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**TERMS OF TRADE AND ECONOMIC GROWTH IN
SUB-SAHARAN AFRICA**

BY

MICHAEL NEGASH

**A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF
ADDIS ABABA UNIVERSITY IN PARTIAL FULFILMENTS OF THE
REQUIREMENTS FOR THE DEGREE OF MASTERS OF SCIENCE IN
INTERNATIONAL ECONOMICS**

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**Terms of Trade and Economic Growth
in Sub-Saharan Africa**

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Abstract

This paper attempts to analyze the impact of terms of trade volatility and trends on economic growth in Sub-Saharan Africa. In this regard, a cross country growth equation, which defines the GDP growth rate as a function of growth rate of investment, growth rate of labor force, terms of trade trends and volatility, is derived. This growth equation is analyzed for 30 Sub-Saharan African countries over the period 1970-2002 using panel cointegration technique. Both the long-run and the short-run parameters are estimated by applying a panel vector error correction model (PVECM). Accordingly, the results of the estimation show that both terms of trade volatility and trends have adverse effects to the growth rate while the volatility is found to have a more powerful negative impact than the trends. On the other hand, the control variables: growth rate of labor force and investments are found to have positive impacts on growth rate of the countries. Hence, the possible advice to these countries, to reduce the adverse impact of terms of trade volatility and deterioration, is to move the export sector to labor-intensive manufacturing instead of primary sector exports. Further study is also advised on the determinants of terms of trade deterioration and volatility, which adversely affect the growth of the region; to tackle the problems from the root.

Key Words

Terms of trade volatility, terms of trade trends, panel cointegration, panel vector error correction model (PVECM), and GDP growth rate

CHAPTER I. INTRODUCTION

1.1. Background

International trade has been one of the crucial factors behind the growth and prosperity of nations. Particularly, in the 19th and 20th centuries, trade was, by large, the engine of global economy (African Development Bank, 2004). However, there is nothing in the doctrine of free trade that guarantees an equal or equitable distribution of the gains from external trade. The distribution of the gain from trade will be determined by a country's international competitiveness in terms of both its price and income dimensions. Incidentally, the declining and volatility of world commodity prices have an important influence on economic growth and the occurrence of poverty in Least Developed Countries (LDCs), particularly those that are dependent on primary commodities as their major source of export earnings (UNCTAD, 2002). This occurs through the direct income loss associated with the price changes.

As with the Middle East, North Africa and South Asia regions, Sub-Saharan Africa remains weakly integrated into the global market. Although export as a share of GDP has been increasing in Sub-Saharan Africa during the last two decades, exports as a share of world exports have remained flat throughout the last decade and are lower than in the early 1980s. GDP growth has also been worse than in the early decades. Many countries in the region are dependant on only a handful of commodity with highly volatile and falling prices, which in turn leads the country vulnerable to external shocks. These countries also face very high transport cost and weak institution to facilitate trade. All these factors therefore hobble the trade performance of the region (World Bank, 2005).

A further feature of Sub-Saharan Africa pattern of trade integration in to the world is that their exports structure tends to be concentrated on a narrow range of primary commodities. This export concentration seems to have intensified. Accordingly, three leading export items, which are mostly traditional, accounted for more than 50 percent of the total exports of the region.

Hence, like other commodity-dependant regions, Sub-Saharan Africa suffers from severe terms of trade fluctuations (UNCTAD, 2005).

The commodity-exporting Sub Saharan African countries generally export a narrow range of primary commodity for which the growth of global demand is slow (UNCTAD, 2002). Productivity tends to be lower than in other developing countries and its growth is slow and certainly insufficient to offset the negative effects of falling and volatility of commodity prices. In some of their traditional exports, Sub Saharan African countries are losing market share, and diversification in to more value added segments of commodity production are occurring very slowly. Hence, these largely unprocessed and traditional primary commodities tend to pace volatility and deteriorating terms of trade, and this may in turn has detrimental effects on their economic growth. This paper is therefore aimed to empirically analyze the impact of terms of trade trends and volatility on economic growth of Sub-Saharan Africa.

1.2. Statement of the Problem

The literature about primary commodities is focused on two problems: the long-run deterioration of their terms of trade and their price volatility. When the long-run deterioration of the terms of trade hypothesis was first proposed by Gebrehiwot¹ (1921), Prebisch (1962) and Singer (1950), this trend was seen as an impediment to economic development of developing countries, since they were primarily specialized in the export of primary commodities. It was argued that a fairer international economic order should reverse this trend.

These countries typically experience larger terms of trade fluctuations than industrial countries. They also allocate a great share of their expenditure to imports. Taken together these facts suggest that terms of trade movement probably have a more notable impact on the real income of them (Kouparetsas, 1997). Esterly et al (1993) also argued that fluctuations in

¹ *Quoted by Alemayehu Geda (2003)*

terms of trade not only have a short-run impact but also a considerable impact on the medium-term growth performance of developing countries. Esterly et al (1993) even argued that terms of trade fluctuation have a greater influence on growth than either trade or fiscal policy.

Even though it has been difficult to break up completely from the old pattern of specialization, remarkable industrial growth has been observed in many developing countries since the end of the Second World War. Yet they are more reliant on export of primary products. This means that deterioration and volatility of the terms of trade of primary commodities is still a matter of concern for many developing countries.

The situation in Sub-Saharan African countries is not an exception to the above statement. The volume of international trade of this region accounts more than fifty percent of the region's GDP (Hoffmaister et al 1998). Hoffmaister et al (1998) indicated that international trade of this region was about 64% of the gross domestic product (GDP) over the period of 1970-1993. The recent evidence, from World Bank database 2004, also indicates that international trade of this region account for about 61% of the GDP. Moreover, narrow ranges of primary commodities constitute a significant fraction of their exports, and their main import items are intermediate inputs and capital goods. Export revenues, in the region, are highly unstable due to recurrent and sharp fluctuations in the prices of primary commodities. This implies that the external sector of the economy is highly exposed to volatility and long-term deterioration of terms of trade. The focus on Sub-Saharan Africa, therefore, reflects the intuition that if volatility and secular changes in terms of trade matter at all, they should do so in the countries most dependent on primary products.

There has been a growing research that examines the link between terms of trade and economic growth². While contributing to this literature, our study is also related to some recent studies examining the link between terms of trade and economic growth in Sub-Saharan Africa: Bleaney and Greanaway (2001) employ fixed effect panel regression and Hoffmaister et al (1997) estimate a structural Vector Autoregressive Regression (VAR) model to examine the relation between terms of trade and economic growth. The former researchers concluded

² *Basu and McLeod (1992), Mendoza (1995, 1997), Kose and Riezman (1999), and Blattman et al (2003)*

that terms of trade volatility play an important role in affecting economic growth. While the latter found that terms of trade fluctuations have less significant role in affecting economic growth in the region.

This study is, therefore, aimed at to analyze the impact of terms of trade volatility and their secular changes on economic growth applying a panel cointegration technique and using larger data than the pervious works by Bleaney and Greanaway (2001) and Hoffmaister et al (1997). Accordingly, this study used panel data from 30 Sub-Saharan African countries³ over the period of 1970-2002. It is also examined the existence and the magnitude of deterioration of terms of trade of each sample country and across countries using standard time series analysis.

Although the impact of terms of trade changes on growth instability, for 39 Sub-Saharan African countries over the period of 1961-1999, was analyzed by Alemayehu and Weeks (2005), this study focus on the effects of both terms of trade volatility and its secular changes on economic growth since both terms of trade trends and volatility affect economic growth.

1.3. Objectives of the Study

The main objective of the study is to analyze the impact of terms of trade volatility and secular change on economic growth in Sub-Saharan Africa using a recently developed panel cointegration technique.

The specific objectives are:

- To test the existence and magnitude of long-term deterioration of terms of trade in each sample countries and across countries.

³*Benin, Burkina Faso, Botswana, Burundi, Cameroon, Comoros, Congo democratic, Congo republic, Cote-d'Ivoire, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mozambican, Niger, Nigeria, Rwanda, Sera Leon, Senegal, South Africa, Swaziland, Togo, Tunisia, Zambia and Zimbabwe*

- To examine the link between terms of trade and economic growth based on available data in Sub-Saharan Africa.
- To analyze the performance and structure of exports in the region.

1.4. Hypothesis of the Study

The hypotheses of this study are: (i), terms of trade deterioration and volatility do exist in each sample country and across country; (ii), both terms of trade deterioration and volatility have an adverse effect on economic growth in the region although the adverse effect of terms of trade volatility is greater than the adverse effect of the trends.

1.5. Significance of the Study

The effects of world trade on production, consumption and wellbeing heavily depend on international price ratios that are established (Lindert, 1986). Since Sub-Saharan African countries are highly dependent on exports of certain primary commodities and imports of intermediate and capital goods, they are highly exposed to terms of trade deterioration and volatility. Previous empirical works on the area are scant, particularly in the region. Thus this study, by incorporating larger data and relevant variables, analyze the impact of terms of trade volatility and trends on economic growth in Sub-Saharan Africa. In this case, the study will supplement the existing empirical literature on the developing countries in general and Sub-Saharan Africa countries in particular. It will also inform policy maker and interested researcher by providing information about the impact of secular terms of trade changes and volatility on economic growth.

1.6. Scope of the Study

The current study covers the period between 1970 and 2002 for 30 Sub-Saharan African countries. The period and countries are chosen on the basis of the availability of reliable data.

1.7. Organization of the Study

Remaining part of the paper will be organized as follows. The second Chapter will be concerned with review of related literature. The third Chapter will discuss about the region's external trade: an overview, the performance and structure of exports in the region and finally, the case of terms of trade volatility and trends in the region and their link with growth performance. The fourth Chapter will focus on data, model specification and econometric methods reliable for the current study. Following this, the estimation of the model and the analysis of the empirical results are addressed in Chapter five. In the last Chapter, conclusion and policy implications are discussed based on the findings.

CHAPTER II. SURVEY OF LITERATURE

2.1. Theoretical Review

This part of the paper reviews the relevant literatures to the study. Thus, it includes definitions and measurements of terms of trade, the theory of terms of trade deterioration, terms of trade volatility and economic growth and finally, terms of trade trends and economic growth.

2.1.1. Definitions and Measurements of Terms of Trade

The effect of world trade on production, consumption and wellbeing depends to a great extent on international price ratios that are established (Lindert, 1986). For this reason economists have paid close attention to the terms of trade.

Terms of trade of a nation are defined as the ratio of the price of its export commodity to its import commodity (Lindert, 1986; Salvatore, 1998). These terms of trade are often referred to as the commodity or net barter terms of trade. In a world of many (rather than two) traded commodities, the barter terms of trade of a nation should be defined as the ratio of the price index of its exports to the price index of its imports (Lindert, 1986; Salvatore, 1998). They can be defined algebraically as:

$$T = \frac{P_x}{P_m}, \dots \dots \dots (3.1)$$

Where T represents net barter terms of trade, and P_x and P_m are indices of export price and import price, respectively. P_x and P_m can be calculated as:

$$P_x = \sum x_i p_i, \dots \dots \dots (3.2)$$

Where x_i is the share of each " i^{th} " commodity in the total value of exports in a base year and p_i is the ratio of the current price of the same commodity to its price in the base year.

$$P_m = \sum m_i p_i, \dots \dots \dots (3.3)$$

Where m_i is the share of each commodity in the total value of import in base year and p_i is defined as above. The other types of terms of trade are income terms of trade, single factorial terms of trade and double factorial terms of trade. The net barter terms of trade (3.1) can be called income terms of trade (3.4) when they are weighted by the volume of exports. The income terms of trade are therefore given algebraically by: (Salvatore, 1998)

$$Y = \left(\frac{P_x}{P_m} \right) Q_x, \dots \dots \dots (3.4)$$

Where Y is income terms of trade and Q_x is an index of the volume of exports. Thus, income terms of trade measures the nation's export-based capacity to imports (Salvatore, 1998).

The single factorial terms of trade, on the other hand, can be defined as the net barter terms of trade multiplied by an index of productivity change in the export industries. They can be defined algebraically as: (Salvatore, 1998)

$$D = \left(\frac{P_x}{P_m} \right) Z_x, \dots \dots \dots (3.5)$$

Where D is single factorial terms of trade and Z_x is a productivity index in the nation's export sector. So, single factorial terms of trade measures the amount of imports that the nation gets per unit of domestic factors of production embedded in its exports.

The double factorial terms of trade, which are an extension of single factorial terms of trade (3.5), can be defined algebraically as: (Salvatore, 1998)

$$G = \left(\frac{P_x}{P_m} \right) \left(\frac{Z_x}{Z_m} \right), \dots \dots \dots (3.6)$$

Where G represents double factorial terms of trade and Z_m is an import productivity index. Thus G measures how many units of domestic factors embodied in the nation's exports are exchanged per unit of foreign factors embodied in its imports.

Of the four terms of trade defined above, barter terms of trade, income terms of trade and single factorial terms of trade are the most important ones (Salvatore, 1998). Since barter terms of trade are the easiest to measure, most of the discussion in economic literature has been in terms of net barter terms of trade. Indeed, the net barter terms of trade is often referred to simply as the terms of trade. This study also used the net barter terms of trade of Sub-Saharan African countries to analyze the relationship between terms of trade and economic growth.

2.1.2. The Theory of Terms of Trade Deterioration

Since the days of the classical economists, the long-run behavior of the terms of trade between primary products and manufactures has been a much-discussed theme. From Adam Smith (1776) to Keynes (1912) and Clark (1942), there was an idea that terms of trade of primary products vis-à-vis manufactures have a trend to improve in the long run as a result of the operation of the law of diminishing returns in the primary producing sector (summarized by Sarkar, 1986). However, one of the Ethiopian scholars, Geberhiwote (1921), identified the deterioration of terms of trade for primary commodities.

After World War II, some economists also identified and explained the deterioration of the terms of trade for primary commodities (Prebisch, 1962; Singer, 1950; Kaldor, 1976). A number of arguments have been proposed by economists for the declining trend in the terms of trade i.e. the income and price elasticity, the unlimited supply of labor and market structures (Singer, 1950; Prebisch, 1962; Kaldor, 1976; Sproas, 1982; Banos and Amazonas, 1993).

It has been argued that the income and price elasticities of demand for primary commodities, especially agricultural products', are lower than that of manufactures', causing terms of trade to turn against primary producers (Singer, 1950; Prebisch 1962). Regarding income elasticity of demand argument, Singer (1950) introduced income-inelastic demand as a factor contributing to relative price deterioration right from the beginning. In other words, an increase in world income, through Engle's law, leads to a higher increase in the demands for manufactures than for primary products, which in turn leads to a deterioration in terms of trade for primary products. The propensity towards deterioration aggravated by the development of industrial substitute for primary products (Prebisch, 1962)

With respect to price elasticity argument, (Singer, 1950: 479) noted that as primary product exporters increase their output and exports; price would tend to fall if price elasticity of demand for primary products was less than unity. This accompanied with low elasticity of supply as emphasized by the classical analysis, also means that there is greater instability of primary commodity prices and hence terms of trade (Sproas, 1982)

In relation to the second argument, which is unlimited supply of labor, an increase in demand for primary commodities (produced in the developing countries) leads to an increase in labor absorption, which would create more supply at the same price level, while in the case of manufacture goods such an increased demand leads to an increase in price to clear the market at a new level of demand (Barros and Amazonas, 1993). The result of this would be deterioration in relative prices. Sproas (1983, 133) also show that not only under totally unlimited supply of labor but also in a high elastic supply of labor situation, deterioration does occur.

The third argument, which relates to market structures of primary commodities and manufactured goods, states while the agricultural sector of primary exporters is highly competitive; the manufactured sector is monopolistic (Barros and Amazonas, 1993; Kaldor, 1976). In other words, the developed countries sell in an oligopolistic fix-price market where price are administered or fixed by the producers themselves. However, the developing countries operate with in a flexi-price one, where market price is given to the individual

producer and consumer (Kaldor, 1976). The implication of this is, in the long-run, terms of trade move against developing countries since productivity increase in these countries would translate fully in to price decrease while productivity increase in developed countries would translate in to higher factor income and monopolistic profit rather than lower product price (Kaldor, 1976).

In developed countries, a rise in output per person is captured by trade unions and monopolistic firms in the form of higher money incomes, with absolute prices of manufactures remaining constant. Asymmetrically, a rise in output per person in the case developing countries is reflected in lower prices, because trade unions in these countries are weak and primary goods producers lack market power (Sproas 1982 and Kaldor 1976). This also implies terms of trade move against primary commodities.

In the same way, Prebisch (1962) noted the impact of cyclical nature of the north's economy in that profit increases, during upswings in the north's economy, have a tendency to be absorbed by increase in wage since the labor is well organized in strong trade union. Hence transfer to the south is little as increase in demand for primary commodities. When profits reduced, during downswings, the encumber will be transferred to primary producer as demand declines, since strong trade unions in the north refuse to accept wage decline.

2.1.3. Terms of Trade Volatility and Economic Growth

In the introduction to his 1950 article, Singer proposed that fluctuations in the terms of trade considerably affected the funds available to underdeveloped countries for capital formation, and hence growth. He noted that changes in the volume and value of foreign trade tend to be important in developing countries because their surplus income over subsistence is often entirely dependent on export revenues, and investment is in turn dependent on these income sources (Blattman et al, 2003).

Some economists, Mendoza (1995 and 1997) and Basu and McLeod (1997), have begun to formulate business cycle theory and growth model to establish a relationship between terms of

trade volatility and growth such as that discussed by Singer (1950) and Prebisch (1962) as well. In general, they have found that, as Singer seemed to suggest, short-term volatility appears to be negatively correlated with growth, perhaps by reducing levels of investment.

Mendoza (1997) constructed a stochastic endogenous consumption growth model where terms of trade uncertainty could adversely affect savings and growth. He formulated a model where planned consumption growth is an increasing function of terms of trade growth (because of its impact on lifetime income), but a decreasing function of terms of trade volatility (because of risk preferences). He also examined this model using data from 40 developed and developing countries. He then concluded that terms of trade volatility bring a significant adverse effect on economic growth while terms of trade trends (growth) will improve economic growth.

Bleaney et al (2001) and Blattman et al (2003) also argued that there is a negative relationship between terms of trade volatility and economic growth. More specifically, using data for thirty five developing and industrialized countries, Blattman et al (2003) proved that terms of trade volatility has a significant and higher adverse effect on growth than the effect of terms of trade trends. Moreover, they argued that the adverse effect of terms of trade volatility on growth is higher in developing than industrialized countries. Similarly, Bleaney et al (2001), based on data from 15 Sub-Saharan African countries that are highly primary producing countries, concluded that terms of trade volatility have a significant adverse effect on growth.

In general, the literature suggests that terms of trade volatility have an adverse impact on economic growth particularly in developing countries than their industrial counterparts.

2.1.4. Terms of Trade Trends and Economic Growth

It is argued that literature on the relationship between economic growth and secular deterioration in the terms of trade is older and more debatable than that on the impact of terms of trade volatility. In 1950 Prebisch and Singer emphasized that primary product prices would, in the long run, fall relative to those of manufactures due to the fundamental nature of primary

products and manufactures. Primary product specializing countries would therefore see deterioration in their terms of trade and, as producers of increasingly cheaper primary products and consumers of increasingly expensive manufactures, a relative fall in incomes (Blattman et al, 2003).

Regarding the relationship between terms of trade and economic growth, economists have proposed two opposing views. The first view includes positive relation between (i) terms of trade improvement and economic growth (Mendoza, 1997; Blattman et al, 2003) and (ii) terms of trade deterioration and a decline in economic growth (Mendoza, 1995). For example, Blattman et al (2003) remarked that terms of trade improvement leads to an increase in investment and hence growth. For Mendoza (1997), growth is faster in economies in which terms of trade grow at faster rate, on average, because rapid terms of trade growth increases the expected real rate of return on savings (in units of imported goods) and this affects the saving rate.

On the other hand, Mendoza (1995) summarized the argument of Harberger-Laursen (HL) effect in that, 'when terms of trade deteriorate, net exports and savings decline because a fall in the purchasing power of exports is a reduction in income, and marginal propensity to consume and save are less than unitary'. If a country's growth increases the volume of trade (trade is concentrated on primary export sector), the terms of trade of the country will deteriorate, and reduce the gain in welfare. In extreme case, the terms of trade could move against the country to such an extent that its welfare is actually reduced (Sodersten, 1998). This paradox has been termed as immiserizing growth.

Several economists also believed that there is a negative relation between terms of trade improvement and economic growth, which is the second view (Sachs and Warner, 2001; Hadass et al, 2003). Sachs and Warner (2001), for example, noted that countries with large natural wealth discovery tend to grow more slowly than resource poor countries: natural resources, and any terms of trade boom that raises their value, are therefore a curse to

development. In relation to this, literature has examined Dutch disease effects extensively⁴. For example, Alemayehu (2002) summarized the idea of Corden (1984) and Van Wijnbergen (1984) in that the booming sector has a negative effect on growth due to spending effect (if part of the revenue from the booming sector spent on the other sector) and then resource movement effect (if resource shift towards the non- tradable sector from the booming sector). Similarly, the recent evidence by Hadass et al (2003), also show that while terms of trade movements between 1870 and World War I favored primary product exporters, it reduced their growth.

2.2. Empirical Review

In this subsection we review empirical literature conducted on the deterioration of terms of trade hypothesis, and on the impact of terms of trade volatility and trends on economic growth in Sub-Saharan African countries and other countries (especially in developing countries).

Prebisch and Singer started the statistical analysis on the deterioration of terms of trade hypothesis in the 1950 (Leon and Soto, 1995). For example, Prebisch (1950) estimated that terms of trade of least developed countries deteriorated in the range of 0.5%-0.7% per year during the period of 1870-1945 (Leon and Soto, 1995). However, the Statistical techniques employed by both Prebisch (1950) and Singer (1950) are very crude by today's standards, amounting basically to simple data inspection (Balasubramanyan and Sapsford, 1994). Moreover, their work was constrained by quality of available data (Sapsford, 1989). Hence, the Prebisch-Singer hypothesis, secular deterioration in the net barter terms of trade between primary products and manufactures, has fostered subsequent empirical studies (Spraos, 1980; Sapsford, 1985; Sarkar, 1986; Grilli and Yang, 1988; Cuddington and Urzua, 1989; Bloch and Sapsford, 2000)

⁴ *Van Wijnbergen, 1984, 1986a, 1989; Edward and van Wijnbergen, 1989; Corden, 1984; Salter, 1959; Swan, 1996; Neary and Wijnbergen, 1986 (cited by Alemayehu, 2002)*

Spraos (1980), for example, examined the hypothesis using a semi-log linear regression model for Prebisch's and Legue's series. The model is formulated as:

$$\ln y_t = \alpha + \beta t + \mu_t$$

Where y_t represents the relative price of primary products to manufactures at time t and t represents the time trend. Hence, the deterioration hypothesis can be tested by estimating the coefficient β .

The results of this model indicated that the Pribisch's series show an annual rate of change of -0.9 % and the Legue's series of -0.6 %. Thus, he concluded that for the 70-years period ending with outbreak of World War II, a secular deterioration in the net barter terms of trade has been statistically observed; however, Prebisch exaggerated the rate of deterioration. Spraos (1980) also remarked the hypothesis to open to doubt when the analysis is extended to include the period up to 1970.

In an extension of Spraos (1980) study, Sapsford (1985) found evidence of structural instability problem in the early analysis of Spraos (1980). He corrected the problem by allowing for intercept and slope dummies after 1950 and he concluded that (with the exclusive of petroleum products) there was a down ward trend of about 1.3 % per annual, but with a substantial up ward shift in the data in 1950. In this regard, Sarkar (1986) also concluded that the deterioration in terms of trade hypothesis is valid. Moreover, he noted that the declining trend continued in the post-Second World War years.

On the other hand, Grilli and Yang (1988) undertook a major effort to generate a reliable database for the period of 1900-1986, also called G-Y series. Using this series, they estimated and found that the down ward trends in the net barter terms of trade for primary commodities was about 0.6 % per annum but found no evidence of shifts in the series. Hence, they concluded, like that of Spraos (1980), the deterioration hypothesis is valid; however, Preblich overestimated the long run trend.

With the advancement of time series econometrics, the statistical analysis applied by Spraos, (1980) and Grill and Yang, (1988) is subjected to criticism for its fundamental implicit assumption that the relative price follows a trend stationary (T-S) process (Cuddington and Urzua, 1989; Cuddington 1992 cited in Balasubramanyan and Sapsford, 1994). Moreover, Cuddington and Urzua (1989) also questioned the existence of a structural break in the relative price series in 1950. Cuddington and Urzua (1989), hence, reexamined the empirical validity of the hypothesis using difference stationery (D-S) time series model to the G-Y series of non-fuel commodity prices; by allowing for the probability of structural breaks. The model is formulated as:

$$d \ln y_t = r + \mu_t$$

Where $d \ln Y_t = (1-L)Y_t$, with L denoting the lag operator. The estimation results indicate that primary commodity prices (relative to manufactures) experienced an abrupt drop after 1920. Hence, they concluded that the 'stylized facts' behind the Prebisch-Singer hypothesis should be changed. They also noted that, the choice between the D-S and T-S model hinges on the presence or absence of unit root in the data process. Meanwhile, Powell (1991) found that terms of trade for commodities did not exhibit any definite long-term trend, but they do reflect three permanent (structural) adverse shocks that occurred in 1921, 1938, and 1975 (Balasubramanyan and Sapsford, 1994). Cunndington (1992) also used the same D-S time series model to the analysis of the 24 commodities that include the G-Y index (plus oil and coal), and found that 21 of them present zero or positive trend, hence rejecting the Prebisch-Singer hypothesis (Leon and Soto, 1995).

On the other hand, Balasubramanyan and Sapsford (1994) noted that most of the empirical works in the post-1989 support the Prebisch-Singer hypothesis of deterioration of terms of trade (Ardeni and Wright, 1992; Helg, 1990; Boughton, 1992; Bleaney and Greanaway, 1993). Bloch and Sapsford (2000), using model that induces difference in wage and price determination between primary production and manufacturing in the post-World War II

period, also supported the Prebisch-Singer hypothesis; however, there has been intervals of net improvement in the terms of trade of primary product during periods of particularly rapid manufacturing growth.

In general, although there are mixed results concerning the deterioration of the terms of trade hypothesis, it seems that majority of the studies give support to the original studies of Prebisch (1962) and Singer (1950)

In analyzing the relationship between terms of trade and economic growth, most of the empirical studies focus on the impact of terms of trade volatility and/or shock on economic growth (Basu and McLeod, 1992; Mendoza, 1995; Hoffmaister, Roldos and Wickham, 1997; Kose and Riezman, 1999; Bleaney and Greanaway, 2001). Some other empirical research rather examines the impact of both terms of trade trends and volatility on economic growth (Medoza, 1997; Blattman, Hwang and Williamson, 2003).

Basu and McLeod (1974) made a significant effort to analyze the relationship between terms of trade fluctuations and economic growth using some standard time series tests⁵, which applied in several literatures, and a simple open economy stochastic model. The results of the time series tests for twenty developing countries shows that their output movements are dominated by swings in average growth rate, while their terms of trade are characterized by considerable short-term fluctuations around a more stable long term down trend. Hence, they

⁵ The time series tests include Augmented Dickey Fuller (ADF) test (to examine the existence of random walk or not in the terms of trade series) and variance ratio test of Cochrane (1988), to check the magnitude/ size of the random walk. The ADF test is:

$$\Delta TOT_t = \mu + \beta t + \gamma TOT_{t-1} + \sum_{i=1}^{\infty} \alpha \Delta TOT_{t-i} + \varepsilon_t$$

Where TOT_t is terms of trade
 t is trend term

The Cochrane (1988) variance ratio test is:
$$V_k = \frac{1}{k} \left[\frac{\text{var}(TOT_t - TOT_{t-k})}{\text{var}(TOT_t - TOT_{t-1})} \right] \tau$$

Where V_k is variance ratio,
 $\tau = [T/(T-k+1)]$,

K and T represent number of lag period and observations, respectively

concluded that the temporary terms of trade shocks or booms have permanent effects on output levels and average growth rate.

The results of their model also show that temporary terms of trade shocks have persistent effects on output level & a mean-preserving spread in export price may lower output growth. Basu and McLeod (1974) examined terms of trade and growth dynamics by estimating unconstrained VARs for twelve least developing countries. Their estimation results confirmed their model prediction of the persistent effects of terms of trade shock on outputs level. Moreover, the results show that the long-run terms of trade-output elasticity are in the range of 0.1 to 0.2 with terms of trade level and variability explaining 20-50 percent of the long-term variation in the output levels in ten of the twelve least developed countries. Hence, the authors concluded that greater terms of trade volatility reduce economic growth significantly.

On the other hand, Mendoza (1995) conducted a quantitative examination on the relationship between terms of trade shocks and business cycles using a three-sector intertemporal general equilibrium model and a large multi-country data from 30 developing and industrialized countries. The results revealed that terms of trade disturbance account for around $\frac{1}{2}$ (i.e. 45-60 %) of the actual variability of GDP and real exchange rate.

Mendoza (1997) also examined a stochastic endogenous growth model in which terms of trade uncertainty affect saving and consumption growth. For him, the model can also be interpreted as a stochastic version of the one sector endogenous growth model of Rebelo (1991). In the model, the mean and variance of the terms of trade determine the savings rate and consumption growth. He noted that although most existing empirical work has been clearly identified the positive relationship between terms of trade and growth, they didn't conduct structural tests tied to the theoretical framework in which the role of terms of trade is explicitly modeled.

He also examined the empirical relevance of the model's key predictions using data from 9 industrial (G-7 plus Australia and Spain) and 31 developing countries and applying panel estimation methods. More specifically, the estimation results shows the growth rate of

consumption at import price raises by 0.2 % and that of consumption at domestic price by about 0.05 % when ever there is an increase of 1 percentage point in the rate of change of terms of trade. Where as, 1 percentage point increase in the variability of the terms of trade reduces consumption growth by slightly more than $\frac{1}{2}$ of the percentage point. The major finding of his empirical analysis, hence, supported the model's prediction that economic growth is linearly related to the rate of change of terms of trade and terms of trade variability, which has a large adverse effect on economic growth.

By measuring the relative importance of domestic versus external shocks, Hoffmaister, Raldos and Wickham (1998) analyzed the source of macroeconomic fluctuation in Sub-Saharan Africa. They applied vector autoregressive regression model to analyze the data from 23 Sub-Saharan Africa (8 from CFA franc and 15 from non-CFA franc countries) over the period of 1971-93. From the model estimation they found that trade disturbances, i.e. terms of trade shocks, account for only a small fraction of variation in output of Sub-Saharan Africa economies in general compared to supply shock. However, terms of trade shocks had a great influence on fluctuations of output in CFA franc countries; this is mainly because of the rigidity of real exchange rate in those countries. Their empirical result also identified that despite the larger terms of trade shocks, non-CFA franc countries were better able to withstand these, in part due to the greater flexibility of their exchange rate regimes.

Using a dynamic, stochastic, multi-sector, small open economy model, Kose and Reisman (1999), examined the effect of trade shocks, namely fluctuation in the prices of exported primary commodity, imported capital goods and intermediate inputs; and financial shocks on macroeconomic fluctuation of Africa economies. Unlike other economists, they used a brooder definition of trade shocks (i.e. they focused on the price changes of the main export and import items instead of terms of trade disturbance). Based on the annual data taken from twenty-two non-oil exporting Africa countries for the period of 1970-1990, the researcher found that trade shock, modeled by fluctuation in the prices of exported primary commodity, imported capital goods and intermediate inputs, have a significant role in deriving macroeconomic fluctuations in African economies. In particular, more than 44 percent of

variation in aggregate output was explained by trade shocks. They further conclude that trade shocks cause prolonged recession in these economies.

Bleaney and Greanaway (2001), on the other hand, examine the impacts of terms of trade and exchange rate volatility on investment and growth using a cross country growth equation for a panel of annual data of 14 Sub-Saharan African countries over 1980-1995. They formulated the growth equation by taking GDP growth as a dependent variable and the volatility of terms of trade and real exchange rate, the level of terms of trade & the real exchange rate misalignment in the current & the previous two periods, together with two lags of GDP & inflation as independent variables. Some other variables such as initial GDP, education level, openness & other that commonly appears in gross regression were considered as control variables. In the equation, the authors assumed those terms of trade as exogenous but current values of other macroeconomic variables are endogenous, and they are instrumented by using a one-period lag.

Their empirical results indicate that volatility in terms of trade has a negative impact on growth, which is around 48 percent of the fluctuation in growth was explained by terms of trade volatilities; and that volatility in the exchange rate has a significant negative impact on investment. They also showed that the impact on output growth of both the trend & the volatility of the terms of trade, explained by Mendoza (1997) theoretical model, can not be determined unambiguously due to the uncertainty of the risk avers factor.

Similarly, using a partial adjustment version of Harod-Dommar model for 39 Sub-Saharan African countries over the period of 1961-1999, Alemayehu and Weeks (2005) found that the variation in terms of trade has a significant impact on growth instability. They also noted that coefficient of variation in the terms of trade is the most statistically significant behavioral variable.

Recently, following the research strategy of Mendoza (1997), Blattman et al., (2003), undertook a cross country panel regression to examine the impact of secular terms of trade change & volatility on economic growth of 35 developing & industrial countries over the

period of 1870-1938. They estimated 10-years average GDP per capita growth rates on 10-years average terms of trade growth and 10-years standard deviation of terms of trade, by controlling for initial income per capita, export shares, primary product exports shares in total exports & a variety of other variables. Although they applied a cross-country regression analysis like other economists (Bleany, et al., 2001 and Mendoza, 1997), they used data for long period.

Their estimation results indicate that those less developed countries in the periphery were much more sensitive to terms of trade trends and volatility than was the true of industrial countries in the core. Over the full 1870-1938 period, Blattman et al., (2003) found that secular changes in terms of trade served to diminish GDP growth rates in the periphery (by 0.2 percentage points). Over the same period, terms of trade volatility also served to diminish growth rate (by 0.5 percentage points). But even more damaging to the primary product producers in the periphery was the high degree of volatility in terms of trade that exerted a negative impact to growth more than twice the size of negative impact of the trend (-0.501 versus -0.201). Finally, they found that terms of trade trends and volatility combined slowdown annual growth rate in the periphery by more than 0.7 percentage points.

CHAPTER III. SUB-SAHARAN AFRICA'S EXTERNAL TRADE

3.1. Over View

There is nothing in the doctrine of free trade that guarantees an equal or equitable distribution of the gains from external trade. The distribution of the gain from trade will be determined by a country's international competitiveness in terms of both its price and income dimensions.

Majority of Sub-Saharan African countries' external trade is still dependent on commodities, which are becoming increasingly unattractive in the international market (Africa Development Bank, 2003). The market for the region's traditional exports is shrinking relative to the global export market. Accordingly, the region export share to world exports has been declining from 2.53 in 1970s to 1.77 and 1.35 in the following two decades (table 3.1). This implies that as world income in general and income of the trade partners in particular grow, a smaller proportion of this income growth is devoted to the purchase of these commodities. In other words, the world's income elasticity of demand for the region's traditional exports is less than unity. In addition, the majority of Sub-Saharan African countries are dependant on the importation of manufactured goods, which have income elasticity of demand greater than unity. Thus, due to this weak trade performance, the income dimension of global competition tends to work against the Sub-Saharan African countries.

When considering the distribution of the gains from trade, the problem of many Sub-Saharan African countries is that their predominantly primary product exports have inherent tendencies for there terms of trade deterioration and volatility in relation to manufactured goods coming from the developed countries (UNCTAD, 1999). These primary commodities have not only low price; they also have a low income elasticity of demand, which means that when supply increases prices can drop dramatically, and demand growth only slowly with global growth. This, in general, implies that Sub-Saharan African countries are less benefited from current global trade due to their weak external trade performance.

3.2. The Performance and Structure of Sub-Saharan African Exports

3.2.1. The Export Performance of Sub-Saharan Africa

In the last decade (1990s) the export sector of the region has generally revealed an improvement as compared to the preceding two consecutive decades. This can particularly be observed if we look at the ratio of exports to GDP, exports to imports as well as the growth rate of export earnings. Accordingly, export as a share of GDP that registered 23.74 percent in the 1970s increased to 27.23 and 28.65 percents in the 1980s and 1990s, respectively (table 3.1). The same table also indicates that the ratio of export to import and average growth rate of export earnings show an improvement in the 1990s by 15.34 and 2.07 from the preceding decade (1980s), although they declined in the 1980s by 0.12 and 0.76 percents from the period of 1970s.

Table 3.1. The Ratio of Export to GDP (X/GDP), Export to Import (X/M) and Region's Export to World Export (X/WX), and Average Growth Rate of Exports (AGX)

	<i>X/GDP</i>	<i>X/M</i>	<i>AGX</i>	<i>X/WX</i>
<i>1970-79</i>	<i>23.74</i>	<i>78.34</i>	<i>3.16</i>	<i>2.53</i>
<i>1980-89</i>	<i>27.23</i>	<i>78.22</i>	<i>1.56</i>	<i>1.77</i>
<i>1990-2002</i>	<i>28.65</i>	<i>93.68</i>	<i>3.63</i>	<i>1.35</i>

Source: Own Computation Using Data from World Bank Development Indicators, 2004 CD-ROM

On the other hand, the contribution of the region's exports to world total exports has been declining throughout the decades under consideration from 2.53 in 1970 to 1.77 and 1.35 in the following two decades (Table 3.1). This is mainly due to majority of the countries in the region are dependent on only a handful of commodities, which have large volatile price; and also they face very high transport costs and have weak institution to facilitate trade. These

countries have also experienced a number of armed conflicts throughout the previous decades, which have major impacts on their economies (World Bank, 2005). All these factors therefore hobble trade performance of the region.

Over the past two decades developing countries, in general, have increased their share of global trade from just under one-quarter to about one third due to their movement beyond their traditional specialization in agricultural and resource exports in to manufactures trade, while Sub-Saharan Africa's export shares has becoming sluggish and very weak (World Bank, 2004). This is an indication for weak performance of the region's exports in current global market. It also indicates that the region's contribution to towards the developing countries export share is less. As table 3.2 reveals, unlike the other regions, Sub-Saharan African countries' exports share to world market has been declining from 1.2 percent in 1990 to 1 percent in 2000, this is by 0.2%. In addition, the average annual growth rate of exports is also by far lower than the rest of the regions, even lower than the average growth rate of the developing countries as a whole by 5.6 percent. From this, we can conclude that the competitiveness of the region in the international market is still weak.

According to Africa Development Bank (2003), the major factor for this weak performance in the global market is the dependency of majority of the countries' exports on commodities, which are becoming increasingly unattractive and have highly volatile relative price in the international market. On the contrary, they import manufactured good that are highly demanded. Thus, the income dimension of the global competition tends to work against these countries.

In general, although an improvement in the export performance has been observed taking the ratio of exports to GDP and export to import in to consideration, the region has still a sluggish and weak contribution in the international market share as compared to other developing countries.

Table 3.2 World Market Shares, and Growth, of Exports by Region, 1990-2000

	<i>World market share</i>		<i>Change in market share 1990-2000</i>	<i>Average growth of exports 1990-2000</i>
	<i>1990</i>	<i>2000</i>		
<i>World</i>	-	-	-	6.6
<i>Developed economics</i>	71.5	64.0	-7.5	5.5
<i>Developing economies Of which:</i>	23.9	32.0	8.1	9.1
<i>Asia</i>	16.9	24.2	7.3	9.5
<i>East and South Asia</i>	13.0	20.0	7.0	10.3
<i>Latin America</i>	4.2	5.6	1.4	10.2
<i>Sub-Saharan Africa*</i>	1.2	1.0	-0.2	4.1

Source: UNCTAD, Handbook of Statistics 2002 (CD-ROOM)

- *Excluding South Africa*

3.2.2. The Structure of Sub-Saharan Africa's Export

The structure of exports in sub-Saharan Africa countries reveals the familiar developing country case. A narrow range of primary commodities is still overwhelming export sectors. This structure has not significantly changed over time.

As indicated in Appendix 1, in many of the countries under consideration primary commodities, which had been the leading exports in the 1985, were also leading export items in the 1997. However, change in composition of exports is observed in few countries of the region, particularly from primary products to service items (like in Sierra Leone and United Republic of Tanzania). This implies that majority of Sub-Saharan African countries are still dependent on the export of primary products.

Changes in composition of export items in the region, as a whole is not satisfactory, particularly towards the manufactures trade (UNCTAD, 2002). Table 3.3 shows us the percentage of manufactures exports to merchandise exports in the region for the last three decades. From the table we can understand that Sub-Saharan Africa countries in general show certain improvement in the manufacture exports as a share of merchandise exports during the last thirty years (from 9.51 in 1970s to 13.34 and 21.09 in 1980s and 1990s), however, majority of the countries in the region have little contribution (i.e. 8.24, 9.56 and 12.84 in 1970s and the next two consecutive decades, respectively).

On the other hand, few countries of the region, namely Kenya, South Africa, Mauritius, and Senegal have larger contribution to the change for merchandise exports composition of the region (i.e. 19.14 in 1970s, and 24.88 and 44.87 in 1980s and 1990s). Hence, in terms of export diversification (changes in the composition of export items) in the region as a whole, only the few countries are dominated; the rest (majority) are still dependent on primary commodity exports. In this regard, appendix 2 reveals further information in that few primary commodities (i.e. the three leading products) accounted on average for more than 75 percentages of the merchandise exports of the countries in the region during the period of 1981-1983 and 1997-1999.

Table 3.3 Ratios of Manufactures Exports as a Percentage of Merchandise Exports

<i>Countries</i>	<i>Ratio of Manufacture export as a percentage of merchandise exports (average)</i>		
	<i>1970-1979</i>	<i>1980-1989</i>	<i>1990-2002</i>
<i>Five Sub Saharan African countries*</i>	<i>19.14</i>	<i>24.88</i>	<i>44.87</i>
<i>Other countries of the Sub-Saharan Africa region**</i>	<i>8.24</i>	<i>9.56</i>	<i>12.84</i>
<i>Over whole Sub-Saharan African countries</i>	<i>9.51</i>	<i>13.34</i>	<i>21.09</i>

Source: Own Computation Using Data from Africa Development Indicators, 2002

CD-ROM

** Kenya, South Africa, Mauritius, and Senegal*

*** Angola, Burkina Faso, Benin, Burundi, Cameroon, Cape Verde, Central Africa, Chad, Comoros, Congo Dem. Rep, Congo Rep., Cot d'Ivoire, Djibouti, Equatorial Guinea, Gabon, Gambia the, Ghana, Guinea, Guinea Bissau, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Seychelles, Sire Leon, Somalia, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.*

The structure of the region's export sector is also explained by high concentration indexes (table 3.4). The concentration indexes of certain countries of the region are almost the same in 15 years period. This implies that the countries effort to wards transformation and diversification is unsatisfactory. Apparently, this absence of diversification or high dependency on specific commodity renders the economy vulnerable to terms of trade volatility and deterioration associated with the product on which the region concentrates. Moreover, it limits opportunities for earning adequate foreign exchange and it does not foster international linkage. Hence, it brings a negative effect on the stability of the economy in general (UNCTAD, 1999).

In short, primary export sector is still a predominant sector in many of the countries in the region, however, certain improvements have been considered, regarding changes in composition of exports towards manufacture and service sectors, in few countries of the region.

Table 3.4 Export Concentration⁶ and Diversification Index by country

Country	1980			1995		
	Number of commodity exported	Diversification index	Concentration index	Number of commodity exported	Diversification index	Concentration index
Nigeria	147	0.711	0.948	109	0.906	0.897
Uganda	22	0.953	0.950	27	0.960	0.816
Gabon	46	0.732	0.763	36	0.931	0.730
Burundi	26	0.940	0.594	17	0.947	0.676
Rwanda	13	0.959	0.668	8	0.946	0.664
Mauritania	24	0.956	0.661	29	0.966	0.610
Congo	29	0.765	0.890	41	0.882	0.557
Sierra Leone	39	0.922	0.444	14	0.890	0.502
Cote D'ivoire	154	0.850	0.383	121	0.905	0.408
UK	237	0.233	0.083	236	0.220	0.069
USA	236	0.428	0.064	235	0.262	0.068

Source: UNCTAD 1996/1997

Sub-Saharan African countries are ranked according to the concentration index in 1995.

⁶ The concentration index is based on the Herfindahl-Hirschman index normalized to obtain values ranking from 0 to 1 according to the following formula:

$$H_i = \frac{\sqrt{\left(\frac{x_j}{X}\right)^2} - \sqrt{\frac{1}{239}}}{1 - \sqrt{\frac{2}{239}}}$$

Where H_i = Concentration index, x_j = Value of export of product i , $X = \sum_{i=1}^{239} x_i$

and 239 is the number of products at the three digit SITC

3.3. Terms of Trade and Their Link with Economic Growth

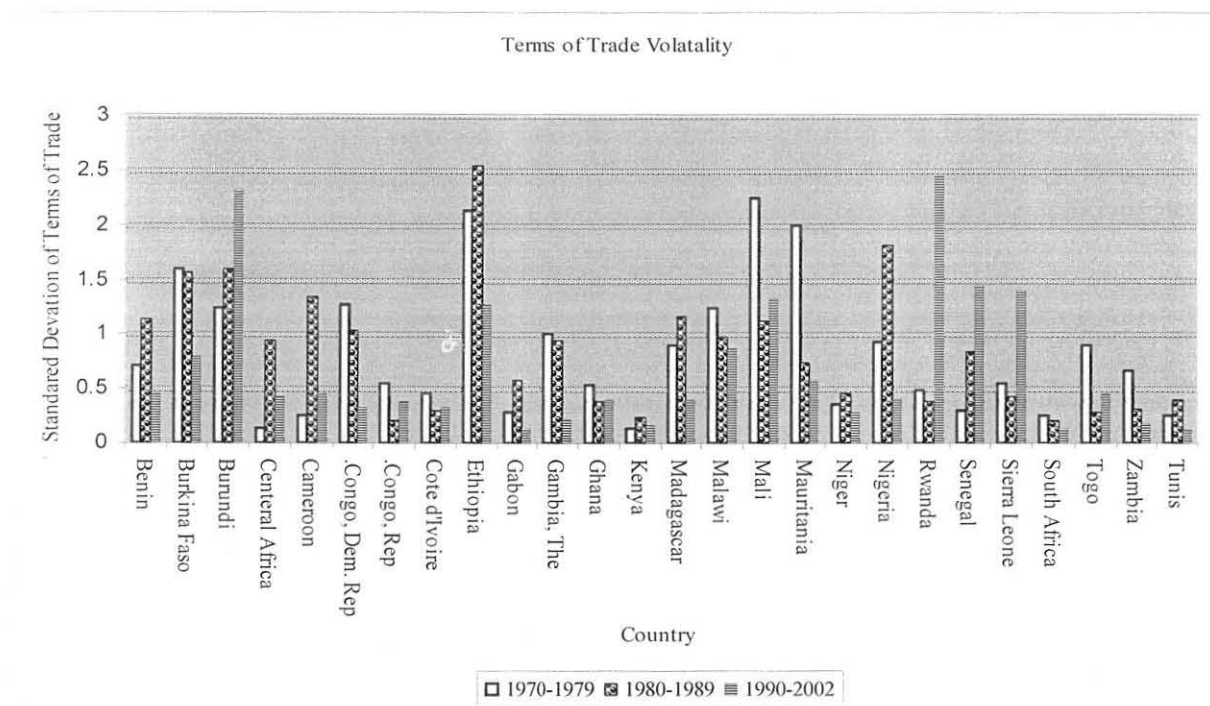
In this sub-section of the paper we concentrate on the characteristics/structure of terms of trade volatility and trends in each country of the region and across country. We will also try to see their link with economic growth.

3.3.1. Terms of Trade Volatility and Economic Growth

It has been argued that terms of trade volatility have a negative impact on economic growth (Mendoza, 1997; Bleaney et al., 2001; Blattman et al., 2003). More specifically those countries, which are heavily dependent on primary commodities as their major source of export earnings, are highly exposed to terms of trade volatility, and this in turn has detrimental effects on their long-term economic growth and investment (UNCTAD, 2002). Figure 3.1 and 3.2 explain this argument using an empirical data from a sample of Sub-Saharan African countries.

Figure 3.1, for example, depicts that the terms of trade volatility, which is measured by standard deviation of 26 Sub-Saharan African countries. From the figure we can understand that Sub-Saharan African countries have faced higher terms of trade volatility than that of the developed countries, which exports manufactured products. This is mainly due to their dependence on export of narrow range of primary commodities, in which their relative prices are highly volatile (UNCTAD, 2005).

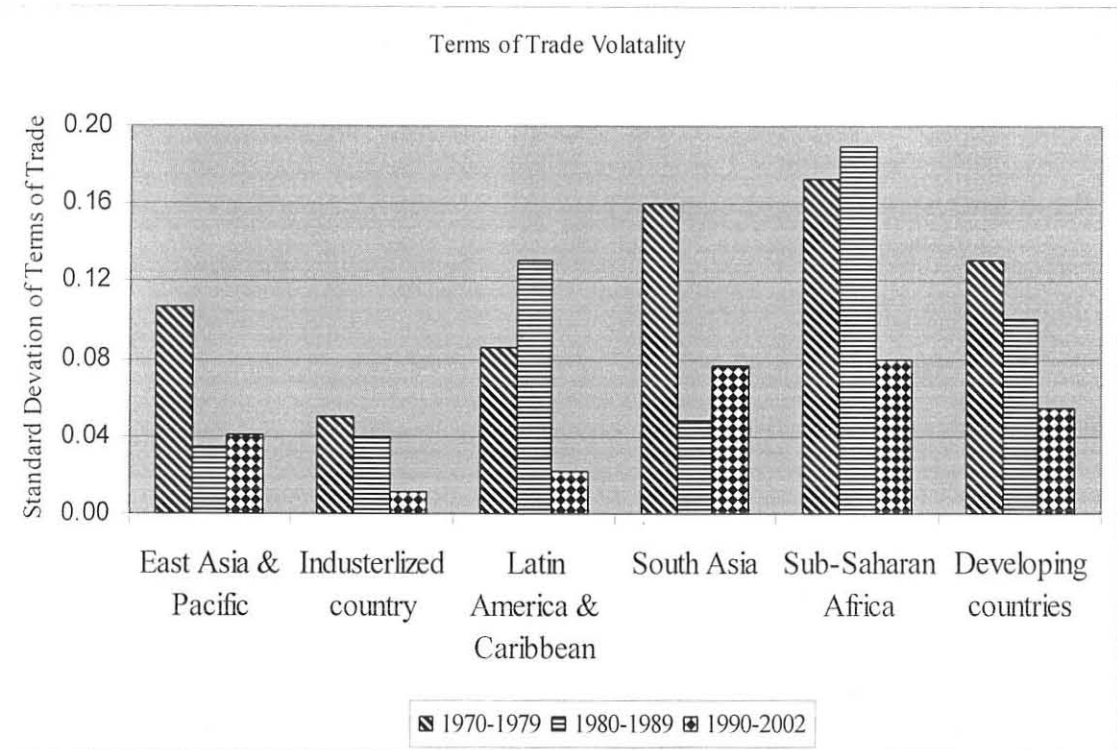
Figure 3.1 Terms of Trade Volatility by Country



Source: Own Computation Using Data from Africa Development Indicators, 2004 CD-ROM

The same fact, high terms of trade volatility, is observed when we come to the case of the region relative to other regions (figure 3.2). Among the regions under consideration sub-Saharan Africa has experienced higher terms of trade volatility than the other regions, mainly in the 1970s and 1980s. The figure also explains that terms of trade volatility are a considerable problem in developing countries than in developed ones. Unlike the developing countries, the developed countries face less terms of trade volatility since they specialize on the production and export of manufactured products. Moreover, due to high technology and level of income, the developed countries can easily control the problem of terms of trade volatility. On contrary, in developing countries due to high supply rigidity and technological backwardness, terms of trade volatility can not be easily controlled; hence they may have an adverse impact on economic growth.

Figure 3.2 Terms of Trade Volatility by Region



Source: Own Computation Using Data from Africa Development Indicators, 2004 CD-ROM

As discussed in the literature review part of this paper, several economists argued that terms of trade volatility is one of the factors, which bring an adverse impact on economic growth of a country by reducing level of investment (Mendoza 1995 and 1997; Basu and McLeod, 1997). Accordingly, the average annual growth rate of GDP of the Sub-Saharan Africa has been declining from 3.87 in 1970s to 2.24 and 1.97 in 1980s and 1990s (World Bank, 2004). Although various factors are responsible for a declining in growth rate of GDP of the region, high terms of trade volatility may have also certain contribution towards this declining rate.

3.3.2. Terms of Trade Trends and Economic Growth

In several literature, it is argued that the primary products specializing countries would exposed for deterioration in their barter terms of trade due to exporting an increasingly cheaper primary products and importing an increasingly expensive manufactures, hence face a decline in their relative income (Singer, 1950; Prebish, 1962; Kaldor, 1976). Among those countries, Sub-Saharan African countries are the most dominant exporter of primary products; in these countries, only a hand full of primary products contributes more than fifty percent of the total exports. This, may therefore, implies that these countries should face a deterioration in their barter terms of trade.

This sub-section of the paper therefore examine the above statement, i.e. the existence and magnitude of deterioration in the terms of trade, by taking data from 30 Sub-Saharan African countries, and employing a standard time series analysis (i.e. unit root test and variance ratio). To examine the deterioration in the terms of trade of each sample country and across country, this paper uses a standard Augmented Dickey Fuller (ADF) test by assuming that no structural break exist in each series. The form of the ADF test is:

$$\Delta y_t = \mu + \beta t + \gamma y_{t-1} + \sum_{i=1}^{\infty} \alpha \Delta y_{t-i} + \varepsilon_t$$

Where y_t is terms of trade and t is trend variable. However, as the unit root tests are silent as to the size and relative importance of the permanent component, we proceed to shed some light on this issue by employing the methodology proposed by Cochrane (1988) (cited in Basu and McLeod, 1992; Reinhart and Wickham, 1994). Cochrane (1988) provides a convenient nonparametric estimator of the size of the random walk trend component: $1/k$ times the variance of the k^{th} difference. Comparing this variance to that of the first difference yields the variance ratio, i.e:

$$V_k = \frac{1}{k} \left[\frac{\text{var}(y_t - y_{t-k})}{\text{var}(y_t - y_{t-1})} \right] \tau$$

Where $\tau = [T/(T-k+1)]$, K and T represent number of lag period and observations. Then Cochrane (1988) assume that this ratio approaches one for a pure random trend and zero for a trend stationery series.

Using the above methods, we estimated unit root and variance ratio (for 4, 8 and 12 years difference) by taking data from 30 Sub-Saharan African countries. The results are summarized in appendix 3. The unit root test results reveal that negative trends in terms of trade do exist in many of the sub-Saharan African countries and also on the average series of the 30 Sub-Saharan African countries. However, they are weak (i.e. the t-statistics indicates weak trends). This result is also corroborated by the variance ratio results, in that, more than half of the countries of which unit root test identified to have random trends also supported by the variance ratio results. Hence, we can conclude that terms of trade deterioration do exist in many of the sub-Saharan African countries, although their magnitudes vary across the countries.

The downward trends in terms of trade for commodities certainly remains a crucial concern for large numbers of developing countries, as it affects their capacity to imports essential goods for their development (World Bank, 2002). It is also noted in UNCTAD (2002) that negative terms of trade trends tightens the developing countries' foreign exchange constraint, which leads to reduce the level of capacity utilization and efficiency in resource use, owing to lack of key imports, as well as reduced levels of domestic investment, which in tern affects growth negatively. Hence, terms of trade deterioration, which Sub-Saharan Africa has experienced, have also a contribution towards a decline in growth rate of GDP.

CHAPTER IV. DATA, MODEL SPECIFICATION AND ESTIMATION METHOD

4.1. The Data: Type, Source and Transformation

Before directly undertaking the estimation of our model, it is important to highlight the type and sources of the data used in the current study. The paper used secondary type data on net barter terms of trade, gross domestic investment, total labor force and annual GDP growth rate for 30 Sub-Saharan African countries⁷ over the period 1970-2002. The major sources of data are CD-ROMs and publications from World Bank (Africa Development indicators, 2004 and World Development Indicators, 2004).

In the model, instead of taking the net-barter of terms of trade data directly, we took its annual growth rate and absolute deviation from its mean to measure terms of trade trends and volatility variables, respectively. Except the annual growth rate of GDP, all the other annual growth rate variables, namely: terms of trade trends, growth rate of labor forces and investments, are calculated⁸ using their raw data. The descriptions of the variables are explained in the model specification part.

4.2. Model Specification

In this study the stochastic consumption growth model of Mendoza (1997) is used. This model is chosen because it incorporates the link between terms of trade trends and economic growth in addition to terms of trade volatility and economic growth, which other models are mainly

⁷ Benin, Burkina Faso, Botswana, Burundi, Cameroon, Comoros, Congo democratic, Congo republic, Cote-d'Ivoire, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mozambican, Niger, Nigeria, Rwanda, Sera Leon, Senegal, South Africa, Swaziland, Togo, Tunisia, Zambia and Zimbabwe

⁸ The annual growth rate of each variable is calculated by applying: $\left(\frac{A_t - A_{t-1}}{A_{t-1}} \right) 100$,

Where A_t is raw data.

concentrated. Moreover, the model is suitable and more relevant to achieve our major objective: the impact of terms of trade trends and volatility on economic growth.

Mendoza analyzes the impact of terms of trade movements on consumption growth using a stochastic growth model. In the model consumers maximize expected lifetime utility as:

$$U(C_t) = E \left[\sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\gamma}}{1-\gamma} \right], \dots\dots\dots (4.1)$$

$$\gamma > 0, 0 < \beta < 1$$

Where C_t represents consumption of the imported good and, β is a subjective discount factor and α is the coefficient of relative risk aversion. Savings are invested in a perfectly durable asset that produces the export good subject to a linear technology with a stochastic gross return of R per period.

He assumes that the change in the terms of trade follows a stochastic process with known variance and mean. He then shows that planned consumption growth is an increasing function of the trend in the terms of trade (i.e. the mean of z), but is negatively related to terms of trade volatility (the variance of z) only if $\alpha < 2$ (if $\alpha > 2$, this relationship is positive).

Disregarding the stochastic element, wealth (A) – and therefore output – grows according to the following equation:

$$A_{t+1} = \beta^{1/\alpha} R^{1/\alpha} Z_t^{(1/\alpha)-1} A_t, \dots\dots\dots (4.2)$$

It is clear that output growth is positively correlated with Z as long as $\alpha < 1$. Since the purchasing power of output over the imported consumption good grows at a rate z , we have

$$C_{t+1}/C_t = Z_t (A_{t+1}/A_t), \dots\dots\dots (4.3)$$

Substituting this into (2) yields

$$C_{t+1} = \beta^{1/\alpha} R^{1/\alpha} Z_t^{1/\alpha} C_t \dots\dots\dots (4.4)$$

Rearranging equation (4) result in:

$$C_{t+1}/C_t = \beta^{1/\alpha} R^{1/\alpha} Z_t^{1/\alpha} \dots\dots\dots (4.5)$$

Hence, equation (5) presents Mendoza's result for consumption growth. On the other hand, the impact of terms of trade movements on output growth is similar to its effect on consumption growth. It follows that the sign of the relationship between output growth and both trend and volatility of the terms of trade depends on the value of α . Using this model, Mendoza (1997) and Blattman et al (2003) undertook a cross-countries regression analysis to examine the impact of terms of trade trends and volatility on growth using data from industrialized and developing countries.

The empirical analysis of this study adopts the same technique of cross-country growth regression using data from 30 Sub-Saharan African countries over the period 1970-2002. The cross-country growth regression equation is basically derived from the neo-classical production function:

$$Y_{it} = f(K_{it}, L_{it}) \dots\dots\dots (4.6)$$

Where K is capita stock measured by gross domestic investment and L is labor force measured by total labor force. This production function is converted to growth rate equation as:

$$GY_{it} = \beta_1 + \beta_2 GI_{it} + \beta_3 GL_{it} + \varepsilon_{it} \dots\dots\dots (4.7)$$

Where, GY is annual growth rate of GDP, GI is annual growth rate of investment and GL denotes annual growth rate of labor force.

However, Mendoza (1997) argued that terms of trade movements (denoted by Z) have considerable impact on output growth similar to their effect on consumption growth as indicated in equation (4.5). Hence, we include terms of trade movements (Z), which are measured by terms of trade trends (P_2) and volatility (P_3), in equation (4.7) to see their impact on growth rate in Sub-Saharan African countries. Hence, equation (4.7) takes the following form:

$$GY_{it} = \beta_1 + \beta_2 GI_{it} + \beta_3 GL_{it} + \beta_4 P_{2it} + \beta_5 P_{3it} + \beta_6 S_t + \beta_7 Z_i + \varepsilon_{it} \dots (4.8)$$

Where, P_2 is terms of trade trends measured by annual growth rate of terms of trade

P_3 is terms of trade volatility measured by absolute deviation of terms of trade series from their mean

S_t and Z_i are country and time fixed effects, which control unobserved characteristics for individual and time period.

Finally, it is expected that terms of trade trends and volatility will have an adverse impact on growth rate of GDP while growth rate of investments and labor force will have positive impact on growth rate of GDP.

4.3. Estimation Method

In this study, the cross-country growth equation, which we have derived in the previous subsection, is intended to be analyzed using a panel cointegration technique. Before we discuss this panel cointegration technique in detail, it is essential to have a general view about panel data set.

4.3.1. Panel Data Set

Conventionally, a panel, or longitudinal, data set is a one in which a given set of individual or units is repeatedly sampled at different point in time (Hsiao, 1986; Baltagi, 1995). The panel data sets hold several principal advantages for economic research over conventional cross-sectional or time-series data sets (Hsiao, 1986; Baltagi, 1995). These data sets allow for heterogeneity in individuals, firms, countries, which is absent when using aggregated time series data. They also provide the researcher a large number of data points, increasing degree of freedom and reducing the collinearity among explanatory variables, hence, improving the efficiency of econometric estimates. In addition, they also allow a researcher to analyze a number of important economic questions that can not be addressed using cross-sectional or time-series data sets.

Despite the above advantage the panel data may possess, according to Hsiao (1986), they are subjected to their own limitations. Their limitations are usually related to the design and collection of such information: not just missing data (e.g., from non-response) but also measurement errors, attrition in the panel over time and selectivity problems (including issues such as the weighting of data that is sampled on the basis of a particular stratification of the population).

To begin with panel data model discussion, let us think about the following model:

$$y_{it} = x'_{it} \beta + \varepsilon_{it}, \quad i = 1, \dots, N; t = 1, \dots, T, \dots \quad (4.9)$$

Where $i (= 1, \dots, N)$ standing for the cross section dimension and $t (= 1, \dots, N)$ denoting the time dimension. x_{it} is a $(k \times 1)$ vector of time-varying regressors assumed to be strictly exogenous. The disturbance term ε_{it} can be utilized as a two error component model (Baltagi, 1995; Hsiao, 1986) given as:

$$\varepsilon_{it} = \mu_i + \lambda_t + \nu_{it}, \dots \quad (4.10)$$

Where μ_i denotes the unobservable individual specific effect, λ_t is the unobservable time specific effects and v_{it} denoting the remainder stochastic disturbance term assumed to be independently and identically distributed over i and t with zero mean and variance, σ_v^2 (Baltagi, 1995). Hence, equation (4.9) can be rewritten as:

$$y_{it} = x'_{it}\beta + \mu_i + \lambda_t + v_{it}, \quad i = 1, \dots, N; t = 1, \dots, T, \dots \dots \dots (4.11)$$

In this study, to exploit the advantage from the recently developed econometric technique, we use a panel cointegration method of analysis instead of the traditional one (which is estimating the coefficient β directly using OLS). Under the panel cointegration analysis, three essential steps should be considered i.e. panel unit root test, panel cointegration test and estimation of parameters. These steps are discussed below.

4.3.2. Panel Unit Root Tests

Panel unit root tests are similar, but not identical, to unit root tests carried out on a single series (Harris and Solis, 2003). The primary motivation behind the development and application of the panel unit root tests, as opposed to standard univariate unit root tests, is to exploit the extra information provided by pooled cross section time series data (Konya, 2001). Larsson et al (2001) also noted that the power of the panel unit root tests increases with an increase in the number of panel groups as compared with the well-known low power of standard univariate unit root tests.

The existing literature on panel unit root tests can be classified in two groups based on the null of their tests. The first group, suggested by Levin and Lin (1992), Im, Pesaran, and Shin (1997), Maddala and Wu (1999) and Breitung (2000), takes non-stationarity as the null hypothesis against alternatives involving stationary. The other group, Handri (2000), test for the null of stationary against the alternative of unit roots in panel data (Baltagi and Kao, 2000; Konya, 2001; Harris and Solis, 2003).

Levin and Lin (LL) Test (1992)

Consider the following simple two-variable model that uses panel data:

$$y_{it} = x'_{it}\beta + z'_{it}\gamma + \varepsilon_{it}, \quad i = 1, \dots, N; t = 1, \dots, T, \dots \dots \dots (4.12)$$

The modified version of (4.12), involving only a single variable is: (Harris and Solis, 2003)

$$y_{it} = p_i y_{i,t-1} + z'_{it}\gamma + \varepsilon_{it}, \dots \dots \dots (4.13)$$

Where z_{it} is the deterministic component and ε_{it} is a stationary process. z_{it} could be zero, one, fixed effects, or fixed effect as well as time trend. The LL test Assumes that (i) ε_{it} are independently and identically distributed over i and t with zero mean and variance, δ_v^2 (i.e. $\varepsilon_{it} = IID(0, \delta_e^2)$), which ensures that there is no cointegration between pairs or groups of individual in the cross sections and (ii) $p_i = p$ for all i , which implies homogeneity (Harris and Solis, 2003; Baltagi and Kao, 2000). There are various forms of the LL (1992) test: the first (and simplest) sets $z'_{it} = 0$. In all cases, the null is $H_0: p = 1$, unit root against the alternative $H_1: p < 1$, stationary (Harris and Solis, 2003; Baltagi and Kao, 2000).

This test, however, is said to suffer from several limitations, including its assumption of homogenous panel by setting $p_i = p$ for all i , the requirement that N/T tend to be zero, and significant size distortion in the presence of correlation among contemporaneous cross sectional error terms (Baltagi and kao, 2000; Harris and Solis, 2003).

Im, Pesaran and Shin (IPS) test (1997)

The IPS (1997) test relaxes the homogeneity constraint of LL test by estimating (4.12) with heterogeneous coefficient of $y_{i,t-1}$ across the i individual series in the panel. IPS also allow

different lags for the i cross-sections in the panel, using the flowing model (Baltagi and kao, 2000; Harris and Solis, 2003)

$$\Delta y_{it} = p_i y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{i,t-L} + z'_{it} \gamma + \varepsilon_{it} \quad , \dots \dots \dots (4.14)$$

The null hypothesis is

$$H_0: p_i = 0$$

for all i and the alternative hypothesis is

$$H_1: p_i < 0$$

for at least one i . Essentially the IPS t-bar statistics is defined as the average of the ADF individual unit root test statistics that are obtained from estimating (4.14) for each i as:

$$\bar{t}_p = \frac{1}{N} \sum_{i=1}^N t_{p_i} \quad , \dots \dots \dots (4.15)$$

Where t_{p_i} is the individual t-statistics of testing $H_0: p_i = 1$. As T goes to infinity (for fixed value N) followed by N goes to infinity sequentially, IPS show that their test statistics for testing the null is standard normally distributed. They also proposed an LM-bar test based on lagrangean multiplier test than t-statistics, but essentially the issues are the same for both forms of the test (Harris and Solis, 2003)

This test also suffers from many of the same problems of LL test. Particularly, due to the assumption of each i is cross-sectionally independent, implying no short- and long-run cointegration between pairs or groups of individuals, there is also a loss of power that result from the use of a with-group estimator of the fixed effect. Finally, it is difficult to implement for unbalanced data, which can limit its application (Harris and Solis, 2003).

Madalla and Wu (MW) Test (1999)

This test is developed using the model and null hypothesis, which are similar to that of IPS. However, MW advocates the use of a Fisher type test that combines the significance level for rejecting the null (the p-value) obtained when estimating individual unit root tests (for e.g. using the ADF test) (Harris and Sollis, 2003; Konya, 2001). The statistic is calculated as:

$$p = -2 \sum_{i=1}^N \ln p_i \quad , \dots \dots \dots (4.16)$$

Where p is distributed as χ^2 with $2N$ degrees of freedom as $T_i \rightarrow \infty$ for all N , p_i are the p-values from unit root tests of cross section i . The MW test has advantages over the IPS because it does not require balanced panel, it is possible to use different lag lengths in the individual ADF regressions and it can be applied to any other unit root tests of cross-section i (Baltagi and kao, 2000; Harris and Sollis, 2003).

The disadvantage of the test is that the p-values have to be derived by Monte Carlo simulations (Baltagi and kao, 2000). In addition, this test suffers from two of the same drawbacks of the above two tests. Firstly, it assumes that the observations are generated independently across individuals so the error terms are not cross-correlated. Secondly, rejecting the null hypothesis this test suggest that there is at least one stationary series in the panel, but it doesn't indicate how many and which particular panel members are stationary (Konya, 2001).

Hadri (2000) Test

All the tests discussed formerly are based on the null of unit root, while this test is based on the null of no unit root (i.e. the time series for each i are stationary around a deterministic trend) (Baltagi and kao, 2000; Harris and Sollis, 2003). He Consider the following model:

$$y_{it} = z'_{it} \gamma + r_{it} + \epsilon_{it} \quad , \dots \dots \dots (4.17)$$

Where z_{it} is the deterministic component, r_{it} is a simple random walk and ε_{it} is a stationary process, and:

$$r_{it} = r_{i,t-1} + \mu_{it} \text{ and } \mu_{it} = IID(0, \delta_\mu^2) \text{ ,..... (4.18)}$$

By repeated backward substitution (4.17) can be rewrite as:

$$y_{it} = z'_{it} \gamma + e_{it} \text{ ,..... (4.19)}$$

Where $e_{it} = \sum_{j=1}^t u_{ij} + \varepsilon_{it}$ is the accumulated sum of each cross section i of the past residual u_{ij} . Under the null of stationarity, the variance of e_{it} , $\delta_e^2 = \frac{1}{NT} \left(\sum_{i=1}^N \sum_{t=1}^T e_{it}^2 \right)$ equal zero (Baltagi and kao, 2000). An LM test can also be computed that tests this null, which is distributed exactly under the standard normal distribution as $T \rightarrow \infty$ followed by $N \rightarrow \infty$ sequentially.

4.3.3. Testing for Cointegration in Panel

Testing for cointegration in panel data has the same beneficial effects in terms of power that are present when testing for unit root using panel data. This is because the low power of conventional tests (when $N=1$), applied to series of moderate length, can be improved upon by pooling information across the i member of a panel (Harris and Sollis, 2003).

Literatures have two strands regarding test for cointegration in panel data. One strands is tests of the null of no cointegration between variables in the panel, against the alternative of at least one cointegration relationship (Kao, 1999; Pedroni, 1995 and 1999), the other strands, by McCoskey and Kao (1998), provides estimate of the null of cointegration vector itself (Baltagi and kao, 2000; Harris and Sollis, 2003). Moreover, all tests mentioned above are developed using a single equation approach. While the other cointegration tests developed by Larsson,

Lyhagen and Lothgren (2001) used a multi-equation framework to construct a panel test for cointegration rank.

Kao (1999) test

The tests proposed by Kao are DF and ADF type tests, which are similar to the standard approach adopted in the Engle Granger two-step procedures. Kao started with the panel regression model:

$$y_{it} = x'_{it}\beta + z'_{it}\gamma + e_{it} \quad , \dots \dots \dots (4.20)$$

Where x and y are presumed to be non stationary, and:

$$\hat{e}_{it} = p\hat{e}_{i,t-1} + v_{it} \quad , \dots \dots \dots (4.21)$$

Where \hat{e}_{it} are the residuals from the estimating equation (4.20). To test the null of no cointegration (*i.e.*, $H_0: P = 1$) against the alternative that y and x are cointegrated (*i.e.*, $H_1: p < 1$), he developed four DF-type tests with Z_{it} in equation (4.20) limited the fixed effects case (*i.e.*, $Z_{it} = \alpha_i$). All four tests include non-parametric correlations for any serial correlations. Alternatively, he also proposed a test that extends (4.20) to include the lagged changes in the residuals, thus obtaining an ADF version of his test, and thus a version that parametrically tests for serial correlation as part of the estimation. All his tests are asymptotically distributed under the standard normal distribution and are one side negatively tailed tests (*i.e.*, reject the null if the test statistics is a large enough negative number). Note that all five versions of his tests impose homogeneity in that the slope coefficient β is not allowed to vary across the individual members of the panel.

Pedroni (1997) Test

Pedroni (1997) developed several tests for the null hypothesis of cointegration in panel data model that allows for heterogeneity using the following model (Baltagi and kao, 2000):

$$y_{it} = \alpha_i + \delta_i t + x'_{it} \beta + z'_{it} \gamma + e_{it} \quad , \dots \dots \dots (4.22)$$

His tests can be classified into two categories. The first set involves averaging test statistics for cointegration in the time series across cross-sections. The second set groups the statistics such that instead of averaging across statistics, the average is done in pieces so that the limiting distributions are based on limits of piecewise numerator and denominator terms (Baltagi and kao, 2000). In the current paper, only the first set of statistics is considered.

The first set of statistics, which is based on Philips Z_t statistics, is:

$$Z_{t_{PNT}} = \sum_{i=1}^N \frac{\sum_{t=1}^T (e_{it-1} \Delta e_{it} - \lambda_t)}{(\sum_{t=1}^T e_{it-1}^2)} \quad , \dots \dots \dots (4.23)$$

Where e_{it} is estimated from (4.22) and $\lambda_t = \frac{1}{2}(\delta_i^2 - s_i^2)$, for which δ_i^2 and s_i^2 are individual long-run and contemporaneous variances respectively of the residual e_{it} . As noted by Baltagi and kao (2000), Pedroni finds the following result using results on convergence of functional of Brownian motion:

$$Z_{t_{PNT}} + 1.73\sqrt{N} \Rightarrow N(0,0.93), \dots \dots \dots (4.24)$$

McCoskey and Kao (1998)

Unlike the above cointegration tests, McCoskey and Kao (1998) derived a residual-based test for the null of cointegration rather than for the null of no cointegration in panel. Allowing for varying slopes and intercepts, they considered the following model: (Baltagi and Kao, 2000; Harris and Solis, 2003).

$$y_{it} = \alpha_i + x'_{it} \beta + v_{it} \quad , \dots \dots \dots (4.25)$$

$$x_{it} = x_{i,t-1} + \varepsilon_{it} \quad , \dots \dots \dots (4.26)$$

$$V_{it} = \gamma_{i,t-1} + \mu_{it} \quad , \dots \dots \dots (4.27)$$

$$\gamma_{it} = \gamma_{i,t-1} + \theta \mu_{it} \quad , \dots \dots \dots (4.28)$$

Where μ_{it} are IID(0, δ^2_{μ}). The null hypothesis of cointegration is $H_0: \theta = 0$ against $H_a: \theta \neq 0$.

The test statistic proposed by McCoskey and Kao (1998) is defined as:

$$\overline{LM} = \frac{\frac{1}{N} \sum_{i=1}^N \frac{1}{T^2} \sum_{t=1}^T S_{it}^{+2}}{S^{+2}} \quad , \dots \dots \dots (4.29)$$

Where S_{it} is partial sum process of residuals, $S_{it}^+ = \sum_{j=1}^t \hat{e}_{ij}$ with $S^{+2} = \frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \hat{e}_{it}^2$.

McCoskey and kao (1998) advised to use fully modified (FM) estimator or Dynamic OLS (DOLS) estimator to correct for the problem of serial correlation and weak exogenous regressors in a cointegrated regression. The test of McCoskey and kao (1998) under H_0 is shown to asymptotically distribute as:

$$\sqrt{N}(\overline{LM} - \mu_v) \Rightarrow N(0, \delta_v^2) \quad , \dots \dots \dots (4.30)$$

Where μ_v and δ_v^2 can be found through Monte Carlo Simulation (Baltagi and kao, 2000).

Multiple Equation Based Tests

Unlike the other panel cointegration tests, which are based on essentially univariate extensions of panel unit root tests, Larsson, Lyhagen, and Lothgren (2001) use a multivariate framework. They developed a likelihood ratio panel test based on the average of the individual rank trace

statistics developed by Johansen (1995) (Larsson, Lyhagen, and Lothgren, 2001). They considered a VAR (k_i) model of data generating processes for each individual as:

$$y_{it} = \sum \Pi_{ik} y_{i,t-k} + v_{it}, \quad i=1, 2, \dots, N, \dots \dots \dots (4.31)$$

Where for each group i the values $y_{i,-k_i+1}, \dots, y_{i,0}$ are considered fixed and the errors v_{it} are independently and identically distributed with mean zero and variance Ω_i {i.e. $v_{it} \sim N_p(0, \Omega_i)$ }.

Then the heterogeneous error correction model is given by:

$$\Delta y_{it} = \Pi_i y_{i,t-1} + \sum_{k=1}^{k_i-1} \Gamma_{ik} \Delta y_{i,t-k} + v_{it}, \quad i=1, 2, \dots, N, \dots \dots \dots (4.32)$$

Where Π_i is of order $p \times p$. If Π_i is of reduced rank, it is possible to let $\Pi_i = \alpha_i \beta_i'$ with α_i and β_i are of order $p \times r_i$ and of full column rank. The panel cointegration rank hypothesis, i.e. all of the N groups in the panel have at most r cointegrating relationships among the p variables, is specified as:

Ho: rank (Π_i) = $r_i \leq r$ for all $i = 1, \dots, N$

Against the alternative

H1: rank (Π_i) = p for all $i = 1, \dots, N$

Larsson et al (2001) defined the LR-bar statistic as the averages of the N individual trace statistics, as:

$$\overline{LR}_{NT} \left[\frac{H(r)}{H(p)} \right] = \frac{1}{N} \sum_{i=1}^N LR_{it} \left(\frac{H(r)}{H(p)} \right), \dots \dots \dots (4.33)$$

The standardized LR-bar statistic as a basis for the panel cointegration rank test defined as:

$$\mathcal{Y}_{LR} \left\{ \frac{H(r)}{H(p)} \right\} = \frac{\sqrt{N} \left(\overline{LR}_{NT} \left\{ \frac{H(r)}{H(p)} \right\} - E(z_k) \right)}{\sqrt{\text{Var}(z_k)}}, \dots \dots \dots (4.34)$$

Where $E(z_k)$ is the mean and $\text{var}(z_k)$ is the variance of the asymptotic trace statistic tabulated in Larsson et al (2001, Table 1). Note that the test is a one sided. That is a level α test of the hypothesis $H_0: \text{rank}(\Pi_i) = r_i \leq r$ for all i , is rejected if $\mathcal{Y}_{LR} \left[\frac{H(r)}{H(p)} \right] > Z_{1-\alpha}$ (where $Z_{1-\alpha}$ is the $(1 - \alpha)$ standard normal quintile).

Since the ongoing paper has been intended to analyze using a cross-country growth regression model, which is based on a multivariate framework, we use the Larsson et al., (2001) cointegration test.

4.3.4. Estimation of the Parameters

The last step in the panel cointegration is estimation of the parameters. In this regard, literature Shows several estimation techniques: two stages ordinary least square estimation based on estimating panel vector error correction model (PVECM), general method of moments (GMM), two stage estimation using instrumental variables, fully modified OLS (FMOLS) and dynamic OLS (DOLS) (Harris and Sollis, 2003; Larsson et al., 2001; Breitung, 2002).

In this study, we used a two-stage least square estimation technique, which is based on estimating panel VECM. This is mainly due to absence of instrumental variables for variables of our model; we can not apply two-stage estimation using instrumental variables and GMM techniques that are developed based on instrumental variables. Moreover, to see both the short- and long run dynamics of the derived equation, panel VECM is the only suitable technique. Hence, this sub-section is concentrated on this model.

To estimate the panel VECM, we have to go through two stages. First, we estimate the long-run equation using OLS:

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \dots + \beta_n x_{nit} + \alpha_i S_i + \alpha_t Z_t + \varepsilon_{it} \quad \dots\dots\dots (4.35)$$

Where the parameter β_i ($i = 1, \dots, n$) indicates the coefficients of the explanatory variables in the long run dynamics, α_i and α_t are the individual and time fixed effect coefficients and β_0 is the constant term.

Once we go through the estimation of the long-run equation, in the second stage we estimate the error correction model, which incorporates the short-run coefficients and the speed of adjustment factor, by using the one period lag residual of the above regression (ERC_{it-1}) as a regressor. This regression equation, therefore, take the following form:

$$D(y_{it}) = \beta_1 D(x_{1it}) + \beta_2 D(x_{2it}) + \dots + \beta_n D(x_{nit}) + (1 - \alpha) ERC_{it-1} \quad \dots\dots\dots (4.36)$$

Where the parameter β_i ($i = 1, \dots, n$) denotes the coefficients of explanatory variables in the short-run, $(1 - \alpha)$ indicates the speed of adjustment coefficient, which theoretically expected as negative if any short term shock converges towards long-run equilibrium.

CHAPTER V. ANALYSIS OF EMPIRICAL RESULTS

5.1. Estimation Results

In this study, to analyze the panel of annual data from 30 Sub-Saharan African countries over the period of 1970-2002, we use a panel cointegration technique. Under this technique, as we mentioned in the previous chapter, it is mandatory to go through three steps: panel unit root test, panel cointegration test and estimation of parameters. The results we found after these three steps are presented below.

5.1.1. Panel Unit Root Test

Unit root test is a necessary condition prior to testing for cointegration. It has been conducted to know the order of integration of the variables used in the regression. Accordingly, we used the entire panel unit root tests mentioned in the sub-section (4.2). The results of these tests are given in Appendix 4. Since the results we found are ambiguous to identify the order of integration, we consider the results of Handri test due to the reason mentioned in sub-section (4.3.1), is that all tests, except Handri, have their own disadvantages. Hence, the results of the test reveal that all the variables, except terms of trade trends that is found to be an $I(0)$, are $I(1)$ variables.

5.1.2. Panel Cointegration Test

Once the order of integration of the variables is determined, the next step is to test for the presence of cointegration among the variables used in the model. As already discussed in the previous chapter, due to its validity for multivariate cointegration analysis and since our model is developed based on multivariate framework, we applied the Larsson, Lyhagen, and Lothgren (2001) cointegration test (see sub-section 4.3.2). The results of the test are summarized in

Appendix 5. Accordingly, the test reveals that there is at most two panel cointegrating vector among the variables in the growth model.

5.1.3. Estimation of Parameters

The last step under panel cointegration analysis following unit root and cointegration tests is estimation of the parameters with appropriate diagnostic tests. Following our discussion in Chapter four, we estimated a vector error correction model for the impact of terms of trade trends and volatility on growth rate using an ordinary least square (OLS) estimation technique. Although we have got at most two cointegrating vectors, we estimated only one equation, which is derived in the model specification part using an Engel-Granger procedure. The results of the estimations are given below.

As already discussed in the two-stage ordinary least square estimation technique, the first step is to run an OLS for estimating the coefficient of long-run dynamics. This equation has been estimated using country and time fixed effects. The major reason is that country and time fixed effects helps to control for the unobserved specific characteristics, which vary between countries and times. The result we found from the estimation can be summarized as follows:

$$GGDP_{it} = 0.560313 + 0.051043*GI_{it} + 0.917834*GL_{it} - 0.013031*P_{2it} - 0.053328*P_{3it}$$

t-value (1.2665) (10.1317) (5.7564) (-2.6717) (-2.3494)

R-squared = 0.2847 *Durbin-Watson stat* = 1.7522

Number of obs. = 917 *F-statistics* = 10.649[0000]

Wald (joint): χ^2 (4) = 175.011[0.000]

With respect to the diagnostics test in the regression, the wald test for significance of all variables are rejected implying that the variables included in the regression well explain the dependant variable. Moreover, the F-test (joint test) also reveals that the null of all variables becomes zero is statistically rejected.

Once the long-run relationships are established, the next step is to know the coefficient of short-run dynamics and speed of adjustment through OLS estimation. This is conducted by regressing the first difference of the dependent variable by the first difference of all the regressor variables and the one period lagged residual obtained from the long-run equation. The result of this estimation is summarized as follows:

$$\Delta GDP_{it} = 0.041532 * \Delta GI_{it} + 1.067096 * \Delta GL_{it} - 0.012144 * \Delta P_{2it} - 0.107402 * \Delta P_{3it}$$

t-value (11.8179) (9.3996) (-3.9199) (-4.7272)

$$- 0.905641 * RESID (-1)$$

(-27.1515)

<i>R-Squared</i>	= 0.56382	<i>Durbin-Watson stat</i>	= 1.9704
<i>Number of obs.</i>	= 886	<i>F-statistic</i>	= 284.71[0.000]
<i>Wald (joint): χ^2 (5)</i>	= 1139.37[0.000]		

The same diagnostics tests have been conducted here. The wald test for significance of all variables are rejected implying that the variables including in the regression well explain the dependant variable. Moreover, the F-test (joint test) also reveals that the null of all variables becomes zero is statistically rejected. From the individual coefficients point of view, all the variables are significant with their respective correct and expected sign. The next sub-section will explain about the individual coefficients in details.

5.2. Interpretation of Results

As indicated in the estimation results, all the explanatory variables (i.e. terms of trade volatility and trends, growth rate of investment and growth rate of labor force) are found to have a significant impact on GDP growth rate with their correct and expected sign both in the short- and long-run.

During specification of the model, it is expected that terms of trade trends and volatility have an adverse impact on growth rate. The results of the estimation also confirm this expectation. For example, according to the estimation results terms of trade volatility has a strong negative impact on the growth of GDP of the region both in the short run and long run. That is, a unit changes in terms of trade volatility (measured by the absolute deviation of terms of trade) declines growth of GDP by 0.107402 in the short-run and by 0.053328 units in the long-run.

The same is true for terms of trade trends case i.e. a unit change in the growth rate of terms of trade declines the growth of GDP of the region by 0.012144 and 0.013031 in the short- and long-run, respectively. Finally, with respect to terms of trade trends and volatility impact on growth, we found that the adverse impact of terms of trade volatility is more powerful than terms of trade trends on growth both in the short- and long-run. That is, the negative impact on growth from terms of trade volatility is eight and four times greater than from terms of trade trends in the short- and long-run, respectively. This may be due to the existence of weak deterioration in terms of trade in most of the countries under consideration as indicated in the result of the test for the magnitude of deterioration of the region's terms of trade in the previous chapter.

The results are consistent with recent research results on the issue; by William et al. (2003). They found that terms of trade trends and volatility have an adverse effect on growth, and the adverse impact of terms of trade volatility is more powerful than trends. However, they didn't consider both the short-run and long-run effects, which are taken in to account in this study. Esterly et al. (1993) also argued that fluctuations in terms of trade not only have a short-run impact but also a considerable impact on the medium-term growth performance of developing

countries. Hence, the finding of this paper regarding the impact of terms of trade trends and volatility on growth is rational.

On top of this, the estimation results for the coefficients of the control variables have got the expected signs. That is, the coefficient of both growth of investment and labor force are found positive and significant in both short- and long-run, which means a unit change in growth of investment and labor force brings an increase in growth of GDP by (0.041532, 0.051043) and (1.067096, 0.917834) units in (the short- and long-run), respectively.

Finally, the speed of adjustment coefficient, which indicates the adjustment to wards the long-run equilibrium, is found to have a negative sign as theoretically expected and statistically significant. Its magnitude reveals that economic agents adjust by about 90% to their long-run steady state whenever there is a shock in the system.

In general, we have found that terms of trade trends and volatility combined do lower annual growth rates in sub-Saharan African countries by more than 0.11 and 0.06 units in the short- and long-run, respectively. However, the adverse impact of the terms of trade volatility on growth is more powerful than the trend.

CHAPTER VI. CONCLUSION AND POLICY IMPLICATION

Deterioration in terms of trade and its volatility are certainly crucial issues for developing countries, particularly those countries relying on primary exports. In this regard, Sub-Saharan African countries are not an exception to that of developing countries. In this sphere, the current paper has tried to shed light upon the impact of terms of trade volatility and trends on economic growth. Hence, the cross country growth equation, which defines GDP growth as a function of investment and labor force growth, trends and volatility of terms of trade, has been estimated for 30 Sub-Saharan African countries over the period of 1970-2002.

The estimation procedure has been accomplished by applying recently developed panel cointegration technique, which posses three important steps. As the first steps the order of integration of individual variables has been determined employing panel unit root tests. Accordingly, the variables entering the regression are found to be integrated of order one, $I(1)$ except that of terms of trade trends, which is found to be integrated of order zero, $I(0)$. In determining the long run behavior of the variable, as second step, the Larsson, Lyhagen, and Lothgren (2001) multivariate cointegration test has been employed since it possess a unique advantage over the other tests. From this test we found the presence of at most two-cointegrating vector (relationship) among variables in the regression.

Having these unit root and cointegration tests results, as the final steps, the panel vector error correction model that includes both short- and long-run relationship, has been estimated using a two-stage ordinary least square estimation technique. The coefficients of the explanatory variables are found to be statistically significant with their correct and expected sign. The terms of trade trends and volatility are found to have significant adverse effects on GDP growth rate both in the short- and long-run; however, terms of trade volatility impact on GDP growth rate is found to be more powerful in magnitude than the effects of trends. Regarding the coefficients of investment and labor force growths, we found that both coefficients have positive sign as expected during model specification.

From this result, we can suggest that certain measures should be taken by the region to accelerate their economic growth (which is measured by GDP growth rate) and to address the adverse impacts of terms of trade volatility and trends. Although, this paper has not gone through the determinants of terms of trade volatility and trends, it was mentioned, in chapter three, that the dependency on primary sector exports that have unsatisfactory demand in the global market plays a great roll for deterioration and volatility. Hence, the possible advice to these countries, to reduce the adverse impact of terms of trade volatility and deterioration, is to move the export sector to labor-intensive manufacturing instead of primary sector exports. Such a strategy is chosen on a number of grounds.

- First, since labor force is in a more plentiful supply than natural resources, there is more scope for expanding production based on labor than on natural resources.
- Second, it is easier to upgrade to technology and capital intensives activities and to supply dynamic products from low-skill, labor intensive manufactures than from primary production.
- Third demand for manufacture products is more stable than demand for primary products.
- Fourth the manufacturing products are more market-dynamic than primary commodities: they often better prospects for expansion of volume of exports without incurring a series risk of sharply falling prices and/ or earnings because of low price elasticity of demand.

Finally, further study is advised on the determinants of terms of trade trends (deterioration) and volatility, which adversely affect the growth of the region; to tackle the problems from the root.

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Appendix 1 Leading exports of Sub-Saharan Africa Countries, 1985 and 1997

Country	Products (percentage share to total exports) 1985	Products (percentage share to total exports) 1997
Angola	Petroleum (93.4), Diamonds (6.2)	Petroleum (70.9), Diamonds (2.4)
Benin	Palm oil (16.1), Cotton (15.3), Transport (10.0), Coffee (9.5)	Cotton Yarn (36.8), Transport (14.6), Travel (5.7), Crude Petroleum (2.2)
Burkina Faso	Raw Cotton (31), basic Manufacture products (20.4), Live animals (9.3), Karite nuts (5.8)	Raw cotton (33.5), Live animal (15.1), Gold (9.6), Hides and skin (7.0)
Burundi	Coffee (75), Tea (6.5), Row cotton (0.6)	Coffee (72.9), Tea (7.3), Row cotton (1.0)
Central Africa Republic	Coffee (21.3), Diamond (17.6), Wood (13.6) Cotton (9.4)	Diamond (40.8), Coffee (12.8), Wood (12.3) Cotton (10.1)
Chad	Cotton (59.5), Travel (7.2), Transport (1.5), Livestock and meat (1.2)	Cotton (42.1), Live cattle (7.9), Travel (1.5), Business services (5.3)
Dem. Rep. Congo	Copper (34.1), Crud petroleum (16.3), Cobalt (11.1), Coffee (10.7)	Diamond (17.2), Crud petroleum (11.4), Coffee (8.8), Copper (7.9)
Equatorial Guinea	Cocoa (61.8), Timber (21.1), coffee (2.5)	Petroleum (43.3), Wood (40.6), Cocoa (5.6)
Ethiopia	Coffee (38.9), Air transport (10), Sea transport (8.6), hides and skins (6.8)	Coffee (37.3), Air transport (20.0), hides and Skins (7.8), Business service (4.9)
Gambia	Travel (54.9), Transport (17.1), Peanut Products (15.9), Fish products (0.6)	Travel (64.9), Communication (9.5), Groundnuts (8.8), Transport (7.8)
Guinea	Bauxite and Aluminum (84.2), Transport (0.2), Travel (0.2)	Bauxite and Aluminum (50.9), Gold (11.3), Coffee (7.7), Sea transport (5.3)
Guinea Bissau	Peanuts and Cashew nuts(41.6), Shrimps(14.7), Travel(8.4), Wood(2.6)	Cashew nuts (87.5), Wood (8.3), Cotton(6.4)
Lesotho	Diamond (23.2), Travel (17.7), Food and Live animal (5.7), Manufactures (4.5)	Clothing (43.0), Travel (9.4), Furniture (6.1), Foot wear (5.5)
Liberia	Iron ore (59.3), Rubber (16.4), Coffee (5.8), Logs and Timber (5.3)	Iron ore (55.1), Rubber (28), Logs and Timber (8.4), Diamond (2.1)
Madagascar	Coffee (29.1), Vanilla (13.1), Claves and Oil (12.3), Transport (11.1)	Business (12.1), Coffee (11.5), Vanilla (10.6), Shrimps (8.4)
Mali	Row cotton and products (30.9), Live animal (23.6), Travel (10.6),	Cotton products (48.5), Live animal (17.2), Gold (12.9), Travel (4.0)
Mauritania	Fish (46.9), Iron ore (46.3), Transport (2.1), Travel (1.3)	Fish (53.7), Iron ore (40.2), Travel (2.2), Business services (1.2)
Mozambique	Transport (27.6), Shrimps (26.1), Cashew nuts (11.3), Sugar (2.7)	Business Services (40.5), Shrimps (20.5), Transport (12.3), Cotton (5.4)
Niger	Uranium (71.9), Vegetables (6.0), Transport (5.1), Live animals (3.6)	Uranium (71.9), Live stock (3.6), Cow peas (4.7), Travel (2.2)
Rwanda	Coffee (64.9), Transport (10.9), Tin ore (4.8), Travel (4.2)	Coffee (45.5), Transport (11.2), Travel (11.2), Tea (5.9)
Sierra Leon	Titanium ore (17.8), Coffee (16.6), Diamonds (15.4), Bauxite (14.2)	Travel (47.3), Diamond (16.6), Transport (7.7), Business services (3.1)
Sudan	Cotton (23.9), Gum Arabic (8.0), Travel (7.6), Sheep and lambs (4.3)	Cotton (17.1), Ovine (13.3) Sesame Seeds (12.1), Gum Arabic (11.1)
Togo	Phosphate (37.5), Cocoa bean (19.2), Transport (6.9), Row cotton (6.8)	Cotton products (30.5), Phosphate (24.4), Business services (8.1), Travel (7.5)
Uganda	Coffee (29.2), Transport (1.7)	Coffee (53.6), Travel (18.2), Cotton (1.8)
United Republic of Tanzania	Coffee (29.2), Cotton (9.4), Transport (8.8), Travel (5.7)	Travel (28.3), Coffee (12.8), Cotton (10.8), Cashew Nuts (5.8)
Zambia	Copper (82.2), Transport (5.5), Cobalt (3.9),	Copper (70.6), Cobalt (11.3)

Source: Least Developed Countries Report, 2002

Appendix 2 Merchandise export concentration in Sub-Saharan African Countries, 1981-1983 and 1997-1999, and Leading Merchandise Export Items in the Late 1990s (percentage)

<i>Country</i>	<i>1981-1983</i>	<i>1997-1999</i>	<i>Leading merchandise items</i>
<i>Angola</i>	96.7	43.5	<i>Grape, furs, Skin and wool carpets</i>
<i>Benin</i>	52.9	86.1	<i>Cotton, palm oil, cashew nuts</i>
<i>Burkina Faso</i>	77.5	81.8	<i>Cotton, Sugar and meet products</i>
<i>Burundi</i>	81.4	98.0	<i>Coffee, Tea, and gold</i>
<i>Cap Verde</i>	82.2	76.0	<i>Fish, garment</i>
<i>Chad</i>	95.6	97.0	<i>Cotton, gum Arabica, and livestock</i>
<i>Comoros</i>	93.0	93.2	<i>Vanilla, beans cloves</i>
<i>Dem. Rep. Congo</i>	68.4	79.6	<i>Diamond, petroleum, Cobalt, wood and coffee</i>
<i>Equatorial Guinea</i>	84.9	93.0	<i>Oil and wood</i>
<i>Ethiopia</i>	80.2	81.1	<i>Coffee, sesame seeds and leather</i>
<i>Gambia</i>	74.4	69.1	<i>Octopi and groundnuts</i>
<i>Guinea</i>	96.9	80.1	<i>Bauxite, aluminum and diamonds</i>
<i>Guinea Bissau</i>	58.5	79.8	<i>Cashew nuts and fish products</i>
<i>Liberia</i>	84.6	92.2	<i>Diamond, rubber and timber</i>
<i>Madagascar</i>	70.7	40.5	<i>Garment, shellfish and Coffee</i>
<i>Malawi</i>	82.9	78.8	<i>Tobacco, sugar, tea and coffee</i>
<i>Mali</i>	81.6	92.9	<i>Diamonds, Cotton, livestock and gold</i>
<i>Mauritania</i>	93.3	89.7	<i>Fish product and Iron ore</i>
<i>Mozambique</i>	55.6	59.8	<i>Prawns and Cotton</i>
<i>Niger</i>	94.7	83.3	<i>Uranium and live animal</i>
<i>Rwanda</i>	91.2	84.4	<i>Tea and coffee</i>
<i>Sao Tome and Principe</i>	94.1	77.3	<i>Cocoa beans and fishery</i>
<i>Senegal</i>	52.2	49.5	<i>Fish and fertilizer</i>
<i>Sierra Leon</i>	63.2	75.3	<i>Diamond, footwear and cocoa beans</i>
<i>Somalia</i>	94.8	79.4	<i>Live animals</i>
<i>Sudan</i>	59	52.6	<i>Oil, cotton, sesame seeds and live stocks</i>
<i>United Rep of Tanzania</i>	54.9	51.3	<i>Coffee and cashew nuts</i>
<i>Togo</i>	70.8	76.5	<i>Calcium, phosphates and Cottons</i>
<i>Uganda</i>	97.5	69.6	<i>Coffee and fish</i>
<i>Zambia</i>	93.8	89.3	<i>Copper, Coffee, sugar</i>
<i>SSA*</i>	79.25	76.69	

Source: UNCTAD Secretariat estimates and ITS (2001)

*** Weighted average based on all SSA**

Appendix 3 Results for the Test of Terms of Trade Trends by Country and Average of 30 Sub-Saharan Countries

Country	ADF-Unit Root Test Result				Variance ratio		
	γ	$t(\gamma=1)$	β	t_{β}	V4	V8	V12
Benin	-0.586	-3.09	-0.032	-1.98	0.580638	0.408934	0.293648
Burkina Faso	-0.787	-3.28	-0.055	-1.61	0.377397	0.262033	0.194918
Botswana	-0.299	-1.9	0.183	2.16	0.731791	0.615789	0.620998
Burundi	-0.332	-1.86	-0.021	-0.05	0.401838	0.411245	0.360774
Cameroon	-0.609	-2.74	-0.013	-1.59	0.413148	0.2917	0.296982
Comoros	-0.265	-1.55	-0.001	-0.64	1.104733	1.35463	0.76114
Congo democratic	-0.824	-2.87	-0.013	-1.19	0.366089	0.232032	0.124121
Congo republic	-0.785	-3.86**	-0.105	-3.15	0.430827	0.368711	0.273965
Cote d'Ivoire	-0.303	-2.53	-0.007	-1.95	1.375554	1.10282	0.653426
Ethiopia	-0.969	-3.19	-5.306	-2.71	0.49394	0.198419	0.136673
Gabon	-0.438	-2.47	-0.014	-2.17	0.677888	0.584084	0.500879
Ghana	-1.197	-4.44*	0.031	2.59	0.255258	0.211156	0.127294
Kenya	-0.612	-3.09	0.002	0.66	0.724714	0.260367	0.269573
Lesotho	-0.497	-2.82	-1.296	-2.28	0.742326	0.176641	0.360658
Mali	-0.835	-4.71*	-0.109	-3.59	0.50281	0.327199	0.232394
Malawi	-0.768	-3.42***	-0.061	-1.98	0.381266	0.300994	0.25369
Mauritania	-0.377	-2.93	-0.015	-1.91	1.17558	0.659659	0.630895
Madagascar	-0.418	-2.25	-0.015	-0.85	0.746774	0.410527	0.256962
Mozambique	0.316	1.46	0.006	2.32	1.126983	0.999886	1.110362
Nigeria	-0.456	-2.9	-0.019	-0.92	0.797923	0.692839	0.582223
Niger	-0.212	-1.69	-0.006	-0.92	1.304725	1.154021	1.1593
Rwanda	-0.779	-3.19	0.507	1.46	0.407749	0.308248	0.132614
South Africa	-0.586	-3.48***	-0.001	-0.38	0.711868	0.392152	0.384168
Sierra Leone	-0.203	-1.26	-0.014	-1.12	0.937631	0.879479	0.73746
Senegal	-0.354	-2.05	-0.011	-1.5	0.532011	0.519562	0.503543
Swaziland	-0.283	-2.51	0.0001	0.28	0.896972	0.99345	0.595643
Togo	-0.497	-2.48	0.013	1.09	0.662495	0.308496	0.151436
Tunisia	-0.285	-2.29	-0.006	-1.96	1.110017	0.794436	0.941688
Zambia	-0.187	-4.22**	-0.017	-1.75	0.262566	0.192766	0.164511
Zimbabwe	-0.439	-3.65**	0.002	0.19	1.631311	0.468532	0.491807
Average (30 Sub-Saharan African countries)	-0.341	-2.16	-0.037	-1.87	0.728586	0.695637	0.616026

The null of $\gamma=1$ can be rejected at the 1% (*), 5% (**) and 10% (***) level.

t_{β} = the t-statistics for the trend variable t

Appendix 4 Panel Unit Root Test Result for Hadri (2000) Test

Variable	Status	LL H0:UR	Bt H0:UR	IPS H0:UR	ADF-F H0:UR	PP-F H0:UR	H-Zt H0:NUR	Remark
GY	Level	-18.54	-10.25	-20.26	468.34	527.3	5.26**	I(1)
	First Difference	-20.77	-12.8	-31.63	711.7	988.8	0.806	
P ₃	Level	1.153	-6.197	-5.931	175.33	159.28	12.99**	I(1)
	First Difference	-15.59	-13.08	-25.46	614.2	702.65	-1.069	
P ₂	Level	-26.34	-13.01	-25.96	606.4	742.9	1.07	I(0)
	First Difference	-21.63	-9.843	-33.85	769.03	996.62	-0.77	
GI	Level	-14.35	-12.64	-23.96	564.41	600.98	2.324*	I(1)
	First Difference	-9.094	-15.86	-31.89	757.53	979.25	1.264	
GL	Level	-2.137	1.081	-2.899	110.50	131.62	7.724**	I(1)
	First Difference	-24.97	-7.083	-26.88	606.46	598.31	1.274	

LL = Levin, Lin & Chu t^* ; Bt = Breitung t -stat; IPS = Im, Pesaran and Shin W -stat, ADF-F = ADF - Fisher Chi-square; PP-F = PP - Fisher Chi-square, H-Zt = Hadri Z -stat

- H_0 : UR represents the null hypothesis of unit root
- H_0 : NUR represents null of hypothesis of no unit root

The orders of integrations noted in remark column are chosen based on the Handri test due to the reason discussed in Chapter four.

- ** Significant at 1%; * significant at 5%
- Critical Values of the Standard Normal Test (Z -test): 1% = 2.57; 5% = 1.96

Appendix 5 Panel Cointegration Test Results Using Larsson et al (2001) Test

No.	Country	$r \leq 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r \leq 4$
1	Benin	84.86623	48.06386	17.00277	8.151951	1.212768
2	Burkina Faso	93.48246	50.36771	21.71172	8.394007	2.82459
3	Botswana	82.26225	39.82929	21.67659	12.214	5.101237
4	Burundi	88.37978	31.30262	17.92646	7.854629	0.263595
5	Cameroon	64.88147	33.61318	14.95618	1.822931	0.014514
7	Comoros	74.15861	37.78827	13.72524	5.097909	1.515938
8	Congo democratic	98.14053	36.1577	15.34467	3.732826	1.579084
9	Congo republic	69.6552	38.63328	18.29697	8.186899	0.105283
10	Cot devour	64.18215	37.31774	16.18857	5.231015	0.569854
11	Ethiopia	75.89658	34.9658	17.12907	3.964917	0.042321
12	Gabon	93.1095	39.58968	19.33675	5.426372	0.527931
13	Ghana	76.84775	44.89202	23.73737	6.218093	0.167406
14	Kenya	75.74572	38.74285	20.69109	7.370787	1.165911
15	Lesotho	104.5226	40.86295	16.58677	4.284201	0.484857
16	Mali	68.5536	36.01305	17.01202	7.005878	0.251055
17	Malawi	60.06141	40.17493	24.27596	12.3209	4.129906
18	Mauritania	97.28322	46.92492	22.97763	10.12293	0.156422
19	Madagascar	65.76987	34.25274	17.33259	6.959401	0.749035
20	Mozambique	76.59241	45.16818	18.45755	8.128557	0.166839
23	Nigeria	89.74672	40.93375	20.96304	4.966917	0.413997
24	Niger	66.66485	35.20638	16.42421	5.63346	0.59378
25	Rwanda	81.47152	39.33291	18.89231	5.352442	1.629334
26	South Africa	72.60039	44.12293	20.68233	4.328952	1.056756
30	Sierra Leon	86.54534	42.4713	20.87211	5.540207	0.121049
31	Senegal	70.1782	43.026334	22.79358	7.665907	0.685649
33	Swaziland	69.82224	43.9113	20.67714	9.505665	0.140749
34	Togo	99.51276	48.94692	23.06017	8.004149	0.033138
37	Zambia	81.43146	45.8521	24.29766	7.631	0.142755
38	Zimbabwe	72.45001	40.27791	18.36179	8.059588	1.472639
	LR-bar statistic	81.93424474	42.35462	19.77756	6.73337426	0.835414
	$K=P-r$	5	4	3	2	1
	$E(Z_k)$	44.392	27.729	14.955	6.086	1.137
	$Var(Z_k)$	71.284	45.264	24.733	10.535	2.212
	$\sqrt{var(Z_k)}$	8.443	6.728	4.973	3.246	1.487
	$\gamma_{LR} \left[\frac{H(r)}{H(5)} \right]$	27.41037414*	13.400465*	5.977924*	1.22941478	-1.25023

Critical value for the standard normal distribution, 1% = 2.57; 5% = 1.96

*Significant at 1% level, ** significance at 5 % level

P = total number of variables; r = number of rank; $E(Z_k)$ and $var(Z_k)$ are tabulated in table 1 of Larsson et al (2001) for different values of k

Declaration

I, the Undersigned, declare that this thesis is my original work, has not been presented for a degree in any other university and that all the sources of materials used for thesis have been dully acknowledged

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