

**ADDIS ABABA UNIVERSITY**  
**SCHOOL OF GRADUATE STUDIES**

**THE DETERMINANTS OF EXPORT OF PRIMARY COMMODITIES IN  
SUB-SAHARAN AFRICA: A PANEL CO-INTEGRATION APPROACH**

By  
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**Approved by the Board of Examiners:**

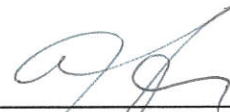
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## **LIST OF ACRONYMS**

ADF-Augmented Dickey Fuller

COMESA-Common Market for Eastern and Southern Africa

DC- Domestic Credits

DF-Dickey Fuller

DOLS- Dynamic Ordinary Least Square

ECOWAS-Economic Community Of West African States

ESA-East and Southern Africa

FDI- Foreign Direct Investment

GDP- Gross Domestic Product

FMOLS- Fully Modified Ordinary Least Square

IFS-International Financial Statistics

IID-Independently and Identically Distributed

IMF-International Monetary Fund

IPS- Im, Pesaran and Shin

ITF- International Task Force

Km-Kilo Meter

LDC-Least Developed Country

LIBOR-London Inter Bank Offer Rate

LLC-Levin, Lin and Chu

ECA- Economic Commission for Africa

OECD- Organization for Economic Cooperation and Development

OLS- Ordinary Least Square



OPEC- Organization of Petroleum Exporting Countries

PP-Phillips-Perron

REER-Real Effective Exchange Rates

SITC-Standard International Trade Classifications

SSA- Sub-Saharan Africa

UN- United Nations

UNCTAD-United Nations Conference on Trade and Development

WB- World Bank

WCA-West and Central Africa

WTO-World Trade Organization



## **ABSTRACT**

SSA is generally characterized by a heavy dependence on export of primary commodities. Export income is the largest resource inflows in the region. However, the performance of the exports of primary commodities is devastating. And this is a source of shock to the economy due to the volatility & continuous decline of the prices of their exports. Both internal and external factors are responsible for the poor performance of the sector. The study employed panel data to empirically analyze these determinants in SSA for the period 1990-2008 using a panel co-integration approach. A sample of 25, 15, 19 and 15 countries from the region were taken to analyze the determinants of exports of food, agricultural raw materials, minerals and energy (as defined under the SITC) respectively.

For the first three commodity groups the real value of export is specified in a semi-log linear form as a function of the relative export price (unit export price of a commodity per its world price), the international value of a commodity relative to its domestic value, the weighted average income of importers, real effective exchange rates, world interest rate, gross domestic investment and foreign direct investment. On the other hand, the real value of export of energy is specified in a log linear form as a function of world export price of energy relative to world prices and gross world income (with the assumption of constant supplies). The long run relationships were estimated using DOLS which accounts for serial correlations and problem of endogeneity. The results demonstrated the inelastic nature of the elasticities of exports of the three commodity groups while elastic price (relative) and income elasticities were found for energy exports. Moreover, the supply side factors and the macroeconomic policies pursued by importers are found to be among the important determinants of exports of primary commodities in SSA.

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the Study

The idea that trade can be the engine of economic growth goes back as far as Adam Smith and his theories on specialization (McCann, 2007). Theoretically, export plays an important role in economic development through different channels. For instance, according to Amin et al (2007), export helps to generate foreign exchange which could be used to import inputs for domestic production and consumption. Development of exports on comparative advantage basis leads to the exploitation of economies of scale which may result to economic growth. Specialization will also be achieved as exports expand to satisfy the increased demand (domestic plus foreign demand), thus increasing the degree of productivity and the skill level. The efficiency level of the economy also increases as resources shift from the inefficient sector to the efficient export sector. It also helps to get greater access to advanced technologies with greater efficiency gains.

In other words, as Sen (1977) noted, a rise in exports enables the existing production units in the exports sector to increase the rate of utilization of capacity or to create fresh capacity through the additional demand for such goods from the foreign market. Moreover, such a rise in export earnings enables the existing units of production in the domestic economy to create and utilize capacity by making it possible for them to make the necessary complementary imports from abroad. However, as McCann (2007) argued trade is not an end in itself. It is not simply the case that a country can easily increase its exports *per se* and

be sure of experiencing economic growth; rather it is the composition and the concentration of these exports that counts.

Export income seems to be almost the largest resource inflows in African countries. However, the performance of the sector is too poor. Since 1970, Africa's share in World export trade has declined. Africa's exports share falls from 3.5% in 1970 to less than 2% in 2006 (Kahn, 2006). The continent has failed to industrialize and improve its agriculture as it tries to compete in the world economy by continuously exporting only raw materials and primary commodities. African exports are characterized by commodity markets that are highly concentrated on one or two products and a high degree of dependence on one export market such as former colonial countries or the European Economic Community. Furthermore, the commodities produced like Cocoa, coffee, rubber, and crude petroleum have very little local demand and not locally processed and as such they are exported with little or no value added (Elu, 2000).

African countries depend on two to three main primary commodity exports for the bulk of their foreign exchange earnings, and they have had to contend with the problem of short-term instability of primary commodity prices, which is greater than that of prices for non-primary tradable commodities. Of the 70 major exports by developing countries, 20 are primary commodities and very lightly processed metals. Developing countries supply more than half for only 7 commodities: almost all rubber, more than 70% of coffee, crude oil, and non-soft vegetable oils, and more than 50% of shellfish, preserved fish, and cotton. They supply about half of sugar and honey and more than a third of frozen fish, fruits and nuts, animal feeds, base metals, refined oil, and gas (UNCTAD, 1999).



The economies of Sub-Saharan African countries are highly dependent on the export of primary commodities whose demand and supply are affected by different factors. According to Iyoha (2005), the high susceptibility of most African economies to trade and current account deficits arise from the extreme volatility of primary commodity prices, high dependence on the exportation of a limited range of primary commodities, high external trade dependence, low world share, declining terms of trade and excessive export earnings variability and falling export revenues. This study tried to address the factors that constrained the performance of the export of primary commodities in Sub-Saharan African countries.

## **1.2 Statement of the Problem**

In many developing countries, particularly in African countries, which have limited access to international financial markets, exports play an important role in their growth process. It helps to generate the scarce foreign exchange necessary to finance imports of energy and investment goods, both of which are crucial for their capital formation. As Iyohha (2005) noted, exports account for almost one-third of the GDP in Africa while imports account for a slightly higher proportion. Therefore, a typical African country exhibits a high degree of "trade openness" which renders it unduly susceptible to external shocks. The adverse effect of the shocks on Africa is aggravated by the continent's low market share of world trade. Indeed, the share of Africa in the world export trade is less than 2%. There is thus an unfortunate asymmetry. Because of its low market share, Africa has little or no influence on

international trade yet because of its openness, it is highly susceptible to internationally transmitted shocks.

It is estimated that primary commodities consist of over 40 percent of the world trade. The market for primary commodities is markedly dichotomized. Small, poor and highly indebted countries, mainly from Sub-Sahara African region, dominate the supply side of the market while rich industrialized countries in Europe and North America dominate the demand side (Swaray, 2000). Sub-Saharan Africa is generally characterized by a heavy dependence on primary commodities. According to a study by the United Nations Economic Commission in 2007, the ratio of primary commodity exports to total merchandise exports in the region in the periods 1975-1979 and 2000-2004 was 76.7 and 64.9 percent, respectively. Therefore, Africa's heavy dependence on the export of primary commodities is another source of shock to the economy due to the volatility and continuous decline of the price of export of primary commodities.

More than for any other developing region, Africa's heavy dependence on primary commodities as a source of export earnings has meant that the continent remains vulnerable to market vagaries and weather conditions. Price volatility, arising mainly from supply shocks and the secular decline in real commodity prices, and the attendant terms-of-trade losses have exacted heavy costs in terms of incomes, indebtedness, investment, poverty and development in the region (UNCTAD, 2003). As studies showed, despite being the backbone of the economy of Sub-Saharan African countries, the performance of the exports of primary commodities is too poor. Both internal and external factors are responsible for the poor

performance of the sector in the region. In this study, such factors are analyzed by disaggregating the export of primary commodities into four groups.

The number of studies that analyzed the determinants of export of primary commodities in Sub-Saharan Africa is limited. Such studies analyzed only the demand side or the supply side determinants and even the results of those studies that analyzed both side determinants are susceptible to the non stationarity of the data they employed. Moreover, most of the studies failed to connect the export sector with the macro economy. However, the studies of Bond (1987), Alemayehu (1999, 2002) and Ibrahim (2007) can be mentioned as related studies. The study by Bond was on the performance of the export of primary commodities for five groups of commodities (food, beverages and tobacco, agricultural raw materials, minerals and energy) in four regions of developing countries (Africa, Asia, the Middle East, Europe and the Western Hemisphere). However, due to the dynamic nature of economic system in general and the export sector in particular, Bond's study can not show the current performance of the sector in the region. Moreover, the results of Bond's are also susceptible to the non-stationarity of the data that she employed. Therefore, it requires an updated study to show the existing performance.

On the other hand, the study of Ibrahim aimed at analyzing the determinants of export of primary commodities in Sub-Saharan African countries. However, Ibrahim's study did not analyze the determinants of exports of energy and minerals which are essential commodities on which the economy of many countries of the region depend. Moreover, the reliability of his results also depends on the nature of stationarity of the variables employed. The study of Alemayehu (1999) analyzed the determinants of the supply of exports of primary



commodities while the demand side determinants are equally important. Having such studies, this study analyzed both the supply and demand side determinants of export of primary commodities in Sub-Saharan Africa simultaneously by employing panel data (which will be checked for stationarity). Therefore, this study helps to assess the existing performance of the export of primary commodities in the region and to find out the factors determining it.

### **1.3 Objective of the Study**

The general objective of the study is to assess the determinants of the export of primary commodities in Sub-Sahara African countries by employing a panel data. The specific objectives of the study are:

- I. To determine the long run price and income elasticities of export of primary commodities (for the different groups of commodities),
- II. To find out the demand and supply side determinants of export of primary commodities (both internal and external factors) with their respective reasonable magnitude of importance for the different groups of commodities,
- III. To examine the impact of macroeconomic policies pursued by the importers and exporters of the commodities,
- IV. To look at the impact of financial markets on exports of primary commodities, and
- V. To suggest policy directions based on the findings of the study.

## **1.4 Data and Methodology**

### **1.4.1 Data Source**

In order to achieve the stated objectives, the study used secondary data. These data were collected from IMF CD-ROMs, WB CD-ROMs, UNCTAD CD-ROMs, UNCOMTRADE trade statistics and from the different publications of IMF, WB, UN, OECD and other international institutions. Thus, the data were compiled from these sources depending on the variable of interest for the sample countries.

### **1.4.2 Model Specification**

In modeling the demand for and supply of export of primary commodities, most studies followed the work of Goldstein and Khan (1978). This study also adopted Goldstein and Kahn's (1978), Bond's (1987) and Alemayehu's (2002) models by augmenting some of the components in order to analyze the exports of primary commodities in Sub-Saharan Africa. For detail description of the model refer chapter three of section 3.3.

### **1.4.3 Method of Data Analysis**

In order to achieve the stated objectives of the study, the collected data were analyzed using non-stationary panel data analysis. Since almost all the variables were found to be non-stationary at level, the study used a panel cointegration approach. After checking the existence a co-integrating relationship among the variables, the long run relation is estimated using Dynamic Ordinary Least Square (DOLS), which helps to correct for simultaneity bias and potential endogeneity of the explanatory variables. For more discussions on the technique of estimation, refer chapter three of sub section 3.4.

### **1.5 Significance of the Study**

The number of studies that analyzed the performance of export of primary commodities in Sub-Saharan Africa (particularly studies that used non stationary panel data) is limited. Therefore, this study provides current and updated information on the performance of the sector. Since the major objective of this study is to analyze the determinants of export of primary commodities which are the main exportable items of the region, it provides veritable tools for trade policy analysis. The findings of the study can also be used for prediction and policy simulation purposes. Moreover, this study will be a benchmark for further studies.

### **1.6 Limitation and Scope of the Study**

Like any other empirical studies, this study is not free from weaknesses. Though a data analysis in a panel setting enables to get more information from a group of units over many years (which is the advantage over cross sectional and time series studies), the inclusion of different units in a group will have impact on the quality of the results. This is because, the cross sectional units in that group exhibit different characteristics. In the case of this study, the sample countries are different in their macroeconomic policies, level of participations in economic integrations and monetary unions, etc. However, since the common characteristics of the economies of Sub-Saharan African countries (particularly their heavy dependence on export of primary commodities) outweigh their differences, the quality of this study will not be affected. Moreover, the sample countries, included for the analysis of a certain commodity group, are those countries that largely depend on the export of a commodity for their bulk of foreign exchange earnings.

The other problem faced in this study, like any other studies conducted in Sub-Saharan Africa, is data related. The availability of data is limited in terms of countries, time and field of interest (i.e. variable of interest). As a result, the period covered and the sample countries for each commodity group in this study are determined by the availability of data. The scope of the study is also determined by the availability of data. It analyzed the economic determinants of exports of minerals, agricultural raw materials, food and energy commodities (defined under the Standard International Trade Classifications (SITC) of revision 3) in Sub-Saharan Africa over the period 1990-2008.

## **1.7 Hypotheses of the Study**

The hypotheses of the study are:

- I. The long run price and income elasticities of export of primary commodities of Sub-Saharan Africa will be inelastic (for each commodity group),
- II. The supply side factors of export of primary commodities in Sub-Saharan Africa will be equally important with that of the demand side factors in affecting export of primary commodities in the region, and
- III. The world interest rate will be a significant determinant of export of primary commodities of Sub-Saharan Africa.



## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Theoretical Review**

##### **2.1.1 The Historical origin of Sub-Saharan Africa's Dependence on Primary Commodities**

African interactions with the rest of the world, and especially Europe, date back many centuries, before culminating in fully-fledged colonization in the late of the nineteenth century. However, it is during the colonial period that Africa's economic structure in general and its trade pattern in particular was established (Amin, 1972; Alemayehu, 2009). The internal trade of the continent was characterized by regional complementarities, with a broad natural resource base. A dense and integrated network was set in place which was dominated by African traders. They traded in salt, West African spices, perfumes, resins and kola nuts (Amin, 1972; Hopkins, 1973; Alemayehu, 2009).

In pre-colonial times, the major commodities traded among West Africans were salt, iron, gold, kola, malaguetta pepper and cotton textiles. Of these, Kola and malaguetta pepper were important, not only in West Africa, but also in the trans-Saharan trade. This trade was so extensive that Europeans were able to obtain malaguetta pepper at inflated prices from Maghreb's middlemen from at least the fourteenth century onwards (Brooks, 1993; Alemayehu, 2009). Moreover, in this period, Europeans were able to purchase cloth from Morocco, Mauritania, Senegal, Gambia, Ivory Coast, Benin, Yoruba land and Loango for resale elsewhere (Hopkins, 1973; Alemayehu, 2009). The quality of many of these processed goods was quite comparable with products originating from other parts of the world. For example, the level of manufacturing of textiles in pre-colonial West Africa was so



sophisticated that these textiles were not only traded in West, North and Central Africa but also in the European market (ibid). Moreover, none of the goods brought by Europeans satisfied any of the basic or unfulfilled needs of African societies. Indeed, similar commodities and/or substitutes were obtainable through West African commercial networks. Specifically, African artisans of the time manufactured high quality iron, cotton, textiles, beers, wines and liquors (Alemayehu, 2009). However, this autonomy in traditional industries was undermined by subsequent events (Konczacki, 1990).

East and Southern Africa were characterized by a well-established economic interaction with Arabian and Asian countries, long before the arrival of the Europeans. This part of Africa supplied a range of products, such as gold, copper, grain, millet, and coconut to the Middle East and Indian Ocean economies. As Alemayehu (2009) argued, there is a long history of integrated and autonomous economic activity in most regions of Africa with local and long distance trade playing a linking role. This is not an attempt to paint a ‘golden past’ for Africa. Rather, it is meant to underline the fact that Africa had a healthy and fairly independent economic system, before colonialism intervened to force a structural interaction with Europe.

The period of the industrial revolution (the 16<sup>th</sup> and 17<sup>th</sup> centuries) witnessed the beginning of the shaping of the African economy by European demand. A clear example is the pressing demand for gold coins in Europe, and the subsequent search for gold in West and Central Africa (WCA). Indeed, demand for labor, required in the American gold search, was instrumental in the formation of the European slave trade. Thus, the shaping of the African economy by Europe began, even before the onset of the formal colonial period (ibid).

With the onset of the industrial revolution in Europe, Africa lost its remaining autonomy and was reduced to being a supplier of slave labor for the plantations of America (Amin, 1972; Alemayehu, 2009). According to Wallerstein (1976), this era also witnessed a widespread expansion of European control. This expansion was undertaken with the dual aims of incorporating new areas under primary crop production, using African land and labor (which were priced below world market prices) and increasing the level of production of the existing primary commodities. On the import side, cheaper and purer iron bars, and implements such as knives and hoes were made available, displacing some of the previous economic activities undertaken by local blacksmiths. This had knock-on effects in terms of a reduction in levels of Iron smelting and even a decline in the mining of iron-ore.

The growing demand for raw materials, the search for a market for finished products of Europe, inter-European competition, and a number of other factors caused colonialism. During that period, one of the main phenomena, which strengthened primary commodity exports from European colonies in Africa, was the so-called 'imperial self sufficiency' scheme. The British, French and Belgian textile industries sought to obtain cotton from Africa, and invested accordingly in their respective colonies. A similar scheme was also developed for tobacco. This was administered both by colonial governments and by some European based companies and resulted in an expansion in colonial trade (Munro, 1976; Alemayehu, 2009). With the onset of colonialism, the centre of African trade shifted from the hinterland to the coast, and the composition of this trade also changed in response to the demands of the increasing external orientation of the economy (Amin, 1972; Alemayehu, 2009). For example, expansion in the production of palm products and groundnuts in Africa was directly linked with

increased demand for inputs required in soap and candle factories, lubricants (particularly for the railways) and European economic growth in general (Hopkins, 1973; Alemayehu, 2009).

The second factor that contributes for African dependence on the export of primary commodities was the two World Wars. Although trade was disrupted during the First World War, African colonies were forced to supply commodities to finance the war. The end of the war was followed by a surge in major commodity prices and hence high export earnings for the African colonies (Munro, 1976; Alemayehu, 2009). The Second World War also resulted in an increased demand for primary commodities, especially for those with military strategic importance such as vegetable oils, metals and industrial diamonds. This reinforced the commodity producing and exporting role of the European colonies in Africa. Moreover, the post-war reconstruction of Europe, the rising levels of European incomes and removal of restrictions on consumer demand and commodity stockpiling, engendered by the outbreak of the Korean War in 1950, resulted in increase of prices of exports (ibid). Generally, when war erupted (expected to erupt) in the colonizing countries, commodity production and exports by African colonies was boosted by non-price mechanisms. The end of the war was also followed by a commodity price boom and associated increase in the level of the commodity exported through the operation of the price mechanism. As a result, the specialization of European colonies in Africa as producers and exporters of primary commodities became firmly established.

The third factor that strengthens African dependence on export of primary commodities was the flow of loans and grants from European countries to the African colonies. These funds were spent on public infrastructure development such as railways and roads to link ports to



export production sites, and, to a lesser extent, on schools and health facilities. This was undertaken with the aim of developing the primary commodity exporting capacity of the colonies (UN, 1954; Alemayehu, 2009). The financial difficulties experienced by colonies forced them to vigorously follow a policy of producing export commodities, at the expense of other alternatives (Munro, 1976; Austen, 1987; Alemayehu, 2009). Peasant cropping, with its attractive minimum cost for colonial governors, was chosen as a convenient vehicle to address this problem. This, the so called the ‘peasant path’ to financial solvency, became a universal phenomenon throughout the colonies, and especially in the present day WCA. It was attained by forced involvement of ordinary peasants in the primary commodity export sector (Munro, 1976, Alemayehu, 2009). A similar emphasis to the ‘peasant path’ was also followed in the British colonies of East Africa (*Ibid*).

### **2.1.2 Theoretical Specification of the Export Functions**

Although an appropriate answer to the question how trade equations should be specified depends on a number of factors, among which, according to Goldstein and Khan (1985), the most important include the type of the good being traded, its final use, institutional framework under which trade takes place, purpose of modeling exercise as well as availability of data, theory suggests two basic models: model of imperfect and model of perfect substitutes. Fundamental assumption underlying the imperfect substitutes model is that neither imports, nor exports can be considered perfect substitutes for the domestic products. Perfect substitutes model, on the other side, assumes perfect substitutability between domestic and foreign goods and is typically used in the case of highly disaggregate data set. Since under the key assumption of the perfect substitutes model each country would be only an exporter or an

importer of a traded good but not both, which is not observed in the real world, this model has attracted much less attention in the empirical studies than the imperfect substitutes model. The two models are usually perceived as competitors, but Goldstein and Khan (1985) suggest their possible coexistence: one should be applied in the case of aggregate and the other in the case of highly disaggregated data (Goldstein and Kahn, 1985; Mervar, n.d.).

Another important concept refers to the demand-supply relationships in the export and import equations. In this regard, theory suggests that the systems of export/import demand and supply equations should be simultaneously solved, in order to emphasize the simultaneous relation between quantities and prices and to avoid possible biased results. However, most of the empirical studies have been concentrated on the estimation of single export and import demand equations, while the supply relationships have been handled by the assumption of infinite price elasticity. Infinite price elasticity may be justified in the case of import supply, but in the case of a small open economy it is quite hard to believe that infinite price elasticity of export supply holds. Namely, if the world demand for the goods from a certain small open economy increases, this country will most probably be unable to meet the demand without the change in price of exports (unless there exist large idle resources). The important advantage of such assumption is, however, that it allows the estimation of the export and import demand equations by single-equation methods in which the price variables are exogenous (ibid). However, this study applied a simultaneous approach (solving demand and supply simultaneously) to find out the coefficients of the export equations.

The limitations of single equation export models (simultaneity bias and problem of endogeneity) forced the development of simultaneous equation export models. Accordingly,



Goldstein and Kahn (1978) developed two models (the equilibrium and disequilibrium models) to analyze the demand for and supply of exports simultaneously. The two models are discussed in detail in the following sections.

### 2.1.2.1 The Equilibrium Model

According to this model there are no lags in the system so that the adjustment of export quantities and prices to their respective equilibrium values is instantaneous. The world demand for an individual country's exports is specified in log-linear form as follows:

$$\ln X_t^d = a_0 + a_1 \ln \left( \frac{PX_t}{PXW_t} \right) + a_2 \ln YW_t \dots\dots\dots(2.1)$$

Where:  $X^d$  = quantity of exports demanded, PX= price of exports, PXW= weighted average of the export prices of the country's trading partners and YW = weighted average of the real incomes of the country's trading partners. Since equation (2.1) is specified in logarithms,  $a_1$  and  $a_2$  are the (relative) price and real income elasticities (of export demand), respectively. It is expected that  $a_1$  will be negative and  $a_2$  positive.

The supply of exports is specified as a log-linear function of the relative price of exports (i.e., the ratio of export prices to domestic prices) and of an index of the productive capacity of the country:

$$\ln X_t^s = \beta_0 + \beta_1 \ln \left( \frac{PX_t}{P_t} \right) + \beta_2 \bar{Y}_t \dots\dots\dots(2.2)$$

Where,  $X^s$  = quantity of exports supplied, PX= price of exports, P = domestic price index and  $\bar{Y}$  = logarithm of an index of domestic capacity.  $\beta_1$  and  $\beta_2$  are expected to be positive in the

results since a rise in the price of exports relative to domestic prices, production for export becomes more profitable and, hence, exporters will supply more. In addition, exports are posited to rise, *ceteris paribus*, when there is an increase in the country's capacity to produce. Equation (2.2) can be normalized for the price of exports as:

$$\ln PX_t = b_0 + b_1 \ln X_t^s + b_2 \bar{Y}_t + b_3 \ln P_t \dots\dots\dots(2.3)$$

$$\text{Where, } b_0 = -\frac{\beta_0}{\beta_1}; b_1 = \frac{1}{\beta_1}; b_2 = -\frac{\beta_2}{\beta_1}; \text{and } b_3 = \frac{\beta_1}{\beta_2} \text{ and } b_1 > 0, b_2 < 0 \text{ and } b_3 > 0. \dots\dots\dots(2.3a)$$

Equations (2.1) and (2.3) constitute the equilibrium model, and estimates of the structural parameters can be obtained by estimating these two equations simultaneously.

### 2.1.2.2 The Disequilibrium Model

In this model the assumption of instantaneous adjustment to equilibrium is relaxed and admits the possibility that adjustment of actual to equilibrium values may take place with some delay. Therefore, in the disequilibrium model, excess demand and supply are allowed to emerge and to affect the prices and quantities of exports. According to Goldstein and Kahn (1978), exports are assumed to adjust to the difference between demand for exports in period *t* and the actual flow in the previous period:

$$\Delta \ln X_t = \gamma \left[ \ln X_t^d - \ln X_{t-1} \right] \dots\dots\dots(2.4)$$

Where  $\gamma$  is the coefficient of adjustment (assumed positive) and  $\Delta$  is a first-difference operator,  $\Delta \ln X_t = \left[ \ln X_t^d - \ln X_{t-1} \right]$ . The adjustment function (2.4) assumes that the quantity of exports adjusts to conditions of excess demand in the rest of the world, and therefore, the price of

exports is determined in the exporting country. By substituting equation (2.1) into (2.4) the estimating equation for exports can be specified as:

$$\ln X_t = c_0 + c_1 \ln \left( \frac{PX_t}{PXW_t} \right) + c_2 \ln YW_t + c_3 \ln X_{t-1} \dots \dots \dots (2.5)$$

$$\text{Where, } c_0 = \gamma a_0, c_1 = \gamma a_1, c_2 = \gamma a_2 \text{ and } c_3 = 1 - \gamma \dots \dots \dots (2.5a)$$

Since the quantity of exports is specified as adjusting to excess demand, the price of exports adjusts to conditions of excess supply:

$$\Delta \ln PX_t = \lambda$$

$$\left[ \ln X_t - \ln X^s_{t-1} \right] \lambda > 0 \dots \dots \dots (2.6)$$

Where  $\lambda$  is the coefficient of adjustment. In this framework an increase in excess supply will lower the price of exports, and conversely for a decrease. Substituting equation (2.2) into (2.6) and solving for  $\ln PX_t$ , we obtain:

$$\ln PX_t = d_0 + d_1 \ln X_t + d_2 \ln P_t + d_3 \bar{Y}_t + d_4 PX_{t-1} \dots \dots \dots (2.7) \text{ W}$$

$$\text{here } d_0 = \frac{-\lambda\beta_0}{1+\lambda\beta_1}, d_1 = \frac{\lambda}{1+\lambda\beta_1}, d_2 = \frac{\lambda\beta_1}{1+\lambda\beta_1}, d_3 = \frac{-\lambda\beta_2}{1+\lambda\beta_1} \text{ and } d_4 = \frac{1}{1+\lambda\beta_1} \dots \dots \dots (2.7a)$$

Since  $\beta_1 > 0$ ,  $\beta_2 > 0$  and  $\lambda > 0$ , we expect that  $d_1 > 0, d_2 > 0, d_3 < 0$  and  $d_4 > 0$ . Equations (2.5) and (2.7) constitute the disequilibrium model, and estimates of the structural parameters can be obtained by estimating these two equations simultaneously.

### 2.1.3 Determinants of the Demand for and supply of Export of Primary Commodities

The structure of African exports is characterized by dependence on primary commodities, which makes them vulnerable to global economic shocks. Such commodities are also

characterized by low income elasticity of demand, volatility, and a secular decline in prices. They also generally represent sectors where the scope for technical progress is limited (Prebisch, 1950; Singer, 1950; Alemayehu, 2002, 2006). For many African countries, more than 50 percent of export earnings derive from only three principal primary commodities. For most small mineral exporting countries this figure increases to over 80 percent. SSA as a whole depends on three major commodities for about 70 percent of its total export receipts. Only 8 out of 43 countries (Djibouti, Gambia, Lesotho, Liberia, Mauritius, Sierra Leon, Sudan, and Swaziland) have a relatively diversified export structure. Such a narrow export base combined with weak domestic capacity results in an export supply response less than that of import demand response (UNCTAD, 2004; Alemayehu, 2006).

In addition, African countries are also highly dependent on a few developed countries as destinations for their exports. For the period 1955-2002, these developed countries received on average, 80 per cent of Africa's exports. This trend, however, has been declining over the last four decades. Europe stands out as the dominant trading partner, with an average share of about 60 percent (Alemayehu, 2002, 2006).

Determinants of export performance can be split into internal and external components. External factors are related to market access conditions and other factors affecting import demand. Apart from trade barriers and competition factors, foreign market access is also determined by transportation costs, which include geography and physical infrastructures. Internal factors refer to supply-side conditions. Supply capacity is affected by location-related elements, which may for example, affect access to raw materials and other resources. It also depends upon factor costs such as labor and capital. Beside resource endowment, factor costs



are essentially the outcome of economic policy and the institutional environment. Access to technology is also an important determinant since it affects the productivity of the external sector (Fugazza, 2004). The following section tries to discuss the different factors that determine the demand for and supply of export of primary commodities.

#### **2.1.3.1 Determinants of Demand for Exports of primary Commodities**

Although activity in the industrial countries is by far the most important determinant of demand for developing country exports, commodity composition, commodity prices, geographical location, and industrial country policies also play a significant role. In the first place, for the developing countries much success or lack of success in exporting can depend on the types of commodities exported and how world demand for each commodity group moves over time. In the second place, the growth of exports can depend in part on the location of the exporter. For example, most of the markets for Africa's commodity exports are in the European Commission because of Africa's proximity to Europe. With European agriculture expanding in the last decade, Africa's exports to this region declined. By comparison, most of the markets for Asian exports have been rapidly growing. Trade in rice between developing countries of South and East Asia has been growing rapidly, as have Japan's imports from the Asian countries. Moreover, trade and agricultural policies of industrial countries influence the performance of export in developing countries. Agriculture in some industrial countries is becoming heavily protected and subsidized. Therefore, in certain products developing countries have been prevented from expanding into traditional industrial country markets (Bond, 1987).

Export demand equation should, according to the theoretical concepts, be specified as a function in which the quantity demanded is explained by the income level of potential importing regions, exported good's own price and price of imperfect substitutes on the importing market. Some other, for a particular country specific, but in general less significant explanatory variables such as dummy variables for unusual occurrences, seasonal variables, lagged variables aimed to capture responses in time, foreign exchange reserves, credits and other variables that take into account special circumstances, might be incorporated as independent variables as well (Mervar, n.d.)

### **2.1.3.2 Determinants of Supply of Exports of Primary Commodities**

Supply-side constraints are receiving increasing attention as a constraint on lifting the trade performance of many developing countries. The factors that determine the supply of primary commodity exports include cost and accessibility of consumer goods, farm subsidies and taxes, research and extension, infrastructure, access to credit, among others. Although literature on commodity export supply functions starts from structural equations, which accommodate a wide spectrum of these factors, the estimated reduced form equations are generally price-focused; they include either current or lagged (relative) prices. The price-focused supply models stem from Nerlove's (1958) model. Nerlove describes the dynamics of agricultural supply by maintaining the assumption that producers are influenced by their perception of normal price, which is captured through adaptive price expectation mechanism. Consequently, production is a function of prices and other adjustment costs (Alemayehu, 1999; Were et al, 2002).

Weather conditions, resource endowments, relative prices, technology, domestic market growth, and population growth all determine the supply of a developing country's exports. Apart from the weather and resource endowment, all the other determinants of supply are affected by domestic policies (Bond, 1987). Although there is a wide range of factors that have been identified as affecting supply of primary commodities, most studies empirically tend to narrow these factors to price variables, indicating the difficulty of quantifying non-price variables or obtaining reliable and complete set of data (Alemayehu, 1999; Were et al, 2002).

Based on the works of Goldstein and Kahn (1978), Bond (1987) specified the supply of exports of commodity K (food, beverage and tobacco, agricultural raw materials and minerals) from region R as a log-linear function of the current and lagged ratios of the export price of commodity K to domestic price level in the producing countries in region R, multiplied by the exchange rate of currencies of the producing countries, i.e. US\$ per unit of local currency, an index of productive capacity in region R, supply shocks and trend value. This specification allows for a positive relationship between supply and export price, relative to domestic prices. It also allows for the operation of a lag supply response. The formulation of this equation differs from the original formulation of the model in Goldstein and Khan (1978) since it includes exchange rate, lagged price effect and supply shock which is broadly defined to include other factors which influence exports from developing countries (Alemayehu, 2009; Bond, 1987).



2.1.3.3 The Demand for and Supply of Exports of Energy

2.1.3.3.1 Demand for Exports of Energy

The equations for the energy market require a treatment different from that in the equations for the other four commodities (food, beverages and tobacco, agricultural raw materials and minerals) because the links between energy prices, economic growth, and energy demand are complex and because energy supply is influenced by both economic and non economic factors. The equations for energy exports will be specified in a two-stage process. First, the export demand for world energy will be specified, with export supply of world energy assumed to be exogenous. Second, export demand for energy will be allocated across exporting developing country regions with reference to a trend term (Bond, 1987).

The world demand for energy is assumed to be determined by the world price of energy relative to the world price level and to world income. The demand can be specified as:

ln XD<sub>W</sub><sup>en</sup> = α<sub>0</sub> + α<sub>1</sub> ln (PW<sup>en</sup> / PW) + α<sub>2</sub> ln YW.....(2.8)

Where, XD<sub>W</sub><sup>en</sup> is the quantity of energy exports demanded by the world, PW<sup>en</sup> is the average world price of energy and PW is the average world price level. World energy demand is allocated across the five regions (Africa, Asia, Middle East, Europe and Western Hemisphere) with reference to each region's share in 1980 in the world energy market and a trend variable:

XD<sub>R</sub><sup>en</sup> = w<sub>R</sub> XD<sub>W</sub><sup>en</sup> e<sup>t</sup>.....(2.9)

Where XD<sub>R</sub><sup>en</sup> is the quantity of exports of energy demanded from region R, w<sub>R</sub> is the weight of demand for region R's energy exports in world demand for energy exports in 1980 and t is a time trend. By substituting equation (2.8) into equation (2.9), the following estimating



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The world demand for energy is assumed to be determined by the world price of energy relative to the world price level and to world income. The demand can be specified as:

$$\ln XD_W^{en} = \alpha_0 + \alpha_1 \ln \left( \frac{PW^{en}}{PW} \right) + \alpha_2 \ln YW \dots\dots\dots(2.8)$$

Where,  $XD_W^{en}$  is the quantity of energy exports demanded by the world,  $PW^{en}$  is the average world price of energy and  $PW$  is the average world price level. World energy demand is allocated across the five regions (Africa, Asia, Middle East, Europe and Western Hemisphere) with reference to each region's share in 1980 in the world energy market and a trend variable:

$$XD_R^{en} = w_R XD_W^{en} e^t \dots\dots\dots(2.9)$$

Where  $XD_R^{en}$  is the quantity of exports of energy demanded from region R,  $w_R$  is the weight of demand for region R's energy exports in world demand for energy exports in 1980 and t is a time trend. By substituting equation (2.8) into equation (2.9), the following estimating

equation, specified in log-linear form, can be obtained for the demand for energy exports from the regions as:

$$\ln XD_R^{en} = a_0 + a_1 \ln \left( \frac{PW^{en}}{PW} \right) + a_2 YW + a_3 t \dots \dots \dots (2.10)$$

Where,

$$a_0 = \ln w_R + \alpha_0, a_1 = \alpha_1 \text{ and } a_2 = \alpha_2 \dots \dots \dots (2.10a)$$

**2.1.3.3.2 The Supply of Exports of Energy**

According to Bond (1987), the world supply of energy ( $XS_W^{en}$ ) is treated as exogenously determined because over the estimation period (1963-1982) many production decisions were made by a partial cartel dominated by OPEC. Therefore, the supply of world energy can be stated as:

$$XS_W^{en} = \overline{XS_W^{en}} \dots \dots \dots (2.11)$$

According to Bond (1987), the supply of energy from each developing country region is also assumed to be determined exogenously. These regions do not include major OPEC members, so that production decisions in these countries were not dominated by OPEC. In many of these countries, however, production decisions were dominated by national governments that provided capital toward initial investments in the oil sector. Thus, non economic criteria also influenced the oil sectors of many of these countries. So,

$$XS_R^{en} = \overline{XS_R^{en}} \dots \dots \dots (2.12)$$

Bond’s (1987), and Goldstein and Khans’ (1978) models are interesting in that they recognize the importance of various factors in modeling trade in primary commodities. The author’s emphasis on the use of functions specified by product type and region, and the method of

solving this, simultaneously, are both worth noting. Moreover, Goldstein and Khan's distinction between equilibrium and disequilibrium models is their model's strength. However, when it comes to applying this model, they fail to specify all the factors that they mentioned as likely to affect the market in their discussion. Indeed, even the suggested classification between products is not reflected in the fully specified and estimated models, except in the case of energy. More importantly, the trade sector in their model is seen as an enclave, which does not affect, and is not affected by the other sectors of the economy (Alemayehu, 2009).

As noted by Alemayehu (2009), based on survey of literatures, the approach to commodity modeling needs to take into account:

- Explicit consideration of the short, medium and long-run impacts of demand and supply factors. Thus, the discussion about equilibrium and disequilibrium models in the works of Chu and Morisson (1986), Goldstein and Khan (1978), and Hwa (1985) are important in this regard.
- The emphasis accorded to estimation across different commodities. In this regard the studies of Hwa (1985), Ramanujam and Vines (1990) and Bond (1987) are informative.
- The importance of focusing on factors, which affect the market owing to the macroeconomic interaction of the two trading economies (say North and South). The studies of Dick *et al* (1983), Taplin (1973) and Bond (1987) represent good starting points from which to proceed. However, these could be improved by placing the commodity market within a global and regional macroeconomic framework.

Considering these points, short, medium and long run supply, demand, stock holding and prices need to be taken as the key relationships required in modeling African trade. A common weakness of the commodity models is the lack of connection with macroeconomic variables of the economy in question and the neglect of the latter's feedback effects on the commodity market (Although Dick *et al* have attempted to take account of such effects). This call for commodity modeling that will focus, first, on the importance of macroeconomic interactions among countries for the commodity market, also and placing the commodity market within a global and regional macroeconomic framework. Second, a model that emphasizes the supply side of the commodity market and the impact of world interest rates on the demand for commodities through this global commodity market. The latter, in particular, will serve as an important mechanism for linking the global commodity market with international finance and Northern macro policy (ibid). Therefore, the following section presents the global macro econometric model of trade in primary commodities.

#### **2.1.4 Global Macro Econometric Model: The Commodity Sub-bloc of the ECA Global Model**

The Economic Commission for Africa (ECA) built a global model that links the OECD countries with regions of Africa. One of the main features of this model is the commodity sub-block that models four (Food, Mineral, Beverage and Agricultural raw materials) primary commodity exports from Africa. The commodity sub-bloc arises out of the empirical analysis, presented in Alemayehu (2002). Ideally the modeling of the commodity market could have been undertaken along the lines of Hwa (1985), and Ramanujam and Vines (1990), both of which are based on the theoretical work of Adams and Behrman (1976). However, this could not be carried out due to the absence of available data on commodity stock holding by



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economic agents in developed countries. As discussed in Alemayehu (2002), the commodity bloc, specified in equations 2.13 and 2.14, indirectly addresses the stock holding behavior of Northern agents. Following an econometric analysis, the equilibrium version is found to be relatively better (Hammouda et al, 2007).

$$\log X_i^{dd} = a_{14} + b_{14} \log Q_N - c_{14} \log i_w - d_{14} \log \left( \frac{P_{Ri}}{PQ_N} \right) \dots \dots \dots (2.13)$$

Where,  $X_i^{dd}$  is the global demand for primary commodities from Africa,  $Q_N$  is real output in North,  $i_w$  is the world interest rate,  $e$  is the nominal exchange rate of Africa,  $P_{Ri}$  is price of export of primary commodities from Africa,  $PQ_N$  is domestic price in the North which could be approximated by price of manufactured goods of North and all parameters are assumed to be positive.

$$X_i^{ss} = a_{15} + b_{15} \left( \frac{eP_{Ri}}{PQ_S} \right)_{t-1} + c_{15} \left( \frac{I_S}{Q_S} \right)_{t-ki} \dots \dots \dots (2.14)$$

Where,  $X_i^{ss}$  is the global supply of primary commodities from south,  $PQ_S$  is the domestic price in the South,  $I_S$  is real investment in the South,  $Q_S$  is real output in the South,  $k$  is the number of lag periods,  $i$  stands for commodity  $i$  and all parameters are assumed to be positive.

$$X_i^{dd} = X_i^{ss} \dots \dots \dots (2.15)$$

Equations 2.13 and 2.14 are used for four commodity categories ( $i=1...4$ ) consisting of food, beverage, agricultural raw material, and, finally, metals, ores and minerals. Thus, through equation 2.15, the global commodity market for each commodity category clears for price. This is in line with various studies relating to the functioning of commodity markets, starting from the classic works of Prebisch (1962) and Singer (1950) (ibid).

The supply of exports from Africa is also modeled based on the analysis presented in Alemayehu (2002) since the real exchange rate based model fits the data best. The ECM version of the export supply equation (equation 2.14) shows both the short run and a long-run impact of price and capital formation indicators on supply of commodities. The short-run parts of the argument are based on (latent) capacity utilization theory (Wickens and Greenfield 1973, Goldestin and Khan 1978, Chu and Morrison 1986, and Hwa 1985). The last argument in equation 2.14 is used to indicate the impact of capital formation (investment) or lack thereof in the sector. The lag structure (i.e., k) is five to six years when i is beverage or minerals while one to two years for food and agricultural raw materials (ibid).

$$XR_{Ai} = a_{33} + b_{33} \left( \frac{eP_{Ri}}{PQ_A} \right)_{t-k} + c_{33} I_{Ai-k} \dots \dots \dots (2.16)$$

Where,  $XR_{Ai}$  is the real export supply of primary commodities from Africa,  $PQ_A$  is the domestic price in Africa,  $I_A$  is real investment in Africa and all parameters are positive. Following a lag period, the price derived in this market, in turn, determines the supply of exports from Africa (ibid).

### 2.1.5 Trade in Primary Commodities: Some Facts and Figures

For least developed countries, the most important commodities in total are oil (23% of the total), diamonds (10%), coffee (7%), cotton (4%), copper (3%), shrimps (3%), and tropical wood and aluminum (2% each). Others among their top 20 exports are other types of wood and fish, cobalt, iron, and tobacco. Almost all these are among those with long or permanent shock persistence: those where efforts to smooth fluctuations are most difficult. All Heavily Indebted Poor Countries have more than 80% of their exports in commodities (ITF, 1999).

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Where,  $XR_{Ai}$  is the real export supply of primary commodities from Africa,  $PQ_A$  is the domestic price in Africa,  $I_A$  is real investment in Africa and all parameters are positive. Following a lag period, the price derived in this market, in turn, determines the supply of exports from Africa (ibid).

**2.1.5 Trade in Primary Commodities: Some Facts and Figures**

For least developed countries, the most important commodities in total are oil (23% of the total), diamonds (10%), coffee (7%), cotton (4%), copper (3%), shrimps (3%), and tropical wood and aluminum (2% each). Others among their top 20 exports are other types of wood and fish, cobalt, iron, and tobacco. Almost all these are among those with long or permanent shock persistence: those where efforts to smooth fluctuations are most difficult. All Heavily Indebted Poor Countries have more than 80% of their exports in commodities (ITF, 1999).



As Page and Hewitt (2001) argued, there must be many serious and long-established problems in the markets for primary commodities. It is notable that almost no developing country has 'developed', has become rapidly growing and increased its share in world trade, through commodity exports. The Asian and Latin American countries moved into manufactures (although some countries (in both regions) did diversify their exports of commodities and increase processing of them, this was not the major explanation for their success). Why do countries find it more difficult to move into processing of commodities they already produce than to start new industries? One reason may be technical conditions: the capital intensity of some processing stages, but electronics factories are also capital intensive. This leads some observers in both the WTO and UNCTAD to suggest that the market conditions in commodities, controlled by a small number of large integrated companies, make this path extremely difficult. For small countries, with no large companies of their own and little experience of competition and contesting markets, it may be impossible (Page and Hewitt, 2001).

Volatility in commodity prices aggravates difficulties in macroeconomic management. It frustrates investment efforts, as it increases uncertainty about overall economic conditions, including exchange rates, return on investments, and import capacity, particularly of critical imports such as oil. Secular decline in commodity prices exercises a permanent pressure on foreign exchange earnings for African countries, in particular because of their high commodity dependence. Between 1997 and 2001, the UNCTAD combined price index of all commodities in US dollars fell by 53 percent in real terms (deflated by the unit value index of manufactured goods exported by the developed market economy countries). That is, commodities lost more than half of their purchasing power in terms of manufactured goods: African commodity exporters would have had to double their export volumes in 2001 to maintain their foreign

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exchange income at 1997 levels. Tropical beverages and vegetable oil seeds and oils, which comprise about one-fifth of Africa's non-fuel commodity exports, registered the highest rates of decline in real terms (UNCTAD, 2003).

One of the major factors for the poor economic performance of Africa is the significant loss of resources due to adverse terms of trade. World Bank estimates suggest that the cumulative loss resulting from adverse terms of trade over a period of almost three decades (1970–1997) for African non-oil-exporting countries (excluding South Africa) amounted to 119 percent of the combined GDP of these countries in 1997, 51 percent of cumulative net resource flows, and 68 percent of net resource transfers to the region (World Bank, 2000; UNCTAD, 2003). Research carried out by the UNCTAD secretariat indicates that if SSA terms of trade had remained at 1980 levels, the share of the subcontinent in world exports would have been double its current level (United Nations, 2002; UNCTAD, 2003).

The importance of developed countries as a destination of Africa's primary exports has substantially declined over the past few years. They, nonetheless, continue to account for about 60 percent of Africa's non-fuel primary exports and about 75 percent of its fuel exports (down from 70 percent and 85 percent in 1990, respectively). Access and entry conditions on developed country markets have a sizeable influence on Africa's export opportunities for primary commodities. Border protection, domestic support and export subsidies in the industrialized countries are the major factors affecting world agricultural markets and hampered agricultural production and exports in Africa. Moreover, in 2003, producer support in developed countries amounted to \$257 billion, equivalent to almost one-third of gross farm receipts (OECD, 2004; Mayer and Fajarnes, 2005).

## 2.2 EMPIRICAL LITERATURE REVIEW

In this section the author presented empirical studies related to the topic by reviewing the objectives, data, methodologies and findings of important studies.

Hamori and Matsubayashi (2009) analyzed the export demand behavior of LDCs for the period 1980-2004 (annual data) using non-stationary panel data by taking a sample of 15 countries. They specified the export demand function in log linear form in a panel framework: real export value as a function of world trade volume and relative prices (export prices divided by the world price). They tested for non stationarity of the panel data for real export value and relative price using the four panel unit root tests (i.e. Levin, Lin, and Chu *t*-test; the Im, Pesaran, and Shin *W*-test; the ADF-Fisher Chi-square test; and the PP-Fisher Chi-square). The Dickey-fuller GLS test is used to test the stationarity of world trade volume. The auxiliary regression of each test included a constant term. They found that the null hypothesis of a unit root is accepted for the level of each variable, whereas the null hypothesis of a unit root is rejected for the first difference of each variable.

Having found a unit root at level for the three variables, they checked for the existence of cointegration using two cointegration tests (i.e. the residual-based panel cointegration test developed by Pedroni (1999, 2004) and the Johansen-type panel cointegration test developed by Maddala and Wu (1999)). They found a cointegrating relation between real export values, relative prices, and world trade volume. Finally, they estimated the export demand function using the fully modified OLS (FMOLS) developed by Pedroni (2001). The empirical results showed that price elasticity ranges between -0.24 and -0.34 and income elasticity ranges between 1.36 and 1.79 for the panel of the sample countries. This paper is interesting for its



application of panel cointegration approach which enables to look at the long run relations of the variables. However, the estimates of the parameters are questionable due to the negligence of the supply side factors (i.e. the study analyzed only the demand side factors by ignoring the supply side factors which are equally important).

A study by Gbadebo O. (2007) modeled Africa's agricultural exports to the United States. In doing so, he used a dynamic econometric model- Vector Autoregressive Analysis- which helps to look at both the short-run and long-run effects of income and price changes. The overall results for the estimated export demand functions for the agricultural commodities covered by the study suggested that there is a statistically significant demand response to income changes in the US. For the combined commodity exports of the region, the trade-weighted average income elasticity of export demand by the US is equal to -3.5 in the short run and -5.7 in the long run. The results also demonstrated the inelastic nature of price responses in the US demand for the SSA agricultural exports. The signs and magnitudes of the estimated coefficients (elasticity estimates of export demand equations) were significantly in line with theoretical expectations and the diagnostic test statistics were quite satisfactory. The relative price (export price per US domestic price) movements affect significantly the trade flows of agricultural commodities, implying that exporter's market share has been influenced by price competitiveness. The short-run relative price elasticity of export demand range from -0.4 to -6.0, and the long-run elasticity from -1.2 to -7.5. Finally, the author concluded that, trade policy measures in the form of tariff and non-tariff barriers are not very significant in changing the quantity of SSA agricultural exports to the US.

Senhadji and Montenegro (1998) analyzed the determinants of demand for exports of 70 developing and industrial countries using time series data (1960-1993) that account for non-stationarity of the data. They specified a log linear export demand function: real exports of goods and services as a function of real effective exchange rate and activity variable (where the activity variable is computed as weighted average of the trading partners' GDP minus exports). Out of the 70 countries, they found a unique cointegrating vector (i.e. all variables are integrated of order one) for the three variables for 53 countries. They estimated the cointegrating vector using the Phillips-Hansen's Fully Modified estimator. The average short run and long run price elasticities are found to be approximately -0.21 and -1, respectively while the average short run and long run income elasticities were 0.41 and 1.48 respectively. The results showed that income of trading partners and real effective exchange rates are important determinants of the demand for exports of commodities. Moreover, they noted that Africa faced the lowest income elasticities for its exports while Asia had the highest income and price elasticities. This study may be liable for its negligence of the supply side factors of export which reduces the reliability of the estimates of the demand side factors.

The impact of the dependence on primary commodities for economic development is analyzed within the framework of growth regressions by Carmignani and Chowdhury (2007). While there is no evidence of a "generalized" primary commodity curse, reliance on primary commodities retarded growth in sub-Saharan Africa (SSA). They tried to find out the factors that account for this SSA specificity. Some suggest that SSA specializes in commodities that are not conducive to economic growth and that SSA depends on primary commodities more deeply than the rest of the world. However, these explanations were not strongly supported by the data. Rather, according to the authors, the key to the SSA specific curse appears to lie in

the interaction between institutions and primary commodities (i.e. institutional constraints in the region were found to be the major constraining factors for the poor performance of export of primary commodities).

They also tried to check whether primary commodities are a curse in SSA because, among the several commodities available, SSA has specialized in those that are particularly less conducive to growth or not. To see how relevant this hypothesis is, they re-estimated the growth regression model using the export shares of individual commodities in place of the aggregate indicator of primary commodity dependence. The individual commodities chosen were those in which SSA specializes. It turns out that only three commodities appear to be intrinsically bad for growth: cotton, coffee and iron ores. A positive growth yield, on the other hand, is generated by oil, cocoa, silver and coal. For the others the growth effect is statistically negligible.

A study by S.A. Yusuf and W.A. Yusuf in 2007 examined the factors that determine the export performance of three major agricultural exportable commodities of Nigeria: cocoa, rubber and palm-kernel in the context of liberalization. They used time series data covering thirty three years and to avoid spurious result, error correction model was applied in the analysis. The results of the parsimonious error correction specifications showed that the lagged output and the net value of world trade negatively affect cocoa exports while lagged GDP positively contributes to cocoa exports. The lagged price ratio reduces rubber exports but real exchange rate significantly increases the export performance of it. The lagged exports of palm kernel and the real GDP contributed positively to palm-kernel exports while the lagged premium and output negatively affected the export of it.

Though the exchange rate policy is probably the most likely instrument to induce increase competitiveness of agricultural export commodities in a developing country like Nigeria, parallel exchange rate premium only significantly affect the export performance of palm-kernel but not cocoa and rubber. Thus, critical attention should be paid to such incentives as export promotion because it is believed that export promotion have potential to stimulate productivity, thrift and entrepreneurship (ibid).

Prasad in 2000 tried to identify some of the main determinants of exports in Fiji. He developed a single equation model for exports in which trading partner income and relative prices play a central role. The underlying conceptual framework is an imperfect substitution model, in which the key assumption is that exports are not perfect substitutes for domestic goods in importing countries. A distinguishing feature of the analysis is the incorporation of the effects of agricultural supply-side shocks in the export equation. The results show that in the long run, trading partner income largely drives movements in Fiji's exports. In the short run, exports are mainly influenced by changes in factors which affect the output capacity of agricultural production, such as weather conditions and industrial disputes, as well as relative prices and changes in foreign demand.

A study by Were et al (2002) examined the determinants of Kenya's export volumes by disaggregating total exports of goods and services into three categories: traditional agricultural exports (tea and coffee) and 'other exports of goods and services' using an error correction model. For each of the three categories of exports, they specified an empirical model along the

standard trade models that incorporate real exchange rate (proxy for relative prices), real foreign income of major trading partners and investment as a proportion of GDP (as a proxy to capture the supply constraints) as explanatory variables . In the case of tea, the results were found to be inconsistent—no cointegration and therefore no error correction model. However, in general, real exchange rate has a profound influence on export performance. The supply response to price incentive (real exchange rate depreciation) for exports of goods and services is significant. Investment as a proportion of GDP had a positive and significant impact on the export volumes of coffee but not for exports of other goods and services. Income of trading partners was found to be more paramount in explaining export volumes of ‘other exports of goods and services’ than coffee exports. The study also acknowledged the impact of other non-price factors such as cost of inputs, labor costs, access to credit, etc on production and export supply.

Goldstein and Kahn (1978) investigated the price responsiveness of both export demand and export supply of eight industrial countries by employing the Full Information Maximum Likelihood (FIML) method using quarterly aggregate export data for the period 1955-1970. In six of the eight countries, estimated export price elasticity of demand was greater than unity, implying a fairly large response of exports to changes in relative prices. They applied both the equilibrium and disequilibrium models so that adjustment to time lags was incorporated.

For the disequilibrium model, short run price elasticities of demand were smaller yet the export supply elasticities were positive and significant for all eight countries. However, it is not clear from the results to judge as which version of the model is superior. On conventional statistical grounds, both models seemed equally well-specified as  $R^2$  were very similar. On a



priori grounds, the disequilibrium model had the advantage that it permitted time lags to occur in the adjustment of actual to equilibrium values. On the other hand, the supply price elasticities obtained from the equilibrium model seemed more credible than those from the disequilibrium model.

A study by Chu and Morrison (1986) developed an econometric model of world non-oil primary commodity markets focusing on supply-price dynamics. The model incorporates supply-side and demand-side factors, as well as the interactions between supplies and prices over the short term and medium term. According to the study, world non-oil primary commodity markets are assumed to be price clearing. Suppliers are assumed to maximize profits, and thus are affected by supply shocks. Demand is supposed to depend on world economic activity and the relative price of commodities. Supply may change as a result either of changes in medium and long run supply or in short and medium term capacity utilization rate. The model decomposed production of commodities into potential production and the utilization rate. The study concluded that potential production responds to medium-term fluctuation in prices, while the utilization rate responds to short-run fluctuations. Industrial production and exchange rate fluctuations are also found to have been major factors underlying commodity price fluctuations, since the early 1970s.

Moreover, the study quantified the impact of supply-price dynamics on fluctuations of commodity prices. It showed that most of the price increase resulting from a demand shock can erode in the long run. For example, the elasticity of commodity prices with respect to industrial production changes from about 2.0 in the short run to 0.3 in the long run. This erosion results from supply responses to the initial price increase. The simulations based on

the model also showed that short-run supply shocks reinforced demand-side factors during the two commodity price cycles (1972-77 and 1979-83). It also estimated the extent of the cost-push channel through which inflation in exporting countries is transmitted to world commodity prices. The study showed that, for agricultural raw materials and metals, the cost-push channel is more important than the substitution channel in the short run.

Bond (1985) analyzed the export quantity flows from groups of exporting non-oil developing countries to group of importing countries. Her model contained separate equations for export volume flows from each exporting groups to each importing group and, in particular, measured the responsiveness of export volumes to real income growth in importing countries and to changes both in effective exchange rates and in deviations from output in the exporting countries. Exporting countries were divided into four groups: low income countries, major exporters of manufactures, net oil exporters and other net oil importers (middle income countries that generally export mainly primary products). While importing countries were divided into three groups: industrial countries, oil producing countries and non-oil developing countries. Initially, two equations were specified for each individual country: an export demand and an export supply equations. These equations were then solved to obtain a single reduced form equation and were then aggregated for each importing and exporting group. These equations were estimated using annual data from 1967 to 1981 by OLS procedure. Empirical evidence showed that the real effective exchange rate, GNP in the importing countries, and output in the exporting countries, as well as long term development in both importing and exporting countries, all played an important role in the determination of exports of groups of non-oil developing countries. That evidence confirmed the view that exchange rate policies in the non-oil developing countries could be successful in promoting export

growth through both the demand for and supply of their products. However, the technique of estimation she used (OLS) may raise questions for the existence of non stationary variables and endogeneity problem.

In another study, also undertaken by Bond (1987), flows of primary commodity exports from non-oil developing countries grouped by geographical region were examined. The study was based on groups of commodities and on regions, rather than on individual commodities and countries so as to permit an analysis of broad economic trends while at the same time allowing enough disaggregation so that differences in these trends among commodity groups and regions could be distinguished.

For empirical purpose five developing country regions (i.e. Africa, Asia, Europe, Middle East and the Western Hemisphere) and five commodity groups (i.e. food, beverages and tobacco, agricultural raw materials, minerals and energy) were distinguished. The peculiar conditions in the energy market required estimation technique that was different from those used for the other four commodity groups thus were estimated by simple OLS. The demand and supply equations for five regions and for the first commodity groupings were estimated by using MINDIS routine which performs minimum distance estimation on a multiple equation model.

The estimated price coefficients in the export demand equations carried expected signs for most of the commodity groups and were statically different from zero in 14 of the 23 estimated equations. In all but one of the equations the estimated price elasticity was less than unity. That finding implied a fairly limited short-term response of demand for exports to changes in relative prices. While the estimated income elasticities had expected positive signs

and were statistically different from zero in 17 of the 23 equations. The results demonstrated the inelastic nature of price responses in the demand for commodity exports and the inelastic income responses in the demand for food, beverages and tobacco, and agricultural raw material exports from developing countries. The performance of the supply equation was generally poor. The estimated coefficients of exports were positive and significantly different from zero at the 10 percent level in 6 of the 19 equations. Still this study is also susceptible for the non-stationarity of variables which reduces the reliability of the estimates.

Marco Fugazza (2004) analyzed the major determinants of export performance in 84 countries by employing an econometric model of bilateral trade flows using gravity techniques. Results indicate that, while trade barriers continue to be of concern, poor supply-side conditions have often been the more important constraint on export performance in various regions, in particular in Africa and the Middle East, despite a generalized deepening of international trade integration. Beside strong linkages to international markets, good transport infrastructures, macroeconomic soundness and good quality institutions appear to be major determinants in the development process of the external sector. Internal transport infrastructure captured by the percentage of paved roads is an important supply capacity element and is found to have a significant and positive impact in raising performance, as does a good macroeconomic environment. The contribution of foreign direct investment to capital formation is included in order to include a technology-related element.

## **CHAPTER THREE**

### **DATA AND METHODOLOGY**

#### **3.1 Data Description**

The study collected data for the four commodity groups which are defined under the Standard International Trade Classifications (SITC) of digit 3. Accordingly, the commodity groups are defined as: basic food (SITC 0+22+4), agricultural raw materials (SITC 2-22-27-28), minerals (SITC 27+28+68+667+971) and energy (SITC 3). Because of the limited availability of data for the sample countries in each commodity group, the study employed annual data over the period 1990-2008. For the sample countries, the nominal values of exports of each commodity group are collected from the different publications of the United Nation's International Trade Statistics Yearbooks and UNCOMTRADE statistics.

To estimate the volume of exports for each commodity group, the analysis deflates the dollar value of exports by the associated dollar unit price index (at 2000 constant prices). Therefore, the real values of each export group, which are computed from their respective nominal values using the year 2000 constant prices, are used as proxies for volume of exports. The unit export prices (PX) and world export prices ( $PW^K$ ) of each commodity group are in index forms (assuming for year 2000=100). These prices are collected from the different publications of UNCTAD. The data for consumer price indices, which are proxies for domestic prices, are collected from the different issues of the World Bank's African Development Indicators by taking 2000 as a base year.



The world consumer price index (PW) is used as a proxy for world price, and is collected from the different reports of IFS (2000=100). The London inter bank rate is used as a proxy for world interest rate ( $I_w$ ) for its better results obtained in Alemayehu (2002) and its reflection of the interest rates faced by the major trading partners of Sub-Sahara African countries. The LIBOR is the world's most widely used benchmark for short-term interest rates. It's important because it is the rate at which the world's most preferred borrowers are able to borrow money. It is also the rate upon which rates for less preferred borrowers are based. For example, a multinational corporation with a very good credit rating may be able to borrow money for one year at LIBOR. Countries that rely on the LIBOR for a reference rate include the United States, Canada, Switzerland and the U.K (IFS, 1998). The data for real effective exchange rates (REER) and world income of importing countries (YW) are computed as per equations 3.1a and 3.1b respectively. Finally, the data for the remaining variables (i.e. exchange rates (domestic currencies per unit of US dollar), world income (gross), gross domestic investment, domestic credit, GDP of exporters, FDI, paved roads, etc.) are as conventionally defined.

### **3.2 Sampling Technique**

To achieve the objective of this study, 36 Sub Saharan African countries are included in the different samples for the different commodity groups. The selection of the sample countries is based on the availability of data for each commodity group since all countries do not specialize in the export of all commodity groups (i.e. countries included as a sample for one commodity group may or may not included as a sample in another commodity group). In analyzing the determinants of the export of food, agricultural raw materials, minerals and

energy commodities, data is collected from 25<sup>1</sup>, 15<sup>2</sup>, 19<sup>3</sup> and 15<sup>4</sup> countries respectively. The sample countries in each commodity group are those countries which are dependent on the export of the respective commodities. Countries are not selected as part of a sample for a given commodity group if their export of that certain commodity group is too low (i.e. either they export insignificant amount or not at all) and those whose data are highly distorted (i.e. their data are not found in most data sources like in UNCTAD, WB, IMF, UNCOMTRADE statistics, etc.).

### 3.3 Model Specification

In modeling the demand for and supply of export of primary commodities, most studies followed the work of Goldstein and Khan (1978). This study also followed the works of Goldstein and Kahn (1978), Bond (1987) and Alemayehu (2002) by adjusting some of the components of their models accordingly. The study specified demand and supply equations for four different commodity groups (i.e. food, agricultural raw materials, minerals and energy).

#### 3.3.1 Specification of the Export Demand Function

In Bond's model, the demand for primary commodities depends on a number of factors such as economic activity within the industrial countries, the price and composition of commodities, the geographical location of the exporting nation, and the trade and agricultural

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<sup>1</sup> Botswana, Burkina Faso, Cameroon, Cape Verde, Congo Dem., Equatorial Guinea, Ethiopia, Gambia, Ghana, Kenya, Madagascar, Malawi, Mauritania, Mauritius, Mozambique, Namibia, Niger, Rwanda, Senegal, Seychelles, South Africa, Sudan, Togo, Uganda and Zimbabwe.

<sup>2</sup> Benin, Burkina Faso, Congo Rep, Congo Dem, Cote D'ivoire, Ethiopia, Gabon, Ghana, Kenya, Mali, Mozambique, South Africa, Sudan, Togo and Zimbabwe.

<sup>3</sup> Botswana, Burundi, Cameroon, Central African Republic, Congo Dem, Cote D'ivoire, Ghana, Guinea, Mali, Mauritania, Mozambique, Namibia, Niger, Rwanda, South Africa, Togo, Uganda, Zambia and Zimbabwe.

<sup>4</sup> Angola, Cameroon, Cape Verde, Congo Rep, Congo Dem., Cote D'ivoire, Equatorial Guinea, Gabon, Ghana, Kenya, Mozambique, Nigeria, Senegal, South Africa and Sudan.

policies pursued by industrial countries. Supply, on the other hand, depends on weather conditions, factor endowment (together with investment), relative prices, technology, domestic market characteristics and population growth.

According to Alemayehu (2009), the key relationships required in modeling African trade are the short, medium and long run responses of supply, demand, stock holding and prices of export of primary commodities. A common weakness of most of the commodity models (including Bond's (1987)) is lack of connection with macroeconomic variables of the economy in question. They failed to show the effect of these variables on the commodity markets. Therefore, a model that places the commodity market within a global and regional macroeconomic framework, and that emphasizes the supply side of the commodity market is required. Moreover, a good commodity model should show the impact of world interest rates on the demand for commodities through the global commodity market. This will serve as an important mechanism for linking the global commodity market with international finance and industrial countries macroeconomic policies.

This study included the world interest rate as an explanatory variable since it helps to connect the commodity market with the financial market as indicated above. According to Alemayehu (2002), the global demand for a commodity group  $K$  has two components. Firstly, a stock or inventory demand which is assumed to be determined by expected level of interest rate and current prices. Agents in the industrial countries are assumed to hold commodities as part of their portfolio diversification scheme. The second part of the aggregate demand is the consumption demand which is supposed to be determined by the level of income of the industrial countries and by the price of the commodities relative to an indicator of price of

competitors. Therefore, including interest rate as an explanatory variable in the demand for exports of primary commodities is an important mechanism for linking the global commodity market with international finance. An increase in the world interest rate will divert demand from commodities to financial products and vice versa. Therefore, world interest rate and demand for primary commodities will have inverse relationships. At the same time, the effect of industrial countries macroeconomic policies (monetary policy, exchange rate policy, etc) on export of primary commodities will be captured by the inclusion of world interest rate.

Another variable which helps to capture the impact of industrial countries policies on the demand for export of primary commodities is real effective exchange rate (REER) (Love and Turner, 2001; Ibrahim, 2007). Though most studies opt to analyze related policy issues that affect the developed countries protectiveness to imports descriptively, it is also possible to capture their protective action through REER. Real effective exchange rate is assumed to capture distortions in the domestic market, the impact of proxies of trade policy as well as the trade orientation of importing countries. Any change in the trade orientation of the country under consideration manifests itself on REER. Thus, REER is used as an indicator of monetary, trade and exchange rate policy of industrial countries (ibid). This study considered REER as one of the determinants of demand for export of primary commodities since it helps to capture the effect of the difference in the level of foreign and domestic prices (or differences in the level of inflation). It also helps to know the impact of foreign exchange rates on the exports of the region.

Therefore, based on the above discussions, the world demand for exports of commodity K (food, agricultural raw materials and minerals) from SSA country  $i$  in year  $t$  is specified in a

semi log-linear form as follows:

$$\ln XD_{it}^K = a_0 + a_1 \ln \left( \frac{PX_{it}^K}{PW_t^K} \right) + a_2 \ln YW_{it} + a_3 I_{wt} + a_4 \ln REER_{it} \dots \dots \dots (3.1)$$

Where  $XD_{it}^K$  is the real value of exports of commodity K demanded from country i in year t (at year 2000 constant prices),  $PX_{it}^K$  is the export price of commodity K from country i in year t,  $PW_t^K$  is the average price of commodity K in the international markets in year t,  $YW_{it}$  is the average real income of importers of country i's product in year t and  $I_{wt}$  is the world interest rate in year t. The REERs for the sample countries are constructed from the various issues of IMF's *IFS* and African Development Indicators of the World Bank. The REER for country i at time t is defined as:

$$REER_{it} = \sum_{j=1}^n \alpha_{ij} \left( \frac{(P_j E_{ij} / P_i)_t}{(P_j E_{ij} / P_i)_{2000}} * 100 \right) \text{ and } \sum_{j=1}^n \alpha_{ij} = 1 \dots \dots \dots (3.1a)$$

Where  $n$  is the number of trading partners;  $P_j(P_i)$  are domestic prices in country  $j$  ( $i$ ) (CPI is used as a proxy);  $E_{ij}$  is the exchange rate defined as number of country i's currency per unit of country j's currency (domestic currencies per unit of US\$); and  $\alpha_{ij}$  is the share of country i's export to country j in year t (using the average shares in 1995 and 2000-2004 as a fixed weight- refer appendix I for the values of the weights). Similarly, the average real income of importing countries of country i's exports is computed as:

$$YW_{it} = \sum_{j=1}^n \alpha_{ij} (YW_j)_t \dots \dots \dots (3.1b)$$



Where  $YW_{it}$  is the average real income of importers of country  $i$ 's export (i.e. an arithmetic average with the average share in total exports of each trading partner during 1995 and 2000-2004 serving as a fixed weight- refer appendix I for these weights) and  $YW_j$  is the real income of the importers of exports of country  $i$  (where real GDP is used as a proxy for real income).

Here an important issue to be raised concerned the demand equation for export is the small country hypothesis. As Athukorala and Riedel (1991) noted if a country is truly a price-taker (i.e. small country),  $PX_{it}^K$  and  $PW_t^K$  will be perfectly (or at least very highly) correlated. In this case, the relative price variable  $PX_{it}^K / PW_t^K$  will exhibit very little variability if there is any change. Therefore, for a true small country, the coefficient on the relative price variable can not be precisely estimated, and may turn out relatively low (and statistically insignificant) even though its true value is extremely high.

They also noted that if the small country hypothesis is maintained for a particular country's exports, then world income should have no impact on that country's exports even if the global income elasticity of demand is high. According to them, the high income elasticities of demand combined with low price elasticities obtained in previous studies could point to the 'false' notion that LDC exports of manufactures are sensitive to the level of income of developed countries.

### 3.3.2 Specification of Export Supply Function

The performance of export flows are determined by supply-side variables, such as domestic prices (official or market-determined), the growth of gross domestic product (GDP), taxes,

tariffs and subsidies (Bond, 1985). Many studies identified different factors as the determinants of the supply of exports of primary commodities. According to Alemayehu (2002), the different factors emphasized by different authors are basically complementary and hence, these factors should explicitly be considered within any estimation. As to him, the general theoretical model of export supply equation which captures the effect of both the capacity utilization and capacity creation factors is specified as:

$$X_{st}^{ss} = a_0 + a_1 \left( \frac{ep_s}{p_d} \right) + a_2 \left( \frac{ep_s}{p_d} \right)_{t-1} + a_3 \left[ \left( \frac{ep_s}{p_d} \right)_{t-i} - k^{-1} \sum_{i=1}^k \left( \frac{ep_s}{p_d} \right)_{t-i} \right] + a_4 (\Delta K)_{t-i} + a_5 FF_{t-i} \dots (3.2)$$

*Capacity Utilization*
*Expected profit*
*Capital Formation*

Where: X is export supply, e is exchange rate,  $p_s$  is export price of South,  $p_d$  is the domestic price, FF is foreign inflow,  $\Delta K$  is the capital formation indicator, the term in the square bracket is the expected profit indicator, the deviation of current price from k years moving average.

The first term in equation 3.2 refers to the short run response of supply to current and lagged relative prices (the capacity utilization theory) while the second term captures the effect of cumulated past prices on future supplies through the impact that they have on investment which in turn affects productive capacity (expected profitability theory). In the short run the supply of exports of primary commodities depends on the utilization of existing capacities. The utilization of capacities is assumed to depend on the current and lagged relative prices of exports. The third argument (capital formation where capital is assumed to accumulate both from domestic investments and foreign inflows) together with the second term represents the long run response of supply to capacity creation. The capacity which is created from past investments will induce the supply of exports of primary commodities.

To model the supply of exports of primary commodities, this study employed the arguments of Alemayehu (2002) and that of Bond (1987) in part. The following paragraphs tried to give theoretical reasons or justifications for the inclusion of different variables in the model.

Gross Domestic Product (GDP) is postulated to have a positive impact on export. Kumar (1989) conducted a study on the determinants of export growth in developing countries and confirmed that GDP has a significant positive impact on volume of exports. He further said that higher level of production is the main cause of export expansion since surplus output can be exhausted in the international markets. Ngeno (1990) carried out a study on the determinants of exports and one of his finding was that export growth is positively related to output level since higher production leads to increased export volumes. This study also included GDP as an explanatory variable assuming that it is the best proxy for the level of domestic production which has an impact on export.

Foreign Direct Investment (FDI) is also supposed to be one of the major determinants of export performance in developing countries since it helps to diversify the export structure. Van Dijk (2002) conducted a study on Indonesia and found out that FDI was very significant in explaining export performance. Analogously, Amelia and Santos (2000) while in studying the effects of trade liberalization in selected 48 developing countries found that FDI significantly impact on export volumes. A study on the relative performance in Eastern Europe suggested that lack of changes in export structure and FDI had significant effect on export performance. The study revealed that FDI sometimes chooses sectors in the economy where a country may not have relatively specialized and this also affects exports performance. Also, the study

suggested that imports of intermediate inputs and machinery are important determinants of changes in the export structure. Therefore, this study included FDI as one factor since it is one of the means to import technologies (intermediate inputs, machineries, skill and knowledge, capital, etc.) and it helps to broaden the structure of export.

As cited in Edwards and Phil Alves (2005), economic infrastructure such as transport, communication, power, water and sanitation systems provide the foundation for economic activity within an economy. The provision of infrastructure also has important consequences for an economy's export performance. Firstly, the provision of economic infrastructure raises economic growth and therefore indirectly exports. This indirect relationship is supported by the positive relationship between exports and trend output. Secondly, good infrastructure lowers the transaction costs associated with exporting. Thirdly, good infrastructure facilitates the diversification of export production (Elbadawi, 1999). Fourthly, lower transport costs can give rise to powerful forces for agglomeration (Redding and Venables, 2004) and contribute towards the expansion of exports.

According to Edwards and Phil Alves (2005), six different variables can be used to assess the impact of infrastructure availability on export performance. These variables are rail carrying capacity (in tons), public-sector infrastructure fixed capital stock, paved roads (in km), the share of total roads paved, electricity generated (in watts), electricity, water and gas fixed capital stock, communication fixed capital stock and telephone mainlines per 1000 people. However, this study included only paved roads in kilo meters to capture the effect of infrastructure on the supply of exports of primary commodities in Sub Sahara Africa since it is the most important types of infrastructures available in the region.

Export supply also depends on the level of capital formation since it is the basis for production and distribution (Alemayehu, 2009; Hammouda et al, 2007). Therefore, real gross investment is included as proxy for capital formation to capture the effect of supply constraints. Moreover, the availability of domestic credit is included as an explanatory variable since it is expected to be one of essential factors in the production and distribution of exportable commodities in the region. The amount of domestic credit to the private sector is used as a proxy for the availability of domestic credit to the economy.

Therefore, as justified in the above discussions and in the literature review section, the supply of export of commodity K from country i in year t can be specified in a log-linear form as:

$$\ln XS_{it}^K = \beta_0 + \beta_1 \ln \left( \frac{PX_{it}^K E_{it}}{P_{it}} \right) + \beta_2 \ln \left( \frac{PX_i^K E_i}{P_i} \right)_{t-j} + \beta_3 \ln INV_{i,t-j} + \beta_4 \ln GDP_{it} + \beta_5 \ln FDI_{it} + \beta_6 \ln R_{it} + \beta_7 \ln DC_{it} \dots\dots\dots(3.3)$$

Where  $XS_{it}^K$  is real value of supply of commodity K from country i at year 2000 constant prices,  $PX_i^K$  is the current and lagged export prices of commodity K,  $P_{it}$  is the domestic price level in country i,  $E_{it}$  is the nominal exchange rate in country i (i.e. local currency per unit of US\$),  $Inv_i$  is real gross domestic investment in country i, GDP is real gross domestic product in country i, FDI is foreign direct investment in country I (net inflows), R is paved roads in kilometers in country i, DC is the level of domestic credit in country i and K refers to the commodity groups: food, agricultural raw materials and minerals.



The lag structure (j) depends on the nature of the commodity to be analyzed. For example, according to Hamouda et al (2007), the length of the lag in the fourth term (investment as a proportion of GDP) is five to six years when K is beverage or minerals while one to two years for food and agricultural raw materials. The lagged price variable allows for the possibility of delayed supply adjustment beyond the period of one year. It is expected that the sign of the elasticities  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$  and  $\beta_7$  to be positive. Finally, the values of the structural parameters can be obtained by estimating equations 3.1 and 3.3 simultaneously based on the equilibrium condition expressed in equation 3.4 using appropriate estimation technique (which depends on the nature of the data).

$$XD^K = XS^K \dots\dots\dots(3.4)$$

Generally, the reduced form equation for the real value of export of the different commodity groups (i.e. food, agricultural raw materials and Minerals), which captured both the demand and supply side factors, can be stated as:

$$\ln X_{it}^K = f \left( \ln \left( \frac{PX_i^K}{PW^K} \right)_t, \ln \left( \frac{E_i PX_i^K}{PW^K} \right)_t, \ln \left( \frac{E_i PX_i^K}{PW^K} \right)_{t-j}, \ln YW_{it}, \ln REER_{it}, I_{wt}, \ln INV_{it}, \ln FDI_{it}, \ln DC_{it}, \ln GDP_{it}, \ln R_{it} \right) \dots(3.5)$$

Where,

- $X^K$  -the real value of export of commodity K in ‘000s of US dollars at 2000 constant prices,
- $E_i$  -the nominal exchange rate of country i (domestic currency per unit of US dollar),
- $P_i$  -the domestic price level in country i (CPI is used as a proxy),
- $PX_i^K$  -the unit export price level of country i in index form (taking 2000 as a base year),
- $Inv$  -Real gross domestic investment in country i in millions of US dollars at 2000 constant prices,

- $gdp$  -real GDP in country  $i$  (in millions of US dollars at 2000 constant prices),
- $FDI$  -Foreign direct investment in country  $i$  (in millions of US dollars),
- $R$  - Paved roads in kilometers,
- $DC$  - Real Domestic credits (in millions of US dollars),
- $PW^K$  - the world price of export of commodity  $K$  (in an index form),
- $YW$  - the weighted average income of importers of country  $i$ 's export (in billions of US dollars),
- $I_w$  - the world interest rate (in percentages),
- $REER$  - the real effective exchange rate of country  $i$  and
- $\ln$  - Natural logarithm.

After specifying the estimating equation in a dynamic panel framework, the next step is to check whether the variables are stationary or not since most estimations involving non stationary variables are spurious. By checking the existence of non-stationarity and co-integrating relationships (for those variables in equation 3.5), the long run coefficients are estimated using dynamic OLS. This method helps to correct the simultaneity bias and endogeneity problems (which are problems in the estimation of demand and supply equations simultaneously) by the inclusion of leads and lags of the differenced explanatory variables. For detail discussions of it refer chapter four of section 4.1.3.

### 3.3.3 Specification of Demand and Supply Equations for Energy

The equations for the energy market require a treatment which is different from that in the equations for the other four commodities because the links between energy prices, economic growth, and energy demand are complex. Moreover, energy supply is influenced by both economic and non economic factors. The equations for energy exports will be specified in a two-stage process. First, the export demand for world energy will be specified, with export

supply of world energy assumed to be exogenous. Second, export demand for energy will be allocated across exporting developing country regions with reference to a trend term (Bond, 1987). Similarly, in this study, the world energy demand is specified first and then this demand is allocated across the sample countries.

### 3.3.3.1 Export Demand for and Supply of World Energy

The world demand for energy is assumed to be determined by the world price of energy relative to the world price level and to world income. The demand can be specified as:

$$\ln XD_{wt}^{en} = \alpha_0 + \alpha_1 \ln \left( \frac{PW_t^{en}}{PW_t} \right) + \alpha_2 \ln YW_{wt} \dots\dots\dots(3.6)$$

Where  $XD_w^{en}$  is the real value of energy exports demanded by the world at year t (at year 2000 constant prices),  $PW^{en}$  is the average world price of energy,  $PW$  is the average world price level (where world CPI is used as a proxy for it) and  $YW_w$  is real gross world income (i.e. world real GDP). According to Bond (1987), the world supply of energy ( $XS_w^{en}$ ) is treated as exogenously determined because over the estimation period many production decisions were made by a partial cartel dominated by OPEC. This study also applied the same reasoning since still the supply of energy is dominated by OPEC. Therefore, the supply of world energy is stated as:

$$XS_w^{en} = \overline{XS_w^{en}} \dots\dots\dots(3.7)$$

### 3.3.3.2 Export Demand and Supply of Energy for the Sample countries

World energy demand is allocated to the Sub-Saharan African countries with reference to their share in 2000 in the world energy market and a trend variable as:

$$XD_{it}^{en} = w_i XD_{wt}^{en} e^T \dots\dots\dots(3.8)$$

Where  $XD_i^{en}$  is the real value of exports of energy demanded from country i,  $w_i$  is the weight of demand for country i's energy exports in the world demand for energy in 2000 and T is a time trend.

By substituting equation (3.6) into equation (3.8), the following estimating equation, specified in log-linear form, can be obtained for the demand for energy exports from country i in year t as:

$$\ln XD_{it}^{en} = \beta_0 + \beta_1 \ln \left( \frac{PW^{en}}{PW} \right)_t + \beta_2 \ln YW_{wt} + T \dots\dots\dots(3.9)$$

Where,

$$\beta_0 = \ln w_i + \alpha_0, \beta_1 = \alpha_1 \text{ and } \beta_2 = \alpha_2 \dots\dots\dots(3.9a)$$

According to Bond (1987), the supply of energy from each developing country region is also assumed to be determined exogenously. These regions do not include major OPEC members, so that production decisions in these countries were not dominated by OPEC. In many of these countries, however, production decisions were dominated by national governments that provided capital toward initial investments in the oil sector. Thus, non economic criteria also influenced the oil sectors of many of these countries. Since the argument still holds, this study will also employ the same logic. Therefore, the supply of export of energy from each country

is assumed to be constant:

$$XS_i^{en} = \overline{XS_i^{en}} \dots\dots\dots(3.10)$$

The structural parameters can be estimated by solving equation 3.9 and 3.10 simultaneously by imposing an equilibrium condition. Therefore, the following estimating equation for the export of energy from country i in year t, in a panel framework, is specified in a log linear form as:

$$\ln X_{it}^{en} = \beta_0 + \beta_1 \ln \left( \frac{PW^{en}}{PW} \right)_t + \beta_2 \ln YW_{wt} + T \dots\dots\dots(3.11)$$

Where,

- $X_{it}^{en}$  - Real value of export of energy in thousands of US dollars at 2000 constant prices,
- $PW^{en}$  - The world price of export of energy in an index form (with 2000 as a base year),
- $PW$ - The world price level in an index form (world CPI is used as a proxy and 2000 is taken as a base year),
- $YW_w$  - The world real income (world real GDP in billions of US dollars at 2000 constant prices) and
- $T$ - Time trend.

After checking the existence of non-stationarity and co-integrating relationships (for those variables in equation 3.11, the long run elasticities are estimated using dynamic OLS.

### 3.4 Techniques of Estimation

The nature of the data should be known in order to determine appropriate techniques of estimation (for both equations 3.5 and 3.11). In doing so, the first step is checking the stationarity nature of the variables. Therefore, in the following sections different methods of



panel unit root tests, panel co-integration tests and panel co-integration estimation techniques are discussed.

### 3.4.1 Panel Unit Root Tests

It is necessary to check whether the variables follow a unit root or not and then employ appropriate methods of estimation accordingly. A variety of methods for the analysis of unit roots in a panel context have been developed. The emphasis in this development is the attempt to combine information from the time series dimension with that obtained from the cross sectional dimension, in the hope that inference about the existence of unit roots and cointegration can be made more straightforward and precise by taking account of the latter. To report the results of the tests, first it is necessary to note some points on the available methods. These tests can be presented in three parts as follow.

#### 3.4.1.1 Levin, Lin and Chu; Breitung and Hadri Tests

The earliest unit root tests developed for panel data are that of Levin and Lin (LL) tests (1992, 1993). The tests are based on estimating some version of a standard dynamic panel model of the form:

$$y_{it} = \rho y_{it-1} + z_{it}'\gamma + \mu_{it} \dots\dots\dots (3.12)$$

The subscript  $i = (1, 2, \dots, N)$  and  $t = (1, 2, \dots, T)$  distinguishes the cross sectional units and time respectively. Where,  $z_{it}$  is the deterministic component and  $\mu_{it}$  is a stationary process.

$z_{it}$  could be zero, one, a fixed effect ( $\pi_i$ ), a simple time trend ( $t$ ) or a mixture of fixed effect and heterogeneous time effect (Alemayehu et al, 2009; ). The Levin and Lin tests assume that  $\mu_{it}$  is IID  $(0, \sigma_\mu^2)$  and  $\rho_i = \rho$  for all  $i$ . This means that the coefficient of the lagged

dependent variable is assumed to be homogeneous across all cross-section units of the panel. Also, the individual processes are cross sectionally independent and hence no serial correlation. The null hypothesis is that each series in the panel contains a unit root, i.e.  $H_0 : \rho_i = \rho = 1$  (a common unit root process) against the alternative hypothesis that all individual series in the panel are stationary, i.e.  $H_a = \rho_i = \rho < 1$ .

Generally, the Levin and Lin test is based on the following pooled ADF estimating equation:

$$\Delta y_{it} = \alpha_i y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{i,t-L} + z_{it}' \gamma + \mu_{it} \dots \dots \dots (3.13)$$

In this case (equation 3.13), the null hypothesis that each series in the panel contains a unit root, i.e.  $H_0 : \alpha_i = \rho - 1 = 0$  under the assumption of  $\rho_i = \rho$  for all  $i$  is tested against the alternative hypothesis,  $H_a : \alpha < 0$  for  $\rho_i = \rho$ . The equation will be estimated by OLS as a pooled regression model. According to Harris and Sollis (2003), as cited in Alemayehu et al. (2009), Harris and Tzavalis (1999) conducted a Monte Carlo experiment to look at the power of the Levin and Lin tests. They found that the test is poor when the time dimension is small. Thus, in a situation where  $T$  (time dimension) is small and  $N$  relatively large, Harris and Tzavalis suggested their version of test. Their test is basically a panel unit root test of the Levin and Lin test type with  $T$  fixed instead of  $T \longrightarrow \infty$  (which is the case for LL test). This test is available for a model based on equation 3.12 with a homogeneity assumption imposed ( $\rho_i = \rho$ ) and  $z_{it} = 0$  or  $z_{it} = \pi_i$  or  $z_{it} = \{(\pi_i, t)'\}$ .

An extension of the Levin and Lin test is made by Levin, Lin and Chu (LLC), Breitung and Hadri. These tests assume that there is a common unit root process so that  $\rho_i$  is identical

across cross-sections, but allow the lag order for the difference terms  $p_i$  in equation 3.13 to vary across cross sections. The first two tests employ a null hypothesis of a unit root while the Hadri test uses a null of no unit root (stationary). The LLC and Breitung tests may be viewed as a pooled ADF test (as in equation 3.13), potentially with differing lag lengths across the units of the panel. The Hadri test is based on the residuals obtained from the individual OLS regressions of  $y_{it}$  on a constant, or on a constant and a trend (see Alemayehu et al (2009) for detail discussions).

### 3.4.1.2 Im, Pesaran and Shin (IPS) Tests

This is another test of stationarity of panel data variables in the model. The Levin and Lin test is restrictive in the sense that it requires  $\rho$  to be homogeneous across all cross sections  $i$ . By relaxing this assumption, Im, Pesaran and Shin (1997) allow for a heterogeneous coefficient of  $y_{i,t-1}$  and propose an alternative testing procedure based on averaging individual unit root test statistics. If a dynamic panel model is given as:

$$\Delta y_{it} = \alpha_i y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{i,t-L} + z'_{it} \gamma + \mu_{it} \dots \dots \dots (3.14)$$

The null hypothesis will be  $H_0 : \alpha_i = (\rho_i - 1) = 0$  (for all  $i$ ) while the alternative hypothesis being  $H_a : \alpha_i = [\rho_i - 1] < 0$  (for at least one  $i$ ), i.e., at least one of the individual series (cross section) in the panel is stationary. The IPS test is an average of the ADF individual unit root test statistics that are obtained from estimating equation 3.14 for each  $i$ , by allowing each series to have different lag length ( $L$ ) if needed (refer Alemayehu et al (2009) for computations of this test).

### 3.4.1.3 Maddala and Wu (MW) or Fisher Type Tests

Those panel unit root tests discussed above have a number of limitations. However, the assumption of cross sectional independence is by far unrealistic (Alemayehu et al (2009)). As Harris et al (2004) noted one of the major factors that any panel test needs to be able to address, if reliable inference is to be made in practical situations, is cross-sectional dependence. Cross-sectional dependencies are likely to be the rule rather than the exception in studying cross-country data due to the existence of strong inter-economy linkages. The tests of Hadri (2000), Choi (2001), Levin, Lin and Chu (2002), Shin and Snell (2002) and Im, Pesaran and Shin (2003) all assume independence across the panel and their size properties are uncertain when this rather unrealistic assumption does not hold.

As cited in Alemayehu et al (2009), the MW test is proposed as a means to overcome some of the limitations of the previous tests. Maddala and Wu (1999) proposed a chi-square ( $\chi^2$ ) test that combines the observed significance levels (P-values) for rejecting the null obtained when conducting a unit root test (the ADF test) for each cross section  $i$  separately. The Fisher-ADF and Fisher-PP tests are of such tests (for further discussions refer Alemayehu et al (2009)).

Having said these much on the available methods of panel unit root tests, the results of the panel unit root tests for the different commodity groups can be presented at this stage. This study used five types of panel unit root tests (i.e. the Levin, Lin, and Chu  $t$ -test; the Im, Pesaran, and Shin  $W$ -test; the ADF-Fisher Chi-square test; the PP-Fisher Chi-square test; and the Hadri test) to examine the existence of unit root process for the variables in equations 3.5 and 3. 11. The null hypothesis of the Hadri test is stationary while it is unit root for the other tests. The Dickey-fuller GLS unit root test is used for those variables which are common for

all cross sections like the world interest rate ( $I_w$ ) from equation 3.5 and the relative price of energy  $\left[\ln\left(\frac{PW^{en}}{PW}\right)\right]$  and gross world income ( $\ln YW$ ) from equation 3.11. The null hypothesis of this test is a unit root while the alternative hypothesis is stationarity. The auxiliary regression of each test includes a constant term. The results of the tests for the different commodity groups are presented in chapter four of section 4.1.

### 3.4.2 Panel Co-Integration Tests

All empirical works undertaken with non-stationary series faces the danger of being spurious. Co-integration analysis developed in the mid-1980s introduced the idea that even if underlying time series are non-stationary, linear combinations of these series might be stationary. Having recognized that the variables are  $I(1)$ , the next step is to check the existence of co-integrating (long run) relationships among them. To do so, the study conducted two residual based panel co-integration tests (i.e. Kao (1999) and Pedroni (1999, 2004)). These tests are applied for the equation of the real value of export of primary commodities (that captured both the demand and supply side factors). The equation of the real value of the export of these commodities can be rewritten using those  $I(1)$  variables; and by introducing individual fixed effects and time trends as:

$$\ln X_{it}^K = \delta_i + \theta_i t + c_{1i} \ln \left( \frac{PX_i^K}{PW^K} \right)_t + c_{2i} \ln \left( \frac{PX_i^K E_i}{P_i} \right)_{t-j} + c_{3i} \ln YW_{it} + c_{4i} \ln REER_{it} + c_{5i} \ln I_{wt} + c_{6i} \ln Inv_{i,t-j} + c_{7i} \ln GDP_{it} + c_{8i} \ln FDI_{it} + c_{9i} \ln DC_{it} + e_{it} \dots \dots \dots (3.15)$$

and

$$\ln X_{it}^{en} = \delta_i + \theta_i t + a_{1i} \ln \left( \frac{PW^{en}}{PW} \right)_t + a_{2i} \ln YW_{wt} \dots \dots \dots (3.16) \text{ Where}$$

re,  $i = 1, 2, \dots, N; t = 1, 2, \dots, T$ ;  $e_{it}$  is the stationary error term with zero mean and finite



variance; equation 3.15 is the specification for export of the first three commodity groups (i.e. food, agricultural raw materials and minerals) while equation 3.16 is for energy export.

First it is necessary to note some points on the features of the tests before presenting the results. The null hypothesis of both tests (Kao and Pedroni) is ‘no co-integration (long run) relationship among the variables (i.e. the residuals are non stationary)’ while the alternative hypothesis is ‘there is a cointegrating relationship among the variables (i.e. the residuals are stationary)’. Pedroni (1999, 2004) proposed residual-based tests for the null of no cointegration for dynamic panels with multiple regressors in which the short-run dynamics and the long-run slope coefficients are permitted to be heterogeneous across individuals. The tests allow for individual heterogeneous slope coefficients, fixed effects, trend terms and no exogeneity requirements are imposed on the regressors of the cointegrating regressions (Barbieri, n.d.). Specifically, the tests ask for the residuals estimation from static cointegrating long-run relation for a time series panel of observables  $y_{it}$  :

$$y_{it} = \alpha_i + \delta_i t + \beta_{1i} x_{1it} + \beta_{2i} x_{2it} + \dots + \beta_{ki} x_{kit} + e_{it} \dots \dots \dots (3.17)$$

$$i = 1, 2, \dots, N; t = 1, 2, \dots, T; k = 1, 2, \dots, k$$

In this specification,  $T$  is the number of observations over time,  $N$  is the number of cross sections in the panel and  $K$  is the number of regressors. It is possible to interpret the model (equation 3.17) as  $N$  different equations, each of which has  $K$  regressors. The variables  $y_{it}$  and  $x_{it}$  are assumed to be  $I(1)$ , for each member  $i$  of the panel, and under the null of no cointegration the residual  $e_{it}$  will also be  $I(1)$ .  $\alpha_i$  and  $\delta_i$  are scalars denoting fixed effects and unit-specific linear trend parameters, respectively and  $\beta_i$  are the cointegration slopes; note that all this coefficients are permitted to vary across individuals, so that considerable heterogeneity

is allowed by this specification. These cases are also assumed to hold in this study, i.e. for equations 3.15 and 3.16.

Pedroni proposed seven residual-based panel cointegration statistics, four based on pooling the data along the within-dimension (Panel v-Statistic, Panel rho-Statistic, Panel PP-test and Panel ADF test) and they are called “panel cointegration statistics”. The other three are based on pooling along the between-dimension (Group rho-Statistic, Group PP test and Group ADF-test) and they are called “group mean cointegration statistics”. Computationally, the former are constructed by summing both the numerator and the denominator terms over the  $N$  dimension separately (i.e. they are based on estimators that effectively pool the autoregressive coefficient across different members for the unit root tests on the estimated residuals), whereas the latter are constructed by first dividing the numerator by the denominator prior to summing over the  $N$  dimension (i.e. they are based on estimators that simply average the individually estimated coefficients for each member  $i$ ) (see the article of Barbieri for their computations).

Another distinction between the two sets of test is based on the alternative hypothesis specification. Although both sets of tests verify the null hypothesis of no cointegration,  $H_0 : \rho_i = 1, \forall i$  where  $\rho_i$  is the autoregressive coefficient of estimated residuals of equation 4.6, i.e.  $\left( \hat{e}_{it} = \rho_i \hat{e}_{it-1} + u_{it} \right)$ , the alternative hypothesis specification is different.

For the panel cointegration statistics, the alternative hypothesis can be stated as:  $H_a : \rho_i = \rho < 1, \forall i$  by imposing a common coefficient. However, the group mean cointegration statistics allow for heterogeneous coefficients under the alternative hypothesis

and it can be written as:  $H_a : \rho_i < 1, \forall i$ . In other words, the residuals of equation 3.17 (under the alternative hypothesis) have a common AR coefficients for the panel cointegration statistics and individual AR coefficients for the group mean cointegration statistics.

It is evident that the tests based on the between dimension are more general allowing for cross-section heterogeneity (refer the article by Barbieri for further discussions and computations of Pedroni's tests). Pedroni's (1997) simulations showed that for large periods (i.e.  $T > 100$ ), all statistics have the same power. However, for small periods (i.e.  $T < 20$ ), the most powerful test is the *ADF* tests based on the between dimension (*group t-statistic*). Therefore, for its superiority for small samples and allowing for heterogeneous coefficients, this study will give more weights for the results of the group t-statistics (the between dimension based statistics).

The other test of panel co-integration applied in this study is Kao's (1999) *ADF* test. He presented two tests for the null hypothesis of no cointegration in panel data: the *DF* and *ADF* type tests. Like pedroni's (1999, 2004) tests, Kao's (1999) test is an Engle/Granger-like residual based test. Similar to single time series, this approach tests the residuals from the estimation of equation 3.17 for stationarity (by assuming homogeneous slope coefficients).

Kao (1999) tests the residuals  $\hat{e}_{it}$  of the OLS panel estimation by applying *DF*- (equation 3.18) and *ADF*- (equation 3.19) like tests. The null hypothesis of no cointegration i.e.  $H_0 : \rho = 1$  is tested against the alternative hypothesis of stationary residuals i.e.  $H_a : \rho < 1$  for all  $i$  (Funke and Nickel, 2006). For further and detail discussions and computations of Kao's (1999) test refer Barbieri's article.

$$\hat{e}_{it} = \rho \hat{e}_{it-1} + u_{it} \dots\dots\dots(3.18)$$

$$\hat{e}_{it} = \rho \hat{e}_{it-1} + \sum_{j=1}^p \varphi_j \Delta \hat{e}_{it-j} + u_{itp} \dots\dots\dots(3.19)$$

If the estimated residuals of a given dynamic model are stationary, a linear combination of the time series included in the estimation exists so that the resulting time series is a stationary process. The time series are thus cointegrated. As in the case of single time series, this form of cointegration test does not allow to test for the number of cointegrating relationships among the variables in panel models. In cases where more than one cointegration relationship exists and/or not all variables are parts of the cointegration space, these tests only show that some combination of the included variables reveals stationary residuals. This means that some of the variables but not necessarily all of them are cointegrated (Funke and Nickel, 2006).

This study used four tests from Pedroni's (i.e. the Panel PP-test, Panel ADF test, Group PP test, and Group ADF-test) and the ADF test from Kao's tests to check the existence of long run relationships among the variables. In the null hypothesis, the residuals are non-stationary (i.e., there is no co-integrating relationship). In the alternative hypothesis, the residuals are stationary (i.e., there is a co-integrating relationship). The Pedroni test of panel co-integration is applicable for a group of variables of only seven or less. However, in this study, the number of non-stationary variables, as shown in equation 3.15, is greater than seven. Therefore, the study formed different combination of variables to check the existence of co-integrating relationships among the variables (by including the important variables [i.e. real export value, relative prices, capital formation indicators, weighted income of importers, world interest rate, etc.] in each combination). The results of the Pedroni tests support the existence of co-integrating relationships for any combination of the variables. However, this study reported

only three groups of variables (each group containing seven variables by including the important variables). These results (existence of co-integrating relationships) are also supported by the Kao test which helps to check the existence of co-integrating relationships among any number of variables. Generally, the results of the tests are reported for each commodity groups in chapter four of section 4.2.

### **3.4.3 Estimation Techniques**

For estimating a long-run relationship among the variables in a panel framework for the different commodity groups, the dynamic OLS (DOLS) estimator by Kao and Chiang (2000) is employed. As Kao and Chiang (2000) noted, the OLS estimation of co-integration regression is biased due to serial correlation and endogeneity. They also demonstrated that the panel OLS estimator is asymptotically normal, but with a non-zero mean. As a result, they proposed to use fully modified OLS (FMOLS) and dynamic OLS (DOLS) estimators in co-integrated panel data estimation. Both approaches take the potential endogeneity of involved variables into account. FMOLS corrects the endogeneity and serial correlation to the OLS estimator non-parametrically, while the DOLS uses the future and past values of the differenced explanatory variables as additional regressors. Therefore, for the case of this study, these methods must be used since they help to correct the endogeneity problem (i.e. the endogeneity of export value and price of export due to the simultaneity nature of demand and supply equations).

It is illustrated by Kao and Chiang (1999) that both estimators have the same (normal) limiting properties, although they demonstrate different performance in empirical analyses. The FMOLS does not improve the properties of the simple OLS estimator in finite samples.

However, DOLS can be considered to be more promising for the estimation of panel co-integration. Furthermore, the DOLS requires neither initial estimator nor non-parametric correction. Its major drawback, however, is that it can be sensitive to the selection of lags and leads. However, in Kao and Chiang's view, the failure of the non-parametric correction for the FMOLS to reduce estimation bias is far more damaging than the possible lack of robustness of DOLS to the exact choice of lags and leads. Moreover, as to them, the DOLS is the best estimator overall in a heterogeneous panel.

DOLS estimator provides valid and efficient inference on the parameters of a cointegrating vector. This method is superior to a number of other estimators as it can be applied to a system of variables with different orders of integration (Husain, 2009). The regression equation should be estimated by Panel OLS using the levels of the variables together with the lags and leads of the first differences' of the explanatory variables. A regression augmented with the leads and lags of the regressors' first differences yield estimators as efficient as those based on the semi parametric approach. This is called the leads-and-lags regression or dynamic OLS regression.

According to Kao and Chiang (2000), adding the number of leads and lags reduces the bias of the DOLS substantially. In this study, the DOLS framework is estimated with Panel OLS. Therefore, the standard errors can not be used since they are not corrected for the cross sectional heterogeneity (due to the inclusion of leads and lags of the differenced explanatory variables). Therefore, for the calculation of standard errors, either Newey-West Heteroscedasticity and Autocorrelation Consistent Covariance estimator or an adjusted covariance matrix (with cross sectional weights) has to be used. This study used the second



option to correct the standard errors (i.e. White cross-section standard errors & covariance matrix are used). Regarding the aforementioned considerations, DOLS method is used to estimate the long run cointegration relationship for the different commodity groups. The estimates of the DOLS, for the different commodity groups, are presented in chapter four of section 4.3.

## **CHAPTER FOUR**

### **ECONOMETRIC ANALYSIS AND DESCRIPTION OF RESULTS**

#### **4.1 Panel Unit Root Test Results**

##### **4.1.1 Panel Unit Root Test Results for Mineral Commodity Group**

The result of the tests for minerals is presented as follow in table 4.1 and 4.2. The results of all tests showed that the null hypothesis of a unit root is not rejected for the level variables of  $\ln YW$ ,  $\ln Inv_i$ ,  $\ln DC_i$ ,  $\ln FDI_i$  and  $\ln GDP_i$  whereas the null hypothesis of a unit root is rejected for the first difference of each variable at 1% significance level. However, for the case of  $\ln X$ , the LLC and ADF - Fisher Chi-square Tests rejected the null of unit root in level at 5% significance level while the other three tests accepted unit root in level and stationarity in first difference at 1% level of significance (remember that the null hypothesis of the Hadri test is stationarity (no unit root)). Since the majority of the tests (3 out of 5) supported a unit root in level for  $\ln X$ , the study considered it to follow a unit root process. For  $\ln(E_i PX_i^K / P_i)$ , the first four tests significantly not rejected the null of unit root in level while it is rejected significantly at 1% level of significance in first difference. For the other variable,  $\ln(PX/PW)$ , the LLC, IPS and ADF - Fisher Chi-square Tests support the existence unit root at level (see table 4.1).

The tests for  $\ln REER_i$  gave mixed results (i.e. the LLC and PP - Fisher Chi-square Tests significantly rejected the null hypothesis of unit root in level at 1% level of significance while the other three tests rejected the null for the first difference). Therefore, based on the results of the majority of the tests,  $\ln REER_i$  is taken to follow a unit root process. Since four of the five

tests significantly rejected the null of non-stationarity at 1% level of significance,  $\ln R_t$  is stationary (see table 4.1). The DF-GLS test significantly rejected the null hypothesis of a unit root at 1% level of significance for the first difference of the world interest rate ( $I_w$ ) while it does not reject the null significantly for level variable (see table 4.2). Therefore, most of the variables are found to be integrated of order one for mineral commodity group.

**Table 4.1: Unit Root Test Results at Level and First Difference for Mineral commodity group**

| Variables                   | LLC Test |            | IPS Test |            | ADF - Fisher Chi-square Test |             | PP - Fisher Chi-square Test |            | Hadri Test |            |
|-----------------------------|----------|------------|----------|------------|------------------------------|-------------|-----------------------------|------------|------------|------------|
|                             | Level    | First Diff | Level    | First Diff | Level                        | First Diff. | Level                       | First Diff | Level      | First Diff |
| $\ln X_{it}$                | -1.71**  | -14.2*     | -0.777   | -14.3*     | 54.33**                      | 239*        | 43.76                       | 582.45*    | 5.65*      | 1.389      |
| $\ln YW_{it}$               | 7.277    | -8.849*    | 10.924   | -5.588*    | 0.846                        | 95.26*      | 1.128                       | 76.48*     | 11.08*     | 3.488*     |
| $\ln(PX_{it}/PW_t)$         | 16.34    | 22.66      | 2.888    | -10.818*   | 18.26                        | 179.24*     | 532.5*                      |            | 13.128*    | 3.199*     |
| $\ln REER_{it}$             | -4.23*   |            | -1.826   | -11.267*   | 45.69                        | 182.72*     | 65.85*                      | 191.22*    | 9.97*      | -0.493     |
| $\ln(E_{it}PX_{it}/P_{it})$ | 0.449    | -12.57*    | 2.39     | -11.15*    | 29.09                        | 185.8*      | 22.98                       | 210.9*     | 3.49*      | 4.88*      |
| $\ln DC_{it}$               | 2.75     | -9.51*     | 3.83     | -9.16*     | 15.98                        | 156.4*      | 16.66                       | 176.6*     | 9.09*      | 3.64*      |
| $\ln R_{it}$                | -0.148   | -11.93*    | -1.63**  | -16.95*    | 57.38**                      | 283*        | 83.62*                      |            | 8.99*      | 2.25**     |
| $\ln GDP_{it}$              | -2.53**  | -5.96*     | 2.897    | -6.88*     | 21.12                        | 122.99*     | 17.28                       | 129.4*     | 10.51*     | 3.73       |
| $\ln FDI_{it}$              | 5.68     | -4.07*     | 8.14     | -5.35*     | 17.568                       | 107.49*     | 70.11*                      |            | 11.01*     | 3.82*      |
| $\ln Inv_{it}$              | 0.768    | -20.4*     | 1.697    | -17.91*    | 37.39                        | 300.1*      | 33.6                        | 657.06*    | 9.789*     | 2.247*     |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%
- LLC test- Null Hypothesis: Unit root (assumes common unit root process); Hadri test- Null Hypothesis: Stationarity; Other Tests- Null Hypothesis: Unit root (assume individual unit root process); Probabilities for Fisher tests are computed using asymptotic chi-square distribution & for others tests using asymptotic normality; Exogenous Variables: Individual effects; Lag length: 0 to 3 (automatic selection of lags based on AIC); and Newey-West bandwidth selection using Bartlett Kernel.

**Table 4.2: Unit Root Test Results at Level and First Difference for Mineral Commodity Group** (for the common variable)

| Variable | t-Statistic |               | critical values |           |                  |
|----------|-------------|---------------|-----------------|-----------|------------------|
|          | Level       | First Differ. | 1% level        | 5% level  | 10% level        |
| $I_{wt}$ | -1.574418   | -10.11454     | -2.571529       | -1.941724 | <b>-1.616098</b> |

- Elliott-Rothenberg-Stock DF-GLS test statistic and DF-GLS Test Equation on GLS Detrended Residuals; Null Hypothesis: has a unit root; and Critical values: MacKinnon (1996) and Lag Length: Automatic based on AIC.

#### 4.1.2 Panel Unit Root Test Results for Agricultural Raw Material Commodity Group

The panel unit root test results for agricultural raw materials are presented in table 4.3 and 4.4 as follow. The test results of  $\ln X$  gave mixed results. Although the LLC test rejected the null hypothesis of a unit root in level at 5% level of significance, the other four tests didn't support it at reasonable (acceptable) level of significance. However, the null hypothesis of a unit root is rejected for the first difference of  $\ln X$  at 1% level of significance by the last four tests. By considering these results,  $\ln X$  is assumed to follow a unit root process. The null hypothesis of a unit root is not rejected for the level variables of  $\ln(E_i PX_i^K / P_i)$ ,  $\ln YW$ ,  $\ln Inv_i$ ,  $\ln DC_i$ ,  $\ln REER_i$ ,  $\ln FDI_i$  and  $\ln GDP_i$  whereas the null hypothesis of a unit root is rejected for the first difference of each variable at 1% significance level by the first four tests. For the other variable,  $\ln(PX/PW)$ , the LLC, IPS and ADF - Fisher Chi-square Tests support the existence unit root at level. However,  $\ln R_i$  is found to be stationary (see table 4.3). The DF-GLS test significantly rejected the null hypothesis of a unit root at 1% level of significance for the first difference of the world interest rate ( $I_w$ ) while it does not reject the null significantly for the level variables (see table 4.4).

**Table 4.3: Unit Root Test Results at Level and First Difference for Agricultural Raw Materials Commodity Group**

| Variables              | LLC Test |           | IPS Test |           | ADF - Fisher Chi-square Test |           | PP - Fisher Chi-square Test |           | Hadri Test |           |
|------------------------|----------|-----------|----------|-----------|------------------------------|-----------|-----------------------------|-----------|------------|-----------|
|                        | Level    | First Dif | Level    | First Dif | Level                        | First Dif | Level                       | First Dif | Level      | First Dif |
| $\ln X_{it}$           | 1.27     | -8.27*    | -1.117   | -6.99*    | 37.93***                     | 110.96*   | 39.1***                     | 229.9*    | 6.58*      | 1.394     |
| $\ln(PX_i/PW)_i$       | 28.29    | 27.82     | -0.026   | -9.58*    | 26.66                        | 141.96*   | 1445*                       |           | 4.09*      | 4.57*     |
| $\ln YW_{it}$          | 4.065    | -6.53*    | 9.115    | -4.69*    | 1.519                        | 72.98*    | 2.88                        | 74.43*    | 10.4*      | 3.55*     |
| $\ln REER_{it}$        | 4.30     | -15.35*   |          |           | 4.363                        | 218.59*   | 3.728                       | 220.59*   | 7.56*      | 2.82**    |
| $\ln(E * PX / P)_{it}$ | 0.22     | -10.45*   | 0.317    | -9.758*   | 31.52                        | 144.45*   | 28.52                       | 204.58*   | 2.5***     | 4.34*     |
| $\ln Inv_{it}$         | 0.887    | -20.37*   | 1.088    | -15.49*   | 36.54                        | 182.74*   | 29.20                       | 213.7*    | 9.6*       | 0.413     |
| $\ln DC_{it}$          | 1.81     | -7.97*    | 2.71     | -8.89*    | 14.50                        | 129.92*   | 15.28                       | 153.04*   |            |           |
| $\ln R_{it}$           | -3.55*   |           | -1.73**  |           | 45.02**                      |           | 47.29**                     |           | 7.81*      | 0.69      |
| $\ln FDI_{it}$         | 2.05     | -6.769*   | 5.686    | -7.028    | 15.044                       | 109.12*   | 62.09*                      |           | 9.56*      | 2.57***   |
| $\ln GDP_{it}$         | 0.405    | -7.17*    | 4.79     | -7.12*    | 14.18                        | 107.19*   | 9.82                        | 85.96*    | 10.2*      | 2.75***   |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%
- LLC test- Null Hypothesis: Unit root (assumes common unit root process); Hadri test- Null Hypothesis: Stationarity; Other Tests- Null Hypothesis: Unit root (assume individual unit root process); Probabilities for Fisher tests are computed using asymptotic chi-square distribution & for others tests using asymptotic normality; Exogenous Variables: Individual effects (intercepts) for all variables but nothing for lnREER; Automatic lag length selection based on AIC: 0 to 5 and Bartlett kernel for lnX; and 0 to 3 for the others and Newey-West bandwidth selection using Bartlett Kernel; and Balanced observations for each test.

**Table 4.4: Unit Root Test Results at Level and First Difference for Agricultural Raw Materials Commodity Group (for the common variable)**

| Variable | t-Statistic |               | critical values |           |           |
|----------|-------------|---------------|-----------------|-----------|-----------|
|          | Level       | First Differ. | 1% level        | 5% level  | 10% level |
| $I_{wt}$ | -1.403738   | -10.16840     | -2.571437       | -1.941712 | -1.61619  |

- Elliott-Rootenbergs-Stock DF-GLS test statistic and DF-GLS Test Equation on GLS Detrended Residuals; Null Hypothesis: has a unit root; and Critical values: MacKinnon (1996) and Lag Length: Automatic based on AIC.

### 4.1.3 Panel Unit Root Test Results for Food Commodity Group

The panel unit root test results of food commodities are presented in table 4.5 and 4.6. The results of the majority of the tests supported that the null hypothesis of a unit root is accepted for the level variables of  $\ln X_i$ ,  $\ln(PX/PW)$ ,  $\ln(E_i PX_i^K / P_i)$ ,  $\ln YW$ ,  $\ln Inv_i$ ,  $\ln DC_i$ ,  $\ln GDP_i$ ,  $\ln REER_i$  and  $\ln FDI_i$  whereas the null hypothesis of a unit root is rejected for the first difference of each variable at 1% level of significance. However,  $\ln R_i$  is found to be stationary (see table 4.5). The DF-GLS test significantly rejected the null hypothesis of a unit root at 1% level of significance for the first difference of world interest rate ( $I_w$ ) while it does not reject the null significantly for level variable (see table 4.6).

**Table 4.5: Unit Root Test Results at Level and First Difference for Food commodity group**

| Variables               | LLC Test |             | IPS Test |             | ADF - Fisher Chi-square Test |             | PP - Fisher Chi-square Test |             | Hadri Test |             |
|-------------------------|----------|-------------|----------|-------------|------------------------------|-------------|-----------------------------|-------------|------------|-------------|
|                         | Level    | First Diff. | Level    | First Diff. | Level                        | First Diff. | Level                       | First Diff. | Level      | First Diff. |
| $\ln X_{it}$            | -1.055   | -8.50*      | -0.001   | -10.25*     | 49.81                        | 198.78*     | 98.11*                      |             | 9.04*      | 2.3***      |
| $\ln YW_{it}$           | 4.102    | -8.63*      | 11.48    | -6.25*      | 2.39                         | 124.15*     | 3.65                        | 110.04*     | 13.113*    | 3.78*       |
| $\ln(PX_i/PW)_i$        | 34.76    | 36.08       | 0.433)   | -10.66*     | 41.9                         | 206.97*     | 2551*                       |             | 5.778*     | 5.36*       |
| $\ln REER_{it}$         | -5.87*   |             | -3.66*   |             | 93.433*                      |             | 120.5*                      |             | 11.61*     | 1.208       |
| $\ln(E_i PX_i / P_i)_i$ | 2.068    | -11.56*     | 2.91     | -11.28*     | 33.65                        | 222.96*     | 31.21                       | 279.9       |            |             |
| $\ln DC_{it}$           | -1.206   | -10.70*     | 2.35     | -10.62*     | 30.07                        | 210.59*     | 25.17                       | 254.9*      | 7.84*      | 4.13        |
| $\ln R_{it}$            | -5.39*   |             | -2.79**  |             | 75.39**                      |             | 81.29**                     |             | 7.64*      | 0.914       |
| $\ln FDI_{it}$          | 3.93     | -8.51*      | 8.44     | -8.45*      | 19.90                        | 172.9*      | 74.37**                     |             | 12.95*     | 3.91*       |
| $\ln Inv_{it}$          | 1.859    | -24.35*     | 3.97     | -19.95*     | 22.66                        | 375.1*      | 25.04                       | 720.3*      | 12.31*     | 1.90**      |
| $\ln GDP_{it}$          | -2.37**  |             | 4.47     | -12.64*     | 25.62                        | 214.3*      | 19.58                       | 186.38*     | 13.18*     | 0.59        |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%



- LLC test- Null Hypothesis: Unit root (assumes common unit root process); Hadri test- Null Hypothesis: Stationarity; Other Tests- Null Hypothesis: Unit root (assume individual unit root process); Probabilities for Fisher tests are computed using asymptotic chi-square distribution & for others tests using asymptotic normality; Exogenous Variables: Individual effects; Lag length: 0 to 3 (automatic selection of lags based on AIC); Newey-West bandwidth selection using Bartlett Kernel; and Balanced observations for each test.

**Table 4.6: Unit Root Test Results at Level and First Difference for Food commodity group (for the common variable)**

| Variable | t-Statistic |               | critical values |           |           |
|----------|-------------|---------------|-----------------|-----------|-----------|
|          | Level       | First Differ. | 1% level        | 5% level  | 10% level |
| $I_{wt}$ | -1.802120   | -11.37270     | -2.569923       | -1.941503 | -1.616244 |

- Elliott-Rothenberg-Stock DF-GLS test statistic and DF-GLS Test Equation on GLS Detrended Residuals; Null Hypothesis: has a unit root; and Critical values: MacKinnon (1996) and Lag Length: Automatic based on AIC.

#### 4.1.4 Panel Unit Root Test Results for Energy Commodity Group

The results of the panel unit root tests for energy are presented in table 4.7 and 4.8. As the results implied, the null hypothesis of a unit root is not rejected for the level variable of  $\ln X^{en}$  whereas the null hypothesis of a unit root is rejected for the first difference at 1% level significance by all tests (see table 4.7). The DF-GLS test significantly rejected the null hypothesis of a unit root at 1% level of significance for the first difference of  $\ln(PW^{en}/PW)$  while it does not reject the null significantly in level. The other variable, gross real world income ( $\ln YW$ ), is also found to be  $I(1)$  at 1% level of significance (see table 4.8).

**Table 4.7: Unit Root Test Results at Level and First Difference for Energy commodity group**

| Variables         | LLC Test |           | IPS Test |           | ADF - Fisher Chi-square Test |           | PP - Fisher Chi-square Test |           | Hadri Test |           |
|-------------------|----------|-----------|----------|-----------|------------------------------|-----------|-----------------------------|-----------|------------|-----------|
|                   | Level    | First Dif | Level    | First Dif | Level                        | First Dif | Level                       | First Dif | Level      | First Dif |
| $\ln X_{it}^{en}$ | 3.342    | -18.47*   | 8.497    | -17.98*   | 0.51                         | 255.76*   | 0.51                        | 276.31*   | 10.84*     | -0.589    |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%

- LLC test- Null Hypothesis: Unit root (assumes common unit root process); Hadri test- Null Hypothesis: Stationarity; Other Tests- Null Hypothesis: Unit root (assume individual unit root process); Probabilities for Fisher tests are computed using asymptotic chi-square distribution & for others tests using asymptotic normality; Exogenous Variables: Individual effects; Lag length: 0 (automatic selection of lags based on AIC); Newey-West bandwidth selection using Bartlett Kernel; and Balanced observations for each test.

**Table 4.8: Unit Root Test Results at Level and First Difference for Energy commodity group (for the common variable)**

| Variable            | t-Statistic |               | critical values |           |           |
|---------------------|-------------|---------------|-----------------|-----------|-----------|
|                     | Level       | First Differ. | 1% level        | 5% level  | 10% level |
| $\ln(PW^{en}/PW)_t$ | -1.618597   | -5.770824     | -2.573217       | -1.941957 | -1.615945 |
| $\ln YW_{it}$       | -1.779591   | -16.57215     | -2.573398       | -1.941982 | -1.615929 |

- Elliott-Rothenberg-Stock DF-GLS test statistic and DF-GLS Test Equation on GLS Detrended Residuals; Null Hypothesis: has a unit root; and Critical values: MacKinnon (1996) and Lag Length: Automatic based on AIC.

Generally, for all commodity groups the null hypothesis of a unit root is not rejected at level while it is significantly rejected at their first differences for most of the variables by the majority of the tests. Therefore, after recognizing that the variables follow a unit root process (i.e. they are  $I(1)$ ), the next step will be investigating whether there exist a co-integrating (long run) relationship or not. The following section deals with this issue.

## 4.2 Panel Co-Integration Test Results

### 4.2.1 Panel Co-Integration Test Results for Mineral Commodity

#### Group

The panel co-integration test results for mineral commodity group are presented below in table 4.9. It tried to show the existence of a co-integrating relationship among  $\ln X$ ,  $\ln(PX/PW)$ ,  $\ln(EPX/P_i)$ ,  $\ln YW$ ,  $\ln Inv$ ,  $\ln REER$ ,  $\ln DC$ ,  $\ln FDI$ ,  $\ln GDP$  and  $I_w$  (see equation 3.15 to identify the  $I(1)$  variables). As table 4.9 show, the Kao's ADF test rejected the null hypothesis of no co-integrating relationship among these variables at 5% level of significance. The

Pedroni's tests also rejected the null hypothesis at 1% level of significance for any combinations of these variables (i.e. seven variables in each combination). Therefore, both tests supported the existence of long run relationships among the aforementioned variables.

**Table 4.9: Panel Co-Integration Test Results for Mineral Commodity Group**

| Group of variables                                                                                | Pedroni Tests          |                        |                       |                            | Kao ADF<br>Statistic |
|---------------------------------------------------------------------------------------------------|------------------------|------------------------|-----------------------|----------------------------|----------------------|
|                                                                                                   | Panel PP-<br>Statistic | Panel ADF<br>Statistic | Group PP<br>Statistic | Group<br>ADF-<br>Statistic |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, \ln Inv,$<br>$\ln FDI, I_w$                            | -2.7596*               | -0.9127                | -10.656*              | -3.3676*                   |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW,$<br>$\ln REER, \ln DC, I_w$                            | -4.3097*               | -2.914*                | -8.286*               | -3.2514*                   |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW,$<br>$\ln GDP, \ln FDI, I_w$                            | -5.1404*               | -4.135*                | -15.279*              | -5.524*                    |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, \ln Inv,$<br>$\ln FDI, I_w, \ln DC, \ln GDP, \ln REER$ |                        |                        |                       |                            | 1.7696**             |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%
- Pedroni Residual Cointegration Test -Null Hypothesis: No cointegration; Alternative hypothesis: individual AR coefs. (between-dimension); Trend assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 2; Newey-West automatic bandwidth selection and Bartlett kernel. Kao Residual Cointegration Test-Null Hypothesis: No cointegration; Alternative hypothesis: common AR coefs. (within-dimension); Trend Assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 3 and Newey-West automatic bandwidth selection and Bartlett kernel.

#### 4.2.2 Panel Co-Integration Test Results for Agricultural Raw Material Commodity Group

The null hypothesis of no cointegration among  $\ln X, \ln(PX/PW), \ln(E_i PX_i^K / P_i),$   
 $\ln YW, \ln Inv, \ln REER, \ln DC, \ln FDI, \ln GDP$  and  $I_w$  is rejected at 1% level of significance

by the Kao ADF test for agricultural raw materials. As table 4.10 show, the existence of a co-integrating relationship among any combination of these variables (a maximum of seven variables in any combination) is also supported by the Pedroni's tests. The null hypothesis is rejected at 1% level of significance.

**Table 4.10: Panel Co-Integration Test Results for Agricultural Raw Material  
Commodity Group**

| Group of variables                                                                                | Pedroni Tests          |                         |                        |                            | Kao ADF<br>Statistic |
|---------------------------------------------------------------------------------------------------|------------------------|-------------------------|------------------------|----------------------------|----------------------|
|                                                                                                   | Panel PP-<br>Statistic | Panel ADF-<br>Statistic | Group PP-<br>Statistic | Group<br>ADF-<br>Statistic |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, \ln Inv,$<br>$\ln FDI, I_w$                            | -6.405*                | -2.5955*                | -9.1818*               | -3.11*                     |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW,$<br>$\ln FDI, I_w, \ln DC$                             | -5.189*                | -2.1949**               | -10.226*               | -3.369*                    |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW,$<br>$I_w, \ln GDP, \ln REER$                           | -3.528*                | -3.493*                 | -4.2078*               | -3.7038*                   |                      |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, \ln Inv,$<br>$\ln FDI, I_w, \ln DC, \ln GDP, \ln REER$ |                        |                         |                        |                            | -2.5288*             |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%
- Pedroni Residual Cointegration Test -Null Hypothesis: No cointegration; Alternative hypothesis: individual AR coefs. (between-dimension); Trend assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 2; Newey-West automatic bandwidth selection and Bartlett kernel. Kao Residual Cointegration Test-Null Hypothesis: No cointegration; Alternative hypothesis: common AR coefs. (within-dimension); Trend Assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 3 and Newey-West automatic bandwidth selection and Bartlett kernel.

### 4.2.3 Panel Co-Integration Test Results for Food Commodity Group

Table 4.11 presented the panel cointegration test results of export of food commodities. The existence of a co-integrating relationship is supported among  $\ln X, \ln(PX/PW), \ln(E_i PX_i^K / P_i), \ln YW, \ln Inv, \ln REER, \ln DC, \ln FDI, \ln GDP$  and  $I_w$  with both tests (i.e. Kao and Pedroni tests). The null hypothesis of ‘there is no co-integrating relationship among these variables’ is rejected significantly at 1% level of significance by the Kao’s DF test. It is also rejected by the Pedroni’s tests for any group of seven variables at 1% of level of significance.

**Table 4.11: Panel Co-Integration Test Results for Food Commodity Group**

| Group of variables                                                                           | Pedroni Tests      |                       |                        |                       | Kao DF Test Stat. |
|----------------------------------------------------------------------------------------------|--------------------|-----------------------|------------------------|-----------------------|-------------------|
|                                                                                              | Panel PP-Statistic | Panel ADF-Statistic   | Group PP-Statistic     | Group ADF-Statistic   |                   |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, \ln Inv, \ln FDI, I_w$                            | -2.656*            | -1.876670<br>(0.0303) | -13.61321<br>( 0.0000) | -5.375920<br>(0.0000) |                   |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, \ln FDI, I_w, \ln DC$                             | -3.35*             | -2.478**              | -17.78*                | -7.22*                |                   |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, I_w, \ln GDP, \ln REER$                           | -13.158*           | -11.205*              | -21.908*               | -10.439*              |                   |
| $\ln X, \ln(PX/PW), \ln(E * PX/P), \ln YW, \ln Inv, \ln FDI, I_w, \ln DC, \ln GDP, \ln REER$ |                    |                       |                        |                       | -4.7067*          |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%
- Pedroni Residual Cointegration Test -Null Hypothesis: No cointegration; Alternative hypothesis: individual AR coefs. (between-dimension); Trend assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 2; Newey-West automatic bandwidth selection and Bartlett kernel. Kao Residual Cointegration Test-Null Hypothesis: No cointegration; Alternative hypothesis: common AR coefs. (within-dimension); Trend Assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 4 and Newey-West automatic bandwidth selection and Bartlett kernel.

#### 4.2.4 Panel Co-Integration Test Results for Energy Commodity Group

A co-integrating relationship is also supported by both tests (Pedroni and Kao) for energy export function (i.e. equation 3.16). In the case of an export function specification with a fixed effect, the null hypothesis of ‘there is no co-integrating relationship among  $\ln X^{en}, \ln(PW^{en}/PW)$  and  $\ln YW^w$ ’ is rejected at 1% level of significance by the Panel PP test, Group ADF test and Kao’s ADF test. However, the panel ADF and Group ADF tests could not reject the null. When the export function is specified with a fixed effect and a time trend, a co-integrating relationship is supported by all tests at 1% level of significance (see table 4.12).

**Table 4.12: Panel Co-Integration Test Result for Energy Commodity Group**

| Deterministic<br>Trend<br>Specification | Group of variables               | Pedroni Tests          |                         |                        |                         | Kao ADF<br>Test |
|-----------------------------------------|----------------------------------|------------------------|-------------------------|------------------------|-------------------------|-----------------|
|                                         |                                  | Panel PP-<br>Statistic | Panel ADF-<br>Statistic | Group PP-<br>Statistic | Group ADF-<br>Statistic |                 |
| With Intercept                          | $\ln X, \ln(PW^{en}/PW), \ln YW$ | -2.892**               | 5.058                   | -2.253**               | 7.6779                  | -3.269*         |
| With Intercept<br>and Trend             | $\ln X, \ln(PW^{en}/PW), \ln YW$ | -4.645*                | -7.144*                 | -4.014*                | -6.80*                  |                 |

- The figures are t-statistics and \*Significant at 1%, \*\*Significant at 5%, \*\*\*Significant at 10%
- Pedroni Residual Cointegration Test -Null Hypothesis: No cointegration; Alternative hypothesis: individual AR coefs. (between-dimension); Trend assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 3; Newey-West automatic bandwidth selection and Bartlett kernel. Kao Residual Cointegration Test-Null Hypothesis: No cointegration; Alternative hypothesis: common AR coefs. (within-dimension); Trend Assumption: No deterministic trend; Automatic lag length selection based on AIC with a max lag of 4 and Newey-West automatic bandwidth selection and Bartlett kernel.



### 4.3 Estimation Results

This study analyzed the determinants of the export of primary commodities in Sub Saharan African countries by applying non- stationary panel data analysis. As justified in the previous chapter, the co-integrating variables for the different commodity groups should be estimated using dynamic OLS (DOLS). The standard errors of the coefficients that are reported in this study are white cross-section standard errors, i.e., the covariance matrix is corrected using cross sectional weights to correct for serial heterogeneity and correlation. In other words, the co-integrating variables are estimated using White cross-section standard errors to allow for general contemporaneous correlation between the cross sections residuals. This estimator is robust to cross-equation (contemporaneous) correlation as well as different error variances in each cross-section. Specifically, the unconditional contemporaneous variance matrix is unrestricted, and the conditional variance matrix can depend on in arbitrary, unknown fashion (Wooldridge, 2003; Arellano, 1987). The results of the panel co-integration estimation for the different commodity groups are presented as follow in the subsequent sub-sections.

#### 4.3.1 Estimation Results for Mineral Commodity Group

Having recognized the existence of a co-integrating relationship among  $\ln X, \ln(PX/PW), \ln(E_i PX_i^K / P_i), \ln YW, \ln Inv, \ln REER, \ln DC, \ln FDI, \ln GDP$  and  $I_w$  for mineral commodities, the next step is estimation of the long run relationship using Dynamic OLS (DOLS). The endogenous variable,  $\ln X$ , is regressed on the other variables together with their lags and leads of their first differences (two lags and leads are used). However, the estimated coefficients of the leads and lags of differenced variables do not have economic interpretations. The existence of high collinearity among the regressors forced to drop some

variables like  $\ln DC$ ,  $\ln GDP$  and  $\ln REER$  (since these variables are highly correlated with the capital formation indicators ( $\ln Inv$  and  $\ln FDI$ ), and with  $\ln(E_i PX_i^K / P_i)$ ). However, the exclusion of these variables will not reduce the quality of the results since the included variables can also play the role of these variables well. The results of the regression are presented in table 4.13.

As table 4.13 shows most of the variables are found to be statistically significant with their expected signs. As per the result, the most important determinants of export of minerals in Sub-Saharan Africa are the relative price of minerals ( $\ln(PX/PW)$ ), foreign direct investment and the weighted average income of importers. However, the magnitude of the relative price and income elasticities is too small (i.e. inelastic). The other variables (the world interest rate and the fifth lag of domestic investment) are also found to be important determinants of export of minerals. The estimated equation of the real value of export of mineral can be written as:

$$\ln X_{it} = -0.6382 \ln \left( \frac{PX_i}{PW} \right)_t + 0.5272 \ln FDI_{it} + 0.38145 \ln YW_{it} + 0.1671 \ln Inv_{i,t-5} - 0.1343 I_{wt} - 0.093 \ln \left( \frac{E_i PX_i}{P_i} \right) \dots \dots \dots (4.1)$$

As equation 4.1 shows, the results are in line with the theory. For instance, an increase in the export price relative to world price of mineral leads to a reduction in the real value of export of mineral. Since relative price is a demand side factor, it affects export value negatively. The world interest rate also negatively affects the value of export of minerals which means importers used the commodity market of minerals to diversify their portfolio of investment. They include minerals as one of their basket of portfolio to reduce the risk in financial investments.

The capital formation indicators ( $\ln Inv_{i,t-5}$  and  $\ln FDI$ ) are also found to affect the export of minerals positively. The result also implied that the participation of foreign direct investors in the mining sector is significant. However, the sign of  $\ln(E_i PX_i^K / P_i)$  is in contrary with theory. An increase in the price of export of mineral relative to domestic price (an indicator of competition of the export sector with the domestic market) leads to a reduction in the value of export of minerals and vice versa. The implication of this is that deflationary pressure in home countries and devaluation of domestic currencies affect export of minerals in the region negatively (as opposed to the neo-classical views). This is may be due to the subsistence nature of life in sub Saharan Africa and consumers do not consume minerals in deflationary situations. It can be also inferred based on the result of the study that revaluation (appreciation) of domestic currencies in the region helps to improve the export performance of minerals.

**Table 4.13: Estimation Results for Minerals**

| Dependent Variable: $\ln X_{it}^K$ |                   |                     |             |                   |
|------------------------------------|-------------------|---------------------|-------------|-------------------|
| Variable                           | Coefficient       | Std. Error          | t-Statistic | Prob.             |
| $\ln(PX_i^K / PW^K)_t$             | -0.638220         | 0.259977            | -2.454912   | 0.0148            |
| $\ln(E_i PX_i^K / P_i)_t$          | -0.092918         | 0.021410            | -4.339858   | 0.0000            |
| $\ln YW_{it}$                      | 0.381448          | 0.030145            | 12.65359    | 0.0000            |
| $\ln FDI_{it}$                     | 0.527208          | 0.060266            | 8.747992    | 0.0000            |
| $I_{wt}$                           | -0.134334         | 0.054957            | -2.444358   | 0.0153            |
| $\ln Inv_{i,t-5}$                  | 0.167077          | 0.027498            | 6.075915    | 0.0000            |
| $(d \ln(E_i PX_i^K / P_i))_{t-1}$  | 0.487528          | 0.320097            | 1.523065    | 0.1291            |
| $(d \ln FDI_i)_{t-1}$              | -0.711313         | 0.216946            | -3.278759   | 0.0012            |
| $(d \ln(PX_i^K / PW^K))_{t-1}$     | -0.509466         | 0.501849            | -1.015177   | 0.3111            |
| $(d \ln YW_i)_{t-1}$               | 1.343238          | 1.157799            | 1.160165    | 0.2472            |
| $(d \ln Inv_{i,t-5})_{t-1}$        | -0.257665         | 0.094840            | -2.716827   | 0.0071            |
| $(dI_{wt})_{t-1}$                  | -0.052745         | 0.068474            | -0.770291   | 0.4419            |
| $(dI_{wt})_{t-2}$                  | -0.096669         | 0.030728            | -3.145976   | 0.0019            |
| $(d \ln Inv_{i,t-5})_{t-2}$        | -0.228272         | 0.075461            | -3.025024   | 0.0028            |
| $(d \ln(E_i PX_i^K / P_i))_{t-2}$  | 0.030208          | 0.355872            | 0.084885    | 0.9324            |
| $(d \ln FDI_i)_{t-2}$              | -0.501103         | 0.269871            | -1.856822   | 0.0646            |
| $(d \ln(PX_i^K / PW^K))_{t-2}$     | 0.051552          | 0.124336            | 0.414617    | 0.6788            |
| $(d \ln YW_i)_{t-2}$               | -1.722678         | 1.055617            | -1.631916   | 0.1041            |
| $(dI_{wt})_{t+1}$                  | 0.007956          | 0.037857            | 0.210163    | 0.8337            |
| $(d \ln Inv_{i,t-5})_{t+1}$        | -0.102255         | 0.121630            | -0.840705   | 0.4014            |
| $(d \ln(E_i PX_i^K / P_i))_{t+1}$  | 0.442757          | 0.349370            | 1.267302    | 0.2063            |
| $(d \ln FDI_i)_{t+1}$              | -0.181221         | 0.107793            | -1.681195   | 0.0941            |
| $(d \ln(PX_i^K / PW^K))_{t+1}$     | -0.626385         | 0.330392            | -1.895882   | 0.0592            |
| $(d \ln YW_i)_{t+1}$               | 2.704736          | 1.485974            | 1.820177    | 0.0700            |
| $(dI_{wt})_{t+2}$                  | -0.057006         | 0.050800            | -1.122168   | 0.2630            |
| $(d \ln Inv_{i,t-5})_{t+2}$        | 0.022123          | 0.122377            | 0.180774    | 0.8567            |
| $(d \ln(E_i PX_i^K / P_i))_{t+2}$  | -0.004739         | 0.017954            | -0.263948   | 0.7921            |
| $(d \ln FDI_i)_{t+2}$              | 0.071465          | 0.160181            | 0.446150    | 0.6559            |
| $(d \ln(PX_i^K / PW^K))_{t+2}$     | -0.280348         | 0.464439            | -0.603627   | 0.5467            |
| $(d \ln YW_i)_{t+2}$               | 2.305991          | 1.606582            | 1.435340    | 0.1525            |
| R-squared                          | 0.562213          | Mean Dependent Var. |             | 7.301172          |
| Adj. R-square                      | 0.507252          | S.D. Dependent var. |             | 1.860445          |
| S.E. of Regression                 | 1.305957          | F-statistic         |             | 142793.9 (0.0000) |
| Sum Squared Residual               | 393.9763          | Chi-square          |             | 1856321           |
| Jarque-Bera                        | 0.71297 (0.70024) | .0000)              |             |                   |

### 4.3.2 Estimation Results for Agricultural Raw Material Commodity Group

The panel co-integration estimation results for the agricultural raw material commodity group are presented as follow in table 4.14. The estimation is done using DOLS by the inclusion of two lags and leads of the first differences of the regressors. Due to higher multicollinearity,  $\ln gdp$  and  $\ln DC$  are dropped from the regression (since the included variables can also play the role of these variables). As table 4.14 shows, most of the variables are found to be statistically significant with their expected signs. However, the two variables [foreign direct investment ( $\ln FDI$ ) and world interest rate ( $Iw$ )] are statistically insignificant though they got their expected signs. This is may be due to lower participation of foreign investors in the production and export of agricultural raw materials in Sub-Saharan African countries. The insignificance of world interest rate implies that investors in the developed countries do not used agricultural raw material products of Sub-Saharan Africa to hedge against the risk of investing in financial markets.

Based on the result, the most important determinants of export of agricultural raw materials in Sub-Saharan Africa in the long run are the real effective exchange rates (which affects positively), the relative price of export of agricultural raw materials (affects negatively), the lagged investment (affects positively), the international value of the commodity relative to its domestic value (affects positively) and the weighted average income of the importing countries (affects positively). However, all elasticities are inelastic for this commodity group. The small country hypothesis (for exports of Sub Saharan African agricultural raw materials) is also rejected since the coefficient of the relative price  $\ln(PX/PW)$  is statistically significant at 5% level of significance. Refer equation 4.2 and table 4.14 for full aspects of the results.

Equation 4.2 indicates the long run estimating result of the real value of export of agricultural raw materials.

$$\ln X_{it} = -0.47358 \ln \left( \frac{PX_i}{PW} \right)_t + 0.10598 \ln \left( \frac{E_i PX_i}{P_i} \right)_t + 0.100223 \ln YW_{it} + 0.041534 \ln FDI_{it} + 0.54639 \ln REER_{it} + 0.4395 \ln Inv_{i,t-1} - 0.0715 I_{wt} \dots\dots\dots (4.2)$$



**Table 4.14: Estimation Results for Agricultural Raw Materials**

| Dependent Variable: $\ln X_{it}$  |             |            |             |        |
|-----------------------------------|-------------|------------|-------------|--------|
| Variable                          | Coefficient | Std. Error | t-Statistic | Prob.  |
| $\ln(PX_i^K / PW^K)_t$            | -0.473580   | 0.217588   | -2.176500   | 0.0310 |
| $\ln(E_i PX_i^K / P_i)_t$         | 0.105976    | 0.013508   | 7.845317    | 0.0000 |
| $\ln YW_{it}$                     | 0.100223    | 0.039692   | 2.524997    | 0.0125 |
| $\ln FDI_{it}$                    | 0.041534    | 0.040638   | 1.022065    | 0.3083 |
| $\ln REER_{it}$                   | 0.546394    | 0.090501   | 6.037414    | 0.0000 |
| $\ln Inv_{i,t-1}$                 | 0.439531    | 0.060850   | 7.223175    | 0.0000 |
| $I_{wt}$                          | -0.071470   | 0.059015   | -1.211049   | 0.2277 |
| $(dI_{wt})_{t-1}$                 | -0.094602   | 0.052909   | -1.787999   | 0.0757 |
| $(d \ln Inv_{i,t-1})_{t-1}$       | -0.621625   | 0.290153   | -2.142407   | 0.0337 |
| $(d \ln(E_i PX_i^K / P_i))_{t-1}$ | 0.186867    | 0.428371   | 0.436227    | 0.6633 |
| $(d \ln FDI_i)_{t-1}$             | -0.085458   | 0.113307   | -0.754216   | 0.4518 |
| $(d \ln REER_{it})_{t-1}$         | -0.469726   | 0.183092   | -2.565515   | 0.0112 |
| $(d \ln(PX_i^K / PW^K))_{t-1}$    | -0.069958   | 0.508846   | -0.137483   | 0.8908 |
| $(d \ln YW_i)_{t-1}$              | 1.706800    | 0.888309   | 1.921404    | 0.0565 |
| $(dI_{wt})_{t+1}$                 | -0.046896   | 0.058369   | -0.803443   | 0.4229 |
| $(d \ln Inv_{i,t-1})_{t+1}$       | 0.001069    | 0.228286   | 0.004685    | 0.9963 |
| $(d \ln(E_i PX_i^K / P_i))_{t+1}$ | -0.055752   | 0.445893   | -0.125034   | 0.9007 |
| $(d \ln FDI_i)_{t+1}$             | -0.193075   | 0.126106   | -1.531048   | 0.1277 |
| $(d \ln REER_{it})_{t+1}$         | 0.866846    | 0.293168   | 2.956826    | 0.0036 |
| $(d \ln(PX_i^K / PW^K))_{t+1}$    | 0.502218    | 0.667683   | 0.752180    | 0.4531 |
| $(d \ln YW_i)_{t+1}$              | 0.955201    | 1.036513   | 0.921552    | 0.3582 |
| $(d \ln(E_i PX_i^K / P_i))_{t-2}$ | -0.280049   | 0.297739   | -0.940587   | 0.3483 |
| $(d \ln YW_i)_{t-2}$              | 0.586978    | 0.820265   | 0.715596    | 0.4753 |
| $(dI_{wt})_{t-2}$                 | -0.018614   | 0.028040   | -0.663841   | 0.5078 |
| $(d \ln Inv_{i,t-1})_{t-2}$       | -0.665736   | 0.206651   | -3.221550   | 0.0015 |
| $(d \ln FDI_i)_{t-2}$             | -0.165490   | 0.079256   | -2.088044   | 0.0384 |
| $(d \ln REER_{it})_{t-2}$         | 0.213460    | 0.143177   | 1.490882    | 0.1380 |
| $(d \ln(PX_i^K / PW^K))_{t-2}$    | 0.378861    | 0.524693   | 0.722061    | 0.4713 |
| $(dI_{wt})_{t+2}$                 | 0.057738    | 0.052879   | 1.091890    | 0.2765 |
| $(d \ln Inv_{i,t-1})_{t+2}$       | -0.249453   | 0.429310   | -0.581055   | 0.5620 |
| $(d \ln(E_i PX_i^K / P_i))_{t+2}$ | 0.120427    | 0.029536   | 4.077292    | 0.0001 |
| $(d \ln FDI_i)_{t+2}$             | -0.120050   | 0.111723   | -1.074536   | 0.2842 |

### CONTINUED

|                                |           |                       |                    |        |
|--------------------------------|-----------|-----------------------|--------------------|--------|
| $(d \ln REER_{it})_{t+2}$      | 0.359564  | 0.433361              | 0.829709           | 0.4079 |
| $(d \ln(PX_i^K / PW^K))_{t+2}$ | -0.022481 | 0.272442              | -0.082518          | 0.9343 |
| $(d \ln YW_i)_{t+2}$           | -0.682280 | 1.057489              | -0.645189          | 0.5197 |
| <hr/>                          |           |                       |                    |        |
| R-squared                      | 0.456364  | S.E. of regression    | 0.715289           |        |
| Adjusted R-squared             | 0.340115  | Jarque-Bera statistic | 0.714708(0.699525) |        |
|                                |           |                       | 124223.2           |        |
| Sum squared residual           | 81.35043  | F-statistic           | (0.0000)           |        |
|                                |           | Chi-square            | 1490678(0.0000)    |        |

### 4.3.3 Estimation Results for Food Commodity Group

The final panel co-integration estimation results for food commodities are given below in table 4.15 and equation 4.3. When  $\ln X$  is regressed on  $\ln(PX/PW)$ ,  $\ln(E_i PX_i^K / P_i)$ ,  $\ln YW$ ,  $\ln Inv$ ,  $\ln REER$ ,  $\ln DC$ ,  $\ln FDI$ ,  $\ln GDP$  and  $I_w$  together with their leads and lags of their first differences, the coefficients became statistically insignificant with unexpected signs. As a result, some of the regressors like  $\ln GDP$ ,  $\ln DC$  and  $I_w$  are dropped from the DOLS regression (due to higher correlations). The real value of export of food commodities ( $\ln X$ ) is regressed on  $\ln(PX/PW)$ ,  $\ln(E_i PX_i^K / P_i)$ ,  $\ln YW$ ,  $\ln Inv_{t-1}$ ,  $\ln REER$ ,  $\ln FDI$  and two leads and lags of the first differences of each regressors. The results are in line with the theory and the estimates are statistically significant (with their expected signs) at reasonable level of significance except for  $\ln(E_i PX_i^K / P_i)$ .

Lagged investment (which is a supply side factor) is found to be the most important determinant of export of food commodities in Sub-Saharan Africa. The relative export price of food (which is a demand side factor) affects the value of export of food commodities negatively. The weighted average income of importers of food commodities from Sub-Saharan

Africa and foreign direct investment inflows are also important determinants of export of food commodities (which affects positively). Real effective exchange rate is also found to be one of the factors affecting export of food from Sub-Saharan Africa. It also implies that devaluation of home currencies encourages the export of food commodities. However,  $\ln(E_i P X_i^K / P_i)$  became statistically insignificant at the conventional levels and got unexpected sign. An increase in the value of export of food relative to its domestic value discourages the export of it. This is may be due to the subsistence nature of life in Sub-Saharan Africa and a decrease in domestic prices may encourage the consumption of exportable food items. Refer table 4.15 and equation 4.3 below for the full version of the results of the estimates.

$$\ln X_{it} = -0.48455 \ln \left( \frac{PX_i}{PW} \right)_t + 0.02733 \ln YW_{it} + 0.732415 \ln Inv_{i,t-1} + 0.28998 \ln REER_{it} + 0.13969 \ln FDI_{it} \dots\dots\dots (4.3)$$

**Table 4.15 Estimation Results for Food Commodity Group**

| Dependent Variable: $\ln X_{it}$  |             |            |             |        |
|-----------------------------------|-------------|------------|-------------|--------|
| Variable                          | Coefficient | Std. Error | t-Statistic | Prob.  |
| $\ln(PX_i^K / PW^K)_t$            | -0.484550   | 0.087463   | -5.540077   | 0.0000 |
| $\ln(E_i PX_i^K / P_i)_t$         | -0.004940   | 0.010201   | -0.484273   | 0.6284 |
| $\ln Inv_{i,t-1}$                 | 0.732415    | 0.037115   | 19.73377    | 0.0000 |
| $\ln YW_{it}$                     | 0.027329    | 0.012084   | 2.261476    | 0.0242 |
| $\ln REER_{it}$                   | 0.289978    | 0.038384   | 7.554657    | 0.0000 |
| $\ln FDI_{it}$                    | 0.139689    | 0.034729   | 4.022240    | 0.0001 |
| $(d \ln Inv_{i,t-1})_{t-1}$       | 0.083634    | 0.090934   | 0.919721    | 0.3582 |
| $(d \ln(E_i PX_i^K / P_i))_{t-1}$ | -0.017390   | 0.033279   | -0.522537   | 0.6016 |
| $(d \ln(PX_i^K / PW^K))_{t-1}$    | -0.028091   | 0.091420   | -0.307270   | 0.7588 |
| $(d \ln YW_i)_{t-1}$              | 0.001461    | 0.037758   | 0.038686    | 0.9692 |
| $(d \ln Inv_{i,t-1})_{t-2}$       | -0.033106   | 0.060542   | -0.546822   | 0.5848 |
| $(d \ln(E_i PX_i^K / P_i))_{t-2}$ | 0.003356    | 0.021706   | 0.154599    | 0.8772 |
| $(d \ln(PX_i^K / PW^K))_{t-2}$    | -0.036734   | 0.055092   | -0.666783   | 0.5053 |
| $(d \ln YW_i)_{t-2}$              | 0.000459    | 0.042373   | 0.010824    | 0.9914 |
| $(d \ln Inv_{i,t-1})_{t+2}$       | 0.087320    | 0.110823   | 0.787927    | 0.4312 |
| $(d \ln(E_i PX_i^K / P_i))_{t+2}$ | 0.032144    | 0.014407   | 2.231222    | 0.0262 |
| $(d \ln(PX_i^K / PW^K))_{t+2}$    | -0.225538   | 0.052244   | -4.317031   | 0.0000 |
| $(d \ln YW_i)_{t+2}$              | -0.009690   | 0.034740   | -0.278937   | 0.7804 |
| $(d \ln Inv_{i,t-1})_{t+1}$       | 0.623372    | 0.084862   | 7.345669    | 0.0000 |
| $(d \ln(E_i PX_i^K / P_i))_{t+1}$ | 0.007564    | 0.015140   | 0.499572    | 0.6176 |
| $(d \ln(PX_i^K / PW^K))_{t+1}$    | -0.560785   | 0.087329   | -6.421500   | 0.0000 |
| $(d \ln YW_i)_{t+1}$              | 0.147307    | 0.041526   | 3.547387    | 0.0004 |
| $(d \ln(FDI_i))_{t-2}$            | -0.112339   | 0.050591   | -2.220529   | 0.0269 |
| $(d \ln(FDI_i))_{t-1}$            | -0.094810   | 0.047465   | -1.997498   | 0.0464 |
| $(d \ln(FDI_i))_{t+2}$            | 0.013555    | 0.023127   | 0.586124    | 0.5581 |
| $(d \ln(FDI_i))_{t+1}$            | -0.078889   | 0.066422   | -1.187698   | 0.2356 |
| $(d \ln(REER_i))_{t-1}$           | -0.061542   | 0.076464   | -0.804844   | 0.4213 |
| $(d \ln(REER_i))_{t-2}$           | 0.020610    | 0.052508   | 0.392500    | 0.6949 |
| $(d \ln(REER_i))_{t+1}$           | 0.166042    | 0.129786   | 1.279353    | 0.2014 |
| $(d \ln(REER_i))_{t+2}$           | 0.219534    | 0.071691   | 3.062240    | 0.0023 |

### Continued

|                    |          |                   |                        |
|--------------------|----------|-------------------|------------------------|
| R-squared          | 0.668738 | Sum squared resid | 653.2195               |
|                    |          | F-statistic       | 134.8 (0.0000)         |
| Adjusted R-squared | 0.646855 | Chi-square        | 808.99 (0.0000)        |
| S.E. of regression | 1.219824 | Jarque-Bera stat  | 1.545763<br>(0.457813) |

### 4.3.4 Estimation Results for Energy Commodity Group

Table 4.16 and equation 4.4 showed the dynamic OLS regression results for energy commodity group. For this commodity group also the leads and lags of the first differences of the regressors are determined to be two. As the table shows, the coefficients of the regressors are statistically significant with their expected signs. The long run relative price elasticity of demand for energy is -2.65633 while the long run income elasticity of demand is 2.450222. The result of the price elasticity is higher as compared with the results of previous studies (related studies) whereas the income elasticity is lower. Generally, the relative prices of energy and gross world income are found to be important determinants of exports of energy in Sub-Saharan Africa.

$$\ln X_{it}^{en} = -2.656332 \ln(PW^{en}/PW)_t + 2.450222 \ln YW_{wt} \dots\dots\dots(4.4)$$

**Table 4.16: Estimation Results for Energy**

| Dependent Variable: $\ln X_{it}^{en}$ |                     |                     |                   |        |
|---------------------------------------|---------------------|---------------------|-------------------|--------|
| Variable                              | Coefficient         | Std. Error          | t-Statistic       | Prob.  |
| $\ln(PW^{en}/PW)_t$                   | -2.656332           | 1.309948            | -2.027815         | 0.0439 |
| $\ln YW_{wt}$                         | 2.450222            | 0.061900            | 39.58362          | 0.0000 |
| $d(\ln(PW^{en}/PW))_{t-1}$            | 4.814648            | 1.810953            | 2.658627          | 0.0085 |
| $d(\ln(PW^{en}/PW))_{t+1}$            | 0.608568            | 1.484930            | 0.409829          | 0.6824 |
| $d(\ln YW_{wt})_{t-1}$                | 24.64172            | 5.121099            | 4.811803          | 0.0000 |
| $d(\ln YW_{wt})_{t+1}$                | 40.61078            | 9.144086            | 4.441207          | 0.0000 |
| $d(\ln(PW^{en}/PW))_{t-2}$            | -0.890032           | 0.831383            | -1.070545         | 0.2857 |
| $d(\ln YW_{wt})_{t-2}$                | 23.49011            | 6.262193            | 3.751099          | 0.0002 |
| $d(\ln YW_{wt})_{t+2}$                | -14.01960           | 8.372344            | -1.674513         | 0.0956 |
| $d(\ln(PW^{en}/PW))_{t+2}$            | -2.379681           | 1.390793            | -1.711024         | 0.0886 |
| <hr/>                                 |                     |                     |                   |        |
| R-squared                             | 0.801073            | Mean dependent var. | 11.91331          |        |
| Adjusted R-squared                    | 0.792121            | S.D. dependent var. | 5.024021          |        |
| Sum squared residual                  | 1049.406            | S.E. of regression  | 1.090640          |        |
|                                       |                     | F-statistic         | 648.5687 (0.0000) |        |
| Jarque-Bera stat.                     | 1.613399 (0.446329) | Chi-square          | 6485.687 (0.0000) |        |



## **CHAPTER FIVE**

### **CONCLUSION AND POLICY IMPLICATIONS**

#### **5.1 CONCLUSION**

This study used panel data to empirically analyze the determinants of export of primary commodities (minerals, food, agricultural raw materials and energy) in Sub-Saharan African countries for the period 1990-2008. The study analyzed both the demand and supply side factors that affect the export of these commodities in the region. For the first three commodity groups, the export demand function is specified in a semi-log linear form: the real value of export as a function of relative price (export price of a commodity per world export price), weighted average income of importers, world interest rate and real effective exchange rate. Export prices relative to the domestic prices, gross domestic investment, foreign direct investment, domestic credits and paved roads in km are included as supply side determinants of export of the first three commodity groups. However, the specification of the energy commodity group is different. After allocating the world energy demand to the sample countries using their share in 2000 as a fixed weight, the real value of energy from the region is specified in log linear form as a function of world energy price relative to world price and gross world income (assuming the supply of energy as constant).

After specifying the export functions for the different commodity groups, the variables are checked for unit root. Most of the variables, except paved roads in km, are found to be integrated of order one (i.e. the results of the majority of the tests revealed that the null hypothesis of a unit root is not rejected at level whereas it is significantly rejected in their first differences). Having found a non stationary process [ $I(1)$ ] for most of the variables, the

existence of a co-integrating (long run) relationship is checked using the Kao (1999) and Pedroni (1999, 2004) panel co-integration tests. For all commodity groups, the null hypothesis of no co-integrating (i.e. no long run) relationship among the variables is significantly rejected by the majority of the tests.

Having found a co-integrating relationship, the long run relationships were estimated using the Dynamic OLS (DOLS) which accounts for serial correlations and problems of endogeneity by the inclusion of the lags and leads of the first differences of the explanatory variables. To account for the bias of the standard errors White cross-section standard errors & covariances were used. The empirical results obtained in this study are in line with those obtained from other studies and theory. The results demonstrate the inelastic nature of price and income responses in the demand for the exported commodities (except energy) of Sub-Saharan African countries in the long run. The macroeconomic policies pursued by the importers are found to be among the important determinants of exports of the region.

The export of minerals from Sub-Saharan Africa mainly depends on the relative price of minerals (the export price of minerals relative to the world export price of minerals), foreign direct investment, the weighted average income of importers, the fifth lag of domestic investment, world interest rate and the relative values of exports of minerals relative to their domestic values. These variables were found to be statistically significant with their expected values. The relative price of minerals and foreign direct investment were found to be the two most important determinants of exports of minerals in the region. The other variable, world interest rate, affects the value of export of minerals negatively which means

importers used the commodity market of minerals to diversify their portfolio of investments. They include minerals in their basket of portfolios to reduce the risk of investing in financial markets. Based on the results, the most important determinants of export of agricultural raw materials in Sub-Saharan Africa in the long run are the real effective exchange rates, the relative price of export of agricultural raw materials (export price of SSA relative to world export prices of agricultural raw materials), lagged domestic investments, the international value of the commodity relative to its domestic value and the weighted average income of the importing countries.

The exports of food commodities from Sub-Saharan African countries highly depend on lagged domestic investments and relative export price (export price of SSA food commodities relative to the world export price of food commodities) in the long run. The weighted average income of importers, real effective exchange rate and foreign direct investment are also found to be important determinants of food commodities. The regression results of the exports of energy were also statistically significant with their expected signs. The long run price (relative price) and income elasticities of exports of energy from Sub-Saharan Africa are -2.656 and 2.45, respectively. Therefore, the export of energy from SSA is highly sensitive to price and income changes in the long run.

## **5.2 POLICY IMPLICATIONS**

Since most of the elasticities found are inelastic, Sub-Saharan African countries should diversify their exportable items and it requires a deliberate policy to expand the number and type of exportable items. Therefore, the exportation of other products (preferably, the

exportation of manufactured goods) should be encouraged to get out of the risks of price volatility and terms of trade deteriorations. Structural transformation is required to diversify their exportable items and to start exporting manufactured commodities.

Export diversification often goes hand in hand with export promotion, which refers to the set of measures and policies used by a country to boost the volume, value and variety of its exports in order to increase foreign exchange earnings, ensure balance-of-payments viability and promote economic development. In general, based on the results of the study, the following points are recommended to improve the performance of exports of primary commodities from Sub-Saharan Africa.

- Nations should establish and strengthen active Commodity Exchange Markets to hedge against the risk of volatility of prices of primary commodities (since stock holding has impact on commodity exports);
- African governments and the international community should work to trickle down the benefits of exports of commodities to the African farmers so as to encourage producers (to enhance investment and production);
- Intensively negotiate with industrialize countries to open their markets for African commodities, to stop their protective measures; expand and consolidate existing export markets as well as create new markets (other than Europe and USA) for destinations of African exports through new agreements, economic integrations, etc.;
- Governments should vigorously promote improvements in rural infrastructure, enhance extension delivery services, undertake aggressive marketing, provide comprehensive agricultural trade information and offer other requisite incentive

packages and trade support infrastructure. Nations should attract an increased number of entrepreneurs (including foreigners) for setting up export-oriented industries and encourage them by establishing different incentive packages. Foreign investors should be encouraged in the sector;

- Establish backward linkages between export-oriented industries and primary sectors for the utilization of local raw materials;
- Countries should enhance the marketability of exportable primary commodities through product diversification, value adding and quality improvements;
- Nations should remove bureaucratic procedures (procedural and regulatory bottlenecks) to attain efficiency in the economy in general and in the export sector in the particular. Sub-Saharan African countries should strengthen and improve their institutional frameworks for providing services to exporters and export-oriented industries; and
- Generally, countries of the region should invest much on human capital development since it is the base for everything. Appropriate human resource development programmes should be designed for the promotion of entrepreneurial and managerial skills in the context of a competitive international environment.

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# APPENDIX I

Table 1: Export Share ( $\alpha_{ij}$ ) of the Sample Countries by Destination (in percentage)

| Importer            | Benin | Burkina F. | Belgium | China | Djibouti | EU | France | German | Ghana | India | Italy | Japan | Kenya Dem | Korea D. Dem. | Netherlands | Nigeria | Portugal | Senegal | S. Arabia | Spain | S. Africa | Switzerland | Tanzania | Uganda | UK | USA |
|---------------------|-------|------------|---------|-------|----------|----|--------|--------|-------|-------|-------|-------|-----------|---------------|-------------|---------|----------|---------|-----------|-------|-----------|-------------|----------|--------|----|-----|
| Exporter            |       |            |         |       |          |    |        |        |       |       |       |       |           |               |             |         |          |         |           |       |           |             |          |        |    |     |
| Benin               |       |            |         | 55    |          |    |        |        |       | 23    |       |       |           |               |             | 22      |          |         |           |       |           |             |          |        |    |     |
| Botswana            |       |            |         |       |          |    |        |        |       |       |       |       |           |               |             |         |          |         |           |       | 10        |             |          | 90     |    |     |
| Burkina Fa.         |       |            |         |       |          |    | 36     |        | 42    |       |       |       |           |               |             |         |          |         |           |       |           | 22          |          |        |    |     |
| Burundi             |       |            | 28      |       |          |    |        |        |       |       |       |       |           |               |             |         |          |         |           |       |           | 51          |          | 21     |    |     |
| Cameroon            |       |            |         |       |          |    | 22     |        |       |       | 31    |       |           |               | 18          |         |          |         |           | 29    |           |             |          |        |    |     |
| Cape Verde          |       |            |         |       |          |    |        |        |       |       |       |       |           |               |             |         | 82       |         |           |       |           |             |          |        | 18 |     |
| Central African Rep |       |            | 82      |       |          |    | 18     |        |       |       |       |       |           |               |             |         |          |         |           |       |           |             |          |        |    |     |
| Congo Dem           |       |            |         |       |          | 82 |        |        |       |       |       |       |           |               |             |         |          |         |           |       |           |             |          |        | 18 |     |
| Congo Rep           |       |            |         | 28    |          |    |        |        |       |       |       |       |           | 29            |             |         |          |         |           |       |           |             |          |        | 43 |     |
| Cote D.             |       |            |         |       |          |    | 47     |        |       |       |       |       |           |               | 29          |         |          |         |           |       |           |             |          |        | 24 |     |
| Ethiopia            |       |            |         |       | 26       |    |        | 33     |       |       |       | 23    |           |               |             |         |          |         | 18        |       |           |             |          |        |    |     |
| Equatorial Guinea   |       |            |         |       |          | 71 |        |        |       |       |       |       |           |               |             |         |          |         |           |       |           |             |          |        | 29 |     |
| Gabon               |       |            |         | 9     |          |    | 10     |        |       |       |       |       |           |               |             |         |          |         |           |       |           |             |          |        | 81 |     |
| Gambia              |       |            |         |       |          |    |        | 12     |       |       |       |       |           |               |             |         |          | 20      |           |       |           |             |          | 68     |    |     |
| Ghana               |       |            |         |       |          |    |        |        |       |       |       |       |           |               |             |         |          |         |           |       | 32        | 24          |          | 34     | 10 |     |
| Guinea              |       |            |         |       |          |    | 47     |        |       |       |       |       |           |               |             |         |          |         |           | 26    |           |             |          |        | 27 |     |
| Kenya               |       |            |         |       |          |    |        |        |       |       |       |       |           | 17            |             |         |          |         |           |       |           |             | 16       | 34     | 33 |     |



Table 1: Continued

| Importer   | Benin | Burkina F. | Belgium | China | Djibouti | EU | France | German | Ghana | India | Italy | Japan | Kenya | Korea Dem. | Netherlands | Nigeria | Portugal | Senegal | S. Arabia | Spain | S. Africa | Switzerland | Tanzania | Uganda | UK | USA |
|------------|-------|------------|---------|-------|----------|----|--------|--------|-------|-------|-------|-------|-------|------------|-------------|---------|----------|---------|-----------|-------|-----------|-------------|----------|--------|----|-----|
| Exporter   |       |            |         |       |          |    |        |        |       |       |       |       |       |            |             |         |          |         |           |       |           |             |          |        |    |     |
| Madagascar |       |            |         |       |          |    | 67     |        |       |       |       |       |       |            |             |         |          |         |           |       |           |             |          |        |    | 33  |
| Malawi     |       |            |         |       |          |    |        |        |       |       |       |       |       |            |             |         |          |         |           |       | 36        |             |          |        | 26 | 38  |
| Mali       |       |            |         |       |          |    | 10     |        |       |       |       |       |       |            |             |         |          |         |           |       | 30        | 60          |          |        |    |     |
| Mauritania |       |            |         |       |          |    | 28     |        |       |       | 29    |       |       |            |             |         |          |         |           | 43    |           |             |          |        |    |     |
| Mauritius  |       |            |         |       |          |    | 30     |        |       |       |       |       |       |            |             |         |          |         |           |       |           |             |          |        | 43 | 27  |
| Mozambique |       |            |         |       |          |    |        |        |       |       |       |       |       |            | 40          |         |          |         |           | 17    | 43        |             |          |        |    |     |
| Namibia    |       |            |         |       |          |    |        |        |       |       |       |       |       |            |             |         |          |         |           | 18    | 44        |             |          |        | 38 |     |
| Niger      |       |            |         |       |          |    | 34     |        |       |       |       | 13    |       |            |             | 53      |          |         |           |       |           |             |          |        |    |     |
| Nigeria    |       |            |         |       |          |    | 10     |        |       | 22    |       |       |       |            |             |         |          |         |           | 10    |           |             |          |        |    | 58  |
| Rwanda     |       |            |         |       |          |    |        |        |       |       |       |       | 75    |            |             |         |          |         |           |       |           | 12          |          | 13     |    |     |
| Senegal    |       |            |         |       |          |    | 59     |        |       |       |       |       |       |            |             | 31      |          |         |           | 10    |           |             |          |        |    |     |
| Seychelles |       |            |         |       |          |    | 25     |        |       |       |       |       |       |            |             |         |          |         | 36        |       |           |             |          |        | 39 |     |
| S. Africa  |       |            |         |       |          |    |        | 20     |       |       |       | 21    |       |            |             |         |          |         |           |       |           |             |          |        | 28 | 31  |
| Sudan      |       |            |         | 84    |          |    |        |        |       |       |       | 8     |       |            |             |         |          |         | 8         |       |           |             |          |        |    |     |
| Togo       | 30    | 31         |         |       |          |    |        |        | 39    |       |       |       |       |            |             |         |          |         |           |       |           |             |          |        |    |     |
| Uganda     |       |            |         |       |          |    |        |        |       |       |       |       | 34    |            | 29          |         |          |         |           |       |           | 37          |          |        |    |     |
| Zambia     |       |            |         |       |          |    |        |        |       |       |       |       |       |            |             |         |          |         |           |       | 36        | 24          |          |        | 40 |     |
| Zimbabwe   |       |            |         |       |          |    |        |        |       |       |       |       |       |            |             |         |          |         |           |       | 60        | 17          |          |        | 23 |     |

## DECLARATION

I, the undersigned, declare that this thesis is my original work and has never been presented in any other university. All sources of materials used for this thesis have been duly acknowledged. The examiners' comments have been dully incorporated.

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