a solution,
 Report of the UN Secretary General.

Appendix 4Table 1EthiopiaExports Values (1960-1989)(By Commodity)

in millions

YEAR	Major Commodities		Other	Total Export (Birr)
	Coffee	Hides & Skins		
1960	94.4	19.3	78.90	192.6
1961	93.9	25.1	69.70	188.7
1962	107.2	24.8	67.60	199.6
1963	110.9	23.5	89.00	223.4
1964	158.9	22.0	81.60	262.5
1965	188.4	23.5	77.90	289.8
1966	156.0	35.7	85.80	277.5
1967	139.5	29.8	83.40	252.7
1968	153.3	24.9	87.80	266.0
1969	174.0	29.2	94.90	298.1
1970	181.3	24.5	100.10	305.9
1971	175.2	25.7	113.50	314.4
1972	182.5	47.6	154.00	384.1
1973	189.8	68.6	244.00	502.4
1974	151.9	47.1	357.20	556.2
1975	152.7	34.5	310.60	497.8
1976	324.6	55.4	200.60	580.6
1977	519.3	47.7	122.00	689.0
1978	502.3	66.3	65.00	633.6
1979	592.7	141.3	130.30	864.3
1980	563.7	108.0	207.10	878.8
1981	469.9	98.3	236.90	805.1
1982	511.8	84.5	239.20	835.5
1983	521.4	83.9	228.00	833.3
1984	545.7	96.3	220.70	862.7
1985	432.7	103.6	153.10	689.4
1986	725.6	109.9	106.10	941.6
1987				
1988				
1989				

Source: United Nations, International Financial
statistics year book 1988

Appendix 4
Table 2

Ethiopia

Exports Values (1960-1989)
Industrial Countries

Millions of U.S. Dollars

Year	United States	United Kingdom	Germany	France	Italy	Netherlands	Japan	Other	Total
1960									
1961									
1962									
1963									
1964	51.81	4.23	3.54	2.57	7.47	3.14	2.42	2.53	77.71
1965	63.31	4.18	5.05	3.16	7.46	2.98	2.81	2.93	91.88
1966	48.09	4.98	5.77	3.51	10.13	2.70	4.69	3.45	83.32
1967	43.35	4.23	5.29	3.60	8.36	2.01	4.35	3.67	74.86
1968	45.60	3.90	8.70	3.70	6.60	2.00	4.60	2.50	77.60
1969	50.24	3.83	11.52	3.57	8.47	1.84	5.68	2.48	87.63
1970	59.61	2.33	8.90	2.65	7.60	1.58	6.64	3.41	92.72
1971	55.16	2.76	9.92	3.13	6.62	3.44	7.49	2.12	90.64
1972	59.14	4.63	12.26	5.03	13.85	3.89	10.35	2.92	112.07
1973	72.07	7.31	21.04	7.79	18.58	9.84	13.26	7.01	156.90
1974	51.99	8.59	30.51	8.43	17.74	11.57	24.28	13.23	166.34
1975	44.96	6.54	27.35	5.63	9.99	5.45	19.36	8.06	127.34
1976	91.52	8.62	16.96	9.93	19.32	12.20	19.42	14.38	192.35
1977	85.75	8.50	28.71	10.24	16.06	11.10	23.16	17.89	201.41
1978	94.91	6.92	36.17	7.50	18.13	10.42	17.65	100.0	291.73
1979	118.91	9.42	29.94	14.66	47.26	15.46	25.81	15.42	276.88
1980	7.11	8.86	35.97	28.21	43.07	8.64	27.37	10.46	239.69
1981	80.21	12.25	40.50	25.57	27.35	5.18	28.71	12.78	232.55
1982	104.35	8.16	64.52	21.39	21.21	5.07	30.03	13.23	267.96
1983	81.96	6.49	66.57	30.59	30.04	7.96	30.34	23.56	277.51
1984	81.11	6.69	75.21	21.12	30.77	8.44	31.17	37.86	295.37
1985	35.42	10.72	62.37	12.72	26.00	44.57	34.65	13.65	240.10
1986	47.70	14.43	84.00	17.13	35.01	60.03	46.66	18.40	323.36
1987	39.58	12.47	70.16	14.72	28.33	43.93	37.67	15.43	262.29
1988	45.01	13.62	79.26	16.17	33.04	56.65	44.03	17.36	305.14
1989	71.01	18.72	80.24	23.27	36.86	22.55	51.47	42.07	356.29

Source: United Nations, Direction of Trade Statistics, year book 1990.

Appendix 4
Table 3

Ethiopia

Export Quantity (1969-1987)
By Commodity
in (000) MT

Year	Major Commodities	
	Coffee	Hides & Skins
1969	88.38	21.25
1970	70.86	10.65
1971	80.82	10.86
1972	82.52	16.30
1973	75.98	13.98
1974	55.67	9.77
1975	57.72	6.68
1976	68.00	9.12
1977	50.16	10.86
1978	65.69	8.15
1979	86.99	33.64
1980	75.91	9.71
1981	85.78	10.31
1982	83.41	8.63
1983	93.34	9.02
1984	87.22	9.48
1985	68.00	12.18
1986	74.95	11.53
1987	73.82	9.53
1988		
1989		

Source: Statistical Abstract, Central Statistical Office,
Ethiopia, Addis Ababa (1971-1988)

Appendix 5
Table 1

Sudan

Exports Values (1960-1989)
Industrial Countries

Millions of U.S. Dollars

Year	United States	United Kingdom	Germany	France	Italy	Netherlands	Japan	Other	Total
1960									
1961									
1962									
1963									
1964	6.07	21.42	22.45	10.22	22.71	11.22	14.28	10.05	118.42
1965	5.86	17.80	20.45	8.43	20.10	12.77	7.78	13.48	106.67
1966	6.48	12.85	18.82	10.00	26.77	14.14	12.58	13.48	115.12
1967	13.09	16.73	25.30	11.53	25.24	13.13	16.42	11.24	132.68
1968	7.90	13.80	35.20	5.90	27.90	12.30	19.10	10.60	132.70
1969	8.39	16.60	29.04	4.61	32.26	9.77	21.18	10.81	132.66
1970	10.83	17.74	30.39	6.75	30.86	10.39	24.14	10.44	141.54
1971	10.95	14.03	25.21	8.87	28.07	11.96	23.93	8.52	131.54
1972	10.60	13.50	33.20	13.00	33.30	12.40	29.00	16.50	161.50
1973	8.40	15.70	39.80	26.60	48.40	21.00	48.50	11.50	219.90
1974	19.80	12.00	23.40	36.30	44.50	14.10	12.40	20.20	182.70
1975	9.60	15.90	27.00	55.30	57.60	19.80	18.70	20.70	224.60
1976	21.70	15.80	36.50	36.80	109.0	27.10	41.50	22.80	311.20
1977	14.50	21.20	48.40	37.30	81.50	16.70	51.60	24.90	296.10
1978	11.30	15.10	19.00	29.80	65.20	17.80	44.00	11.50	213.70
1979	17.70	21.40	21.70	25.90	65.90	14.60	43.50	17.50	228.20
1980	13.20	14.00	28.20	16.60	67.70	10.80	44.70	19.20	214.40
1981	51.30	28.00	27.00	38.40	40.10	40.00	50.40	30.80	306.00
1982	13.40	11.10	25.80	25.00	38.20	16.20	33.20	11.50	174.40
1983	12.40	16.10	46.60	21.20	35.10	14.90	33.40	29.80	209.50
1984	18.30	18.80	48.50	27.80	57.10	9.20	41.20	38.50	259.40
1985	6.70	11.10	25.80	13.20	13.20	7.40	26.20	31.70	135.30
1986	12.30	10.50	23.40	10.50	10.50	5.10	23.50	24.40	120.20
1987	12.40	16.10	37.00	16.60	16.60	15.10	33.70	89.10	236.60
1988	16.20	11.60	33.00	25.40	25.40	15.70	30.70	51.10	209.10
1989	12.70	14.00	31.20	28.30	28.30	10.90	52.30	78.30	256.00

Source: U. N., Direction of Trade Statistics year book (1990)

Appendix 5
Table 2

SudanExports Value (1960-1989)By Commodity

in millions

Year	Major Commodity				Other	Total Exports (Sd. Pounds)
	Cotton	Gum Hashab	Ground nuts	Sesame		
1960	33.15	6.55	4.39	4.59	48.68	63.41
1961	31.16	5.92	5.37	4.18	46.63	59.18
1962	43.53	4.40	6.68	5.61	60.22	74.14
1963	45.72	5.69	6.40	4.81	62.62	78.80
1964	32.40	6.76	9.12	6.45	54.73	68.63
1965	31.35	7.53	8.60	4.75	52.23	67.95
1966	34.91	7.18	7.26	5.56	54.91	70.76
1967	40.91	8.34	5.79	6.53	61.57	74.16
1968	51.29	8.80	5.78	6.22	72.09	81.17
1969	51.84	8.65	5.02	7.15	72.66	86.25
1970	63.67	9.10	5.51	6.50	84.78	103.92
1971	69.91	8.03	9.33	8.00	95.27	114.39
1972	72.84	9.08	9.71	9.17	100.80	124.36
1973	84.31	7.40	12.99	10.71	115.41	151.18
1974	43.26	14.27	18.16	16.51	92.20	122.02
1975	70.20	7.55	34.38	11.94	124.07	152.48
1976	97.81	11.23	39.00	17.29	165.33	193.02
1977	133.20	13.51	28.80	18.25	193.76	230.18
1978	122.89	14.78	20.73	19.18	177.58	195.59
1979	151.26	18.49	9.96	6.28	185.99	232.67
1980	121.93	17.88	5.92	24.87	170.60	271.34
1981	66.48	33.68	66.46	35.31	201.93	357.00
1982	121.99	37.76	33.22	38.13	231.10	483.12
1983	395.88	73.59	16.42	70.04	555.93	810.60
1984	405.00	66.43	26.77	96.11	594.31	817.30
1985	374.26	66.01	23.15	97.82	561.24	844.70
1986	366.72	141.71	2.47	58.86	569.76	833.20
1987						
1988						
1989						

Source: United Nations, International Financial Statistics
year book, 1988

Appendix 5
Table 3

Sudan

Export Quantity (1965-1989)
By Commodity

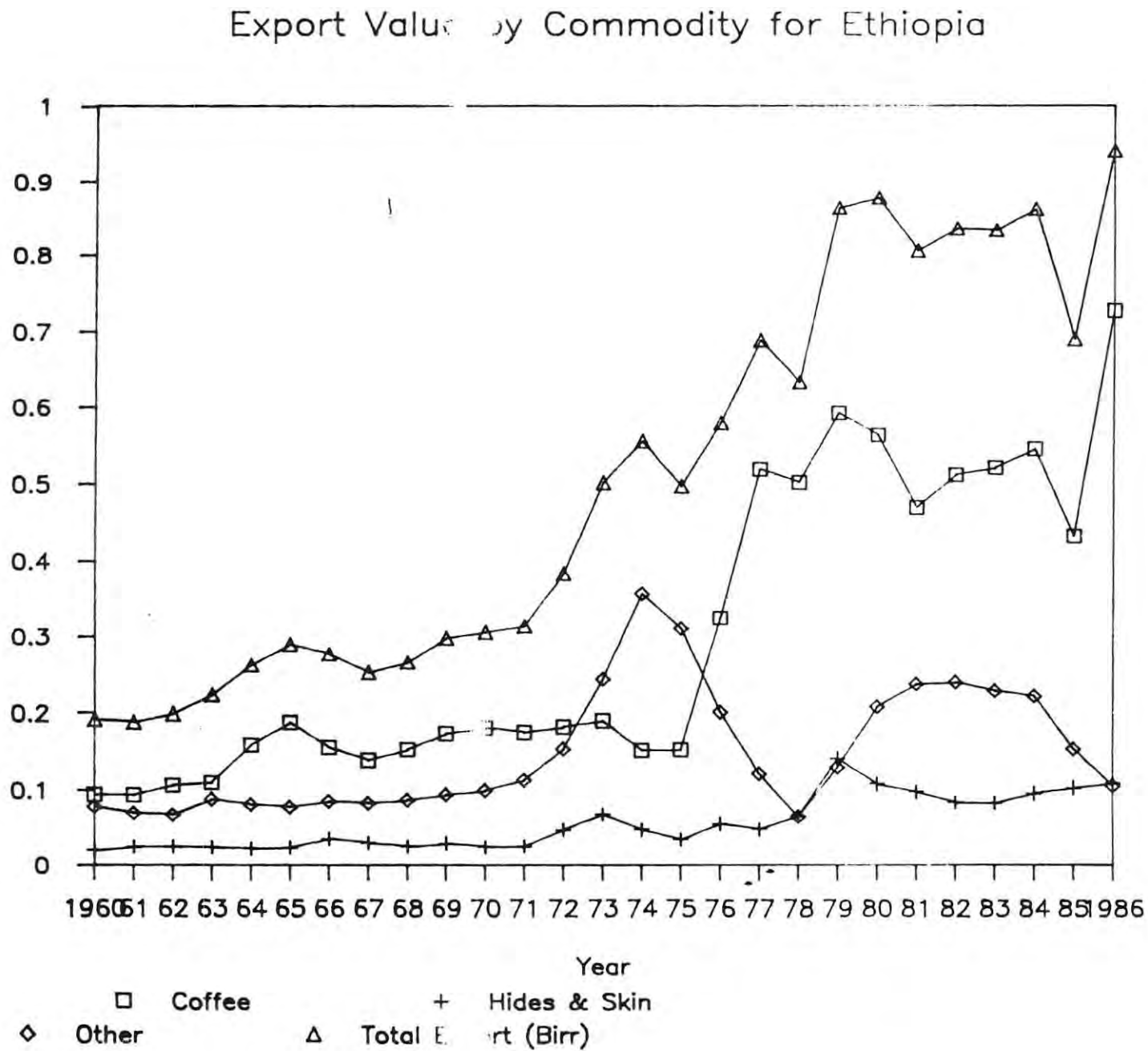
Year	Major Commodities			
	Cotton	Gumhash ab	Ground nuts	Sesame
1965	112.00	58.00	159.00	70.00
1966	142.00	56.00	108.00	74.00
1967	172.00	52.00	109.00	64.00
1968	181.42	51.23	89.47	83.75
1969	190.83	50.46	69.93	103.49
1970	309.63	67.45	65.89	83.75
1971	283.25	41.97	115.06	84.44
1972	246.45	40.76	113.74	85.20
1973	243.73	33.94	138.43	101.86
1974	78.60	20.00	99.00	83.50
1975	156.70	15.60	205.00	56.60
1976	193.70	26.20	282.80	88.80
1977	189.60	30.30	143.80	93.00
1978	147.02	38.70	97.20	76.00
1979	186.46	44.10	37.40	16.00
1980	115.17	26.10	22.10	57.20
1981	64.08	32.90	94.30	58.70
1982	87.38	29.90	89.00	60.80
1983	210.65	41.70	18.00	66.10
1984	180.53	38.40	22.50	80.80
1985	98.80	27.40	13.30	17.50
1986	174.89	19.10	1.10	29.00
1987	175.24	18.60	7.30	60.60
1988	152.36	18.60	69.00	98.80
1989	170.86	18.00	5.70	70.20

Source: Economic survey, Ministry of Finance
Republic of Sudan, Khartoum, 1976/77-1989/90

Appendix 6

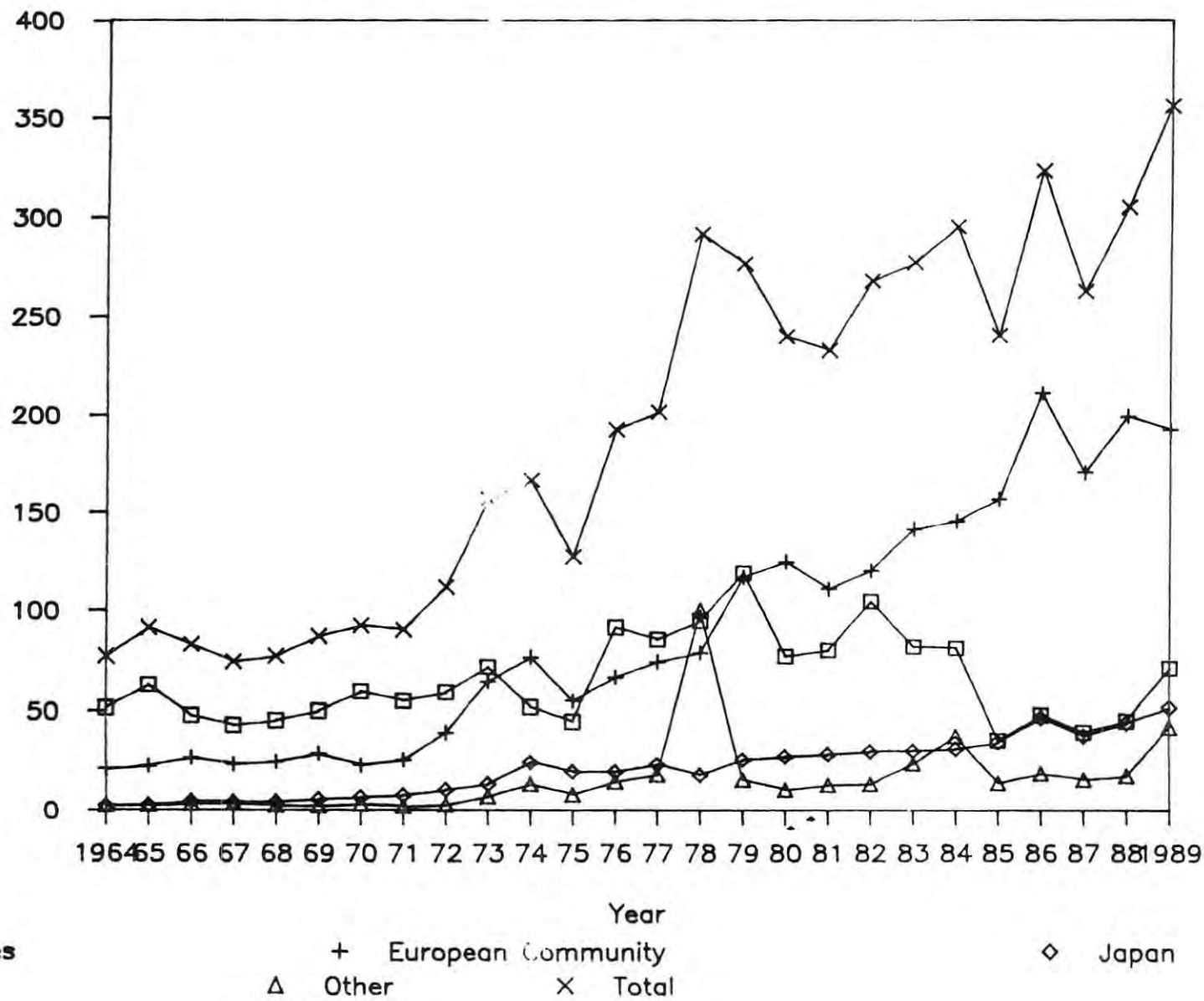
Figure 1

Value in Millions by Commodity
(Thousands)



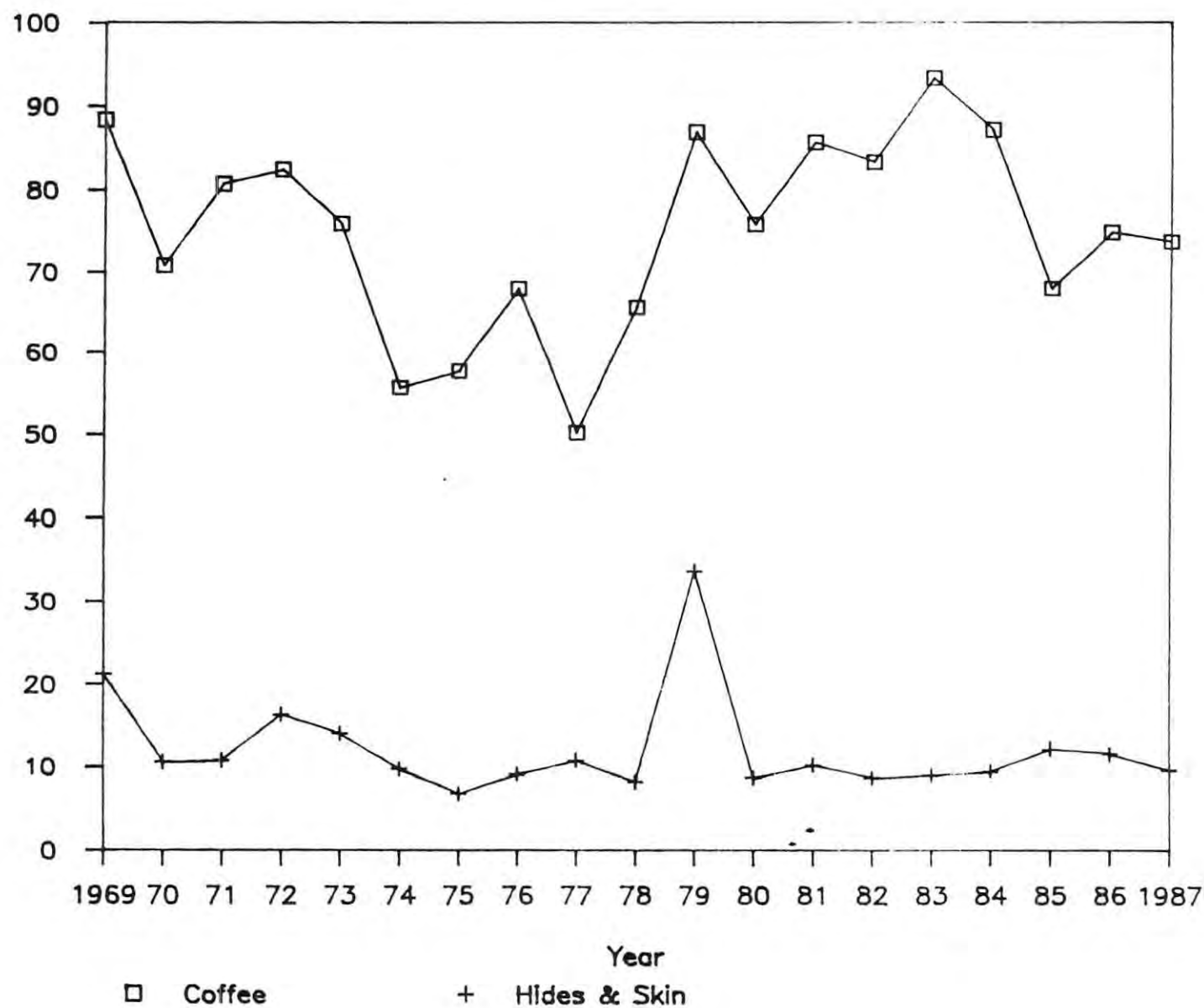
Destination (Millions USD)

Export Value by Destination for Ethiopia



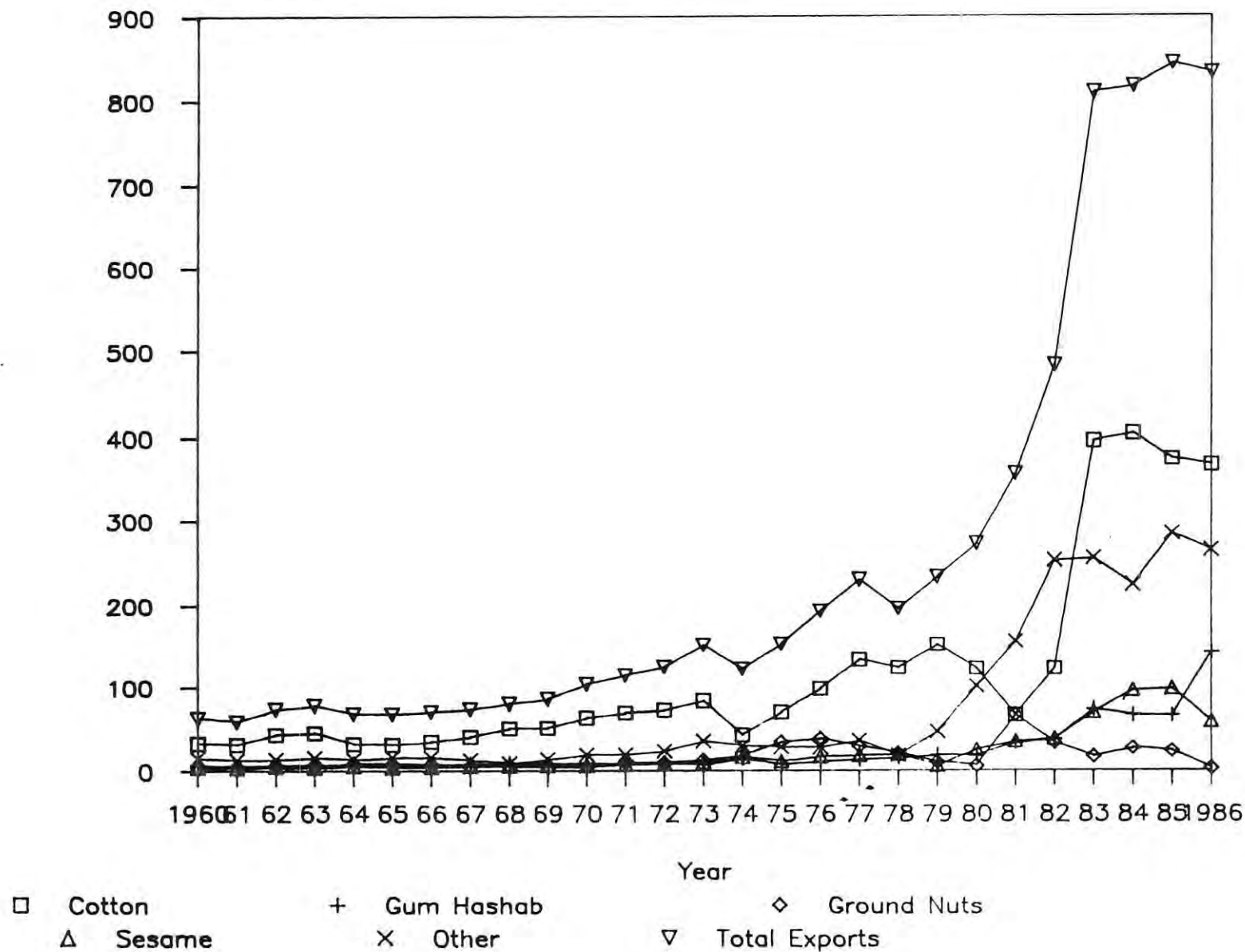
Commodity (in 1000 MT)

Export quantity for Ethiopia



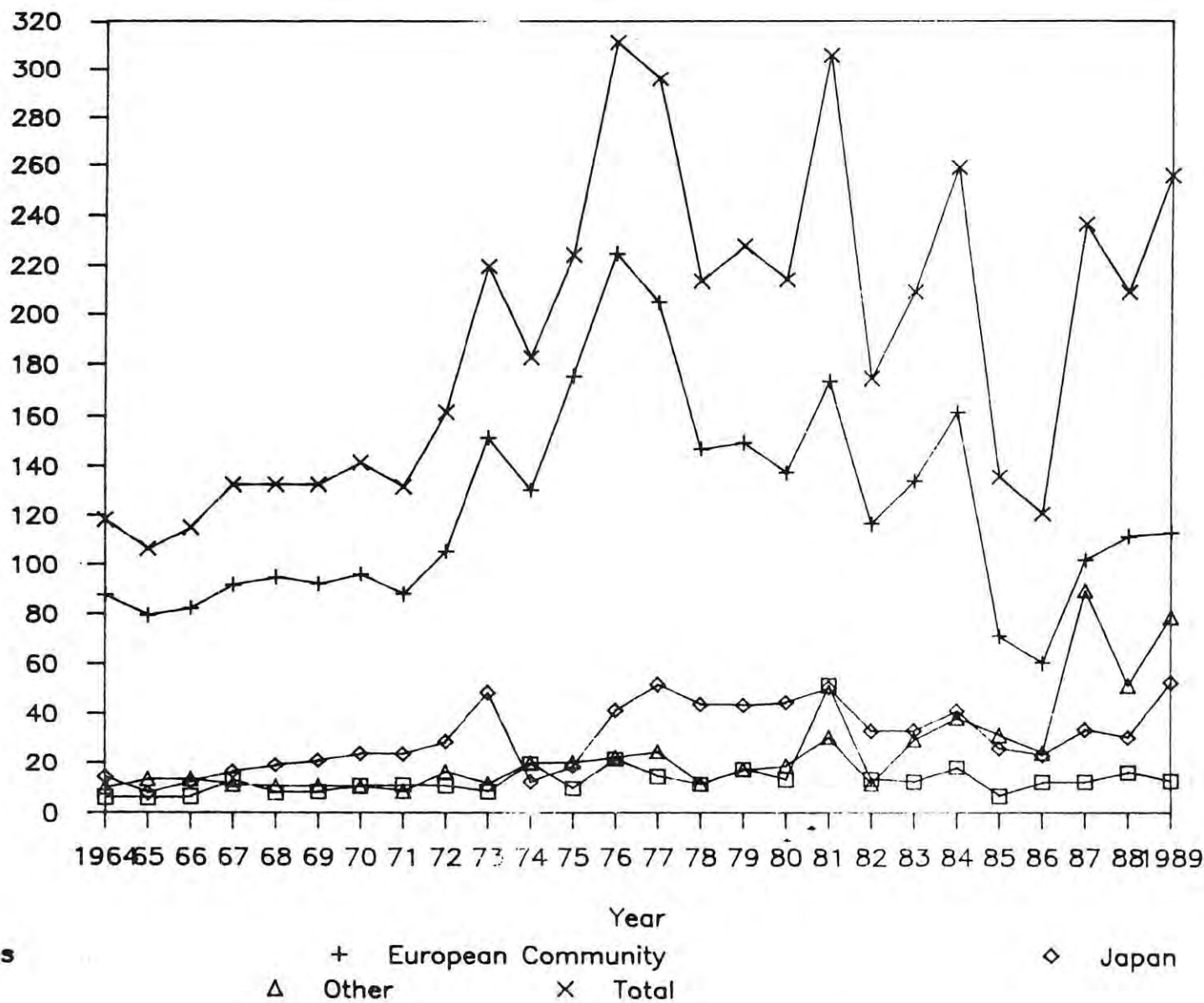
Export Values by Commodity for Sudan

Commodities(Value Millions of SD Pound)



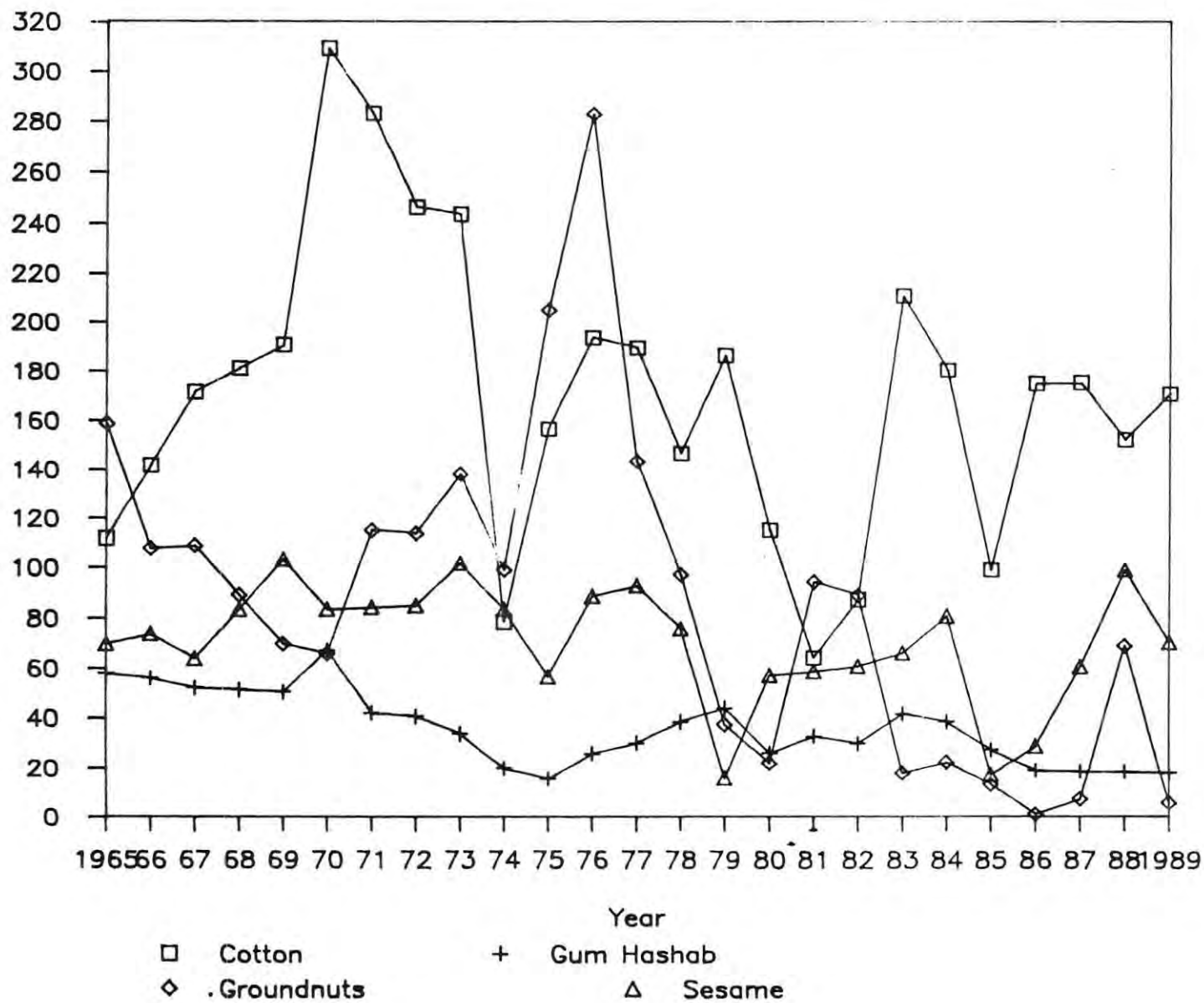
Value Millions of USD

Export Values by Destination for Sudan



Commodity (in 1000 MT)

Export Quantity for Sudan



DECLARATION

I hereby declare that the work herewith submitted, or a part there of, has not already been submitted for any degree and is not being concurrently submitted in consideration for any degree..



Fathia Saeed