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Addis Ababa University

ADDIS ABABA UNIVERSITY

FACULTY OF NATURAL SCIENCE

DEPARTMENT OF STATISTICS

GRADUATE PROGRAMME

AN ASSESSMENT OF THE VARIATION OF THE EXPORT TRADE OF ETHIOPIA ACROSS CONTINENTS AND OVER TIME

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Abstract

The aim of this study is to apply the linear nested classifications and panel data models to assess the variation and the structure of the Ethiopian foreign trade of exports based on annual export data from1970 to 2007. The assessment of the variation of the Ethiopian foreign trade of exports is done by the linear nested classifications and the assessment of the structure is done by the panel data models. The results indicate that the Ethiopian foreign trade of export is dependent on the export of agricultural products and skin and leather across the continents of Africa, Asia, Europe and North America. The structural trend indicates that the export trade is growing with time at random growth rate.

Key words: Foreign trade, variation of foreign trade, structure of trade and growth.

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List of Abbreviations

ECA	Ethiopian Custom Authority
COMESA	Common Market for Eastern and Southern Africa
CSA	Central Statistical Authority
EPA	Economic Partnership Agreement
EU	European Union
FDRE	Federal Democratic Republic of Ethiopia
FTA	Free Trade Area
FE	Fixed Effects
RE	Random Effects
GDP	Gross Domestic Product
LDC	Least Developed Countries
MOTI	Ministry of Trade and Industry
USD	United States Dollar
VAT	Value Added Tax

Chapter One

INTRODUCTION

1.1 BACKGROUND

1.1.1 The foreign trade

When we compare one country to another we can see differences in economic structure and economic dependence. This economic dependence creates economic interrelationships among the countries in the real world. As a consequence, foreign trade comes into existence. In general this trade covers many countries in the world; due to this we can say foreign trade is an international trade.

An international trade is partly a micro level and partly a macro level trade. The micro level is that an international trade influences the output (the selling price) choices and the input (the buying price) choices in every country in the world. This shows us that international trade touches the micro economy of each of the nations. When we see the macro level, an international trade is concerned with the economic relationship among nations. In this case, all the ideas and principles of macroeconomic theory can be applied to the international trade. Therefore, from these two reasonings we conclude that international trade is partly micro level and partly macro level in its structure.

1.1.2 The importance of foreign trade

Today international trade has its own importance in our world. About 15% of the world's output is traded in the international trade. And it is also considered as one of the identifier features of strong nations in the world. The importance of the international sector varies enormously from place to place on the planet. Even though international trade is important to every country in the world, its importance is different among nations. Some nations are almost closed economies, with foreign trade equaling only a very small proportion of total output, while other nations are open economy towards the international trade. One of the most striking characteristics of any relatively poor nation undergoing a substantial amount of economic growth is the decline in self-sufficiency. In general the features of those nations are not strong in their economy.

1.1.3 The economic partnership

International trade consists of the export trade and import trade. According to the demand and supply of the international market structure, the world countries created economic interrelationship. This economic relationship is called economic partnership. The economic partnership is one of the determinant factors of foreign trade. Actually the main benefit from increasing exports is usually to increase the capacity to import intermediate inputs and other goods and services which are necessary or help to foster economic development in the domestic market. There are many studies which show the positive effects of exports but very few focused on the role of imports, and this study contributes on the rule of exports. The contribution of the industrial sector to the non-industrial sector is twofold: directly providing intermediate and capital goods to non industrial sectors and indirectly increasing exports and the capacity to import foreign inputs which contribute to domestic production (Guisan, *2008*).

1.2 STATEMENT OF THE PROBLEM

In the history of Ethiopia, foreign trade and exchange of goods is started at the ancient ages. In the time of the Axum Empire there was a trade among neighboring countries in the region of the Red sea. This trading system has its own importance and considerable influence on the exchange of goods among countries around the region during that time.

The Ethiopian foreign trade of export is dependent on the export of few agricultural commodities. For long periods of time, coffee is the leading export item of Ethiopia. For instance in 1980/01 Ethiopia was the 6^{th} largest exporter of coffee (Atlas Ethiopia, 1981). Next to coffee, the country exports skin and leather, oil seeds, cereals, chat and other similar items.

The major importance of this study is to provide quantitative information about the variation and the structure of the Ethiopian foreign trade of export. In the case of this study, great emphasis is given to the revenue from the export items (response variable) in order to assess the variation and the structure of the Ethiopian foreign trade of exports across continents. In the assessment of the variation, we are concerned with the identification of the least and most influential continents and export items that have impact on the export trade of Ethiopia, while in the assessment of structure, we are concerned with its nature. The study of the variation of the Ethiopian foreign trade of export is done by taking the aggregated revenue from export according to the export items. And, the study of the structure of the Ethiopian foreign trade of export is done by taking revenue form export with the quantities of the items of export (predictor variables).

1.3 OBJECTIVES OF THE STUDY

1.3.1 General objective

The major motivation of this study is to provide quantitative information about the variation and the structure of the Ethiopian foreign trade of export. According to this, the general objective of the study is:

- To develop a statistical model that can show the variation of the Ethiopian foreign trade of exports and to investigate its structure.

1.3.2 Specific objectives

- To estimate the effect of export items within continents on the Ethiopian foreign trade of export.
- To estimate the effects of export items across continents on the Ethiopian foreign trade of export.
- To determine the dynamic/static nature of the items of export on the Ethiopian foreign trade of export.
- To assess the performance of the Ethiopian foreign trade of export with respect to the economic growth rate.
- To determine the between and the within variability of the Ethiopian foreign trade of exports with respect to the continental categories.

1.4 SIGNIFICANCE OF THE STUDY

The study will contribute an econometric/ statistical model of the Ethiopian foreign trade of exports. The following are the important applications of the study: -

- The study will provide statistical information about the structure of the Ethiopian foreign trade of export.
- The study will identify the most and the least influential continents on the Ethiopian foreign trade of export.
- The study will identify the most and the least dominant items that determine the Ethiopian foreign trade of export.

1.5 LIMITATIONS

Most of the limitations of the study are associated with the assumptions that are taken by the study. The following are the limitations of the study:-

- The study has no knowledge and information about the existence of structural break in the foreign trade of Ethiopia. As a result, the study assumed that there is no structural break on the foreign trade of Ethiopia.
- The study estimates the item effects between the continents; it doesn't estimate the item effects of different countries within the continent on the foreign trade of Ethiopia.

CHAPTER TWO

LITERATURE REVIEWS

Most of the empirical studies of foreign trade fall into one of two basic frameworks, the import/export trade and the economic partnership. This paper reviews the literature dealing with the effects of continents and the items of export on the foreign trade of Ethiopia. The overall evidence is best characterized as mixed as the results are sensitive to the choices of sample period, model specification, proxies for effects of continents and the export items. Numerous empirical studies have been conducted to investigate whether Ethiopian foreign trade of export is influenced by the export items. It is widely believed that increasing the agricultural export trade contributes a lot for the growth of the Ethiopian economy.

Actually there are many research papers that deal with foreign trade in general. Most of the research papers are dealt with its effect on the exchange rate and a few are on the economic partnership and the share of a given country. The empirical studies use statistical or econometric models to investigate the solutions to their problem domains.

2.1 EMPIRICAL STUDIES

One of the empirical studies that we are going to see is the research paper on the Brazilian foreign trade of imports (Morais et. al, 2004). The paper uses the Markov Switching model to check the characteristics of the Brazilian demand for imports based on annual data from 1947 to

2002 and on quarterly data from 1978:I to 2002:II. The results show that the model satisfactorily describes the structural and performance characteristics of the Brazilian foreign trade of imports in the last decades. When the economy was in a low state of growth or in a recession at the early times, the demand for imports was much small. When the economy was in a high growth state in recent years, the demand for imports is expanding much. These switches are governed by the transition probability matrix. The long-term analysis, based on annual data, allowed for the identification of cyclic periods of the import trade closure and openness that coincide with the historical events of Brazilian economy. The analysis, based on quarterly data, indicates different elasticities for a regime with rise and fall in imports.

The research paper that studies about the balance of the foreign trade of France using time series models (Pluyaud, 2008) is summarized as follows. The major objective of the study was to determine the effects of the foreign trade of France on the balance of the overall foreign trade of the country. The paper presents equations for intra and extra euro area trade for France. Volumes and prices of imports and exports of goods are modeled. Dynamic simulations, residual tests and rolling forecasts indicate that the equations have satisfactory forecasting properties. Among other results, it found that a stronger long run elasticity to price competitiveness for intra than for extra euro area exports, and positive contributions of price competitiveness to non energy import growth since 1999, probably due to evolutions in costs rather than in exchange rates. The paper indicated that, for the long run extra euro area exports are affected by the vales of the exchanging commodities to the country.

A research paper that studies the balance of the foreign trade of India with its nine trading partners Germany, Canada, Japan, UK, USA, France, UAE, Switzerland, Australia and Sweden (Prasad et. al, 1996) is summarized as follows. The paper uses multivariate co integration models to determine the balance of the foreign trade of India. This paper attempts to model the bilateral trade balance between India and nine of its major trading partners (accounting for 65 % of its total trade with the noncommunist bloc during the decade of the eighties). A monthly analysis was conducted for six out of the nine countries, and a quarterly analysis for the remaining three countries. One of the major and robust conclusions of this study pertains to the effective role played by the exchange rate in influencing the trade balance. Both the real and nominal exchange rates enter all the co integrating vectors with the correct sign. Further, the real exchange rate is significant in all cases except Canada and the nominal exchange rate in all cases except France. The hypothesis however merely predicts that proportionate rise in domestic and foreign incomes does not leave the trade balance unaltered, but does not specify whether such a change affects the trade balance favorably or adversely. The paper concluded that for three of India's trading partners the net impact of such a change is adverse, whereas for the remaining five it is favorable.

When we come to research papers in Africa, we find the study made by Egesa (2007). The aim of the paper was to estimate the long run structure of the foreign trade of Uganda using the co-integration correlation models. The result indicates both an increase in the volume of trade as well as commodity shifts with the share of agriculture exports falling and oil imports rising in the post trade liberalization period. The long-run estimates showed low responsiveness of agricultural exports to price and developments compared to aggregate exports comprised of a large share of non-agricultural commodities. However, agricultural exports showed more responsiveness to changes in trading partners' income compared to aggregate exports. For imports, oil imports were more responsive to both price and income changes compared to both aggregate and non-oil imports. It was not possible to discern from the results a significant exchange rate effect on imports. The results suggest that, Uganda's potential policy options for harnessing gains from trade liberalization include promoting value addition among agricultural exports as well as promoting stability in domestic prices and the exchange rate.

When we come to studies on Ethiopian foreign trade of imports, first we find the paper which was done to determine the demand of imports (Teigist, 2006). Petroleum imports showed an increase of 18.3 per cent from the year 2003/04 and, 55 percent on all oil products compared to prices in 2004/05. Machinery and equipment, chemical products, transport equipment, raw materials and minerals dominate the overall imports of the country. Significant increases in imports of raw materials (89 per cent) and capital goods (125 per cent) were observed in 2004/05 compared to the previous year. It is expected that the expansion in industrial production and, the international price rise for metal products such as iron sheet and steel, are expected to further increase the value of imports into Ethiopia. The import of cereals was relatively stable while that of aircraft has slightly increased since 2003/04. Ethiopia has made significant reductions in import tariff rates and disparities. The quota system, contingency restrictions and seasonal tariffs, which were applied on used clothes and security/safety sensitive items, have been abolished.

Like most of the Least Developed Countries (LDCs) in Africa, Ethiopia exports few commodities that are mainly primary goods in the international market (Chane et. al.2004). Indeed, around 80% of total exports comprised agricultural and food products over the period 1995-2002. Leather and leather products, textiles and garments represented 17%, while mining products represented 2%. Among the agricultural exports, coffee represented as much as 50% in 2002, followed by vegetable products (13%) and dried beans (12%), sesame seed (12%) and raw cane sugar. The five major trading partners of Ethiopia in terms of exports (in decreasing order) were: - the EU, Djibouti, Japan, Saudi Arabia and the United States since 1995. Over the period 1995-2002, the EU, within which Italy, Germany and the United Kingdom represented the major players, remained the first buyers of Ethiopian exports. The export structure has experienced some limited improvements in terms of products and destination diversification as well as in terms of higher degree of processing.

A research paper that indicates the share and the structure of the Ethiopian foreign trade of imports was done by the Ethiopian Ministry of Trade (2002). The paper indicated that the major share of Ethiopia's import expenditure goes to non-durable consumer goods, which took 37 % of all the import values in the last decade. Capital goods had a share of 17 percent followed by semi-processed goods (15%), raw material (13%), durable consumer goods (12%), etc. The major suppliers of Ethiopia's imports have been Europe, Asia and America. In terms of share, Europe was number one with a share of 43 per cent. Asia's share in the decade-long imports of Ethiopia was about 7 per cent. Overall COMESA region accounts only for 3% of the total global imports of the country. Among the COMESA member countries, Djibouti was number one with a share of 46 per cent followed by Kenya with 31 per cent share. The third and fourth were Egypt and Zimbabwe with shares of 14 and 5 per cent, respectively.

CHAPTER THREE

DATA AND METHODOLOGY

3.1 THE DATA

3.1.1 The source of the data

The data for this study are secondary data which are obtained from the Ethiopian Custom Authority (ECA) information access department. The data was collected for various activities done in the last 11 years (from 1997-2007) of the Ethiopian foreign trade. Some supportive data for the study are obtained from Commercial Bank of Ethiopia (CBE) and the Central Statistical Agency (CSA) which contains data of the revenue from the export trade of Ethiopia from 1970-2007.

The export data contains annual data from 1997-2007 on the country of destination, revenue from export and the quantity and the quality of the exported item.

3.1.2 The variables selected for the study

The selection of the independent and the dependent variables for the study is done by the logical interrelationship of the variables with respect to the objective of the study. Based upon the general and the specific objectives of the study, we select the variables by merging the export items as follows.

The export variables

1. The revenue obtained from export of the items (y).
2. The quantity of the export items.

3.1.3 The selection of the dependent and the independent variables

In most statistical and econometric analysis the selection of the dependent and the independent variable is one of the most challenging parts of the study. In this study, the dependent variable is the revenue from exports. The reason behind this are:-

- In the analysis of international marketing system, for a fixed quantity of item the price of the item is continuously changing with position and time. And this supports that the revenue from export is probabilistic in nature.
- According to the general objective of the study, the performance of the Ethiopian foreign trade of export is measured in terms of the amount of this revenue from export which is dependent on the quality and quantity of the export items.

And, the **independent** variables are the quantity of export items (in metric tons) categorized as follows:-

1. Agricultural products (AG)
2. Animal and animal products (AN)
3. Metals and Minerals (MI)
4. Skin and Leather (SK)

3.2. METHODOLOGY

3.2.1 General assumptions

The following are taken as the general assumptions for our analysis.

- Both the dependent and the independent variables are continuous.
- The dependent variable is multivariate normal.
- There is no structural break on the Ethiopian foreign trade of export.
- The item effects are independent of the continental effects on the Ethiopian foreign trade of export.
- The quantities of the items of export are measured without error.

3.2.2 Continental categories

This study is done by classifying the trading partner countries of Ethiopia into five-continental categories. The need for classifying the countries into continental categories rather than considering themselves in the analysis is because of the following reasons: -

1. There are countries whose trading partnership with Ethiopia is least significant.
2. There are shifts of trading partnerships among the trading partners and Ethiopia over time.

3. Including all the countries in the world to assess the variation of the Ethiopian foreign trade of exports over time will create the consideration of many variables. As a result, the statistical/ econometric analysis may not be precise.

Once we see the reason behind the need of continental categories, the classification is done as follows.

Category1. Africa (which includes all African countries AF).

Category2. Asia (which includes all countries in Asia and Australia AS).

Category3. Europe (which includes all countries in Europe EU).

Category4. North America (which includes all countries in North America and the Caribbean NA)

Category5. South America (which includes all countries in South America and Oceania SA).

Based upon these continental categories, the variation and structure of the Ethiopian foreign trade of export will be discussed in detail. The identification of the most and least important continents to the Ethiopian export trading system will be investigated. Moreover, the economic integration and the nature of the Ethiopian foreign trade of export with the continental categories will be studied.

3.2.3 The model

3.2.3.1 The two way nested classifications

The two way nested classifications are linear models having two independent factors in which one of the factors is nesting the other factor. More specifically, given two factors A and B, the levels of B are said to be nested within the levels of A, or more briefly B is nested within A, if every levels of B appears with each level of A. These models are commonly known as nested or hierarchical models where the levels of factor B are nested within the levels of factor A.

In order to use the two way classifications to analyze a given problem, the observations must be randomized. This will help us to create independence among observations. The randomization procedure is done by assigning random numbers to the observations and arranging them accordingly.

The model of the nested classifications is given as:

$$y_{ijt} = \mu + \alpha_i + \beta_{ji} + \varepsilon_{jti}, i = 1,2,\ldots,k. \quad j = 1,2,\ldots,n, \quad t = 1,2,\ldots,T \tag{1.1}$$

where

y_{ijt} = the observed value of the t[th] cell from the j[th] nested factor within the i[th] nesting factor.

μ =the grand mean.

β_{ji} = the j[th] factor nested under the i[th] nesting factor effects.

α_i = the i[th] nesting factor effects.

ε_{jti} =the random error of the model.

3.2.3.2 Model assumptions

- The random errors are serially uncorrelated

$$i.e.\quad E\left[\varepsilon_{jti}\varepsilon_{jt'i'}\right]=0,\forall i\neq i' \quad or \quad j\neq j' \quad or \quad t\neq t'$$

- The expected value of the random errors are zero

$$i.e.\quad E\left[\varepsilon_{jti}\right]=0 \qquad \forall i,j,t$$

- The random errors have common constant variance.

$$i.e\ E[\varepsilon^2_{jti}]=\sigma^2 \qquad \forall i,j,t$$

- The random errors follow normal distribution

i.e $\varepsilon_{jti} \sim N(0,\sigma^2)$

3.2.3.3 Advantages of the two way nested classifications

Instead of using the factorial analysis, the two way nested classifications is appropriate to the study of the variation of naturally hierarchical factors because of the following advantages.

- The two way nested classifications will allow us to determine the between and the within variation of the nested factors.
- The two way nested classifications will contribute to the analysis precision by providing large degrees of freedom to the nested factor.
- The two way nested classifications will allow us to interpret the importance of nested factors in a given nesting factor.

- The two way nested classifications will allow us to compare a given nested factor across different nesting factors.

3.2.3.4 Inference about variation using the two way nested classifications

The systems of linear equations are:

$$y_{ijt} = \mu + \alpha_i + \beta_{j:i} + \varepsilon_{jt:i} \tag{1.2}$$

$$\begin{aligned} y_{111} &= \mu + \alpha_1 + \beta_{1:1} + \varepsilon_{11:1} \\ y_{112} &= \mu + \alpha_1 + \beta_{1:1} + \varepsilon_{12:1} \\ &\vdots \\ y_{knT} &= \mu + \alpha_k + \beta_{n:k} + \varepsilon_{nT:k} \end{aligned} \tag{1.3}$$

The system of linear equations in the matrix form is given as:

$$Y = X\gamma + \varepsilon \tag{1.4}$$

where: X= $[L_k \vdots I_k \otimes L \vdots I_{kn} \otimes l]$

$$I=\begin{bmatrix}1\\1\\\vdots\\1\end{bmatrix}_{Tx1},\quad L=\begin{bmatrix}I\\I\\\vdots\\I\end{bmatrix}_{nTx1},\quad L_k=\begin{bmatrix}L\\L\\\vdots\\L\end{bmatrix}_{nkTx1},\quad Y=\begin{bmatrix}y_{111}\\y_{112}\\\vdots\\y_{ijt}\\\\\vdots\\y_{knT}\end{bmatrix}_{nkTx1},\quad \gamma=\begin{bmatrix}\mu\\\alpha_1\\\vdots\\\alpha_k\\\beta_{1:1}\\\vdots\\\beta_{n:k}\end{bmatrix}_{(nk+k+1)x1},\quad \varepsilon=\begin{bmatrix}\varepsilon_{111}\\\varepsilon_{121}\\\vdots\\\varepsilon_{jt:i}\\\\\vdots\\\varepsilon_{nT:k}\end{bmatrix}_{nkTx1}$$

The normal equations are:

$$X'Xb^0 = X'Y \tag{1.5}$$

where: $[X'Y]' = \lfloor y_{...}, y_{1..}, y_{2..}, \cdots, y_{k.}, y_{11.}, y_{12.}, \cdots, y_{ij.}, \cdots, y_{nk.}\rfloor$

$$b^0 = [\mu^0, \alpha_1^0, \cdots, \alpha_k^0, \beta_{1:1}^0, \beta_{1:2}^0 \cdots, \beta_{j:i}^0, \cdots, \beta_{n:k}^0]$$

$$y_{...} = \sum_{i=1}^{k}\sum_{j=1}^{n}\sum_{t=1}^{T} y_{ijt},\quad y_{ij} = \sum_{j=1}^{n}\sum_{t=1}^{T} y_{ijt} \text{ and } y_{i} = \sum_{t=1}^{T} y_{ijt}$$

Some important properties of the matrix $X'X$ are:

i. The order of $X'X$ = k(n+1)+1

ii. The rank of $X'X$ = kn

iii. The $X'X$ matrix consists k (n+1) +1- kn =k+1 linearly dependent rows/ columns.

These three important properties of the $X'X$ matrix will help us to solve the normal equations and develop orthogonal contrasts of the testable hypothesis based upon our need.

Since the incidence matrix is not of full rank, we have no unique solution to the estimates of the parameters. But there are infinitely many solutions to the normal equation because the system of linear equations is consistent; and among these infinite solutions the following rules are preserved:

i. There are nk linearly independent solutions.

ii. The regression sum of squares is invariant (unaffected) to the choice of one of the solutions

Because of these two important rules our steps are:-

1. To solve the normal equation and then calculate the appropriate sum of squares.
2. We use the $X'X$ matrix to calculate contrasts for our hypothesis to be tested. Since the rank of $X'X$ = kn, we can have kn orthogonal contrasts about the variation of our test problems.

The normal equation is solved by the method of the generalized inverse of the X'X matrix. One of the generalized inverses of the X'X matrix is:

$$G = \begin{bmatrix} 0_{(k+1)X(k+1)} & 0_{(k+1)Xkn} \\ 0_{knX(k+1)} & \frac{1}{T} I_{kn} \end{bmatrix} \tag{1.6}$$

Then one of the solutions is equal to: $b^0 = (0, 0 \ldots 0, \overline{y}_{11}, \overline{y}_{12}, \overline{y}_{13}, \ldots, \overline{y}_{kn})$ (1.7)

The sums of squares of interest are:

- The total sum of squares

$$SST = \sum_{i=1}^{k}\sum_{j=1}^{n}\sum_{t=1}^{T} y_{ijt}^2 \tag{1.8}$$

- The regression sum of squares

$$SSR = b^0 X'Y$$

$$= T\sum_{i=1}^{k}\sum_{j=1}^{n} \bar{y}_{ij.}^2 \tag{1.9}$$

- The sum of the squares about the mean

$$SSM = knT(\bar{y}_{...}^2) \tag{1.10}$$

- The sum of squares of the continental effects

$$R(\alpha_i, \mu) = nT\sum_{i=1}^{k} \bar{y}_{i..}^2 \tag{1.11}$$

- The sum of squares of the continental effects after fitting the mean.

$$R(\alpha_i : \mu) = R(\alpha_i, \mu) - SSM \tag{1.12}$$

- The sum of the square of the item effects after fitting the continental effects and the mean.

$$R(\beta_{ij} : \alpha_i, \mu) = SSR - R(\alpha_i, \mu) \tag{1.13}$$

- The sum of the squares after fitting the mean.

SSRm =SSR-SSM (1.14)

- The error sum of squares.

SSE =SST-SSR (1.15)

Testable functions and testing hypothesis

In linear models of not full rank, there is question about testability of the hypothesis. The concept testability is directly related to the estimability of the linear functions which are originated because of the presentation of the hypothesis. Therefore, in order to determine the testability of our hypothesis, we need to identify which linear functions are estimable functions. Estimable functions are functions which are exactly equal to the linear function of the expected values of the observations.

Mathematically a linear function q' is estimable if

$$q' = c'E[y_{ijt}] \quad \text{for some vector c.} \tag{1.16}$$

And a linear combination of an estimable function is estimable. Based upon the understanding of these concepts, the following linear functions are estimable in the two way nested classifications.

Table 1.1: Estimators of estimable functions

Estimable function	BLUE	Variance of BULE	F-Calculated
$\mu+\alpha_i+\beta_{ji}$	$\bar{y}_{ij.}$	σ^2/T	$\frac{T\bar{y}^2_{ij.}}{MSE}$
$\beta_{ji}-\beta_{j'i}$	$\bar{y}_{ij}-\bar{y}_{ij'}$	$\sigma^2(\frac{2}{T})$	$\frac{(\bar{y}_{ij}-\bar{y}_{ij'})^2}{MSE(\frac{2}{T})}$
$\alpha_i-\alpha_{i'}+\beta_{ji}-\beta_{ji'}$	$\bar{y}_{ij}-\bar{y}_{i'j}$	$\sigma^2(\frac{2}{T})$	$\frac{(\bar{y}_{ij}-\bar{y}_{i'j})^2}{MSE(\frac{2}{T})}$

And any linear combination of the above three estimable functions are also estimable.

Model Adequacy checking and diagnosis

It is always necessary to examine the fitted model to verify that none of the assumptions of the two way nested classifications are violated. This is our crucial step to get enough information about the precision of our inference that we are working for. Our inference is better if any of the assumptions of the model are not violated. When we are going to investigate the model adequacy checking, we need to consider both the data and the statistical problem. If we find at least one violation of the assumption of the model, then we need to diagnose it. The model diagnosis for the data and the statistical problems in this case is done by the analysis of the residuals. Residuals are the differences of the observed and the predicted values of the observations, i.e,

$$e_{ijt} = y_{ijt} - E[y_{ijt}]$$

$$= y_{ijt} - \bar{y}_{ij.}, \quad i = 1,2,...,k. \quad j = 1,2,...,n, \quad t = 1,2,...,T \tag{1.17}$$

1. Checking the existence of outliers

The existence of outliers increases the sum squares of the error. If the sum square of the error increases, then the sum squares of the regression decreases since the total sum square of observations is constant. Therefore, the fit of the model becomes inadequate. If there are outliers, some of the remedies include:

i. Using transformations like the log transformation, the square root transformation, the arcsine transformation, the inverse transformation…etc.
ii. Using another alternative model other than the nested classifications.
iii. Leaving out the observations which create the outliers and do the analysis using the remaining observations.

Checking the existence of the outliers is done by transforming the residuals into standardized residuals, that is, e_{ijt} transformed into $d_{ijt} = \frac{e_{ijt}}{\sqrt{MSE}}$. If $|d_{ijt}| > 3$, then the observation in which the respective standardized residual creates the outlier problem.

2. Checking the normality assumption

The normality assumption is one of the most important assumptions in statistical and econometric analysis. If this assumption fails, then all the statistical or econometric inference is wrong. If the normality assumption has failed, then there are alternative methods that we can use for our inference. These alternative methods are the non parametric model, the robust regression model or other parametric models. The normality assumption can be tested by the Bowman and Shenton tests of normality, among others.

The null and the alternative hypotheses are:

H_0: *The random error terms follow the normal distribution.*

H_1: *The random error terms do not follow the normal distribution.*

We estimate the kurtosis $\hat{k}$ and the skiwness $\hat{s}$ of the estimated residuals and calculate the test statistic:

$$L = n\left[\frac{\hat{s}}{6} + \frac{(\hat{k}-3)^2}{24}\right] \tag{1.18}$$

L is distributed as χ^2 with 2 degrees of freedom.

3. Checking the constant variance assumption

If we made inference with the problem of non constant variance, then the coefficient of determination about the model becomes small, meaning our inference is imprecise. In order to test the constant variance assumption we need to classify the residuals in to k-different classes. These categories will be done in such a way that the classes are internally homogeneous. The constant variance can be checked by the Bartlett's test of homoskedasticity. The null hypothesis is the assumption of constant variance is true and the alternative hypothesis is that at least one of the variances of the error terms is not statistically equal to the others.

The null and the alternative hypotheses are:

$$H_0: \sigma_1^2 = \sigma_2^2 = \dots = \sigma_k^2$$

$$H_1: Not\ H_0$$

Then we estimate the variances as:

$$\hat{\sigma}_i^2 = \frac{\sum_{j=1}^{n}\sum_{t=1}^{T} e_{jti}^2}{nT}, \text{ i=1, 2... k} \tag{1.19}$$

The test statistic:

$$\chi_0^2 = 2.3026 \log \frac{q}{c} \tag{1.20}$$

is distributed as Chi-square with k-1 degrees of freedom, where,

$$q = (knT-k)\log Sp^2 - \sum_{i=1}^{k}(nT-1)\log \hat{\sigma}_i^2$$

$$c = 1 + \frac{1}{3(k-1)}(\sum_{i=1}^{k}(nT-1)^{-1} - (knT-k)^{-1}$$

$$Sp^2 = \frac{\sum_{i=1}^{k}(nT-1)\hat{\sigma}_i^2}{knT-k}$$

3.2.4 The panel data models

Panel data analysis is a method of studying a particular subject within multiple sites, periodically observed over a defined time frame. Within the social sciences, panel analysis has enabled researchers to undertake longitudinal analysis in a wide variety of fields. In economics, panel data analysis is used to study the behavior of firms and wages of people over time. In political science, it is used to study political behavior of parties and organizations over time. It is used in psychology, sociology, and health research to study characteristics of groups of people followed over time.

With repeated observations of enough cross-sections, panel analysis permits the researcher to study the dynamics of change with short time series. The combination of time series with cross-sections can enhance the quality and quantity of data in ways that would be impossible using only one of these two dimensions (Gujarati, 638). Panel analysis can provide a rich and powerful study of a set of people, if one is willing to consider both the space and time dimension of the data. Panel data analysis endows regression analysis with both a spatial and temporal dimension. The spatial dimension pertains to a set of cross-sectional units of observation. These could be countries, states, counties, firms, commodities, groups of people, or even individuals. The temporal dimension pertains to periodic observations of a set of variables characterizing these cross-sectional units over a particular time span. Panel data sets generally include sequential blocks or cross-sections of data, within each of which resides a time series.

3.3.4.1 Advantages of panel data models

1. Controlling for *cross-sectional heterogeneity*. Panel data detects whether the cross-sectional effects are heterogeneous or not. Time-series and cross-section studies not controlling this heterogeneity run the risk of obtaining biased results.

2. Panel data give more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency. Time-series studies are plagued with multicollinearity.

3. Panel data are better able to study the *dynamics of adjustment*. The cross-sectional distributions that look relatively stable hide a multitude of changes.

4. Panel data are better able to identify and measure effects that are simply not detectable in pure cross-section or pure time-series data.

3.3.4.2 Panel structure

Let y_{it} be the value of the dependent variable for i^{th} cross-section unit at time t and x_{jit} be the value of the j^{th} explanatory variable for the i^{th} cross-sectional unit at time t, where:

i= 1, 2…k (number of cross-sections)

t=1, 2…T (number of time periods)

j= 1, 2…p (number of explanatory variables)

The general panel model is given as:

$$y_{it} = c_{it} + X_{it}'\beta + \varepsilon_{it} \tag{2.1}$$

where $X_{it} = (x_{1it},\ x_{2it},\ \ldots,\ x_{pit})'$

c_{it} = the constants of the model

$\beta=(\beta_1,\ \beta_2,\ \ldots,\ \beta_p)'$ *is a vector of parameters.*

ε_{it} =*the random errors of the model.*

3.3.4.3 Types of Panel Models

There are several types of panel data analytic models. These are **constant coefficients models**, **fixed effects models**, and **random effects models**. Among these types of models are dynamic panel, robust, and covariance structure models.

1. ***The Constant Coefficients Model (c_{it}=c which is constant $\forall i,t$.)***

One type of panel model has constant coefficients, referring to both intercepts and slopes. In this case, there are neither significant cross-sectional nor significant time effects on the dependent variable. We could pool all of the data and run an ordinary least squares regression model. Although most of the time there are either cross-sectional or significant time effects, there are occasions when neither of these is statistically significant. This model is sometimes called the pooled regression model.

Model assumptions

An assumption of the constant coefficient model is that all the observations are homogenous, meaning they are drawn from the same population. Formally, we have the following assumptions about the model:

I. $c_{it} = c, \forall i, t$

II. $\varepsilon \sim N(0, \sigma^2 I_{kT})$, where $\varepsilon = [\varepsilon_{11}, \quad \varepsilon_{12}, \ldots, \quad \varepsilon_{it}, \ldots \quad \varepsilon_{kT}]'$

III. The explanatory variables x_{jit} are exogenous, that is, they are uncorrelated with ε_{it}.

The pooled model is given as:

$$y_i = c + x_i' \beta + \varepsilon_i, \text{ i=1, 2...k} \tag{2.2}$$

where: $\underset{(T\mathrm{x}1)}{y_i = \begin{bmatrix} y_{i1} \\ y_{i2} \\ \vdots \\ y_{iT} \end{bmatrix}}$, $\underset{(T\mathrm{x}p)}{x_i = \begin{bmatrix} x_{i1} \\ x_{i2} \\ \vdots \\ x_{iT} \end{bmatrix}}$ and $\underset{(T\mathrm{x}1)}{\varepsilon_i = \begin{bmatrix} \varepsilon_{i1} \\ \varepsilon_{i2} \\ \vdots \\ \varepsilon_{iT} \end{bmatrix}}$

If the individuals are further stacked, then the model becomes:

$$Y = X\beta * + \varepsilon \tag{2.3}$$

where

$$Y = \underset{(kTx1)}{\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_k \end{bmatrix}}, \quad X = \underset{(kTx(p+1))}{\begin{bmatrix} l & x_1 \\ l & x_2 \\ \vdots & \\ l & x_k \end{bmatrix}}, \quad \beta^* = \underset{((p+1)x1)}{\begin{bmatrix} c \\ \beta \end{bmatrix}} \quad \text{and} \quad \varepsilon = \underset{(kTx1)}{\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_k \end{bmatrix}}$$

Here l is a (Tx1) vector of ones.

This model is applied to the static nature data that there is no time or cross-sectional effects. The coefficients of the estimates of the model are homogenous with the change of time and across cross-sections. The method of estimation is the ordinary Least Square (OLS) estimation method.

$$\hat{\beta}^* = (X'X)^{-1}X'Y \tag{2.4}$$

2. The Fixed Effects Model (Least Squares Dummy Variable Model)

Another type of panel model would have constant slopes but intercepts that differ according to the cross-sectional (group) unit. Although there are no significant time effects, there are significant differences among cross-sections in this type of model. While the intercept is cross-section (group) specific, it may or may not differ over time. These models are called fixed effects models.

Model assumptions

The assumptions that specify the fixed effect models are associated with the heterogeneity of the time effects of the cross sections. Here the constant of the model is assumed to be correlated with independent variables. Formally we have the following assumptions:

I. $c_{it} = c_i$, the constant of the model is different across cross-sections.

II. $\varepsilon \sim N(0, \sigma^2 I_{kT})$,

III. The explanatory variables x_{jit} are exogenous, that is, they are uncorrelated with ε_{it}.

The fixed effect panel model is given as:

$$y_{it} = c_i + X_{it}^{'} \beta + \varepsilon_{it} \tag{2.5}$$

This can also be written as:

$$Y = [D \mid \quad X] \begin{bmatrix} c \\ \overline{\beta} \end{bmatrix} + \varepsilon \tag{2.6}$$

where $D = I_T \otimes L$ and c= $(c_1, \quad c_2, \dots, \quad c_k)'$

The method of estimation to this model is the Least Square Dummy Variables (LSDV) estimation method.

$$\begin{bmatrix} \hat{c} \\ \hat{\beta} \end{bmatrix} = [(D \mid X)'(D \mid X)]^{-1}[(D \mid X)'Y] \qquad (2.7)$$

Fixed Effect Hypothesis Testing (the Chow test)

We may wish to hierarchically test the effects of the fixed effects model. We use the pooled regression model as the baseline for our comparison. We first test the cross-sectional effects. We can perform this significance test with an F test resembling the standard F test for R^2 change, i.e.

$$F = \frac{(R^2_{fem} - R^2_{pooled})/(k-1)}{(1-R^2_{fem})/(kT-k-p)} \qquad (2.8)$$

Here T=total number of time observations, k=the number of cross-sections and p=number of regressors in the model. If we find significant improvements in the R^2, then we have statistically significant cross sectional effects.

3. The Random Effects Model

Greene (2003) calls the random effects model a regression with a random constant term. One way to handle the error is to assume that the intercept is a random outcome variable. The random outcome is a function of a mean value plus a random error. But this cross-sectional specific error term c_i, which indicates the deviation from the constant of the cross-sectional unit, must be uncorrelated with the errors of the variables if this is to be modeled. The time series cross-sectional regression model is one with an intercept that is a random effect.

The assumptions that specify the random effects model is that the constant in the fixed or pooled model is taken as the random variable. It means that the c_{it} of the model is resulted from both the cross-sectional, time effects and the random error, which is highly dynamic in nature. Formally, we have the following assumptions:

I. $c_{it} = c + c_i + v_{it}$, where c_i is the cross-sectional random effect and v_{it} is the random error term.

II. $c_i \sim N(0, \sigma_c^2)$

$v_{it} \sim N(0, \sigma_v^2)$

$E[c_i \cdot v_{it}] = 0, \forall i, t.$

III. The variance covariance matrix structure of the random error and the cross-sections Ω.

$$V = \sigma_c^2 ll' + \sigma_v^2 I_T$$

where, *l is a Tx1 vector of ones.*

$$\Omega = V \otimes I_T$$

IV. The explanatory variables x_{jit} are exogenous. that is, they are uncorrelated with ε_{it}.

The random effect panel model is given as:

$$y_{it} = c + X_{it}'\beta + c_i + v_{it} \tag{2.9}$$

In matrix form, the model is given by:

$$Y = [I \mid \quad X]\begin{bmatrix} c \\ \overline{\beta} \end{bmatrix} + u \tag{2.10}$$

$$Y = [I \mid \quad X]\beta^{**} + u \tag{2.11}$$

where: I is a kTx1 vector of ones, $u = [c_1, \quad v_{11}, c_1, \quad v_{12}, \cdots, c_i, \quad v_{it}, \cdots, c_k, \quad v_{kT}]$ and $\beta^{**} = \begin{bmatrix} c \\ \cdots \\ \beta \end{bmatrix}$

The method of estimation to this model is the Generalized Least Square (GLS) estimation method. The GLS estimator is given by:

$$\hat{\beta}^{**}_{GLS} = (X'\Omega^{-1}X)^{-1}(X'\Omega^{-1}Y) \tag{2.12}$$

Specification Tests: the Quandary of Random or Fixed Effect Models

The Hausman specification test is the classical test of whether the fixed or random effects model should be used. The research question is whether there is significant correlation between the unobserved cross-sectional-specific random effects and the regressors. If there is no such correlation, then the random effects model may be more powerful and parsimonious. If there is a correlation, the random effects model would be inconsistently estimated and the fixed effects model would be the model of choice.

Chapter Four

THE VARIATION OF THE ETHIOPIAN FOREIGN TRADE OF EXPORT ACROSS CONTINENTS

One of the aims of this paper is to identify the geographical and economic dependence of the structure of the Ethiopian foreign trade of export. The need for classifying Ethiopia's trading partners into their continents for this study emanates from the fact that it can help us to decompose our general hypothesis about the Ethiopian foreign trade of export into meaningful components and interpretable results can be obtained from our statistical and econometric analysis.

Based upon the export items of the Ethiopian foreign trade, we can analyze the link and variation of the export items to the continent of destination. Such kind of econometric analysis is helpful for our general and specific objective of the study by identifying the following important points on the Ethiopian foreign trade of export. These points are:-

1. Which export item dominates a given continent?
2. Which continent affects the Ethiopian foreign trade of export?
3. Is the Ethiopian foreign trade of export dependent on the geographical location of the continents?

Using these three concrete points we are going to assess the variation of the Ethiopian foreign trade of export.

4.1 ANALYSIS OF THE VARIATION OF THE ETHIOPIAN FOREIGN TRADE OF EXPORT

In order to analyze the variation of the Ethiopian foreign trade of export across continents, we need to know about the composition of the export items. The items of the Ethiopian foreign trade of export are classified in to four categories for the purpose of this study. The reasons behind the importance of categorizing the items are similar to the reasons that we gave for the importance of the continental categories. The categories of the composition of export are done by merging the items into categories having similar relative price and source. Based upon this we have the following categories of the export items:

1. Agricultural products

This category consists of only processed and row products of farm lands. The item agricultural products include seeds, coffee, cereals, cotton (which is fabricated or prefabricated) and flowers, among others.

2. Animal and Animal products

This is the second category of exporting items of the Ethiopian foreign trade of export. This category contains live animals, meat, milk (which contains cheese and better) and similar items.

3. Minerals and Metals

This category contains two different classes of export items namely the category of minerals which consists of gold, silver ...etc, and the category of metals consisting of iron, zink, aluminum and similar items. The need of merging these two categories is that, if we take them separately, their individual contribution to the export sector may be insignificant. Therefore, in order to observe their significance it is better to merge them together.

4. Skin and Leather

This is the forth category of exporting items of the Ethiopian foreign trade of export. These include skin and hide and processed leather products.

A suitable statistical model to analyze the variation of the Ethiopian foreign trade of export is the two way nested classifications. The method of analysis consists of two-factors. These factors are the continental categories and the export items in which one of the factors is nesting the other factor.

The nesting factor: Continental categories which import Ethiopian items.

The nested factor: The export items of the Ethiopian foreign trade.

The observations are taken in millions of US dollars for this analysis.

4.1.1 INFERENCE ABOUT THE VARIATION OF THE ETHIOPIAN FOREIGN TRADE OF EXPORT

The model of the nested classification of the Ethiopian foreign trade of export is given as:

$$y_{ijt} = \mu + \alpha_i + \beta_{ji} + \varepsilon_{tji}, \quad i = 1,2,\dots 5, j = 1,2,\dots 4, t = 1,2,\dots 11$$

where y_{ijt} = Revenue collected due to the export of item j to the continent i.

β_{ji} = the jth item nested under the ith continental fixed effects.

α_i = the ith continental fixed effects.

μ = the grand mean

$\varepsilon \sim N(0, \sigma^2 I_{220})$, where $\varepsilon = [\varepsilon_{111}, \quad \varepsilon_{121}, \ldots \quad \varepsilon_{jti}, \ldots \quad \varepsilon_{4\ 115}]' \sim 220x1$

Using the solution of the normal equations, we can calculate the sum of squares that are helpful for checking the model adequacy and further analysis (See the sum of squares in Annex 1). The results of the model adequacy test are presented in Table 1.1.1.

Table 1.1.1: ANOVA for nested classifications model

Source of variation	DF	SS	SM	F-cal.	P-value
SSR	20	955,275.70	47,763.75	14.51	0.0000
SSE	200	658,505.80	3,292.529		
SST	220	1,613,781.49			

As can be seen from the table, the F-statistic is significant. Thus, the nested classifications model adequacy describes the total variation of the Ethiopian foreign trade of exports, and we can base our statistical/ econometric analysis about the variation of Ethiopian foreign trade of export on this model.

Now, we need to test whether the continental and item effects are significant or not on the Ethiopian foreign trade of export. The result of the test is given in Table 1.1.2.

Table 1.1.2: ANOVA for the test for the significance of continental and item effects

Source of Variation	DF	SS	MS	F-cal	P-value
SSR	20	955,275.7	47,763.75	14.51	0.000
$R(\mu)$	1	207,077.7	207,077.7	62.98	0.000
$R(\beta_{j:i}, \alpha_i : \mu)$	19	748,179.00	39,377.8	11.95	0.001
$R(\alpha_i, \mu)$	5	350,932.7	70,187.5	21.3	0.000
$R(\alpha_i : \mu)$	4	146,055	36,513.75	11.1	0.001
$R(\beta_{ji} : \alpha_i, \mu)$	15	602,143	40,142.9	12.18	0.001
SSE	200	658,505.80	3,292.529		
SST	220				

From the table we see that:

a. The items and continental effects corrected for the mean, $R(\beta_{j:i}, \alpha_i : \mu)$, is statistically significant. This implies that at least one of the continental categories and export items do have a significant impact on the overall export trade of Ethiopia.

b. The items effect corrected for the continental effects and mean $R(\beta_{ji} : \alpha_i, \mu)$ is statistically significant. This implies that at least one of the export items significantly affects the export trade of Ethiopia controlling for the continental effects (or adjusting for the effects of the destination continent).

c. Continental effects (with and without adjusting for the mean) are statistically significant. This implies that at least one of the continental categories do have a significant effect on the overall export trade of Ethiopia.

After determining the results from the above ANOVA table, we need to identify the most and the least influential continents that consistently affect the Ethiopian foreign trade of export with respect to the export items. The hypotheses which contain all the 20 orthogonal contrasts about the general variations of the Ethiopian foreign trade of exports generally take the following form:

H_0: *The export of the j^{th} item to the i^{th} continent is not important to the overall performance of the Ethiopian foreign trade of export, i=1,2,3,4,5, j=1,2,3,4*

H_1: H_0 *is not true.*

The results are presented in Table 1.1.3

Table 1.1.3: The test results about the hypotheses

The sources of variations are the export of item j to the continent i.	SS	DF	MS	F-CAL	P-value
Agricultural prod. to Africa	**123939.8**	**1**	**123939.8**	**37.649***	**0.0000**
Animals prod to Africa	467.2595	1	467.2595	0.141938	0.3724
Metals &minerals to Africa	32.61567	1	32.61567	0.009908	0.4602
Skin & leather to Africa	6.387816	1	6.387816	0.00194	0.4880
Agricultural prod. to Asia	**346613.8**	**1**	**346613.8**	**105.29***	**0.0000**
Animals prod to Asia	1950.259	1	1950.259	0.592424	0.4681
Metals &minerals to Asia	409.2355	1	409.2355	0.124312	0.3669
Skin & leather to Asia	4449.087	1	4449.087	1.351485	0.1539
Agricultural prod. to Europe	**498241.3**	**1**	**498241.3**	**151.349***	**0.0000**
Animals prod to Europe	8.636966	1	8.636966	0.002624	0.4801
Metals &minerals to Europe	13.25318	1	13.25318	0.004026	0.4761
Skin & leather to Europe	**18769.79**	**1**	**18769.79**	**5.70164***	**0.0087**
Agricultural prod. to N.America	**16514.29**	**1**	**16514.29**	**5.01649***	**0.0091**
Animals prod to N.America	2.395674	1	2.395674	0.000728	0.4920
Metals &minerals to N.America	2.558467	1	2.558467	0.000777	0.4923
Skin & leather to N.America	8.641476	1	8.641476	0.002625	0.4801
Agricultural prod. to S.America	58.73265	1	58.73265	0.017841	0.4483
Animals prod to S.America	0	1	0	0	1.0000
Metals &minerals to S.America	0.000269	1	0.000269	0.000269	0.4929
Skin & leather to S.America	0.171964	1	0.171964	0.171964	0.3409

From the results we can see that:

- ✓ The significant items of the Ethiopian foreign trade of export are agricultural products and skin and leather across the continents.
- ✓ The significant continents that affect the Ethiopian foreign trade of export are Europe, Asia, Africa and North America.
- ✓ The Ethiopian foreign trade of export is unaffected by the export of each of the items to the continent of South America. This might be an indication that the Ethiopia foreign trade of export is affected by the geographical location of the country.
- ✓ The export of Metals and Minerals and Animal and animal products do not have a significant contribution to the Ethiopian foreign trade of export across all the continents.

4.1.2 INTRA CONTINENTAL ANALYSIS OF EXPORT ITEMS

4.1.2.1 ANALYSIS OF EXPORT TO AFRICA

The Ethiopian foreign trade of export to the continent of Africa is limited to countries like Djibouti, Sudan, Kenya, Somalia and Egypt. From the ANOVA table 1.1.3 we have seen that only the exports of agricultural products are significant to the overall Ethiopian foreign trade of export to the continent of Africa. The ranking of export to Africa by money value is given as:-

1. Agricultural products.
2. Animals and animal products.
3. Skin and leather.
4. Metals and minerals.

4.1.2.2 ANALYSIS OF EXPORT TO ASIA

The Ethiopian foreign trade of export to the continent of Asia covers countries like UAE, Saudi Arabia, Yemen, China, India, Japan, and Korea. From the ANOVA table 1.1.3 we have seen that only the exports of agricultural products are significant to the overall Ethiopian foreign trade of export to the continent of Asia. The ranking of export to Asia by money value is given as:-

1. Agricultural products.
2. Skin and leather.
3. Animals and animal products.
4. Metals and minerals.

4.1.2.3 ANALYSIS OF EXPORT TO EUROPE

The Ethiopian foreign trade of export to the continent of Europe covers countries like Italy, France, Britain, German, Belgium, Norway, Sweden, Spain Turkey, the Netherlands, Greece, Denmark and the Czech Republic. From the table ANOVA 1.1.3 we have seen that the exports of agricultural products and skin and leather are significant to the Ethiopian foreign trade of export to the continent of Europe. By money values, the ranking of export items to the continent of Europe is given as:-

1. Agricultural products.
2. Skin and Leather.
3. Metals and minerals.
4. Animals and animal products.

4.1.2.4 ANALYSIS OF EXPORT TO NORTH AMERICA

The Ethiopian foreign trade of export to the continent of North America is limited to countries like USA and Canada. From the ANOVA table 1.1.3 we have seen that only the export of agricultural products is significant to the Ethiopian foreign trade of export to the continent of North America. The ranking of export to North America by money value is given as: -

1. Agricultural products
2. Skin and leather
3. Metals and minerals
4. Animals and animal products

4.1.3 INTER-CONTINENTAL ANALYSIS OF EXPORT

4.1.3.1 ANALYSIS OF THE EXPORT OF AGRICALTURAL PRODUCTS ACROSS CONTINENTS

We have seen that agricultural products are the most influential items to the overall performance of the Ethiopian foreign trade of export across all continents than the others items. The export of skin and leather to Europe is also significant. In this section we compare the variation of agricultural products export across continents.

The estimable functions which compare the most and least importer continents of agricultural products from Ethiopia are given as:- $\alpha_i - \alpha_{i'} + \beta_{1i} - \beta_{1i'}$, with the point estimator $\overline{y}_{i1} - \overline{y}_{i'1}$, where i, $i'=1, 2...5$, $i \neq i'$, α_i is the continental fixed effects, β_{1i} is the fixed effect of agricultural products, $\overline{y}_{i1}$ is the revenue collected from the export of agricultural products.

Here the null hypothesis is there is no difference on the revenue obtained from the export of agricultural products across continents. The results of the multiple comparison is given in Table 1.1.4

Table 1.1.4: Multiple comparisons of agricultural products across continents

Comparaisons of continents i and i', i≠ i'	The point estimates of the difference $= \overline{y}_{i1} - \overline{y}_{i'1}$	DF	F-cal	P-value
Africa Vs Asia	-71.35	1	8.54*	0.0018
Africa Vs Europe	-105.85	1	18.7*	0.0000
Africa Vs North America	68.15	1	7.84*	0.0026
Asia Vs Europe	-34.5	1	1.99	0.0793
Asia Vs N-America	139.5	1	32.5*	0.0000
Europe Vs North America	174	1	50.5*	0.0000

Results of the multiple comparisons and its interpretations:

- ✓ From the table we see that the revenue obtained from the export of agricultural products is statistically equal between the continents of Europe and Asia. However, there are differences among the other continents.

- ✓ Based upon the point estimates of the differences of the money value from the export of agricultural products, the ranking of the continents as the destinations for Ethiopian agricultural products export is:-

  1. Europe.

1. Asia.
2. Africa.
3. North America.
4. The last and the insignificant continent to the overall export of agricultural products is South America.

4.1.4 Model Adequacy checking

The existence of outliers is checked by transforming the residuals into standardized residuals. From the numerical value of the maximum and the minimum standardized residuals; we found that there is no problem of outliers (see the plot in Annex 3).

The normality assumption is checked by the Bowman and Shenton test. The test statistic (L=2.6) is not significant. Therefore the assumption that the random error terms follow the normal distribution is not violated.

The constant variance assumption is checked by the Bartlett's test of homoskedasticity. The null hypothesis is that the assumption of constant variance is true against the alternative hypothesis that the variances of the error terms are not statistically equal. The results indicated that the variances of the error terms are statistically homoskedastic.

Note:

The data for this study is both a time series and cross sectional. In the analysis of the variation of the Ethiopian foreign trade of exports, we assumed that there is no serial correlation among the random errors. The reason behind this are:-

1. We have utilized 11 years of data, which is so small to test for the existence of serial correlation.
2. Since the observations are randomized at the beginning of our analysis, we already know that the time sequence is eliminated. Therefore, we assure ourselves that the problem of serial correlation does not affect our inference.

Chapter Five

The structure of the Ethiopian foreign trade of export

5.1 The concept of the structure of the export trade

In the previous chapter we have discussed about the variation of the Ethiopian foreign trade of export across continents using the aggregated revenue from export. In this chapter, we try to assess the structure of the Ethiopian foreign trade of export using the revenue obtained from export (response variable) and the quantities of the items of export (predictors) using panel data analysis.

One of the advantages of panel data is that it allows us to see both the time and the continental effects. This is the critical step to determine the structure of the Ethiopian foreign trade of export. The structure of the Ethiopian foreign trade of export is assessed by comparing the pooled, the fixed effects and the random effects panel data models.

In order to compare the results of the three different models that show the structural trend of the Ethiopia foreign trade of export, we need to have the following hypotheses to be tested first:-

1. Are there continental/time effect on the Ethiopian foreign trade of export?
2. Are the time and continental effects fixed or random on the Ethiopian foreign trade of export?
3. Is there heterogeneity across continents on the Ethiopian foreign trade of export with respect to the export items?

5.2 The assessment of structure of the Ethiopian foreign trade of export

In the panel data analysis of the Ethiopian foreign trade of export, we consider the quantities of the export items to predict the revenue from export. The revenue from export is measured in millions of US dollar and the quantities of export items are measured in metric tons.

5.2.1 The pooled model analysis

Our first alternative is the assumption that the continental and the time effects are homogenous; the coefficients of the pooled methods are the consistent estimators of the model. In this case the interpretation is given as the Ethiopian foreign trade of export is showing the static nature across continents and the change of time. This means the structure of the Ethiopian foreign trade of export is statistically stable with time and across continents.

If we ignore the constant of the model, the coefficients of the independent variables are interpreted as the average revenue in millions of US dollar per metric ton of the item of export of the foreign trade of Ethiopia. Even if there are systematic changes in the foreign trade of Ethiopia across continents and the shift of time, there is no fluctuation on these coefficients of the variables. This means that the foreign trade of Ethiopia is showing similar trend across continents or the shift of time.

The pooled model is given as:

$$y_{it} = C + \beta_1 AG_{it} + \beta_2 AN_{it} + \beta_3 MI_{it} + \beta_4 SK_{it} + \varepsilon_{it}$$

$i = 1,2,\ldots,5, t = 1,2,3,\ldots,11$

where C = the constant of the model

β_i = The coeffitients of the quantities of the export items.

y_{ij} = Revenue collected due to the export of items from continent i in the year j.

AG, AN, MI and SK are the quantities of agricultural products, animal and animal products, metals and minerals and skin and leather, respectively, measured in metric tons.

The model fit statistics of the pooled model are summarized in Table 1.2.1. The F-statistic (P-value<0.0001) indicates that the model is a good fit.

Table 1.2.1: Pooled model fit statistics

Model		Sum of Squares	DF	Mean Square	F	Sign.
1	Regression	1124944	4	281236.095	56.533	.000
	Residual	243762.4	51	4974.743		
	Total	1368707	55			

a. Predictors: (Constant), SK, MI, AN, AG

b. Dependent Variable: y

Parameter estimation

In the pooled model, there are six parameters to be estimated, two of which are the constant and the variance and the rest are for the coeffitients. The method of estimation is the Ordinary least square (OLS) estimation method. The result is given in Table 1.2.2.

Table 1.2.2: Results of the pooled model for exports

		Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
Model 1	(Constant)	*12.483*	*12.610*		*.990*	*.327*
	AG	*.899*	*.119*	*.641*	*7.526*	*.000**
	AN	*-2.587*	*1.790*	*-.103*	*-1.445*	*.155*
	MI	*-.498*	*1.974*	*-.017*	*-.252*	*.802*
	SK	*16.584*	*2.880*	*.426*	*5.759*	*.000**

Dependent Variable: y

From the table of the estimates of the parameters we see that:

- ✓ The coefficients of agricultural products and skin and leather are significant to predict the revenue from the export trade of Ethiopia using the pooled model analysis.
- ✓ The export of animal and animal products and metals and minerals do have an insignificant impact on the revenue from the export trade of Ethiopia (See the scatter plot in Annex 6).

When we fit the pooled model, we find that there are correlations among the independent variables (See the output in Annex 5).

5.2.2 The fixed effect panel data analysis

Our second alternative is to provide a model which can show the existence of continental or time specific effects. If the observations are fixed, the initial observations are exogenous since they are assumed uncorrelated with the random spherical disturbances. In this case the model is used to check whether or not the structure of the Ethiopian foreign trade of export shows significant differences across continents or the shift of time periods with respect to the quantity of the export items. If we find that there are no significant changes with the shift of time, this means that the structure of the Ethiopian foreign trade of export is homogenous within continents over time.

The continental effects tell us the concentration and the direction while the time effects tell us the net growth of the Ethiopian foreign trade of export. If only continental effects are observed that there is no statistical difference on the Ethiopian foreign trade of export due to the shift of time, then the constants of the model are the fixed effects of the corresponding continent on the Ethiopian foreign trade of export. The changes of the constants exist due to the shift of the items of export across continents. Meaning the revenue from export is statistically constant within the continent whenever there were time changes. In short, we interpret the i^{th} constant as the benefits of the foreign trade of Ethiopia due to export to the i^{th} continent.

The model for the fixed effect analysis of the Ethiopian foreign trade of exports is given as:

$$y_{it} = c_i + \beta_1 AG_{it} + \beta_2 AN_{it} + \beta_3 MI_{it} + \beta_4 SK_{it} + \varepsilon_{it}$$
$$i = 1,2,\dots,5,\ t = 1,2,3,\dots,11$$

where

y_{it} = Revenue collected due to the export of items to continent i in the year t.

c_i = The i^{th} continental fixed effects of the Ethiopian foreign trade of export.

β_i = The coefficients of the independent variables.

The model fit statistics of the fixed effects model are summarized in Table 1.2.3.

Table 1.2.3: Fixed effects model fit statistics

R-sq: within = 0.7527	Obs per group: min = 11
Between = 0.9566	avg = 11
Overall = 0.8617	max = 11
F (4, 45) = 28.32	Prob > F = 0.0000
Corr (c_i, Xb) = 0.6595	

About 86.17% of the total variation of the Ethiopian foreign trade of export is determined by the fixed effects panel data model. From the table we see that the correlation between the constants and the quantities of the items of export is 0.6595. The large between continents coefficient of determination (0.9566) shows us that the fixed effect model is suitable to handle the variation across continents. And, the F- statistic (p-value<0.001) indicates that the model is a good fit.

The parameters of the fixed effects model are estimated by applying the Least Square Dummy Variables (LSDV) estimation technique. The results are given in Table 1.2.4

Table 1.2.4: Estimates of the coefficients of the fixed effect model

yc	Coef.	Std.Err.	t	p>z
c1	-11.45	5.02	-2.279*	0.027
c2	90.44	11.529	7.844*	0.000
c3	129.52	66.66	1.943*	0.032
c4	-86.02	48.3	-1.781*	0.039
c5	-124.16	65.9	-1.884*	0.035
AG	1.01	0.124	6.954*	0.000
AN	0.455	0.32	1.423*	0.033
MI	1.87	1.007	1.857*	0.03
SK	13.74	3.384	4.061*	0.000
sigma_c	11.9860			
sigma_v	49.688318			

F test that all c_i=0: F (4, 46) = 3.30 Prob > F = 0.006

F test that all t_i=0: F (10, 46) = 1.30 Prob > F = 0.2851

Before we interpret the fixed effects model, it is better to compare the fit of pooled model and the fixed effect model. The hypothesis of the test problem is given as:

$$H_0: C_1 = C_2 = C_3 = C_4 = C_5 = C$$

$H_1: H_0$ *is not true.*

Using the chow test, the calculated F-value is 3.30 with significance of probability of 0.0017. Thus, we reject the null hypothesis. This means the fixed effect panel data model is a better fit than the pooled panel data model for predicting the structure of the Ethiopian foreign trade of export.

5.2.3 The random effect panel data analysis

Our third alternative is the assumption that the constants of the model are random variables. If this is the case the Ethiopian foreign trade of export is showing high scale of dynamism across continents and changes of time periods. Here we assume that the continental effects (c_i) are not exogenous, that is, $\operatorname{cov}(c_i, x_{it}) = 0$. This means that the continental effects are entered into the disturbance terms. Because of this, the variance covariance matrix of the error terms becomes non spherical. In this case the OLS estimators of the coefficients of the independent variables are not efficient estimators. Therefore, we need to use the GLS estimation method. The interpretation of the estimates of the coefficients of the model is that, the Ethiopian foreign trade of export is heterogeneous across continents and over time.

The random effects model is given by:

$$y_{it} = C + \beta_1 AG_{it} + \beta_2 AN_{it} + \beta_3 MI_{it} + \beta_4 SK_{it} + C_i + v_{it}$$
$i = 1,2,..,5,\ j = 1,2,3,...,11$

where

y_{it} = Revenue from the export items to continent i in the year t.

c_i = The ith continental random effects on the Ethiopian foreign trade of export

C= The constant of the model

β_i = The coefficients of the independent variables

The model fit statistics for the random effects model are summarized in Table1.2.5

Table 1.2.5: The model fit of the random effects model

R-sq: within = 0.7820	Obs per group:
	min = 11
Between = 0.9587	avg = 11
Overall = 0.869	max = 11
Random effects c_i ~ Gaussian	Wald chi2
(5) = 177.34	
Corr (c_i, X) = 0 (assumed)	Prob > chi2 = 0.0000

About 86.9% of the total variation of the Ethiopian foreign trade of export is determined by the random effects panel data model. The Wald statistic shows us that the random effects model is a good fit (P-value<0.0001).

The Generalized Least Square (GLS) estimation results for the random effects model is given in Table1.2.6.

Table 1.2.6: Estimates of the coefficients of the export random effects model

yc	Coef.	Std.Err.	z	p>z
AG	0.8993064	0.1194925	7.53*	0.000
AN	-2.586805	1.79039	-1.44	0.149
MI	-0.4980362	1.97417	-0.25	0.801
SK	16.58447	2.879537	5.76*	0.000
_cons	12.48341	12.60999	0.99	0.322
sigma_v	*66.68831*			

From the table we see that only the coefficients of agricultural products and skin and leather are significant.

The Hausman specification test

The Hausman specification test is the classical test of whether the fixed or random effects model should be used. The research question is whether there is a significant correlation between the unobserved continental-specific random effects and the quantities of the items of export. If there is no such correlation, then the random effects model may be more powerful and parsimonious. If there is a significant correlation, the random effects model would be inconsistently estimated and the fixed effects model would be the model of choice. The hypothesis of the test problem is given as:

$$H_0: Cov(c_i, X_{it}) = 0$$

$$H_1: Cov(c_i, X_{it}) \neq 0$$

The Hausman specification test statistic reveals a Chi-square value of 17.834 (with P-value< 0.0001). Since the significance probability is much greater than the significance level of 1% we reject the null hypothesis. Therefore, we consider the fixed effects panel data models to investigate the nature of the structure of the Ethiopian foreign trade of export.

The interpretation of the fixed effect model

From the comparison of the model fit, we reached to the conclusion that the fixed effect panel data model is the best fit than the others for the prediction of the structure of the Ethiopian foreign trade of export. The following are the interpretations of the fixed effects model about the Ethiopian foreign trade of exports:

- ✓ Each of the export items of export has a significant impact on the revenue obtained from export.
- ✓ All continental fixed effects are significant.
- ✓ The Ethiopian foreign trade of export is showing heterogeneity across continents and is homogenous within the continents over time.
- ✓ The following table gives the expected values of the continental fixed effects on the Ethiopian foreign trade of export with standard error $11.98 million.

Table 1.2.7: Continental fixed effects

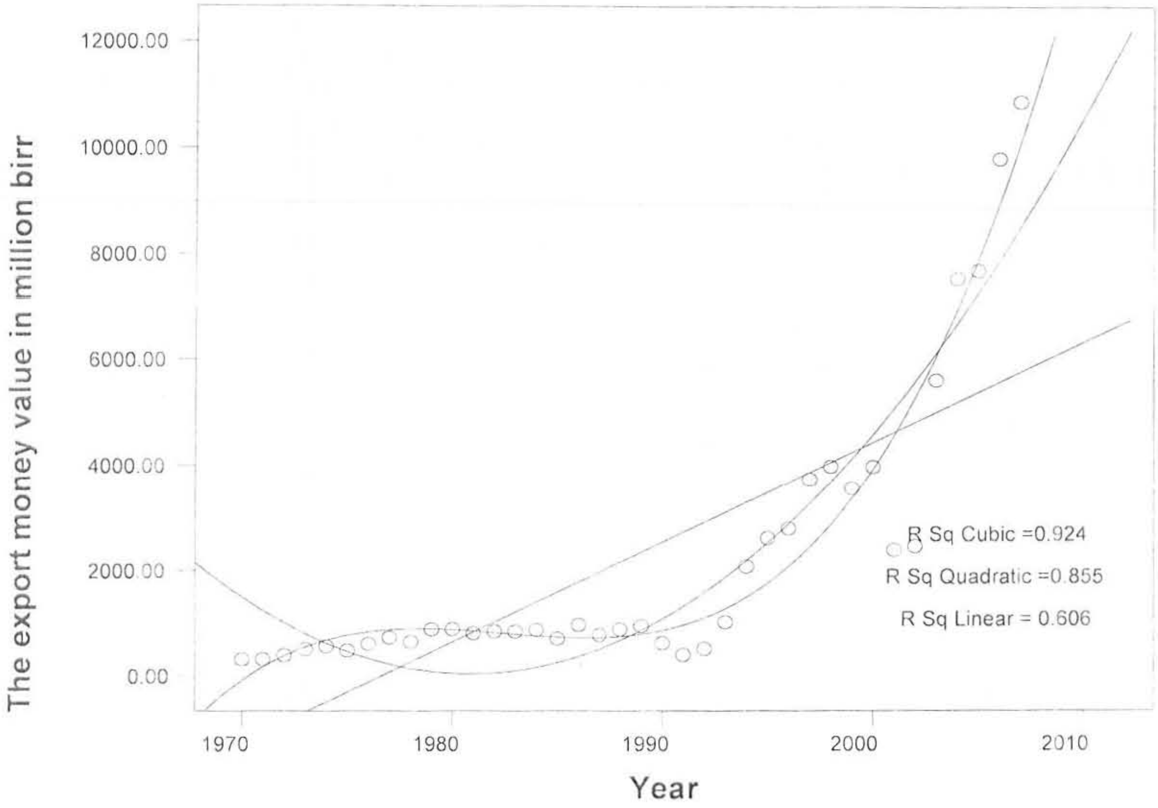
Continents	The expected values of the continental fixed effect in MUSD
Africa	-11.451171
Asia	90.437488
Europe	129.5171
North America	-86.018109
South America	-124.15932

The From the table we see that Europe and Asia are the influential for the Ethiopian foreign trade of exports with continental fixed effects of $129.52 million and $90.44 million respectively.

5.3 The growth of the Ethiopian foreign trade of export

In this section we try to summarize the growth of the Ethiopian foreign trade of export by considering the revenue from export with respect to time. The growth of the export trade is shown in figure 1.

Figure 1: The growth in revenue from the Ethiopian foreign trade of export

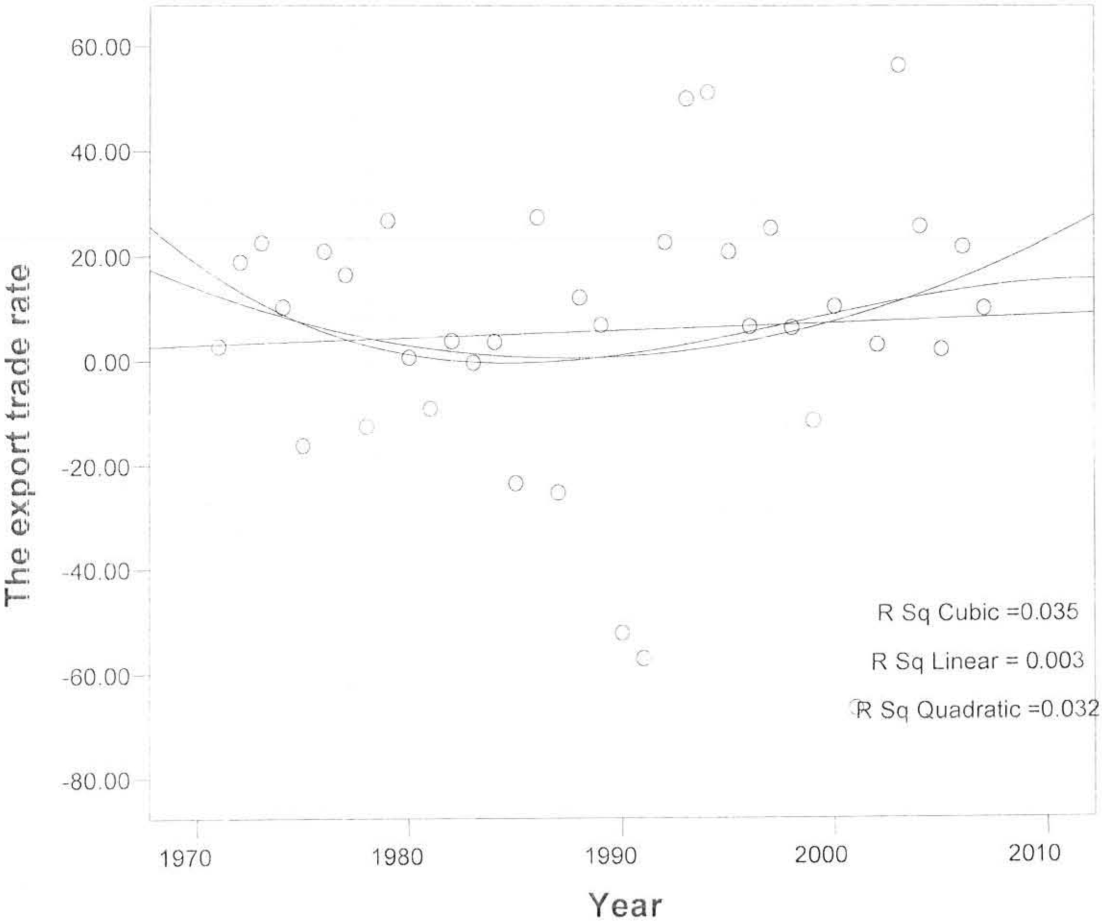


- From the scatter plot we see that the revenue obtained from Ethiopian foreign trade of export is generally growing with time.

- From the scatter plot we see that; there are two time phases on the Ethiopian foreign trade of export. The first time phase is from 1970 up to 1990 in which the revenue from exports was stagnant. The second phase is 1990 to 2007 in which the Ethiopian foreign trade of exports showing rapid growth.

- From the fit we see that the growth of the Ethiopian foreign trade of exports is showing the cubic trend.

Figure 2: The rate growth of the Ethiopian foreign trade of export



- The scatter plot of the growth rate of the Ethiopian foreign trade of export looks random. This means that the growth rate of the export trade has no particular trend.

Chapter Six

Conclusions and Recommendations

Using the nested classifications and panel data models, we analyzed the variation and the structure of the Ethiopian foreign trade of export. According to the results obtained from the analysis, we can conclude the following important points on the export trade.

1. The Ethiopian foreign trade of export is dependent on the export of agricultural products and skin and leather. From the expected values of the revenue from export trade, agricultural products account for 85% and skin and leather account for 10% of the overall revenue from the export trade of Ethiopia.

2. Across all the continents, the leading export item of the Ethiopian foreign trade of export is agricultural products. Next to agricultural products, only the export of skin and leather to the continent of Europe is significantly affecting the Ethiopian foreign trade of export.

3. The Ethiopian foreign trade of export is affected by all continents except South America. Considering the revenue obtained from exports, the expected ranking of the import partners of Ethiopia are: Europe, Asia, Africa, North America and South America (in descending order).

4. By assuming that there is no structural break on the foreign trade of Ethiopia, the average annual revenue earned from export is \$631.32 million.

5. The expected revenue collected and share from the Ethiopian foreign trade of export across the continents (with standard error of $ 34.6 million) are as follows Africa $115.14 (share 18.24%), Asia $217.04 (share 34.38%), Europe $256.12 (share 40.57%), North America $40.58, (share 6.43%) and South America 2.44 (share 0.387%).

6. The contribution of the export of animal and animal products and metals and minerals to the overall Ethiopian foreign trade of export is insignificant. The expected share of these two items to the Ethiopian foreign trade of export is less than 5%.

7. The structure of the Ethiopian foreign trade of export shows lack of diversification across continents. Especially it is at its infant stage to the continent of South America.

8. The structural trend of the Ethiopian foreign trade of export shows that the revenue from export is generally increasing with time.

9. There are two time phases on the Ethiopian foreign trade of export. The first time phase is from 1970 up to 1990 in which the revenue from exports was stagnant. The second phase is 1990 to 2007 in which the Ethiopian foreign trade of exports shows rapid growth.

Recommendations

Using the two way nested classifications and the panel data models we try to assess the variation and the structural trend of the Ethiopia foreign trade of export. The result of the study indicated that the export trade is growing with time. It is also identified that the foreign trade of Ethiopia is affected by the geographical location of the import partners of Ethiopia. We recommend the following points to improve the performance of the Ethiopian foreign trade of export.

1. When we consider the revenue obtained from export trade of Ethiopia, we found that its value has considerably increased from 1990 up to 2007. Therefore, both the government and the private sector should work together to keep up the pace.

2. The contribution of animal and animal products and metals and minerals to total revenue from export is insignificant. Here much attention should be given to the export of these items in order to achieve significant growth in revenue from the export trade of Ethiopia.

3. Next to agricultural products, the export of skin and leather to Europe is significant to the total revenue from the export trade of Ethiopia. The export of this item should be diversified across all continents.

4. Increasing the quantities of all export items can increase the revenue from the export trade. Therefore, by analyzing the demand of the international market system, the country should increase the supply of the items.

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ANNEX 1. The sum of the squares

- The total sum of squares

  SST =1613781.49

- The regression sum of squares

  SSR =955,275.70

- The sum of squares of the continental effects

  $R(\alpha_i, \mu)$ =350,936.7

- The sum of squares of the continental effects after fitting the mean.

  $R(\alpha_i : \mu)$ =131,721.8

- The sum of the square of the item effects after fitting the continental effects and the mean.

  $R(\beta_{ji} : \alpha_i, \mu)$ =9,155,544.55

- The sum of the squares about the mean

  SSM =$220(31.56)^2$

  $R(\mu)$ =219,214.9

- The sum of the squares after fitting the mean.

  SSRm =SSR-SSM

  $R(\beta_{j:i}, \alpha_i : \mu)$ ==736060.8

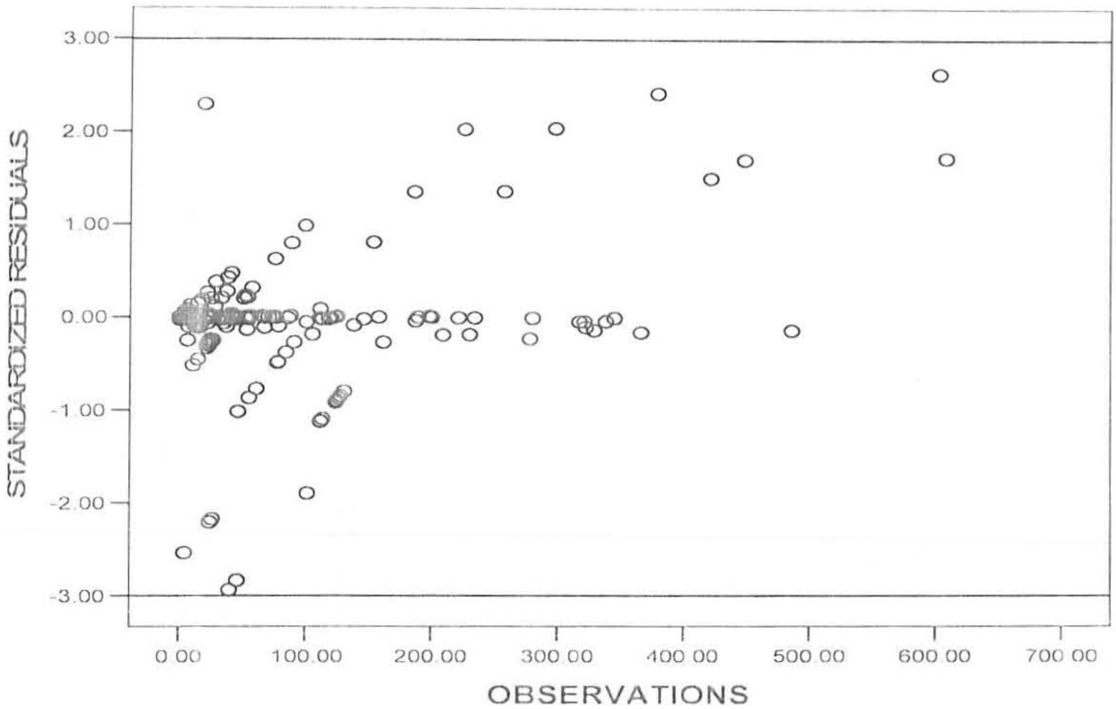
- The error sum of squares.

  SSE =658,505.80

ANNEX 2: Expected share and revenue from export across continents on the Ethiopian foreign trade

The export of item j to the continent i.	The estimated money value from export in MUSD.	The 95% prediction	interval
		Lower	Upper
Agricultural prod. to Africa	106.1473	72.18332	140.1113
Animal prod. to Africa	6.517526	0	40.48153
Minerals & Metals to Africa	1.721935	0	35.68594
Skin &Leather. to Africa	0.762044	0	34.72604
Agricultural prod. to Asia	177.5115	143.5475	211.4755
Animal prod. to Asia	13.31526	0	47.27926
Minerals & Metals to Asia	6.099445	0	40.06344
Skin &Leather. to Asia	20.11125	0	54.07525
Agricultural prod. to Europe	212.8254	178.8614	246.7894
Animal prod. to Europe	0.886103	0	34.8501
Minerals & Metals to Europe	1.09765	0	35.06165
Skin &Leather. to Europe	41.30792	7.343919	75.27192
Agricultural prod. to North America	38.7466	4.782605	72.7106
Animal prod. North America	0.466678	0	34.43068
Minerals & Metals to North America	0.482274	0	34.44627
Skin &Leather. to North America	0.886334	0	34.85033
Agricultural prod. to South America	2.310699	0	36.2747
Animal prod. to South America	0	0	33.964
Minerals & Metals to South America	0.004949	0	33.96895
Skin &Leather. to South America	0.125032	0	34.08903
Total	631.326	406.7188	1310.606

ANNEX 3: The plot of the standardized residuals versus the observed values for export



ANNEX 4: The statistics of the residuals

N	220
Mean	.0000
Std. Error of Mean	8.42
Std. Deviation	.048
Skewness	.147
Std. Error of Skewness	3.094
Kurtosis	.293
Std. Error of Kurtosis	.0012

ANNEX 5: The out puts

Model fit of the pooled model

The pooled model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.907	.822	.807	70.53186

. Predictors: (Constant), AG, AN, MI, SK

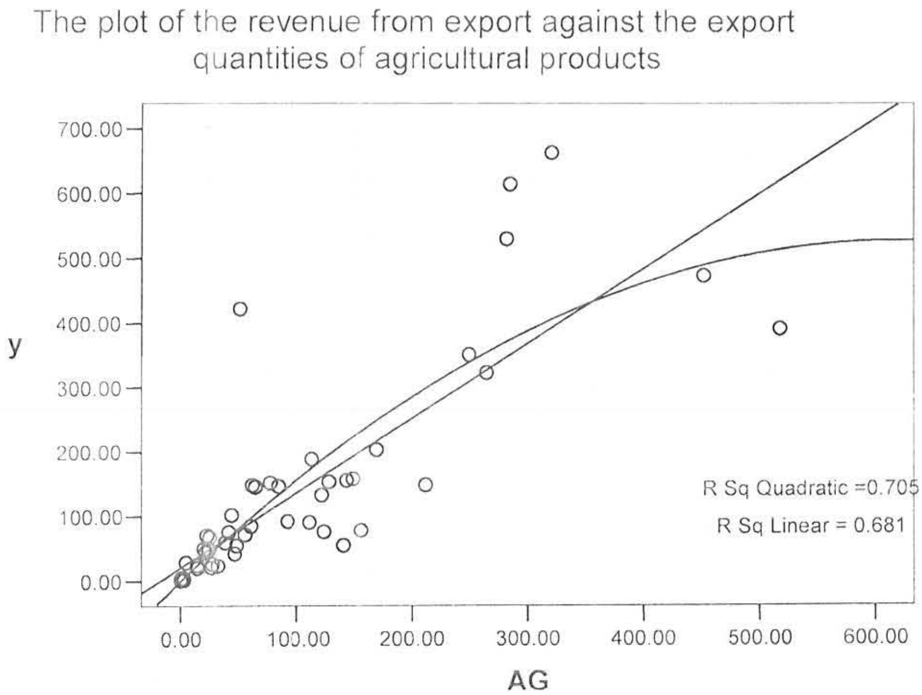
Coefficient Correlations for the pooled panel model

			SK	MI	AN	AG
Model 1	Correlations	SK	*1.000*	*.099*	*.088*	*-.554*
		MI	*.099*	*1.000*	*-.205*	*-.211*
		AN	*.088*	*-.205*	*1.000*	*-.413*
		AG	*-.554*	*-.211*	*-.413*	*1.000*
	Covariances	SK	*8.292*	*.563*	*.456*	*-.191*
		MI	*.563*	*3.897*	*-.723*	*-.050*
		AN	*.456*	*-.723*	*3.205*	*-.088*
		AG	*-.191*	*-.050*	*-.088*	*.014*

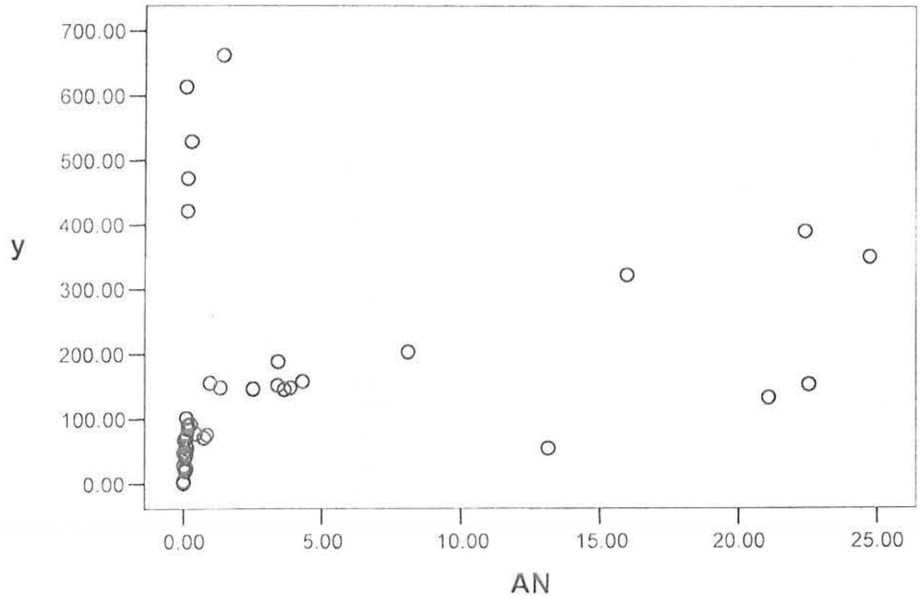
Dependent Variable: y

The revenue obtained from export of skin and leather and agricultural products, metals and minerals and animal and animal products and metals and minerals and agricultural products are linearly correlated.

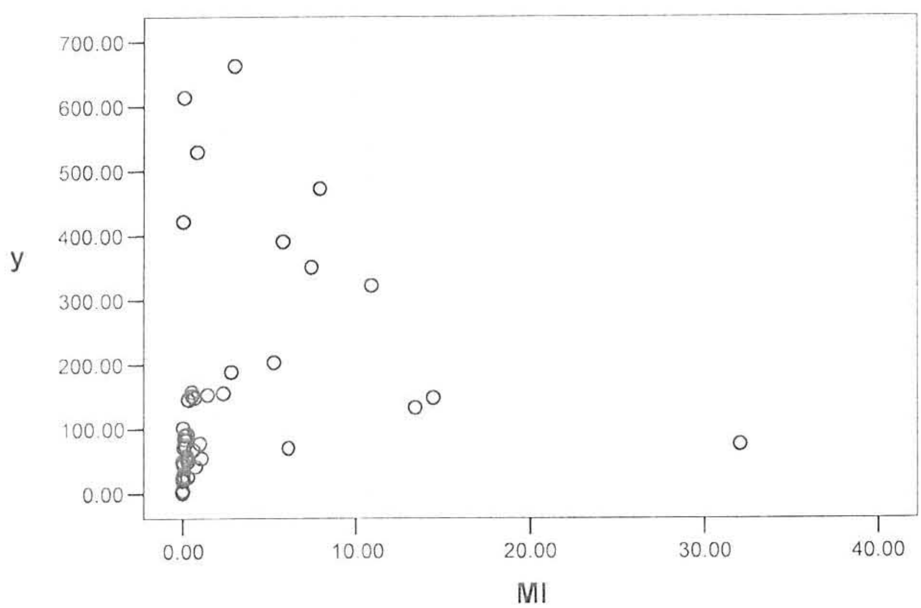
ANNEX 6: Plots of revenue against quantity



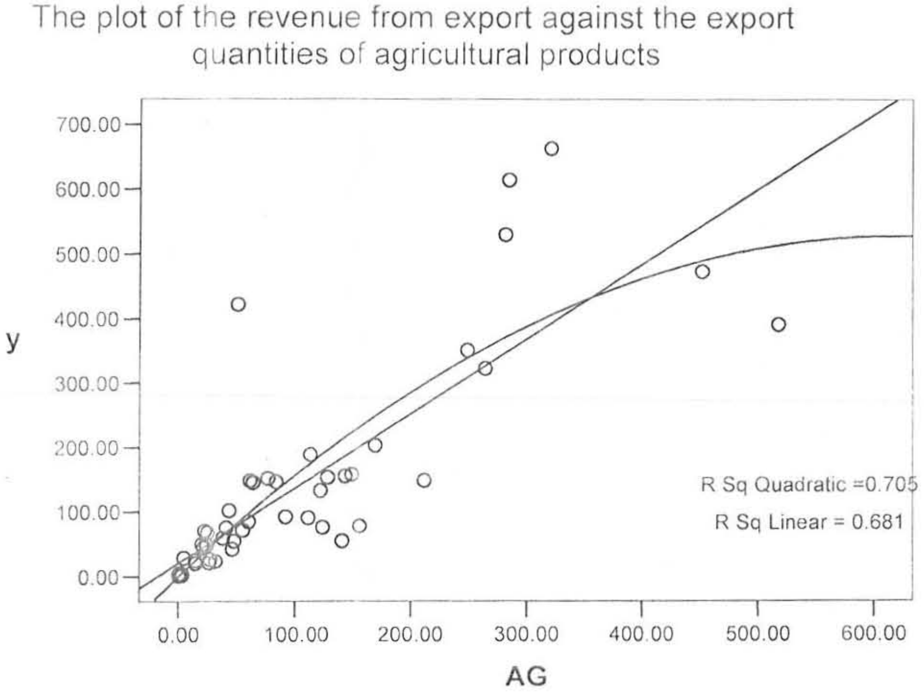
The plot of the revenue from export against the export quantities of animal and animal products



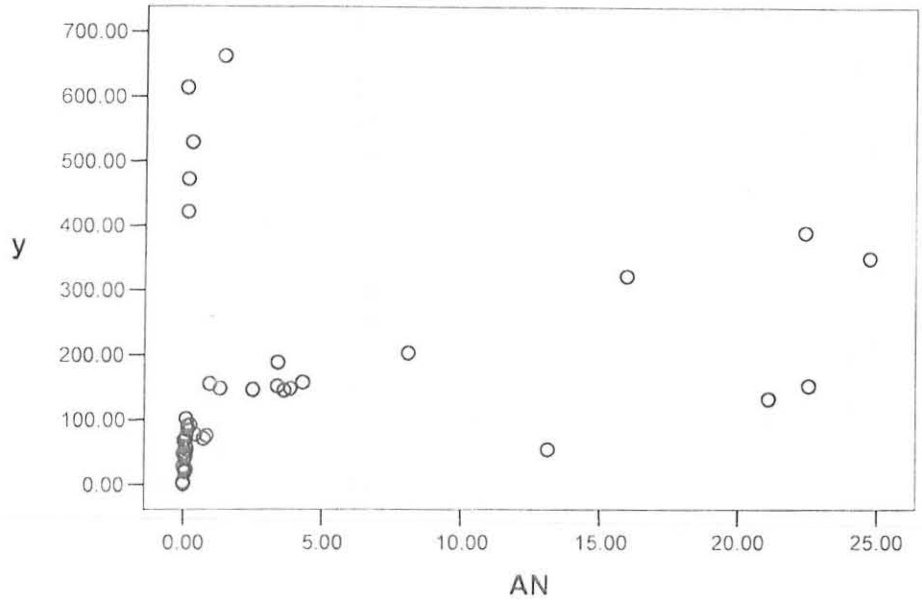
The plot of the revenue from export against the export quantities of metals and minerals



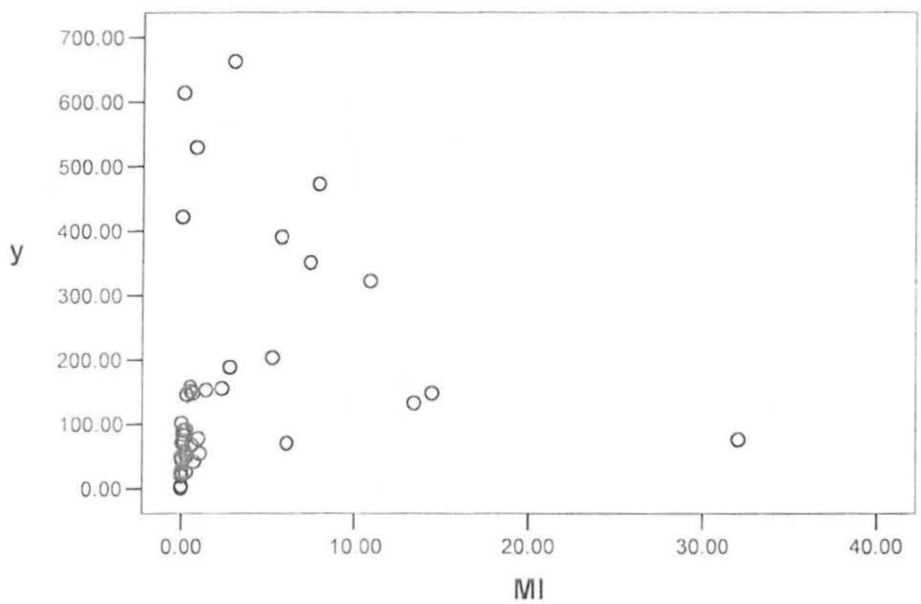
ANNEX 6: Plots of revenue against quantity



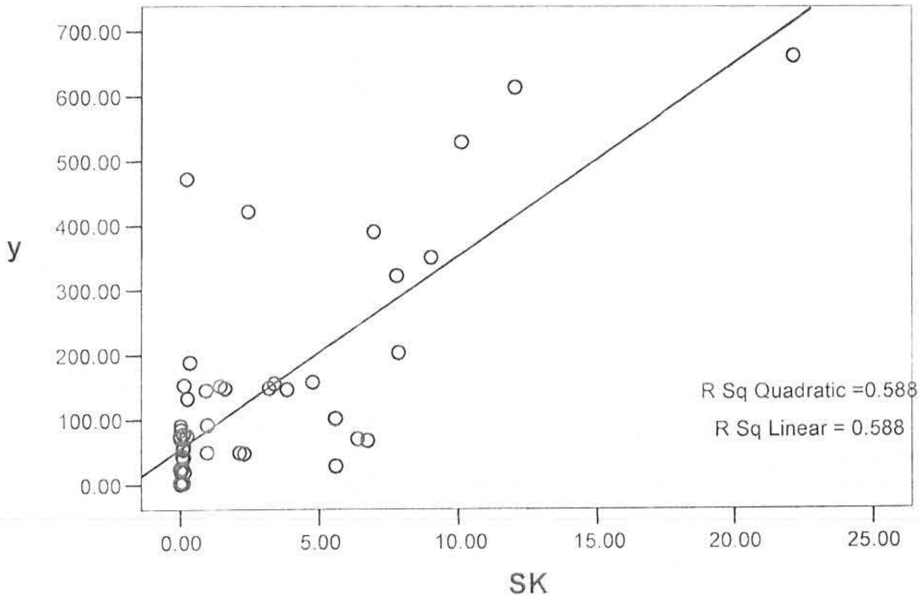
The plot of the revenue from export against the export quantities of animal and animal products



The plot of the revenue from export against the export quantities of metals and minerals



The plot of the revenue from export against the export quantities of skin and leather and animal products



DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for degrees in any other University and all source materials used for the thesis have been duly acknowledged.

Name: YOHANNES YEBABE ------------------------------------

Signature____________________

Place of submission-DEPARTMENT OF STATISTICS,

SCIENCE FACULTY

ADDIS ABABA UNIVERSITY

Date of submission____________________

This thesis work has been submitted for examination with my approval as a University advisor.

Dr. EMMANUEL G/YOHANNES____________________