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TRENDS IN THE TIMBER EXPORT TRADE IN GHANA

A CASE STUDY FOR FORESTRY COMMISSION IN GHANA

By

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DECLARATION

I hereby declare that this submission is my own work towards the award of the MSc. (Mathematics) degree and that to the best of my knowledge, it contains no material previously published by another person or material which had been accepted for the award of any other degree of the university, except where due acknowledgement had been made in the text.

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Certified by:

Prof. I. K. Dontwi	…………………………	1st October, 2013.
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DEDICATION

For I am the Lord, your God,

who grasp your right hand;

It is I who say to you,

"Fear Not, I will help you."

Isaiah 41:13

I dedicate this research to the Most High God, to Him be the Glory for making all things beautiful in his time and also to my family, friends and all loved ones.

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ABSTRACT

This study looks at the combined power of quantitative analyses and technology in exploring the trends in the timber export trade to unlock the complexities hidden in the timber export trade data for the maximum socio-economic benefits to the Forestry Commission, their valued stakeholders and Ghana.

Currently manipulations on timber export trade data are largely qualitatively analyzed (descriptive statistics) which mostly results in inconsistent or inadequate information which have the tendency to affect quality decision taking processes.

The methods to be applied in this study for the quantitative analyses (inference statistics) are Trend Analysis using Mann-Kendall Trend Test, Holt Exponential Smoothing model for forecasting and Random Intercept Model to evaluate annual price variations.

It is believed that the above methods applied on the FC time series data will provide FC with quality information to be disseminated to the Timber Industry to give them insight into comparative advantage production of timber export products (maximize resources) which invariably will make Ghana effective timber export trade competitor (improved revenue for effective planning).

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LIST OF ABBREVIATIONS

AAC	Annual Allowable Cut
ACT	Act Of Parliament
ARIMA	Autoregressive Integrated Moving Averages
BSC	Balanced Scoreboard Card
CEO	Chief Executive Officer
DBH	Diameter at Breast Height
DF	Degrees of Freedom
EU	European Union
FBIs	Forest Based Industries
FC	Forestry Commission, Ghana
FD	Forestry Department
FPIB	Forest Products Inspection Bureau
FPID	Forest Products Inspection Division
FRIM	Forest Research Institute Malaysia
FSD	Forestry Services Division
GDP	Gross Domestic Product
GNU	GNU's Not Unix (Operating System)
ICC	Intraclass Correlation Coefficient
IDE	Integrated Developer Environment
IKEA	IKEA Home Furnishing
IRR	Internal Rate of Return
ITC	International Trade Centre
ITTO	International Tropical Timber Organisation
LAD	Lumber Aired Dried
LKD	Lumber Kiln Dried
LUS	Lesser Used Species
NEST	National Export Strategy Template
RM	Malaysian Currency

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RV	Rotary Veneer
RWE	Round Wood Equivalent
SAS	Statistical Analysis System
SPSS	Statistics Practically Short and Simple
SQL	Structured Query Language
Std. Dev.	Standard Deviation
SV	Sliced Veneer
TEDB	Timber Export Development Board
TEDD	Timber Export Development Division
TIDD	Timber Industry Development Division
TIDD_DB	TIDD Contract and Permit Database
UNCTAD	United Nations Conference on Trade and Development
US	United States
WD	WildLife Department
WSD	WildLife Services Division
WSDP	Woodworking Sector Development Project

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

In the bid to really transform the Forestry and Wildlife resources in Ghana into a blessing for her citizenry, policy makers and implementers have been trying to make the Timber Exports Trade as a new growth driver and admittedly it has not been very smooth over the period but there is steady progress. And as most Presidents of Ghana desire to make Ghana become a middle-income country (over US $ 1,000.00 GDP per capita as stated by Shanta Devarajan, lead economist for World Bank in Nairobi), the economy will require an increase in real growth rate in GDP from 7.3% (World Economic Forum, 2008) to 16% (before 2025) to fulfill such a target Such rapid growth requires structural transformation, technology and scientific analysis (quantitative) of all the productive sectors of the economy such as the Timber Exports sector.

Timber wood products exports add extensively to Ghana's economy. In 2009, the Timber Industry contributed average revenue of $212 million over the past five years, currently accounting for about 4% of the Gross Domestic Product (GDP) and 11% of national export revenue (Minister Alhaji Collins Dauda, 2009). Domestic timber and wood products demands are met (with the establishment of the Wood Village in Kumasi) largely by Timber and Wood Processing Companies and Sawmills, even though these tend to focus more on higher values from export markets. Regardless of the demand (local and international), there are issues which thwart Ghana's successful implementation of the nation's timber export trade strategies in maximizing trade benefits in international markets; like the illegal chainsaw activities. According to Timber

Industry Development Division (TIDD) of the Forestry Commission (FC), in 2005, Ghana earned €170 million from the export of 455,000m^3 of timber wood products in 2004.

However, the International Tropical Timber Organization (ITTO reported that Ghana's timber wood products exports fell in 2006; timber wood product exports in the early quarters of 2006 were €125.82 million in value and 328,620 m^3 in volume. These figures corresponded to 8.81% and 6.72% fall in value and volume respectively, comparative to 2005. The fall was attributed to millers facing continued reductions in supply of raw materials as well as macro-economic constraints. During the same period, timber wood exports to the US and European markets were reported to have fallen in volumes 23% and 32%, respectively due to a policy which was ensuing that timber export products should be sourced legally and from sustainable forests and forest practices.

Actually, the trend for Ghana's overall timber wood products exports in terms of both volume and value has been declining over the past six years signifying an overall decline in export performance. Asia, Africa and the Far East were emerging markets for Ghana's timber wood products over this period while traditional European and U.S markets declined (ITC, 2006).

According to (ITC 2004), a sector-level strategy must be proactive and comprehensive, responding to all issues that have an impact on the sector's international competitiveness. The strategy must address the following key question: How will improved competitiveness of the sector contribute directly to the wider concern of the economic and social development within the country as a whole? In simple terms, what is, and what should be the sector's contribution to national development (ITC, 2005). To achieve this combination of competitiveness and developmental impact, the "Four Gears" should be critically examined, i.e., quantitatively analyzed.

Export competitiveness is a function of the capacity to sell the products demanded in the international market place, at the quantity, quality, price and time required; and this strategy has not been pursued comprehensively (UNCTAD, 2004). It is only through the institution of a strategy that is driven by the combined power of quantitative analyses with technology yielding relevant and accurate information for quality decision making purposes can the long-term international competiveness of the Timber Exports sector be achieved.

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This study looks at the combined power of quantitative analyses and technology in exploring the trends in the timber export trade to unlock the complexities hidden in the timber export trade data for the maximum socio-economic benefits to the Forestry Commission, its cherished stakeholders and Ghana.

1.2 Study Area

Forestry Commission came into being by an act of parliament (ACT 571) in 1999 which seeks to make agencies such as the Forestry and Wildlife Departments of the Ministry of Lands and Forestry (now Ministry of Lands and Natural Resources), Divisions of Forestry Commission. Furthermore, bodies such as Forest Products Inspection Bureau and the Timber Export Development Board are by this bill made Divisions (Forest Products Inspection Division and Timber Export Development Division respectively; then both were merged to become Timber Industry Development Division) of the

Forestry Commission. The current Forestry and Wildlife Department of Ministry of Lands and Forestry became Forest Services Division and Wildlife Services Division respectively of the Commission. The organizational chart is depicted in Appendix 1.

The Vision Statement of the Forestry Commission is "***To leave future generations and its communities with richer, better, more valuable forestry and wildlife endowments than we inherited.***"

The Mission Statement of the Forestry Commission is "***To sustainably develop and manage Ghana's forestry and wildlife resources.***"

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Forestry Commission has the following as its functions:

- Create, protect and manage the permanent forest estates and protected areas in the various ecological zones of the country to conserve Ghana's biophysical heritage.
- Prepare and implement integrated forest and wildlife management plans for the maintenance of the environment to the benefit of all segments of society.
- Regulate the harvesting of timber, wildlife and other non-timber forest products.
- Vet and register contracts and issue permits for export of forest and wildlife products.
- Track the movement of timber, wood and wildlife products
- Monitor the harvesting and marketing of forest and wildlife products
- Develop and enforce appropriate industrial standards and trade guidelines for timber and wildlife products.

- Promote value addition as well as increased use of lesser known timber and wildlife species to ensure the optimization of utilization and benefits of forest and wildlife resources. (www.fcghana.org).

Timber Export Products definition is the prerogative of the Timber Mills in Ghana working closely with the Forestry Commission for the socio-economic benefits of all stakeholders.

1.3 Problem Statement

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The Timber Export Trade as a global business generates a large amount of timber export data hence the necessity for organisations to take advantage of technology with its analytical applications to reengineer their business processes for success and survival.

Currently manipulations on timber export trade data are largely qualitatively (Descriptive Analyses) analyzed which mostly results in inconsistence, or inadequate information which have the tendency to affect quality decision taking processes, for instance in policy formulation and policy implementation planning in the timber and wood export trade..

Effective applications of quantitative (Inference Analyses) analyses with technologies are not only crucial to prevent eventual quality decision making crisis in the timber trade and for the nation, they will also unlock the .the complexities of captured trade export data to deliver meaningful Business Intelligence information to decision makers when they need it, in whatever format they want it and on whatever device they prefer to use.

1.4 Research Objectives

Technology gives us a voice of influence around business strategy and most CEOs are realizing that hidden away in the quantitatively analyzed data they have is the essential Business Intelligence Information that can bring competitive advantage to their organisations and as such, this research has the following as objectives:

- To study Trends in volumes (m^3) of Timber Export Trade data for five major timber export products over a ten year period.
- To fit suitable models to the time series data for the five major timber export products and forecast for the next five years.
- To study the annual price (euro/m^3) variations amongst the top five products for the Timber Exports Trade in Ghana.

1.5 Methodology

The methods to be applied in this study for the quantitative analyses on timber export trade data (2000 to 2010) are:

- Trend Analysis; to investigate product volumes (m^3)
- Mann-Kendall Trend – two parameter
- Holt-Exponential Smoothing model
- Random Intercept model for price variations

Software to be used includes Microsoft Excel 2010, SAS 9.2 and R. Timber Export Trade data was obtained from TIDD Contract and Permit Database (TIDD_DB) and other information from the internet.

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1.6 JUSTIFICATION

It is believed that the above methods applied on the FC data will provide FC with quality information to be disseminated to the Timber Industry to give them insight into comparative advantage production of timber export products (maximize resources) which invariably will make Ghana effective timber export trade competitor (improved revenue; export levies for effective planning).

This thesis is arranged as follows; chapter one focuses on the Introduction, chapter two is about the Literature Review, chapter three emphases on the Methodology, chapter four highlights on Exploratory Analysis and chapter five stresses on the Conclusions and Recommendations.

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CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Trend Analysis

The adoption of a free-market based economic recovery program in 1983 to resuscitate Ghana's economy in a "sustainable" manner marked a major watershed in its timber trade. Generally, the program engendered a dramatic up-turn and expansion in timber exports, especially lumber, to the traditionally dominant European market, with new markets including the Middle East, Asia/Far East, North America, and some West African countries also steadily becoming important. Beyond the associated deforestation, these new trends have largely undermined the traditional interdependent relationships between the formal and informal sectors of the wood industry and the very livelihood of the forest communities and forest management. Using a qualitative analytical approach, this paper examines some implications of these new trends. It shows how the centralized approach in Ghana's quest to sustain its wood exports has further marginalized the forest communities, created a domestic lumber shortage, and constricted the traditional local forward linkage between sawmills and downstream processors. It also shows how Ghanaian wood firms now operate as subcontractors of convenience for firms overseas via an expanded forward linkage, thereby exporting potential Ghanaian jobs overseas. The analysis draws on the author's on-going research on the wood-processing sector, related literature, primary and secondary data on Ghana's timber industry including relevant Government policy documents and statistical data on the timber trade. The discussion is couched in the view that a healthy symbiotic relationship between the formal and informal wood sectors as well as the forest communities is critical for the sustainability of the timber industry, as a whole, and the associated domestic and international trade. It concludes that fostering such a relationship requires a new, pragmatic and sympathetic look, by African governments and policy makers, at the true nature and dynamics of the informal sector and the forest communities. This way, policies formulated and implemented would be based on partnership, a necessary ingredient for the sustainability of the forest sector as a whole. (Owusu J. H., April 2008, New Trends in Ghana's International Timber Trade: some implications for Local Livelihoods and Sustainable Forest Management, Durban, South Africa).

Recent reports of China's efforts to secure access to natural resources in Africa suggest that timber has already become an important traded commodity between China and the African continent. Many hold a general impression that Africa exports a significant and growing amount of timber to China. However, the true magnitude of the China-Africa forest products trade and its trends over time has been poorly documented to date. Greater insight into the importance of Africa within China's overall forest product trade and the importance of China for each African forest product-exporting nation is needed.

In this report, we examine the recent trends of the China-Africa forest product trade as revealed by customs data and reports of Chinese investment and trade-related activities in specific African nations. The results indicate that the China-Africa forest product trade is significant in some, but not all, of the ways generally assumed. In several instances, trade growth is less than many would have expected, and trends have often been highly variable. Key findings include:

1. African share of Chinese wood supply: China's imports of Africa's forest products are substantial (2.6 million cubic meters (m^3) round wood equivalent (RWE) in 2006), but have been highly variable from year to year.

Imports of African forest products make up only a small proportion (2.9%) of the total RWE volume of China's forest product imports from all around the world and have been growing more slowly than these imports overall (especially compared to Russia, the largest supplier of wood to China).

Examining timber exports only (where pulp and paper are excluded), Africa's share of China's imports rises to 5.0% by volume, demonstrating that timber constitutes a greater proportion of Africa's forest product exports to China than other supplying countries.

If one were to remove from the equation China's imports of temperate Russian softwood logs and sawn wood—about half of China's timber imports—the share of African to total imports would register as 9.4%.

2. Value of African timber : Africa's forest product exports to China command a higher share of China's total imports by value (4.9%) than they do by volume (2.9%), suggesting the export of relatively higher value timber to China relative to other supplying countries. This comparison is more pronounced when performed with tropical hardwoods: Africa's share of China's tropical hardwood log and lumber imports by value (14.5%) is more than double its share by volume (6.5%).

3. Export market orientation: For most major exporting countries in Africa, European markets still dominate. In 2006, Africa exported 4.4 million m^3 RWE of natural (non-

plantation) timber products to the EU, compared to 2.1 million m^3 RWE sent to China. The relative importance of the EU market as compared to China, however, varies greatly between regions and individual countries. Important wood producing countries in the western region (e.g. Ghana, Côte d'Ivoire, Nigeria and Cameroon) tend to export to the European Union (EU) markets, with little trade to China. Indeed, Côte d'Ivoire and Ghana export virtually no wood to China.

Mozambique represents the other extreme, with more than 90% of its timber product exported to China. Approximately 70% of Equatorial Guinea's, 50% of the Republic of the Congo's and more than 40% of Gabon's timber are exported to China (2005).

4. Growth trends: Since 1997, growth in African timber exports to China has not shown the same rapid growth as China's overall timber imports, and is in fact quite variable from year to year. Considering the continent as a whole, Africa's exports to China grew rapidly from a small baseline during 1995–1997. Since that expansion, the trade trend could best be described as fluctuating around a relatively flat trend.

Given the scale of traded volumes, drops in the overall figures might be the result of just one or two producer/trader enterprises curtailing exports to China. A drop in exports in 2004 can be partially explained by the cessation of a handful of enterprises' exports from Liberia to China (which was approximately 0.5 million m^3 RWE in 2003) due to UN sanctions barring Liberian timber exports (Forest Trends 2006a).

5. Major supplying countries: Gabon has historically been the leading African supplier to China. Cameroon, Equatorial Guinea, Mozambique and the Republic of the Congo make

up the remainder of the "top five." Regionally, China imports most of its forest products from central Africa, likely due to a preference for endemic tree species such as okoumé.

6. Product mix: Logs dominate the mix of African forest product exports to China (85% by volume in 2006) and play an even greater role in this mix than in China's overall forest product imports from all countries (36% by volume in 2006). Even in African countries that have the capacity to produce value-added timber products (as evidenced by processed wood exports to Europe), Chinese markets are not buying them. Pulp and paper are the second largest category of wood products exported to China, virtually all coming from South Africa and Swaziland.

7. Imports of processed wood products from China to Africa: Many have speculated that China's manufacturing industry will be able to send cheap manufactured wood products back to supplier countries, effectively displacing any emerging African manufacturing capabilities. Comparison of the import/export balance of the China-Africa trade, however, shows that China is a net importer of forest products when it comes to Africa: for every 100 m^3 RWE imported, 68 m^3 is exported. While Chinese exports of manufactured wood products to Africa have been increasing dramatically, it is starting from a very small base. However, with the exception of South Africa, none of the top ten exporting countries are significant importers of manufactured forest products from China. The greatest volume of these imports (45%) goes to North African countries such as Egypt (top African importer of plywood and fiberboard); Nigeria, Egypt and South Africa (paper); and South Africa (furniture).

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While China's overall forest product imports from Africa have not grown substantially over the period studied, they have become increasingly important within particular countries, such as the Republic of the Congo, Equatorial Guinea, and Mozambique. Chinese demand for wood has given support to African exporters of logs, but has not promoted the development of Africa's domestic processing and manufacturing capacity in the forest sector. In order to ensure that these growing exports provide economic and livelihood benefits to local stakeholders, particularly forest-dependent communities, such growth will need to operate through sustainable forestry mechanisms. In many African countries, trade flows of wood products to the rest of the world, often through China, are increasing the stress on already weak systems of forest governance and law enforcement. These flows have been shown in other reports to be heavily correlated with increases in unsustainable or illegal harvesting, biodiversity loss, and the abuse of forest communities' rights. (Kerstin Canby, James Hewitt, Luke Bailey, Eugenia Katsigris and Sun Xiufang, February 2008, Forest products trade between China and Africa, An analysis of Imports & Exports).

2.2 Alternate Analytical Models

Since the mid - 1990s Ghana's forestry sector has been going through reforms geared towards achieving the ITTO Year 2000 Objective for sustainable forest management and forest product trade. The reforms were partly introduced through legal approaches and also through activities under a long-term Forestry Sector Development Master Plan. The legal approaches mainly dealt with strengthening of sector institutions to effectively carry out forest concession administration and management, stumpage fee increases and more punitive actions against forest offences. Reforms with more direct impact on forest product export trade came through the implementation of the Forestry Sector Development Master Plan – reduction in annual allowable cut (AAC), introduction of air-dry levy, and promotion of value-addition and lesser-used species (LUS). These actions have infuriated the forest product industry blaming the government for a collapsing industry as a result of the interventions. Considering the current confusion between government and the industry, it is imperative that such an evaluation is carried out to gain insights into the program's usefulness or otherwise. SPSS Decision Time 1.0 software's Autoregressive Integrated Moving Average (ARIMA) modeling was used in this analysis. The four variables of interest are (1) proportion of LUS of total volume of all species exported, i.e., Percent LUS, P (dependent), (2) raw material (AAC) level, R (metric predictor), (3) air-dry levy, L (dummy predictor), and (4) Woodworking Sector Development Project (WSDP), W (dummy predictor). The ARIMA model in this study applies Bowerman and O'Connell (1993) and Box and Tiao (1975) transfer function and intervention models.

A far-reaching importance of this study would be the guidance it could offer to other tropical nations seeking to adopt similar measures. (Donkor Ben Nathan, December 2003, Evaluation of Government Interventions in Ghana's Forest Product Trade: A Post-Intervention Impact Assessment and Perceptions of Marketing Implications).

Export-led strategies are very crucial to achieving growth and goals of developing and transition economies such as Ghana. As a result, export strategies are being adopted in many developing countries. Although such export strategies might be in place, the deployment of public resources and funds warrant periodic programmatic evaluation. The objective of the study was to assess Ghana's wood products export sector strategies and performance. Using a combined National Export Strategy Template (NEST) and Balanced Scorecard (BCS) framework, we surveyed the 250 largest wood products manufacturers in Ghana. Overall, respondents indicated there was no comprehensive and well documented export strategy in place. We suggest that public and private sector institutions in the wood export sector coordinate activities to create an enabling environment for Ghana wood products exporters to compete favorably in the international market. The application of a combined National Export Strategy Template (NEST) and Balanced Scorecard (BCS) framework can be used to evaluate wood product export strategies in any geographical or national setting. This approach is a valuable tool that pinpoints strategic strengths and weaknesses. (Odoom Domson M. S. and P. Richard Vlosky, April 2010, Strategic Positioning Analysis of Ghana's National Wood Export Sector).

The growing of global trade and sales activity in the global market cause the increasing attention to the variables effect on firm export performance. However, despite a lot published about determinants of firm export performance, the literatures are characterized by the lack of consensus among researchers as to what constitutes export marketing strategy of firm export performance. As a result, this study reviews the articles published between 1993 and 2010 assesses the effect of export marketing strategy elements on firm export performance. Based upon a comprehensive and systematic literature study, a synthesized model which can be apply for understanding export marketing strategy influence on export to enhance the firm export performance will be eventually designed. In this study the export marketing strategy are classified to price strategy, product strategy, promotion strategy and place strategy. Later, the results of previous studies about detailed analysis on dimensions of export marketing strategy and the relationship between export marketing strategy and firm export performance are mentioned. In addition, a proposed conceptual framework is developed for the researchers who are interested to evaluate this issue in further research. (Farshid Movaghar Moghaddam et al, December 2011, The Influence of Export Marketing Strategy determinants on Firm Export Performance: A Review of Empirical Literatures between 1993-2010).

2.3 Trends in the Timber Export Industry in Malaysia

This study analyses the international timber trade between Malaysia and Europe with respect to the importance of environment issues on trade and the role of Malaysia as a major timber exporter to Europe. It also evaluates the comparative advantage of Malaysian wood products and the willingness of French consumers (to represent European communities) to pay for sustainable forest management. The first part gives an overview the clash of perception between developed and developing countries on the environmental concerns over trade. It was observed that environmental standards may act as non-tariff barriers to exporting countries. In addition, the stringent requirements pose by importing countries on technical, marking and labeling to some extent provide unnecessary barrier to trade. The second part deals with the role of Malaysia as a key player in the tropical timber trade. This part evaluates the main export market for Malaysian wood products to the world. For the purpose of this thesis, the analysis focuses on the European market. From the observations it was found that the export of wooden furniture surpassed major timber exports in 2004. However, to penetrate the European market, Malaysia has to compete with the Chinese with their lower cost tropical wood products, and Brazil with their advantage in certification and labeling of tropical wood products. In tandem with that, the commitment towards sustainable forest management at national level causes shortage of raw materials in Malaysia. To a certain extent, the internal and external factors create necessary challenges to enter the European market. In the third part, the Balassa approach was used to classify the comparative advantage of Malaysia's twenty one types of wood products in Europe. It was estimated that Malaysia had high comparative advantage only in five products which were mechanized and intermediary industrial products. The products identified were sawn wood, wooden mouldings, plywood, veneer and builders' joinery and carpentry. The remaining products had lower comparative advantage and disadvantage to export to the European market based on the Balassa index. In the last part, the estimation of the willingness to pay for sustainable forest management attributes was conducted. Besides that, additional attributes such as fair trade and wood origin were included. A questionnaire was set up using all the attributes reflected in the hypothetical wood flooring product in the market. Based on the result, consumers were willing to pay the highest for the presence of fair trade and wood origin (in this study referring to French origin); nevertheless they were still willing to pay for sustainable aspects of forest. However, the willingness to pay for all the attributes was altered depending on the respondents' knowledge of forest labeling, their attitudes towards environmental preservation, living area, education level, type of job and income level. In the overall finding of the thesis, all the results from each part were synthesized in a systemic approach simultaneously deliberating on the macro and microeconomic perspectives as well as the dimensions on demand and supply. Overall,

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the findings suggest that the challenges and constraints facing the Malaysian timber industry indirectly shaped the export of Malaysian wooden products. Malaysia has adapted by going into value-added products to lessen the impact of environment-related trade barriers and to circumvent the shortage of raw materials supply. Malaysia has successfully customized the wooden products to the sustainability and legality requirements of the European market by pursuing the national certification (Malaysian Timber Certification) and being committed to sustainable forest management objectives. (Zakaria Noor Aini Binti, April 2011, Trade Barriers in Forest Industry between Malaysia and Europe).

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The rubber tree (Hevea Brasiliensis) is indigenous to the forests of the Amazon basin, where, in its native habitat, grows to about 25-30 meters tall with average girth of over one meter diameter at breast height (DBH). In Malaysia, the species is found to be much smaller having historically been bred for latex production with little regard for timber yield. Research to determine the potential use of rubberwood timber and its applications in products such as fiberboard, wood pulp, and other products was initiated in the Forest Research Institute Malaysia (FRIM) in 1953 resulting in Malaysia being the first country in the world to develop and employ a system of wood preservation with proper kiln drying procedures resulting in the production of export quality moldings, wood components and furniture.

The Malaysian furniture industry became an international player because of the technical developments that enabled a cheap and plentiful timber: rubberwood, to be turned into a value added product: furniture at a competitive price. However, Malaysia's once cheap raw material is becoming more and more expensive generating a lot of discussion about the trend of increasing rubberwood costs and questions as to the long term sustainability of the whole rubber and rubberwood-based furniture industry. The concern arises from the conversion of rubber plantations to oil palm since oil palm provides a higher rate of return than rubber and with less labor input.

To ensure a long term supply of raw material for the furniture industry, we explore the viability of establishing forest plantations of fast growing exotics like acacia and indigenous re-growth pioneers like Meranti (Shorea spp.). Many researchers have pointed out that plantation forestry currently forms the foundation on which a RM 7.6 billion industry has grown and without a change, could die. Suggestions have been made that it is time the government stepped in with policy changes and incentives to encourage plantation timber production.

For close to four decades, the forestry sector and the forest based industries (FBIs) have been one of Malaysia's largest earners of foreign exchange but the development of the FBIs is closely correlated with timber availability in the country. Since Malaysia has been over-harvesting its natural forests by some 11 million m3 per year since 1996, there has been a substantial decrease total forested land area and serious degradation of much of the areas classified as Permanent Forest Reserves and Production Forests. Although the Malaysian furniture industry is dependent on tropical timber for only 20% of its solid wood inputs, limitations in the primary forest based industries will also limit the development, adaptability, and options of the secondary industries like particle board plants, and the tertiary furniture industry. These limitations will impact the furniture industry as research has shown a desire for manufacturers to shift production to using more tropical timber, not less.

Twenty years ago, many observers questioned the efforts of FRIM to develop uses for the large numbers of unproductive rubber trees that were being cut and replaced each year. Some people wondered why Malaysia would bother with such crooked, small-diameter trees, whose wood was susceptible to blue stain and borer attack and for which there was virtually no market recognition. Today no one questions the logic of FRIM's efforts. In barely two decades, rubberwood has become the preferred raw material for Malaysia's RM 7.6 billion furniture industry and the mainstay of the country's particleboard and fiberboard sectors. Because of the increasing importance of rubberwood there is an urgent need to review policies and guidelines governing the production of this resource to ensure a consistent and continued supply.

The material shortage facing the industry is a result of structural changes to the Malaysian economy, changes in international commodity markets, and a lack of Government intervention. Throughout the 1990s, a general slump in the world latex market, together with rising labor costs, pushed many plantation owners to shift from rubber to oil palm. The resulting glut of rubberwood logs from plantation conversion depressed prices below RM 75 per m3 for much of the decade. More recently, however, many processors in Malaysia have been reporting shortages of timber supplies due to high latex prices and a reluctance to harvest the rubber trees.

Demand for rubberwood timber has continued to increase while the total area replanted in rubber has been decreasing, with the predicted result being a shortage of round logs for downstream processors in rubberwood based industries. Since the potential of rubberwood was first made known to timber manufacturers, there have been numerous projections made as to the quantity of timber available for manufacturers.

Due to declines in domestic tropical timber production and conversion of rubber plantations to oil palm, there is a pressing need for Malaysia to take steps in assuring wood security for its important wood-based industries. There are various options for Malaysia to obtain wood security domestically involving sustainable forest management and commercial forest plantations. However, bases on current forest cover, reliance on the Sustainable Forest Management of Malaysia's forests will not provide enough wood security to support the primary and secondary wood-based industries of the country.

The other alternative is the establishment of commercial forest plantations but Malaysia has had limited experience with the establishment of commercial forest plantations. However, there has been some endeavors to establish plantation area in the Peninsular and East Malaysia with 80% of this having been planted by the Australian exotic, acacia. With a larger volume coming on line, the Malaysian furniture and panel board industry is starting to seriously consider acacia. This is in part due to the improvement in timber quality and availability, to the reduction in price per m^3 vis-à-vis rubberwood, and IKEA. The impact of IKEA's buying habits to influence an industry is highlighted in case study.

The remaining barrier to the establishment of plantation forests, in acacia or rubberwood-latex, is the financial viability of all of the commercial production forest alternatives examined is the poor rate of return. The IRR is low at around 10 to 15%, when compared to other agricultural crops like oil palm. However, with some more incentives for plantation establishment, we may see an increase in the coverage of acacia as the demand for the timber continues to grow. Sentang, teak, and bamboo are also considered as potential species for large-scale plantation development.

In addition to examining the historical precursors and trends to the establishment of Malaysia's furniture industry, a market survey of furniture manufacturers was conducted with the intention of getting a better "industry feeling" of their past use of rubberwood in their products and of the direction that manufacturers intend to take in the future in regards to material and specie substitution and utilization as a response to the increase in rubberwood prices. What we see is a trend away from relying solely on rubberwood as a raw material and substitution with wood composite materials and other tropical timber species. This is a similar trend gleaned from interviews of industry players.

Substitution of solid rubberwood with composite materials is a positive move for the sustainability of the industry because composite materials utilize low grade wood or other fibrous material as the raw material. However, we have seen also a general move to replacing rubberwood with tropical timbers. Although tropical timber is more expensive that rubberwood, it is currently more available. The availability of tropical timber is due to a continual smuggling of Indonesian timber into Malaysia with neither Malaysia nor Indonesia having been able to properly address the situation. This trend does not auger well for the long term sustainability of the Malaysian furniture industry as it, like other FBIs, is dependent on forests for the raw material and the forest cover in Indonesia continues to decline. (Hromatka Timothy, 2005, Timber Shortage and the Sustainability of the Malaysian Furniture).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction

In this chapter we discuss Time Series in terms of Timber Export Trade data, explore the trends in the trade data using Mann-Kendall trends test then apply Holts Exponential Smoothing model for forecasting and evaluate price variations using Random Intercept model, making use of technology (software) to automate the modeling and forecasting processes and procedures.

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3.2 Time Series Data

Today time series data are being generated at an unprecedented speed from almost every application domain, e.g., daily fluctuations of stock market, traces of dynamic processes and scientific experiments, medical and biological experimental observations and timber export transactions just to mention a few. As a consequence, in the last decade there has been a dramatically increasing amount of interest in querying and mining such data which, in turn, resulted in a large amount of work introducing new methodologies for indexing, classification, clustering and approximation of time series.

3.2.1 Representation Techniques

Two key aspects for achieving effectiveness and efficiency, when managing time series data are *representation methods* and *similarity measure* (which are not the primary focus of this work). Time series are essentially high dimensional data and directly dealing with such data in its raw format is very expensive in terms of processing and storage cost. It is thus highly desirable to develop representation techniques that can reduce the dimensionality of time series, while still preserving the fundamental characteristics of a particular data set. In addition, unlike canonical data types, e.g., nominal or ordinal variables, where the distance definition is straightforward, the distance between time series needs to be carefully defined in order to reflect the underlying (dis)similarity of such data. This is particularly desirable for similarity-based retrieval, classification, clustering and other mining procedures of time series. Typically, most of the existing work on time series assume that time is discrete. For simplicity and without any loss of generality, we make the same assumption here. Formally, a time series data is defined as a sequence of pairs $T = [(p1, t1), (p2, t2), \ldots, (pi, ti), \ldots, (pn, tn)]$ $(t1 < t2 < \ldots < ti < \ldots < tn)$, where each pi is a data point in a d-dimensional data space, and each ti is the time stamp at which pi occurs. (Querying and Mining of Time Series Data by Hui Ding et al).

3.2.2 TIDD Contract and Permit Database (TIDD_DB)

The specific Time Series data which was used for this research was queried and mined from a database called TIDD_DB (designed, developed and implemented by the researcher of this project) for the Forestry Commission (FC).

The Timber Export Trade in Ghana is regulated by FC by providing the enabling environment for the Exporter/Seller (Miller) and the Importer/Buyer to do timber business. Both parties enter into contract (initializing the timber export business) specifying requirements which may include the timber species, the products, measurement specifications, quality, quantity, price per cubic meter, destination amongst others. When they (Seller and Buyer) come to an agreement, the seller comes to FC (TIDD) for the contract to be approved, then proceed to acquire permit to ship the parcel to the agreed destination of the buyer on an agreed mode of payment supervised by the negotiating bank approved by both parties. The above mentioned database captures every detail of this timber export trade transactions. Approved contract and permit executed each working day averaged forty to fifty then.

Time Series Data has been carefully queried and mined from the TIDD_DB into representations (Cumulative Volume (m^3) and Value (euros) of permitted export timber products) as shown in Table 3.1 below (See Appendix 2 for the other years) for effective and efficient trend analyses with significance testing using Mann-Kendall test with LOWESS modelling. Holt Method will be applied for forecasting then the Random Intercept model is used to evaluate annual price (euro/m^3) variations.

Table 3.1

	TIMBER PRODUCTS	VOLUME.(M3)	VALUE.(EURO)
1	LUMBER (KILN DRIED)	143,749.048	46,521,515.90
2	LUMBER (AIR DRIED)	93,279.751	29,041,411.12
3	SLICED VENEER	35,560.084	28,980,986.11
4	ROTARY VENEER	75,059.239	18,337,853.41
5	BOULES (AIR DRIED)	57,117.424	17,016,550.09
6	PLYWOOD	46,790.839	12,085,336.69
7	PROCESSED L/MOULDING	22,123.344	8,551,777.99
8	FURNITURE PARTS	2,498.522	6,464,114.45
9	BOULES (KILN DRIED)	11,514.447	2,489,235.23
10	FLOORING	2,217.829	1,566,955.53
11	CURLS VENEER	114.157	1,118,587.78
12	LUMBER (OVERLAND)	5,487.361	1,044,520.79
13	POLES	1,032.828	728,298.87
14	PROFILE BOARDS	972.959	537,299.94
15	DOWELS	1,001.736	460,199.87
16	LAYONS	185.469	222,866.81
17	BROOMSTICKS	103.248	40,309.50
18	FLUSH DOORS	35.030	36,158.00
	TOTAL	498,843.316	175,243,978.00

Table 3.1 Summary on Export Permit for 2000

3.2.3 Selected Timber Export Products

For the purposes of this research, five timber products will be used for analyses namely Lumber Kiln Dried (LKD), Lumber Air Dried including overland lumber (LAD), Sliced Veneer (SV), Rotary Veneer (RV) and Plywood (which includes overland plywood). Criteria for selecting these include:

1. They are all Secondary Products (Homogeneous) unlike furniture which is a Tertiary product
2. Their Volume (m^3) and Value (€) contribution to the timber trade and their individual contributions to Ghana's GDP
3. Their consistency (in demand and production) over the period of study (2000 – 2010).
4. The variables for the trend analyses will be volumes (controlled) and values (uncontrolled)

It is important to note that the production of these timber export product depends on contract specification like requested timber species and product quality, *all held constant.*

3.3 Trend Analysis

The purpose of trend testing is to determine if a series of observations of a random variable, in this instance the export product volume (m^3) is generally increasing or decreasing with time or it has probability distribution changed with time? Also, we may want to describe the amount or rate of change, in terms of some central value of the distribution such as the mean annual price (euro/m^3) of the time series data used in this research.

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Broadly speaking, trends occur in two ways: a gradual change over time that is consistent in direction (***monotonic trend; in other words, the variables should either increase in values together, or when one gets increased, and then the other should get decreased***) or an abrupt shift at a specific point in time (***step trend***).

3.3.1 Approaches to Trend Testing

Our prime concern for this research will be monotonic (nonparametric test: as we are using only five products, thus our n = 5) trend approach as shown in the table below:

Table 3.2

Type	**Not Adjusted for X**	**Adjusted for X**
Nonparametric	Mann-Kendall trend test on Y	Mann-Kendall trend test on residuals R from LOWESS of Y on X
Mixed	-	Mann-Kendall trend test on residuals R from regression of Y on X
Parametric	Regression of Y on T	Regression of Y on X and T

Table 3.2 Approaches to Trend Testing

where Y = random variable of interest in the trend test (timber export product *volumes*),

X = an exogenous variable expected to affect Y, (timber export product *values*; made up of market price influenced by foreign exchange rate and interest rate for borrowing, regulated by the FC's guiding selling price),

R = residuals from a regression or LOWESS of Y on X and

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T = time (each month in 2000 to 2010)

Nonparametric Mann-Kendall test, the same as Kendall's τ (Tau) test is invariant to power transformation.

3.3.2 Mann-Kendall Trend Test

Given n consecutive observations of a time series z_t , $t = 1, \cdots, n$, Mann (1945) suggested using the Kendall rank correlation of z_t with t, $t = 1, \cdots, n$ to test for monotonic trend. The null hypothesis of no trend assumes that the z_t , $t = 1, \cdots, n$ are independently distributed. Our R software function, MannKendall(z) implements the Mann-Kendall test using Kendall(x, y) to compute τ and its significance level under the null hypothesis.

The Mann-Kendall trend test has some desirable features. In the simple linear trend model with independent Gaussian errors, $z_t = \alpha + \beta_t + e_t$, where e_t is Gaussian white noise, it is known that the Mann-Kendall trend test has 98% efficiency relative to the usual least squares method of testing $\beta = 0$. Also, an empirical simulation study of Hipel, McLeod and Fosu (1986) showed that the Mann-Kendall test outperformed the lag one autocorrelation test for detecting a variety of deterministic trends such as a step-intervention or a linear trend.

In the case of no ties in the values of z_t , $t = 1, \cdots, n$ the Mann-Kendall rank correlation coefficient τ has an interesting interpretation. In this case, the Mann-Kendall rank correlation for a trend test can be written:

$$\tau = \frac{S}{\binom{n}{2}}, \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where

$$S = 2P - \binom{n}{2}, \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where P is the number of times that $z_{t2} > z_{t1}$ for all $t1$, $t2 = 1, \ldots, n$ such that $t_2 > t_1$. Thus $\tau = 2\pi_c - 1$, where π_c is the relative frequency of positive concordance, i.e., the proportion of time for which $z_{t2} > z_{t1}$ when $t_2 > t_1$. Equivalently, the relative frequency of positive concordance is given by $\pi_c = 0.5(\tau + 1)$.

The Mann-Kendall test is essentially limited to testing the null hypothesis that the data are independent and identically distributed. Our time series data may *diverge* from this assumption in two ways. First there may be *autocorrelation* and second may be a *seasonal* component. To eliminate these factors we can use annual data but this has the effect of reducing the power. For strong positive autocorrelation in the series, the effect of using annual totals will reduce the effect of this autocorrelation substantially and the loss of power is, perhaps, not expected to be too much — this is something we will investigate further in a methodological study.

The method of Brillinger (1989) deals with both the problems of seasonality and autocorrelation but it also requires an estimate of the spectral density at zero. However the test of Brillinger (1989) is not suitable for testing for long-term trend with monthly data with a strong seasonal component since the running-average smoother used will not be useful in this case. Another model-building approach to trend analysis is intervention analysis (Box & Tiao, 1975; Hipel & McLeod, 1994) which can also handle both seasonality and autocorrelation. This assumes a known intervention time and the development of a suitable time series model.

The Seasonal-Mann-Kendall trend test is a test for monotonic trend in a time series with seasonal variation. Hirsch et al (1982) developed such a test by computing the Kendall score separately for each month. The separate monthly scores are then summed to obtain the test statistic. The variance of the test statistic is obtained by summing the variances of the Kendall score statistic for each month. The normal approximation may then be used to evaluate significance level. In this test, the null hypothesis is that the time series is of the form $z_t = \mu_m + e_t$ where e_t is white noise error and μ_m represents the mean for period m. The τ coefficient is defined by

$$\tau = \frac{\sum_{i=1}^{s} S_i}{\sum_{i=1}^{s} D_i},$$

where Si , Di , $i = 1, \cdots, s$ denote the Kendsall scores and denominators for the *i-th* season and s is the seasonal period. We implemented this procedure in R software with the function SeasonalMannKendall(z).

3.3.3 Lowess Modelling

LOWESS is a data analysis technique for producing a "smooth" set of values from a time series which has been contaminated with noise, or from a scatter plot with a "noisy" relationship between the 2 variables. In LOWESS, the data is modeled locally by a polynomial weighted least squares regression, the weights giving more importance to the local data points. This method of approximating data sets is called Locally Weighted

Polynomial Regression. LOWESS describes the relationship between Y and X without assuming linearity or normality of residuals. LOWESS pattern should be smooth enough that it doesn't have several local minima and maxima, but not so smooth as to eliminate the true change in slope. The LOWESS residuals are given by:

$$R = Y - \hat{Y}$$

Then, Kendall S statistic is computed from R and T pairs to test for trend.

In R software, LOWESS is implemented by the function LOWESS () supposing the model: $y = y(x) + \varepsilon$.

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3.4 The Holt's Exponential Smoothing Method

This is the simplest form of exponential smoothing and can be used only for data without any systematic trend or seasonal components. Given such a time series, a sensible approach is to take a weighted average of past values. So for a series, $y_1, y_2, \ldots, y_n$, the estimate of the value of y_n+1, given the information available up to time n, is:

$$\hat{y}_{n+1|n} = w_0 y_n + w_1 y_{n-1} + w_2 y_{n-2} + \ldots\ldots$$

or $$\hat{y}_{n+1|n} = \sum_{i=0}^{\infty} w_i y_{n-i}$$

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where w_i are the weights given to the past values of the series and sum to one. Since the most recent observations of the series are also the most relevant, it is logical that they should be given more weight at the expense of observations further in the past. This is achieved by assigning geometrically declining weights to the series. These decrease by a constant ratio and are of the form:

$$w_i = a(1-a)^i$$

where $i=0, 1, 2, ...$ and a is the smoothing constant in the range $0 < a < 1$ For example, if a is set to 0.5, the weights will be:

$w_0 = 0.5$

$w_1 = 0.25$

$w_2 = 0.125$ *and so on.*

It can be seen that weights taking this form will sum to ~1 for all values of a in the above range. The equation for the estimate of y_n+1 then becomes:

$$\hat{y}_{n+1|n} = ay_n + a(1-a)y_{n-1} + a(1-a)^2 y_{n-2} + ...$$

Since:

$$\hat{y}_{n+1|n} = ay_n + (1-a)(ay_{n-1} + a(1-a)y_{n-2} + ...)$$

it can be seen that:

$$\hat{y}_{n+1|n} = ay_n + (1-a)\hat{y}_{n|n-1}$$

where $\hat{y}_{n|n-1}$ is simply the previous estimates.

This equation defines exponential smoothing and is extremely useful since we can now update each forecast using only two pieces of data: the latest observation; and the

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previous forecast. It can also be written in the alternative error correction form as follows:

$$\hat{y}_{n+1|n} = a\,e_n + \hat{y}_{n|n-1}$$

Where $e_n = y_n - \hat{y}_{n|n-1}$ and is the one step ahead prediction error.

The final matter with which to deal is the value of a, the smoothing constant. This will depend on the characteristics of the particular time series, especially the irregularity of the data. A high value of a will lead to the majority of the weight being placed on the most recent observations whereas a low value of a will mean that observations further in the past will gain more importance. A value of a = 1 will obviously make the forecast equal to the final value of the series. The smoothing constant is commonly set between 0.05 and 0.3, although it is possible to estimate a by minimizing the sum of squared prediction errors.

This can be done by calculating:

$$\sum e_t^2$$

for values of a between 0 and 1 (say in steps of 0.1) where e_t is the one step ahead prediction error as stated above. By doing this it is possible to obtain, to the nearest tenth, the value of a, which minimizes the sum of squared errors. Steps of 0.01 can then be taken around this value to minimize the sum of squares further. Accuracy at this point is

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not particularly important as the sum of squares function tends to be quite flat near the minimum.

3.4.1 Holt's Method

The next step involves introducing a term to take into account the possibility of a series exhibiting some form of trend, whether constant or non-constant. In single exponential smoothing, the forecast function is simply the latest estimate of the level. If a slope component is now added which itself is updated by exponential smoothing, the trend can be taken into account.

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For a series $y_1, y_2, \ldots, y_n$, the forecast function, which gives an estimate of the series 1 step ahead can be written as:

$$\hat{y}_{n+l|n} = m_n + lb_n \qquad l=1, 2, \ldots$$

where m_n is the current level and b_n is the current slope. Therefore, the one step ahead prediction is simply given by:

$$\hat{y}_{t/t-1} = m_{t-1} + b_{t-1}$$

Since there are now two terms to the exponential smoothing, two separate smoothing constants are required, a_0 for the level and a_1 for the slope. As in single exponential smoothing, the updated estimate of the level m_t is a linear combination of $\hat{y}_{t|t-1}$ and y_t:

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$$m_t = a_0 y_t + (1 - a_0)(m_{t-1} + b_{t-1}) \qquad 0 < a < 1$$

This provides the level at time, *t*. Since the level at time *t-1* is already known, it is possible to update the estimate of the slope:

$$b_t = a_1 (m_t - m_{t-1}) + (1 - a_1) b_{t-1}$$

These equations can also be written in the appropriate error correction form:

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$$m_t = m_{t-1} + b_{t-1} + a_0 e_t$$

$$b_t = b_{t-1} + a_0 a_1 e_t$$

This method, known as Holt's method, requires starting values for m_t and b_t to be inputted, and estimates of the values for a_0 and a_1 to be made. It would be typical to find $0.02 < a_0, a_1 < 0.2$, but they can be estimated by minimizing the sum of squared errors as in single exponential smoothing. Also, it is often found that $m1 = y1$, and $b1 = y2 - y1$ are reasonable starting values.

3.4.2 Holt-Winter's forecasting

Holt's method can be extended to deal with time series which contain both trend and seasonal variations. The Holt-Winters method has two versions, additive and multiplicative, the use of which depends on the characteristics of the particular time series. The latter will be considered first. The general forecast function for the multiplicative Holt-Winters method is:

$$\hat{y}_{n+l|n} = (m_n + lb_n)c_{n-s+l} \qquad l=1, 2, \ldots$$

where m_n is the component of level, b_n is the component of the slope, and c_{n-s+l} is the relevant seasonal component, with s signifying the seasonal period (e.g. 4 for quarterly data and 12 for monthly data.)

Therefore if a monthly time series is considered, the one step ahead forecast is given by:

$$\hat{y}_{n+1|n} = (m_n + b_n)c_{n-11}$$

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The updating formulae for the three components will each require a smoothing constant. If once again a_0 is used as the parameter for the level and a_1 for the slope, and a third constant a_2, is added as the smoothing constant for the seasonal factor, the updating equations will be:

$$m_t = a_0 \frac{y_t}{c_{t-s}} + (1 - a_0)(m_{t-1} + b_{t-1})$$

$$b_t = a_1(m_t - m_{t-1}) + (1 - a_1)b_{t-1}$$

$$c_t = a_2 \frac{y_t}{m_t} + (1 - a_2)c_{t-s}$$

Once again, a_0, a_1, and a_2 all lie between zero and one. If the aforementioned additive version of Holt-Winters was used, the seasonal factor is simply added as opposed to multiplied into the one step ahead forecast function, thus:

$$\hat{y}_{n+1|n} = m_n + b_n + c_{n-11}$$

and the level and seasonal updating equations involve differences as opposed to ratios:

$$m_t = a_0(y_t - c_{t-s}) + (1-a_0)(m_{t-1} + b_{t-1})$$

$$c_t = a_2(y_t - m_t) + (1-a_2)c_{t-s}$$

The slope component, b_t, remains unchanged.

The choice of starting values and smoothing parameters is of some importance and Chatfield and Yar (1988) discussed this in some depth. For starting values, it seems sensible to set the level component m_0, equal to the average observation in the first year, i.e.

$$m_0 = \sum_{t=1}^{s} y_t / s$$

where s is the number of seasons. The starting value for the slope component can be taken from the average difference per time period between the first and second year averages. That is:

$$b_0 = \frac{\left\{\sum_{t=1}^{s} y_t / s\right\} - \left\{\sum_{t=s+1}^{2s} y_t / s\right\}}{s}$$

Finally, the seasonal index starting value can be calculated after allowing for a trend adjustment, as follows:

$$c_0 = \frac{\{y_k - (k-1)b_0/2\}}{m_0} \qquad \textbf{(multiplicative)}$$

$$c_0 = y_k - \{m_0 + (k-1)b_0/2\} \qquad \textbf{(additive)}$$

where k=1, 2, …, s. Obviously this will lead to *s* separate values for c_0, which is what is required to gain the initial seasonal pattern.

The smoothing parameters are often selected between 0.02 and 0.2. It is again possible to estimate them by minimizing the sum of the squared one-step-ahead errors, but there is no exclusive combination of a_0, a_1, and a_2 which will minimize the square errors for all t.

3.4.3 Correction for Autocorrelation of Residuals

When the correction for autocorrelation of residuals is included, the Holt-Winters forecast function then becomes:

$$\hat{y}_{n+l|n} = (m_n + lb_n)c_{n-s+l} + r_1^l e_n \qquad \textbf{(Multiplicative)}$$

$$\hat{y}_{n+l|n} = m_n + b_n + c_{n-s+l} + r_1^l e_n \qquad \textbf{(Additive)}$$

e_n is the one step ahead forecast error and r_1 is the first order autocorrelation coefficient of the forecast errors, given by:

$$r_1 = \frac{\sum e_n e_{n-1}}{\sum e_n^2}$$

3.5 Random Intercept Model

Longitudinal data arise when repeated measurements are obtained for an individual (or unit of analysis) on one or more outcome variables at successive time points. Longitudinal data require the most elaborate modeling of the random variability. (Diggle, Liang and Zeger, 1994) distinguish among these components of variability, in longitudinal settings, where each individual typically has a vector Y_i of responses with a natural (time) ordering among the components.

We are interested in describing the timber export trade trend over a decade which is a function of time as well as whether there are significant differences in the trend across export product volumes (m^3) or values (euros). For example, export product volumes (m^3) may increase over time because the product may be in high demand or may be cheaper to produce, as they advance in the duration. However, there may be differences in the rates of increment for annual prices (euros/m^3) for the product volumes (m^3) from year to year.

The simplest regression model for longitudinal data is one in which measurements are obtained for a single dependent variable at successive time points. Let Y_{ij} represent the measurement for the ith export value at the jth point in time,

$$Y_{ij} = \beta_0 + \beta_1 t_{ij} + \varepsilon_{ij}$$

β_0 is the intercept, β_1 is the slope, that is the change in the outcome variable for every one-unit increase in time (annual) and ε_{ij} is the error component. In this simple regression they ε_{ij}'s are assumed to be correlated, and follow a normal distribution

i.e.

$$\varepsilon_{ij} \sim N(0, \Sigma)$$

β_0 represents the average value of the dependent variable when time = 0, and β_1 represents the average change in the dependent variable for each one-unit increase in time. There is a possibility that an export product may start with low annual volume and value or price and then increase over years as shown in figure 3.1(a) or no change in annual volume and value or price over years as shown in figure 3.1(b) or start with high annual volume and value or price and decrease over the period as in figure 3.1(c).

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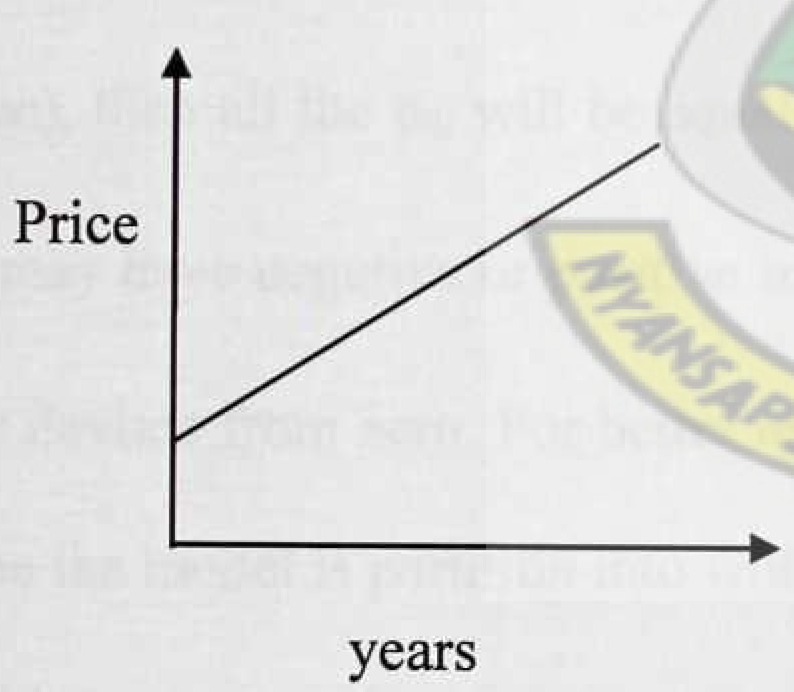
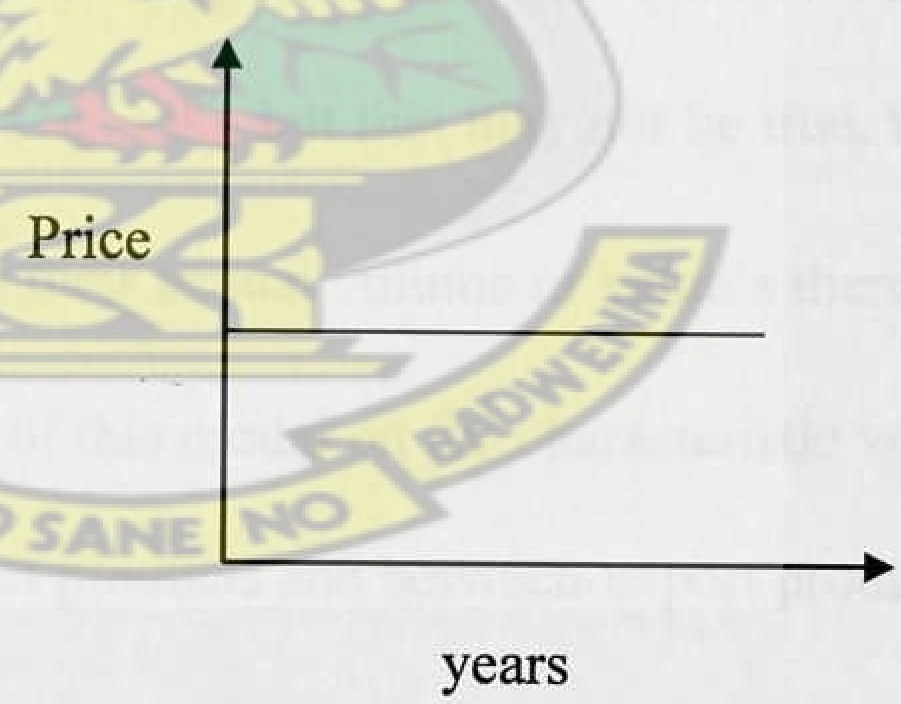
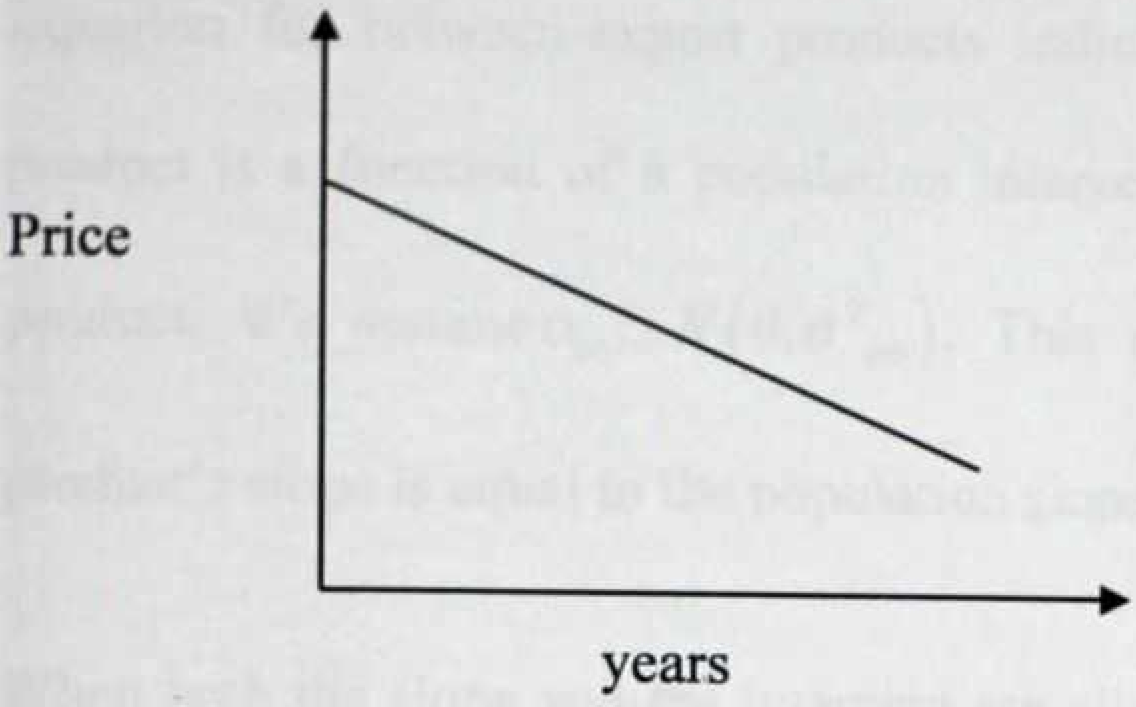
Figure 3.1



(a)



(b)



(c)

Figure 3.1(a), 3.1(b) and 3.1(c): Demonstrating the possible average change of price over years.

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The simple random effects model is the one which the intercept is allowed to vary across export products:

$$y_{ij} = \beta_0 + \beta_1 t_{ij} + \upsilon_{0i} + \varepsilon_{ij}$$

Where υ_{0i} represent the influence on product *i* on its repeated observations. Note that if the export products have no influence on their repeated outcome (annual volume or value), then all the υ_{0i} will be equal to zero ($\upsilon_{0i} = 0$), but that may not be true, therefore υ_{0i} may have negative or positive impact on their annual volume or value's therefore υ_{0i} may deviate from zero. For better reflection of this model on the characteristic volume or value the model is partition into within-export products and between-export products.

Within-export products $\quad y_{ij} = b_{0i} + b_1 t_{ij} + \varepsilon_{ij}$

between export products $\quad b_{0i} = \beta_0 + \upsilon_{0i}$

$$b_{1i} = \beta_1$$

Equation for between-export products indicates that the intercept for the *i*th export product is a function of a population intercept plus unique contribution for individual product. We assume $\upsilon_{0i} \sim N(0,\sigma^2_{\upsilon 0})$. This model also indicates that each individual product's slope is equal to the population slope, β_1.

When both the slope and the intercept are allowed to vary across individual product the model is: $$Y_i = \beta_0 + \beta_1 t_{ij} + \upsilon_{0i} + \upsilon_{1i} t_{ij} + \varepsilon_i$$

The within –export products model is the same as

$Y_i = b_{0i} + b_{1i} t_{ij} + \varepsilon_i$ where i = 1,2,3, ….

and between-export products model is:

$b_{0i} = \beta_0 + \upsilon_{0i}$

$b_{1i} = \beta_1 + \upsilon_{1i}$

The within-export product model indicates that the individual *i*th price at time *j* is influence by their initial level b_{0i} and the time trend or the slope b_{1i}. The between- export product indicate that the individual price *i*'s initial level is determined by the population initial level β_0 plus the unique contribution of υ_{0i}. Thus each individual price has their own distinct initial level. Intercept for the *i*th individual price is a function of a population intercept plus unique contribution for that individual price. As well, the slope for the *i*th individual price is a function of the population slope plus some unique contribution for that price. We assume

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$$D = \begin{pmatrix} \sigma^2_{\upsilon_0} & \sigma_{\upsilon_0}\sigma_{\upsilon_1} \\ & \sigma_{\upsilon_1}^{\ 2} \end{pmatrix}$$

is the variance-covariance matrix of random effects. Correlation exists between the random slope and the random intercept, so that individual prices which have higher values for the intercept (i.e. higher or lower values on the dependent variable at the baseline time point) will also have higher or lower values for the slope. The resulting linear model can now be written as:

$$Y_i = X_i\beta + Z_i b_i + \varepsilon_{1i}$$

$$b_i \sim N(0, D)$$

$$\varepsilon_{1i} \sim N(0, \sigma^2 I_{ni})$$

Assumptions:

$b_1,\ldots,b_N,\varepsilon_1,\ldots,\varepsilon_N$ *b's* are independent

$\varepsilon_1 \sim N(0, \sigma^2 I_{ni})$ Is the measurement error

The variance of the measurement is given below:

$$V(y_i) = Z_i \Sigma_\upsilon Z_i' + \sigma^2 I_{ni}$$

This model implies that conditional on the random effects, the errors are uncorrelated, as is displayed. This is seen in the above equation since the error variance is multiplied by the identity matrix (i.e. all correlations of the error equal zero).

Also, the Intraclass Correlation Coefficient (ICC) computed from this null model is a useful tool for deciding whether a random effects model might be an appropriate choice for the data. The numeric formula for the ICC is

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$$ICC = \frac{\hat{\sigma}_{v0}^2}{\hat{\sigma}_{v0}^2 + \hat{\sigma}^2}$$

where $\hat{\sigma}^2$ is the residual variance.

3.6 Software

Software are essential when one wants to investigate time series data for trends and then make predictions and/or forecast for decision making purposes and effective planning. There are a lot of propriety software packages and open source packages for such statistical analyses such as Microsoft Excel, Statistics Practically Short and Simple (SPSS), R and SAS are just a few examples. In this research the R statistical package was used extensively because R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License. Other advantages of R is that R compiles and runs on a wide variety of platforms; UNIX , LINUX and all variants, WINDOWS and MAC OS as compared to Microsoft Excel and SAS which have some restrictions in their usage. R has a language and Integrated Developer Environment (IDE) very reliable and efficient in terms of processing and storage cost for statistical computing and graphical reporting. R as open source package has the advantage of importing and exporting other packages in and out that provides a wide variety of statistical processing capabilities like linear and nonlinear modeling, classical statistical tests, time-series analysis, classification, clustering and graphical techniques, making it highly flexible and extensible. More information about R can be found at the website http://cran.r-project.org. More importantly within R a researcher can write his/her own codes (extensions and functions) to reflect or achieve his/her research objectives.

3.6.1 Application of Software

From the TIDD_DB, queries (using the SELECT clause in SQL) were performed to extract tuples / records from timber export trade data and data mining (standardizing all export product volumes to cubic meter and all export product values to euros) were performed. Then the required or desired data (information) exported into Excel.

3.6.1.1 Microsoft Excel 2010

Aggregations and summaries were performed on Trade data (using the Advance Pivot feature under the Data Ribbon in Excel as shown in Table 3.1, then the annual prices (euro/m^3) for timber export products were calculated.

Codes were given to the five top timber export products and totals for each were computed over the ten year period of this study and saved in formats to be exported into R and SAS (Version 9.1).

3.6.1.2 SAS (9.1)

This fantastic package was used to evaluate annual price variations. The package computed the Simple Statistics on Annual Timber Export Price variations like the mean annual price and their standard deviations which could be critically examined for planning.

3.5.1.3 R Statistical Package

This powerful yet elegant statistical package (version 2.13.1) was used for the trend analyses carried out in this research applying Mann-Kendall trend test by running appropriate and approved commands producing colourful pictorial representations of trends for the top five timber export products. Seasonality was considered and LOWESS was modeled using this package.

Holt Exponential Smoothing forecasting model was executed in R and a five year (2011 – 2015) forecast values were generated.

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CHAPTER FOUR

4.0 EXPLORATORY ANALYSIS

4.1 Queries and Data Mined from TIDD_DB

Queries and Data mined from the TIDD_DB were exported to Microsoft Excel 2010 as shown below in Figures 4.1a (beginning) and 4.1b (ending).

Figure 4.1a Contract Issued for Timber Products for 2000 – 2010 (Beginning)

Figure 4.1b Contract Issued for Timber Products for 2000 – 2010 (Ending; 50,636 records)

4.2 Data Representation

Data exported into excel was manipulated and further represented into Tables 4.2a and 4.2b as shown below:

SUMMARY REPORT ON EXPORT PERMITS: 2000				
	TIMBER PRODUCTS	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	143,749.048	46,521,515.90	323.63
2	LUMBER (AIR DRIED)	93,279.751	29,041,411.12	311.34
3	SLICED VENEER	35,560.084	28,980,986.11	814.99
4	ROTARY VENEER	75,059.239	18,337,853.41	244.31
5	BOULES (AIR DRIED)	57,117.424	17,016,550.09	297.92
6	PLYWOOD	46,790.839	12,085,336.69	258.28
7	PROCESSED L/MOULDIN	22,123.344	8,551,777.99	386.55
8	FURNITURE PARTS	2,498.522	6,464,114.45	2,587.18
9	BOULES (KILN DRIED)	11,514.447	2,489,235.23	216.18
10	FLOORING	2,217.829	1,566,955.53	706.53
11	CURLS VENEER	114.157	1,118,587.78	9,798.68
12	LUMBER (OVERLAND)	5,487.361	1,044,520.79	190.35
13	POLES	1,032.828	728,298.87	705.15
14	PROFILE BOARDS	972.959	537,299.94	552.23
15	DOWELS	1,001.736	460,199.87	459.40
16	LAYONS	185.469	222,866.81	1,201.64
17	BROOMSTICKS	103.248	40,309.50	390.41
18	FLUSH DOORS	35.030	36,158.00	1,032.20
	TOTAL	498,843.316	175,243,978.00	20,476.98

Table 4.2a Permits Issued for Timber Export Products for 2000

SUMMARY REPORT ON EXPORT PERMITS: 2010				
	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	(PLYWOOD) OVERLAND	136,812	41,725,193	304.98
2	LUMBER (KILN DRIED)	78,154	29,506,530	377.54
3	SLICED VENEER	31,527	23,492,186	745.15
4	LUMBER (AIR DRIED)	51,259	16,356,503	319.10
5	PROCESSED L/MOULDIN	17,821	8,901,649	499.51
6	POLES	22,019	3,915,998	177.85
7	BILLET	13,411	2,863,915	213.55
8	LUMBER (OVERLAND)	30,249	2,640,848	87.30
9	ROTARY VENEER	8,904	2,524,333	283.52
10	PLYWOOD	6,234	2,153,483	345.43
11	BOULES (AIR DRIED)	3,980	1,849,831	464.77
12	FLOORING	817	793,502	971.19
13	DOWELS	834	466,071	558.95
14	LAYONS	158	267,898	1,696.54
15	CURLS VENEER	31	148,785	4,865.28
16	BLOCKBOARDS	544	147,362	271.11
17	PROFILE BOARDS	102	62,058	611.03
18	KINDLING	400	31,693	79.24
	TOTAL	403,254	137,847,837	12,872.03

Table 4.2b Permits Issued for Timber Export Products for 2010

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4.3 Mann-Kendall Test

This is a test for monotonic trend in a time series z[t] based on the Kendall rank correlation of z[t] and t.

4.3.1 Trend Analysis for Kiln Dried and Lumber Air Dried

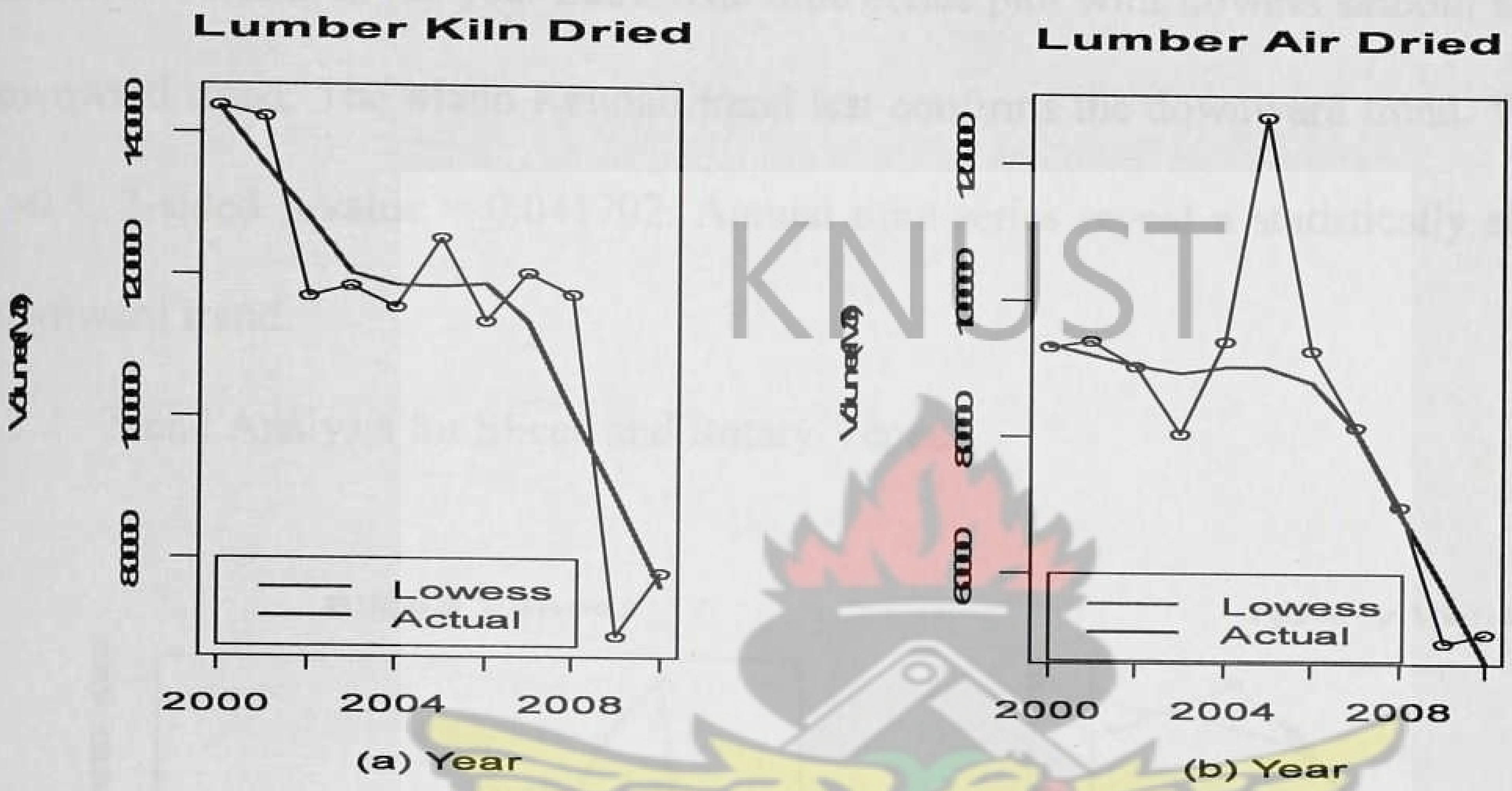

Figure 4.3(a) Time series plot with Lowess of annual exported volumes of Lumber Kiln Dried 4.3(b) Time series plot with Lowess of annual exported volumes of Lumber Air Dried.

From figure 4.3(a), there seems to exist some variations in the Annual volume (m^3) of timber wood export for Lumber Kiln Dried (LKD) product from 2000 to 2010. There seems some sharp variation in the volume from 2001 to 2002. Similarly, the variation from 2008 to 2009 seems to be larger. The maximum volume of LKD exported was in the year 2000 and the minimum volume of LKD exported was in the year 2009. These variations have not been explained yet in this analysis. The time series plot with Lowess smooth suggests a downward trend. A linear approximation for the regression function maybe inadequate or questionable. The Mann-Kendall trend test for LKD confirms the downward trend. Where tau = -0.564, 2-sided p-value = 0.019517. Annual time series reveal a statistically significant downward trend.

Figure 4.3(b) shows some variation in the Annual volume (m^3) of export for the Lumber Air Dried (LAD) product from 2000 to 2010. There seem to be a spike at year 2005 and a minimum volume in the year 2009. The time series plot with Lowess smooth suggests a downward trend. The Mann-Kendall trend test confirms the downward trend. Where tau = -0.5, 2-sided p-value = 0.041702. Annual time series reveal a statistically significant downward trend.

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4.3.2 Trend Analysis for Sliced and Rotary Veneer

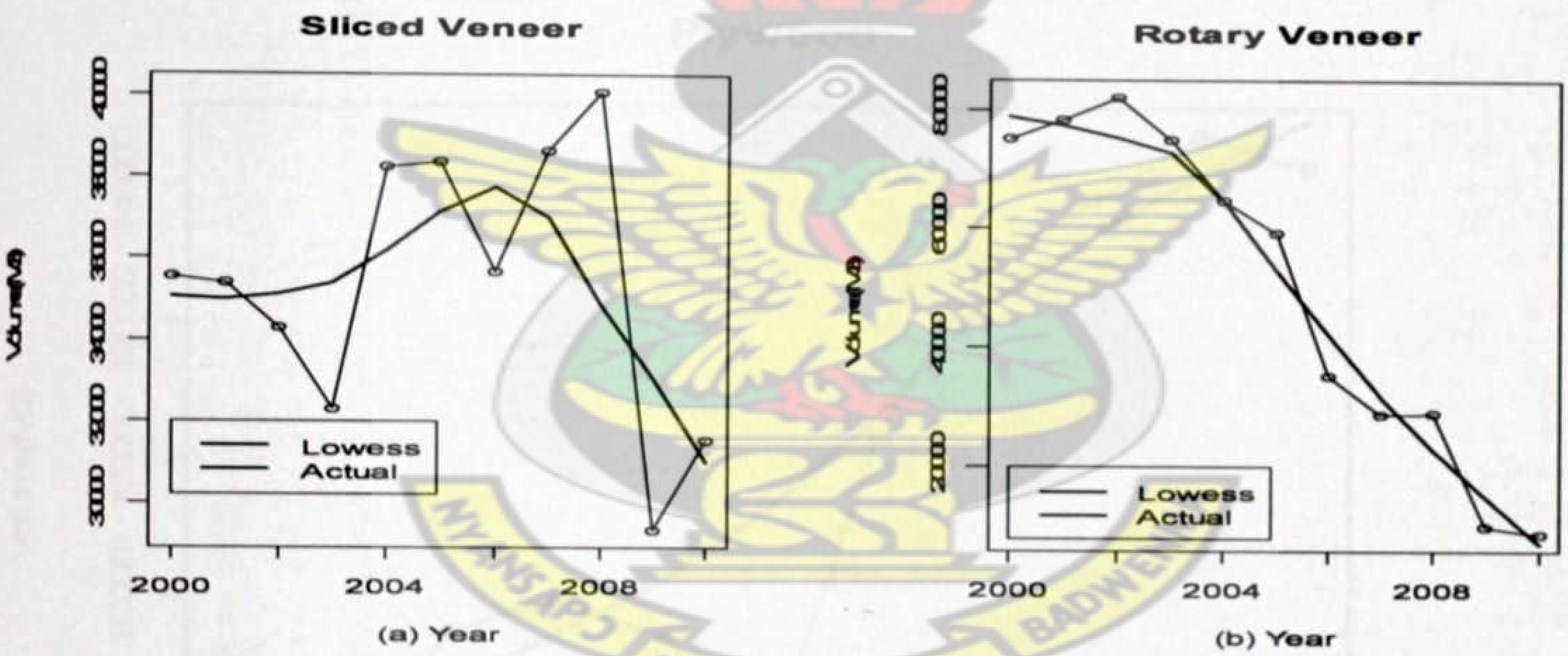

Figure 4.4(a) Time series plot with Lowess of annual exported volumes of Sliced Veneer. 4.4(b) Time series plot with Lowess of annual exported volumes of Rotary Veneer

From figure 4.4(a), there seems to be some irregular pattern of the observed annual exported volume of Sliced Veneer (SV) in figure 1.1(a). There seems an upward trend from year 2000 to 2006 and a downward trend from year 2007 to 2010. The autocorrelations in this data shows some randomness. The Mann-Kendall trend test confirms no significant trend as tau = 0.0381, 2-sided p-value =0.93686. Annual time series reveal a statistically non-significant trend.

Figure 4.4(b) reveals that the volume of export for Rotary Veneer (RV) decreased over the period with less variation. However, the rate of decrease was fast probably due to certain factors like slow demand. The Mann-Kendall trend test confirms significant downward trend with tau = -0.855 and the 2-sided p-value = 0.00034216. Annual time series reveal a statistically significant downward trend.

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4.3.3 Trend Analysis for Plywood

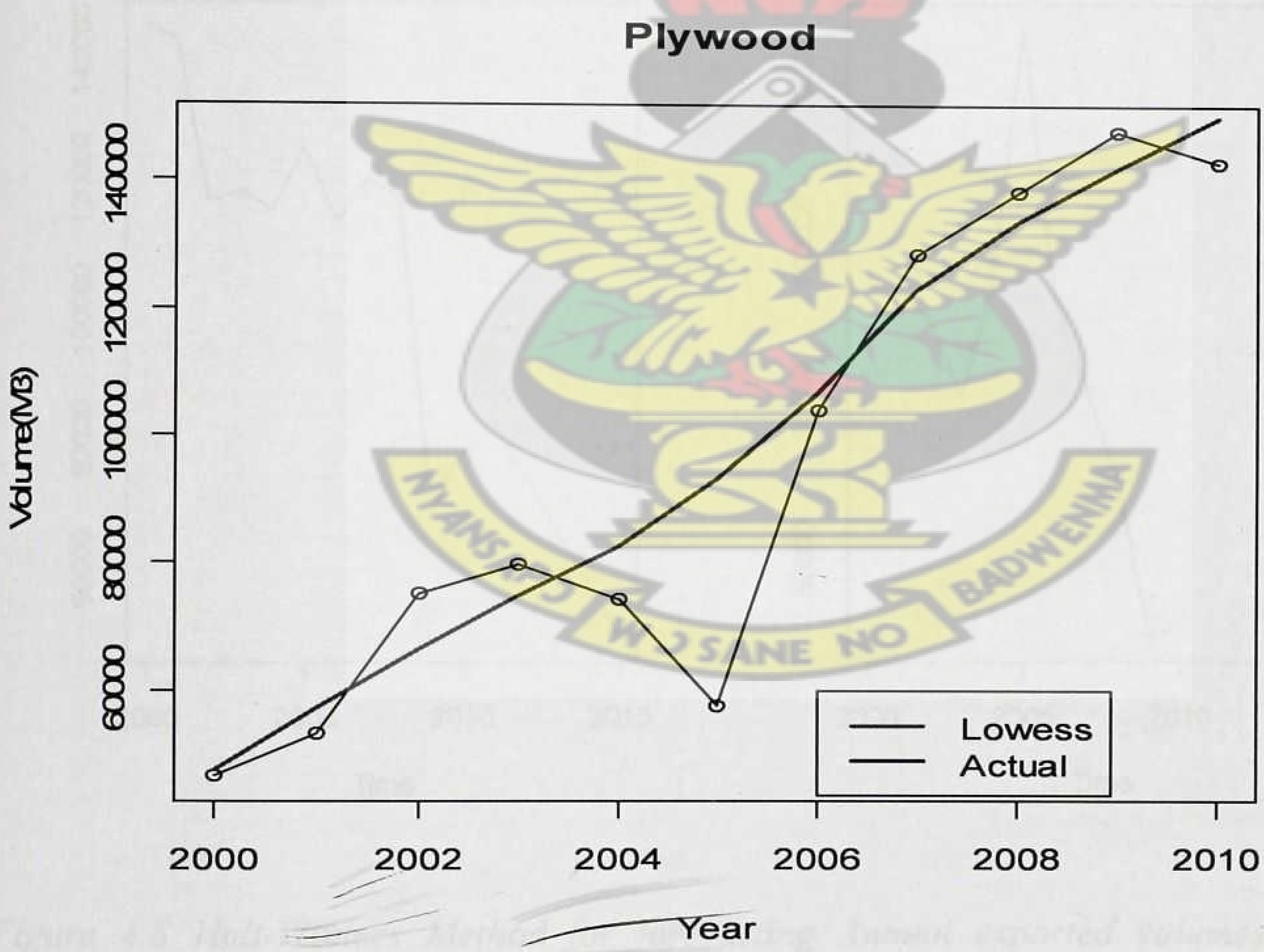

Figure 4.5 Time series plot with Lowess of annual exported volumes of Plywood

From figure 4.5, there seem to exist some variations in the Annual volume (m^3) of plywood export product from 2000 to 2005. There was a spike in 2006 and then an upward trend to 2009.before a dip in 2010. The time series plot with Lowess smooth suggests an upward trend. The Mann-Kendall trend test confirms significant upward trend for the annual volume (m^3) of Plywood exports where tau = 0.782, and 2-sided, p-value = 0.0010766. Annual time series reveal a statistically significant upward trend.

4.4 Holts Exponential Smoothing Method

4.4.1 Lumber Kiln and Air Dried Annual Volume Forecast for Five Years

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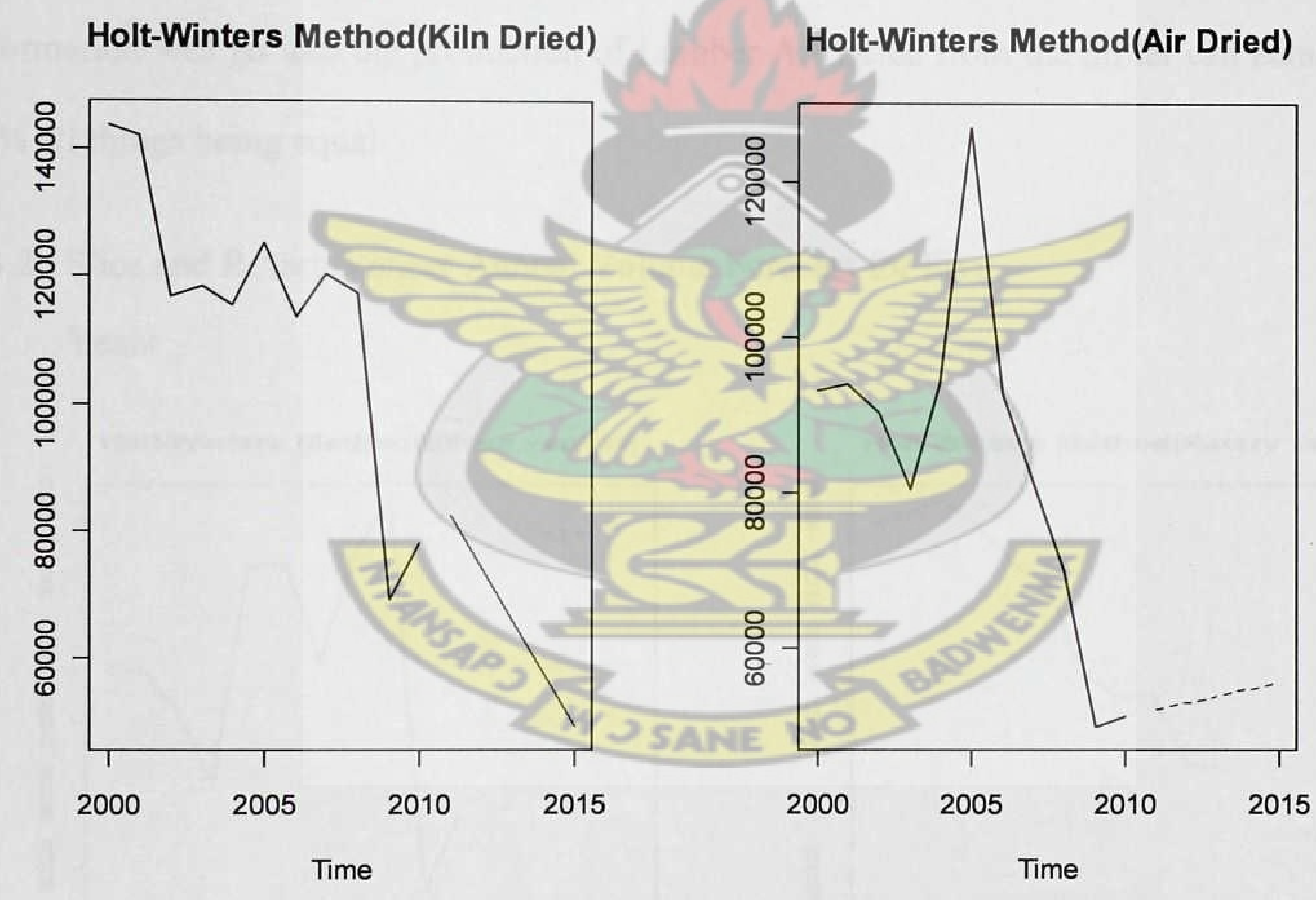

Figure 4.6 Holt-Winters Method for forecasting Annual exported volumes (m^3) for Lumber Kiln Dried and Lumber Air Dried

Table 4.1 Forecasted values for annual lumber exports volumes (m^3)

Forecast Year	Lumber Kiln Dried	Lumber Air Dried
2011	82,296.360	52,164.000
2012	74,049.370	53,069.000
2013	65,802.370	53,974.000
2014	57,555.380	54,879.000
2015	49,308.380	55,784.000

From Table 4.1 forecasted volumes for Lumber Kiln Dried kept declining at an average rate of 20% whiles the forecasted volumes for Lumber Air Dried increased at an average rate of 20%. Such information will be useful to a miller who is considering future production of Lumber Kiln Dried and Lumber Air Dried, obviously the miller with such information will go into the production of Lumber Air Dried from the miller can achieve 20% all things being equal.

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4.4.2 Slice and Rotary Veneer Annual Volume Forecast for Five Years

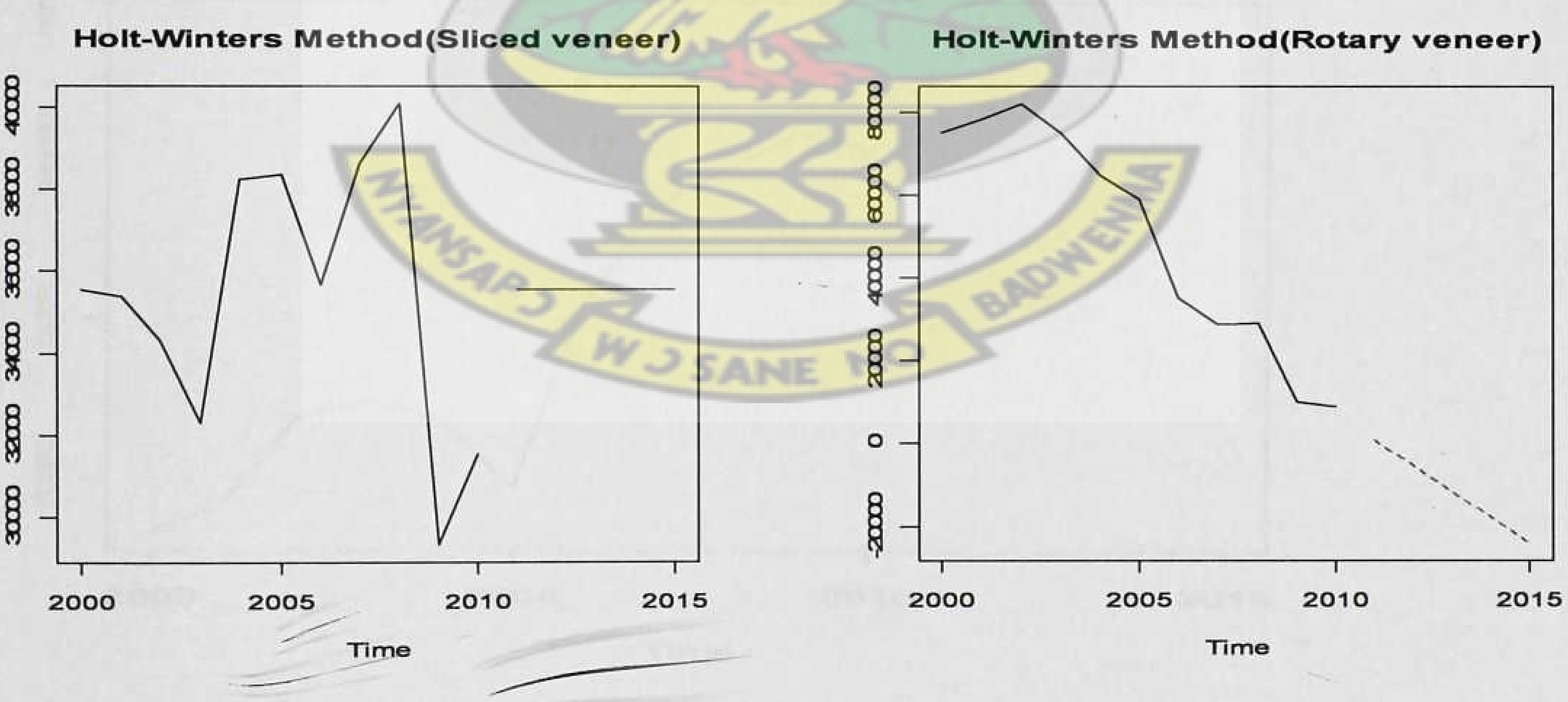

Figure 4.7 Holt-Winters Method for forecasting Annual exported volumes (m^3) for Sliced and Rotary Veneer

Table 4.3 Forecasted values for annual plywood exports volumes

Forecast Year	Plywood
2011	149,523.000
2012	156,000.000
2013	162,477.000
2014	168,954.000
2015	175,431.000

From Table 4.3, the forecast for the production of Plywood shows improved product volumes with the expected volume for 2015 is to be 175,431.000m^3. The production of plywood could be the strength of the Timber Industry as per the forecast values; the industry has a comparative advantage in the production of this product.

4.5 Evaluating Annual Price Variations

Table 4.4 Simple Statistics on Annual Timber Export Price Variations

Simple Statistics						
Variable	**N**	**Mean**	**Std. Dev.**	**Sum**	**Minimum**	**Maximum**
p2000	5	428.580	239.074	2143	244.312	814.986
p2001	5	417.946	250.067	2090	236.199	841.905
p2002	5	448.980	265.749	2245	246.261	889.728
p2003	5	453.280	236.273	2266	238.849	840.272
p2004	5	490.252	218.021	2451	220.703	798.333
p2005	5	495.034	216.980	2475	233.154	817.823
p2006	5	477.347	208.759	2387	231.325	783.150
p2007	5	478.364	210.641	2392	239.878	805.309
p2008	5	485.108	215.564	2426	249.834	798.047
p2009	5	449.073	178.828	2245	250.868	683.168
p2010	5	492.604	195.621	2463	283.516	745.152

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The above table 4.4 shows the simple statistics of the annual price (euro/m^3) of the five timber export products with the highest mean annual price occurring in 2005 at €495.03 per cubic meter. The annual price deviations were closely bunched around the mean annual price with the lowest being €178.83 per cubic meter in 2009. The minimum annual price was in 2003 at €238.85 per cubic meter and the maximum was €889.73 per meter cube in 2002.

4.6 Covariance Matrix on Annual Timber Export Price Variations

Table 4.5 Covariance Matrix on Annual Timber Export Price Variations

Covariance Matrix, DF = 4												
		p2000	**p2001**	**p2002**	**p2003**	**p2004**	**p2005**	**p2006**	**p2007**	**p2008**	**p2009**	**p2010**
p20 00	**p20 00**	57156.1 2166	59325.8 1519	63180.9 2126	45521.8 8726	46680.1 5889	43233.0 2056	38138.1 1073	41319.4 4085	36603.6 0686	26855.2 2075	28753.5 7807
p20 01	**p20 01**	59325.8 1519	62533.3 5196	66251.3 4848	50526.6 3696	48183.3 8060	46207.6 8157	41670.4 2286	44969.3 6851	40761.8 2098	30032.6 2904	32165.4 2439
p20 02	**p20 02**	63180.9 2126	66251.3 4848	70622.6 8233	51447.3 4655	50283.4 3658	47434.4 2053	42308.3 4808	46051.0 4805	40944.9 7272	29660.0 1458	31592.3 2244
p20 03	**p20 03**	45521.8 8726	50526.6 3696	51447.3 4655	55825.0 8074	45033.2 5250	49161.2 1885	48077.7 8305	49049.0 8473	49796.3 0858	39775.9 2972	43143.3 2258
p20 04	**p20 04**	46680.1 5889	48183.3 8060	50283.4 3658	45033.2 5250	47533.1 0508	45742.2 0448	41816.5 6404	42788.2 7530	40946.4 8189	32905.8 0857	35702.3 1923
p20 05	**p20 05**	43233.0 2056	46207.6 8157	47434.4 2053	49161.2 1885	45742.2 0448	47080.2 9739	44794.3 8535	45314.0 6278	45249.2 7581	36724.5 3261	39873.7 9096
p20 06	**p20 06**	38138.1 1073	41670.4 2286	42308.3 4808	48077.7 8305	41816.5 6404	44794.3 8535	43580.1 8074	43741.6 7238	44722.7 7850	36554.8 2867	39701.5 9544

p2007	**p2007**	41319.44085	44969.36851	46051.04805	49049.08473	42788.27530	45314.06278	43741.67238	44369.76476	44681.87404	35997.06449	39001.06377
p2008	**p2008**	36603.60686	40761.82098	40944.97272	49796.30858	40946.48189	45249.27581	44722.77850	44681.87404	46467.81125	38158.78821	41507.10032
p2009	**p2009**	26855.22075	30032.62904	29660.01458	39775.92972	32905.80857	36724.53261	36554.82867	35997.06449	38158.78821	31979.25552	34944.15013
p2010	**p2010**	28753.57807	32165.42439	31592.32244	43143.32258	35702.31923	39873.79096	39701.59544	39001.06377	41507.10032	34944.15013	38267.73627

The above table is showing the Covariance Matrix with degrees of freedom being 4 for the annual timber export price (euro/m^3) which is a statistical measure of the tendency of two variables to change in conjunction with each other. It is equal to the product of their standard deviations and correlation coefficients in a matrix form.

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4.7 Pearson Correlation Coefficient on Annual Timber Export Price Variations

Table 4.6 Pearson Correlation Coefficient on Annual Timber Export Price Variations

Pearson Correlation Coefficients, N = 5 Prob. > |r| under H0: Rho=0											
	p2000	p2001	p2002	p2003	p2004	p2005	p2006	p2007	p2008	p2009	p2010
p2000	1.00000	0.99233	0.99445	0.80589	0.89558	0.83342	0.76416	0.82050	0.71026	0.62815	0.61481
		0.0008	0.0005	0.0996	0.0399	0.0795	0.1325	0.0888	0.1789	0.2565	0.2698
p2001	0.99233	1.00000	0.99693	0.85516	0.88378	0.85161	0.79823	0.85372	0.75617	0.67159	0.65753
	0.0008		0.0002	0.0647	0.0467	0.0671	0.1054	0.0657	0.1391	0.2144	0.2278
p2002	0.99445	0.99693	1.00000	0.81936	0.86787	0.82262	0.76262	0.82267	0.71475	0.62412	0.60771
	0.0005	0.0002		0.0896	0.0565	0.0873	0.1338	0.0872	0.1748	0.2605	0.2769
p2003	0.80589	0.85516	0.81936	1.00000	0.87422	0.95893	0.97473	0.98554	0.97770	0.94139	0.93343
	0.0996	0.0647	0.0896		0.0525	0.0099	0.0048	0.0021	0.0040	0.0169	0.0204
p2004	0.89558	0.88378	0.86787	0.87422	1.00000	0.96694	0.91877	0.93172	0.87125	0.84400	0.83711
	0.0399	0.0467	0.0565	0.0525		0.0072	0.0275	0.0212	0.0544	0.0722	0.0770
p2005	0.83342	0.85161	0.82262	0.95893	0.96694	1.00000	0.98892	0.99145	0.96742	0.94646	0.93940
	0.0795	0.0671	0.0873	0.0099	0.0072		0.0014	0.0009	0.0070	0.0148	0.0177

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p2006	0.76416	0.79823	0.76262	0.97473	0.91877	0.98892	1.00000	0.99473	0.99382	0.97919	0.97218
	0.1325	0.1054	0.1338	0.0048	0.0275	0.0014		0.0005	0.0006	0.0036	0.0055
p2007	0.82050	0.85372	0.82267	0.98554	0.93172	0.99145	0.99473	1.00000	0.98404	0.95563	0.94649
	0.0888	0.0657	0.0872	0.0021	0.0212	0.0009	0.0005		0.0024	0.0111	0.0147
p2008	0.71026	0.75617	0.71475	0.97770	0.87125	0.96742	0.99382	0.98404	1.00000	0.98988	0.98431
	0.1789	0.1391	0.1748	0.0040	0.0544	0.0070	0.0006	0.0024		0.0012	0.0024
p2009	0.62815	0.67159	0.62412	0.94139	0.84400	0.94646	0.97919	0.95563	0.98988	1.00000	0.99890
	0.2565	0.2144	0.2605	0.0169	0.0722	0.0148	0.0036	0.0111	0.0012		<.0001
p2010	0.61481	0.65753	0.60771	0.93343	0.83711	0.93940	0.97218	0.94649	0.98431	0.99890	1.00000
	0.2698	0.2278	0.2769	0.0204	0.0770	0.0177	0.0055	0.0147	0.0024	<.0001	

The above symmetric table shows the Pearson Correlation Coefficient of the annual timber export price (euro/m^3) which is generally showing a high degree of correlation as figures lie between 0.75 and 1, thus depicting the strength of relationship between the annual timber export value (euros) and the annual timber export volumes (m^3). A careful examination of 2003 and 2005 where the correlation coefficients were all near perfect degree of correlation with the least being 0.80 and the most being 0.99 depicting the strength of association between the annual timber export value and volumes. This association can be described as statistically significant as some values of tau were far greater than 0.05 especially on the left side of the line of symmetry.

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4.8 Export Product Profile

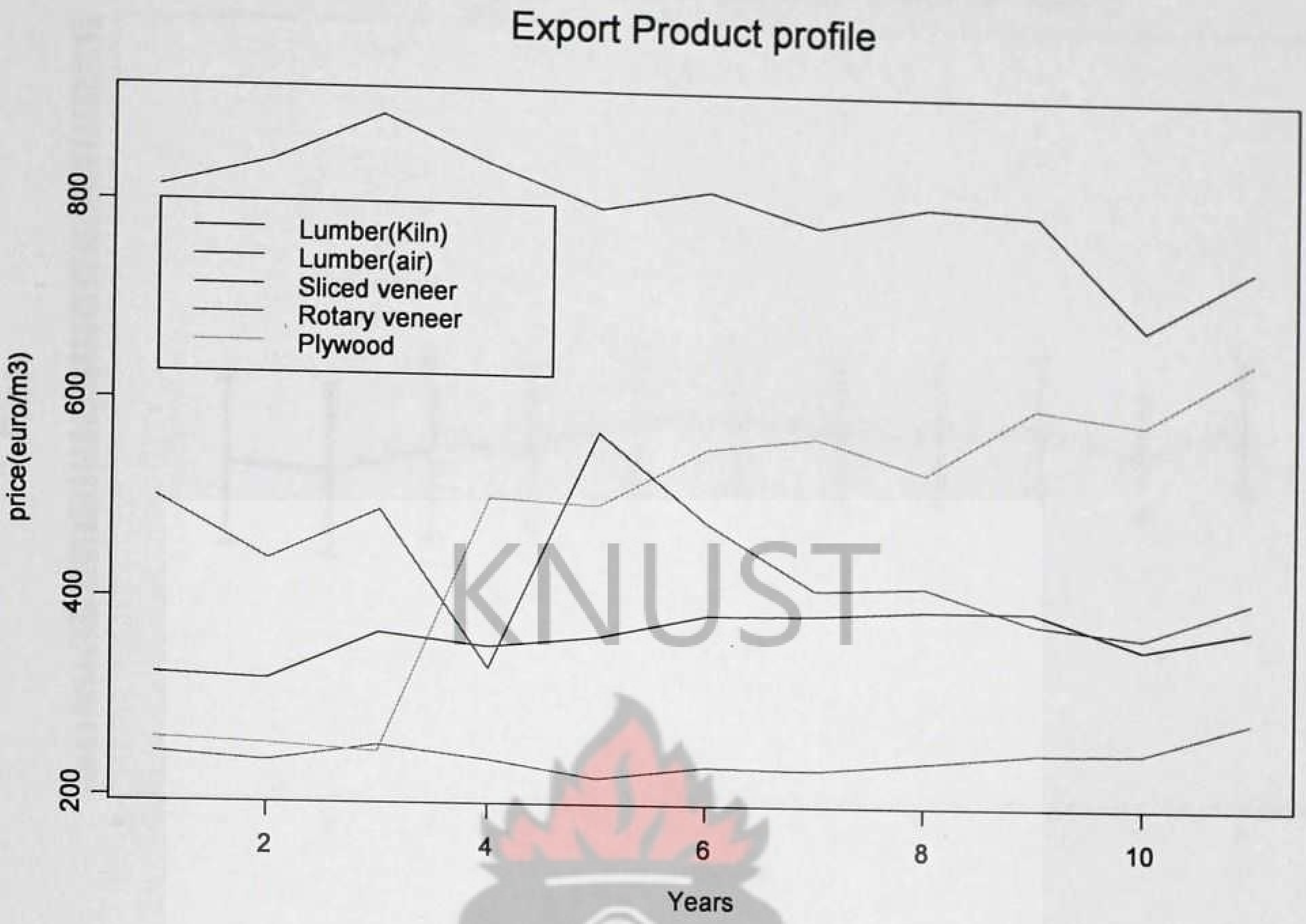

Figure 4.9 Export Product Profile

Figure 4.8 shows the price (euro/m3) fluctuations of timber export trade in Ghana over the period under consideration. Generally the price fluctuations were fairly steady with the highest price fluctuation being Sliced veneer and the lowest price fluctuation being Rotary veneer. There were spikes in the price fluctuation of Lumber Air Dried and price for plywood was increasing. Future prices have the tendencies to increase probably due to appreciating exchange rates or improved negotiating skills of sellers or improved performance of the timber industry resulting in increased productivity by introducing technology.

4.9 Average Evolution with Standard Errors of Means

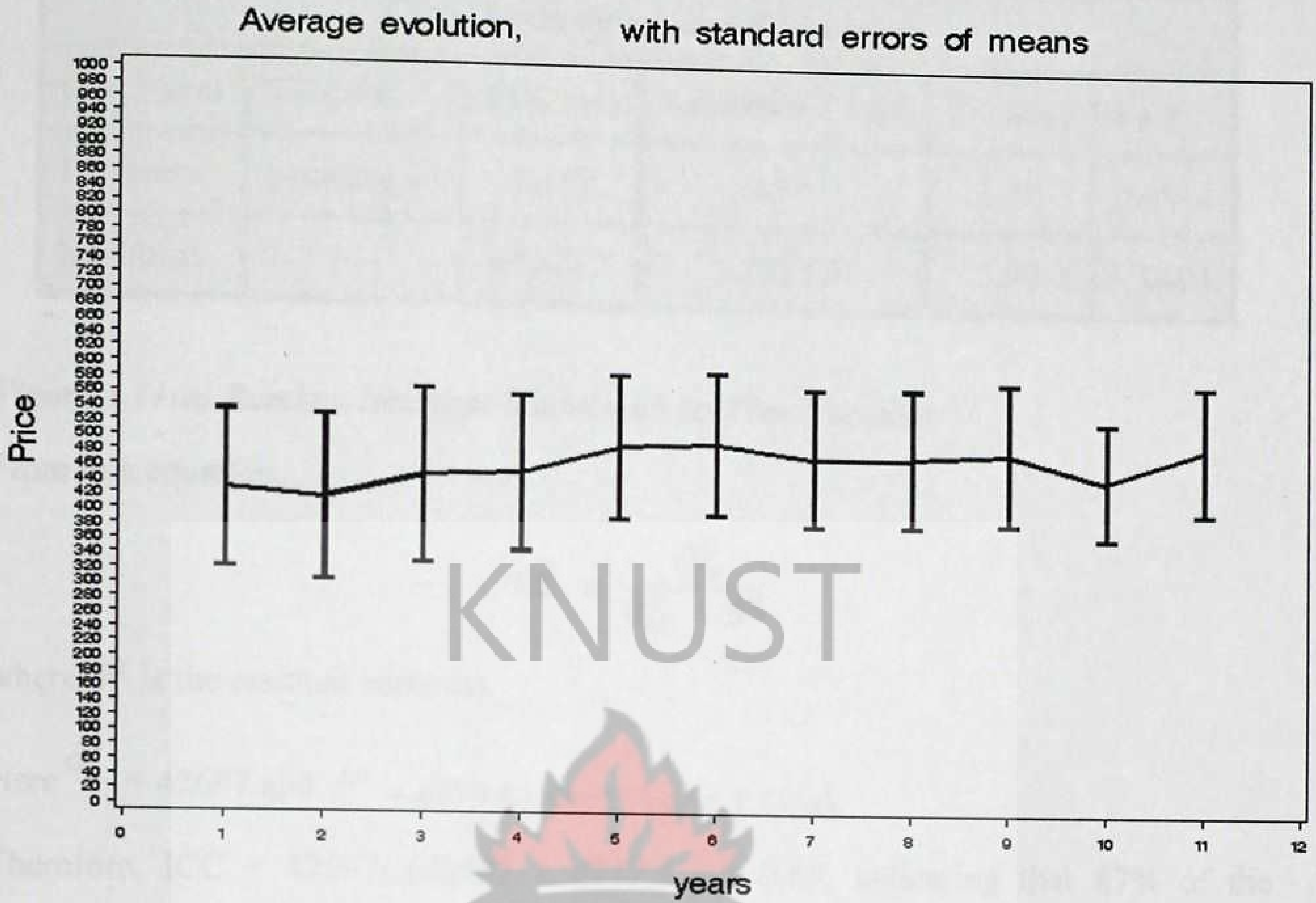

Figure 4.10 Average Evolutions with Standard Errors of Mean

Standard error of the mean (or uncertainty) is an estimate of the amount that an obtained mean may be expected to differ by chance from the true mean.

From figure 4.10, the following facts can be stated from the average evolution with standard errors of means:

- No factors or independent variables were considered in the above structure.
- Linear average trends of the standard errors are fairly stable but we keep in mind the steadiness over time points.
- Time points are equally spaced.

4.10 The Random Intercept Model with No Time Variable

Covariance Parameter Estimates					
Cov Parm	**Subject**	**Estimate**	**Standard Error**	**Z Value**	**Pr Z**
Intercept	**product_id**	42697	30595	1.40	0.0814
Residual		6279.87	1255.97	5.00	<.0001

Figure 4.11(a) Random Intercept Model with no Time Variable

From this equation,

$$ICC = \frac{\hat{\sigma}_{v0}^2}{\hat{\sigma}_{v0}^2 + \hat{\sigma}^2}$$

where $\hat{\sigma}^2$ is the residual variance.

Here $\hat{\sigma}_{u_0}^2 = 42697$ and $\hat{\sigma}^2 = 6279.87$ from Figure 4.11(a).

Therefore, ICC = 42697/ (42697 + 6279.87) = 0.87, indicating that 87% of the variation in the data is explained by allowing the intercept to vary across individuals. The statistically significant value for the within-individual variation suggests the data structure is best captured by using a random effects model.

Solution for Fixed Effects					
Effect	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
Intercept	465.14	93.0248	4	5.00	0.0075

Figure 4.11(b) Random Intercept Model with no Time Variable - Solution

From figure 4.11(b), the estimate for the intercept is the average value of 465.14 of the dependent variable which is the timber export product from which the export value was got hence the price.

4.11 The Random Intercept Model with Time Variable

Covariance Parameter Estimates					
Cov Parm	**Subject**	**Estimate**	**Standard Error**	**Z Value**	**Pr Z**
Intercept	**product_id**	69709	49950	1.40	0.0814
Tm	**product_id**	417.89	309.84	1.35	0.0887
Year		2224.04	470.09	4.73	<.0001

Figure 4.12(a) Random Intercept Model with Time Variable

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Solution for Fixed Effects					
Effect	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**
Intercept	432.95	118.86	4	3.64	0.0219
Tm	5.3662	9.3607	4	0.57	0.5972

Figure 4.12(b) Random Intercept Model with Time Variable - Solution

From this equation,

$$ICC = \frac{\hat{\sigma}_{v0}^2}{\hat{\sigma}_{v0}^2 + \hat{\sigma}^2}$$

where $\hat{\sigma}^2$ is the residual variance.

Here $\hat{\sigma}_{v0}^2$ = 432.95 and $\hat{\sigma}^2$ = 5.3662 from Figure 4.12(b).

Therefore, ICC = 432.95/ (432.95 + 5.3662) = 0.98, indicating that 98% of the variation in the data is explained by allowing the intercept to vary across individuals. The statistically significant value for the within-individual variation suggests the data structure is best captured by using a random effects model.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion

In examining large collections of timber Export Trade data, it is helpful to be able to present numbers that provides summaries of the data called Descriptive Statistics such as the mean annual volume (m^3), mean annual value (euros) and the mean annual price (euros/m^3) with their totals, their minimums and their maximum values for yearly comparisons.

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Similarly, the standard deviation (for volumes, values and price), is a number representing how closely or loosely the Timber Trade dataset is around the mean annual figures, which is important because it is the precise indicator for talking about the degree of variability.

Finding precisely how much is the level of degrees of variability, begins the process of quantitative analyses (Inferential Statistics). When two physical phenomena (such as volume and value as per the timber export product from the Timber Export Trade data) increase or decrease proportionately and simultaneously because of identical external factors (like currency exchange rate, and Trade Regulations), the phenomena are correlated positively, under the same conditions if one (volume) increases in the same proportion that the other (value) decreases, the two phenomena are negatively correlated.

An investigator will be called upon to decide whether an assumed hypothesis (test of reliability) for some phenomena is valid or invalid. The assumed hypothesis leads to a mathematical model. The model in turn, yields certain predicted or forecasted values.

To determine whether the hypothesis is to be kept or rejected, the deviations must be judged as normal fluctuations caused by sampling techniques or as significant discrepancies.

Importantly, a statistical measure of the tendency of two variables (volume and value) to change in conjunction to each other is the Covariance which is equal to the product of the standard deviations and the correlation coefficient of the variables.

From the above discussion, the following can be deduced:

1. There is more to be discovered from time series data captured by FC as exhaustive or comprehensive investigations carried out on the data (considering all parameters) will unlock the complexities hidden in the data and provide accurate and concise information timely for effective planning and quality decision making processes.
2. Comparative Advantage product production can be carefully looked at in this time of dwindling raw material (timber which is imported nowadays) as this research revealed that plywood production is the best, followed by Lumber Air Dried production among the top five products analyzed and when this information is given to the timber industry, all things being equal, it will serve as insightful guide to help industry optimize production for increased profits to be appropriated amongst all stakeholders.
3. Deductions from the annual price evaluations, can be used in several different ways like:
    a. The Mean Annual Price can be used as a reference point for the fixing of Guiding Selling Price (base price) done by the pricing committee at TIDD

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b. Annual Price Standard Deviations can be used for risk evaluations in the Industry

c. The Price Correlation table can be used to determine the price elasticity of the timber export products.

4. A collaborative approach between FC and the Timber Industry to broadly embrace quantitative analyses as a business strategy will in the long run provide the Timber Export Trade with the vital tool to have competitive edge in the timber export market which will propel the success and sustainability of the industry. FC by way of commitment shall create the Research and Development Department (medium to long term) with its sole function is to scientifically analyze data, finding trends, fitting appropriate models with error consideration tools and then provide forecasts. With such information new products can be developed and improve existing products for the socio-economic transformation of all stakeholders.

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5.2 Conclusions

From the above quantitative analyses, we can confidently conclude that:

1. There were statistically significant downward trends in the export volumes of LKD, LAD and RV volumes (m^3) but there was statistically significant upward trend in the production of Plywood volumes (m^3) whilst there was no trend in the production of Sliced Veneer volumes (m^3)

2. Forecasted values for LKD volumes (m^3) were falling at an average rate of 20% while forecasted values for LAD volumes (m^3) were increasing also at an average rate of 20%. Values forecasted for Sliced Veneer volumes (m^3) were

constant as no peculiar pattern was found but values for Sliced Veneer volumes (m^3) were negative from 2012 to 2015.

3. Therefore, ICC = 42697/ (42697 + 6279.87) = 0.87, indicating that 87% (a high degree of correlation) of the variation in the data is explained by allowing the intercept to vary across export products.

5.3 Recommendations

5.3.1 Research Recommendations

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1. Plywood production should be made a comparative advantage business solution because of the significant growth in volumes (m^3) shown by this research.
2. Lumber Air Dried production could be made a strategic business solution as it has a 20% volume (m^3) growth rate over the forecasted period.
3. Rotary Veneer production would be bad business as forecasted volumes (m^3) were mostly negative values.
4. Optimizing plywood and LAD production could maximum revenues to the Timber Industry and export levies to FC for socio-economic benefits.

5.3.2 Corporate Recommendations

1. For FC to reposition itself both as regulatory and advisory to the Timber Industry, it should undertake quantitative analyses to explore production and market trends to provide scientific proven business solutions that are not only feasible but credible to inspire success and sustainability in the timber export trade to improve the amount of export levy to be collected.

2. FC should explore TUC allocation and Yield data for revealing trends for effective planning and efficient monitoring to enhance good forest practices for sustainability as well as satisfying international timber trade regulations.

3. FC shall explore financial data for trends so as to plan effectively towards revenue collections, disbursement of the collected revenue to all stakeholders and FC's investment drive for maximum satisfaction of all stakeholders.

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4. FC must explore the tourism trends of Ghana's National Parks and develop tourism products which will inspire and boost domestic and international tourism as it will ease the pressure on existing products, for instance, pressure on the Kakum Canopy Walk tourism product in the central region.

5. FC should explore trends in the Transportation System (acquisition, repairs, maintenance and servicing, disposal) to optimize its operations.

6. FC must explore its human resource capital base for trends to effectively plan training programme to inspire innovation for quality and sustained succession plans for efficient continuity in discharging its mandate.

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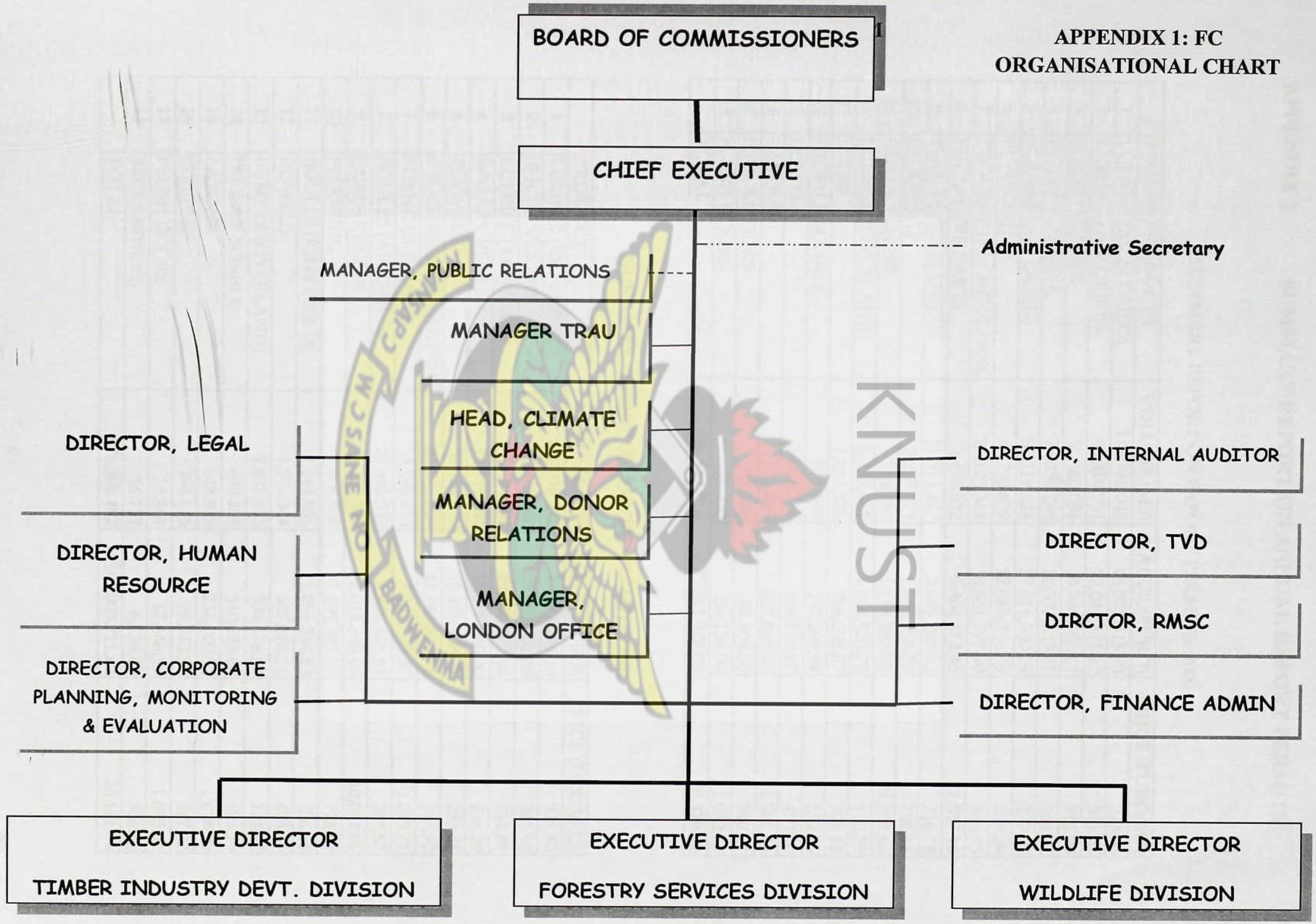
APPENDIX 1: FC
ORGANISATIONAL CHART



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APPENDIX 2 SUMMARY REPORT ON ANNUAL EXPORT PERMITS

SUMMARY REPORT ON EXPORT PERMITS: 2000

	TIMBER PRODUCTS	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	143,749.048	46,521,515.90	323.63
2	LUMBER (AIR DRIED)	93,279.751	29,041,411.12	311.34
3	SLICED VENEER	35,560.084	28,980,986.11	814.99
4	ROTARY VENEER	75,059.239	18,337,853.41	244.31
5	BOULES (AIR DRIED)	57,117.424	17,016,550.09	297.92
6	PLYWOOD	46,790.839	12,085,336.69	258.28
7	PROCESSED L/MOULDING	22,123.344	8,551,777.99	386.55
8	FURNITURE PARTS	2,498.522	6,464,114.45	2,587.18
9	BOULES (KILN DRIED)	11,514.447	2,489,235.23	216.18
10	FLOORING	2,217.829	1,566,955.53	706.53
11	CURLS VENEER	114.157	1,118,587.78	9,798.68
12	LUMBER (OVERLAND)	5,487.361	1,044,520.79	190.35
13	POLES	1,032.828	728,298.87	705.15
14	PROFILE BOARDS	972.959	537,299.94	552.23
15	DOWELS	1,001.736	460,199.87	459.40
16	LAYONS	185.469	222,866.81	1,201.64
17	BROOMSTICKS	103.248	40,309.50	390.41
18	FLUSH DOORS	35.030	36,158.00	1,032.20
	TOTAL	**498,843.316**	**175,243,978.00**	**20,476.98**

SUMMARY REPORT ON EXPORT PERMITS: 2001

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	142,316.440	45,373,236.19	318.82
2	SLICED VENEER	35,401.900	29,805,031.38	841.90
3	LUMBER (AIR DRIED)	94,184.994	29,656,925.94	314.88
4	ROTARY VENEER	78,311.081	18,496,960.00	236.20
5	PLYWOOD	53,268.089	13,498,408.77	253.41
6	PROCESSED L/MOULDING	33,042.856	11,488,858.76	347.70
7	FURNITURE PARTS	3,399.413	7,137,790.87	2,099.71
8	BOULES (AIR DRIED)	24,410.512	6,946,406.93	284.57
9	CURLS VENEER	200.580	2,018,358.03	10,062.61
10	FLOORING	2,606.605	1,899,389.70	728.68
11	BOULES (KILN DRIED)	4,144.556	1,063,744.52	256.66
12	DOWELS	1,192.344	587,886.24	493.05
13	LUMBER (OVERLAND)	2,887.635	359,576.03	124.52
14	PROFILE BOARDS	689.809	340,483.60	493.59
15	LAYONS	145.839	236,009.52	1,618.29
16	SLEEPERS	264.613	70,842.36	267.72
17	FLUSH DOORS	16.464	17,666.13	1,073.02
18	BROOMSTICKS	16.752	6,136.45	366.31
	TOTAL	**476,500.482**	**169,003,711.42**	**20,181.64**

SUMMARY REPORT ON EXPORT PERMITS: 2002

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	116,976.472	42,843,374.20	366.26
2	LUMBER (AIR DRIED)	90,351.782	32,433,872.88	358.97
3	SLICED VENEER	34,295.398	30,513,585.41	889.73
4	ROTARY VENEER	81,937.685	20,690,262.67	252.51
5	PROCESSED L/MOULDING	54,471.249	20,271,495.84	372.15
6	PLYWOOD	75,194.094	18,517,394.70	246.26
7	FURNITURE PARTS	2,880.213	6,972,421.20	2,420.80
8	CURLS VENEER	370.028	3,644,105.77	9,848.19
9	FLOORING	3,448.452	2,947,791.74	854.82
10	BOULES (AIR DRIED)	9,381.879	2,876,236.53	306.57
11	DOWELS	1,262.918	735,036.47	582.01
12	BOULES (KILN DRIED)	1,120.395	457,486.03	408.33
13	PROFILE BOARDS	424.960	248,078.58	583.77
14	LAYONS	131.014	156,584.72	1,195.18
15	SLEEPERS	97.552	29,450.91	301.90
16	FLUSH DOORS	18.814	13,862.25	736.81
17	BROOMSTICKS	19.312	8,980.08	465.00
18	LUMBER (OVERLAND)	44.339	5,815.72	131.16
	TOTAL	**472,426.556**	183,365,835.70	**20,320.42**

SUMMARY REPORT ON EXPORT PERMITS: 2003

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	118,400.278	41,793,490.93	352.98
2	SLICED VENEER	32,313.906	27,152,457.80	840.27
3	LUMBER (AIR DRIED)	80,512.277	26,639,111.98	330.87
4	ROTARY VENEER	74,949.324	17,901,565.55	238.85
5	PLYWOOD	66,615.272	16,376,863.91	245.84
6	PROCESSED L/MOULDING	39,508.299	14,800,319.01	374.61
7	FURNITURE PARTS	2,182.757	4,186,107.27	1,917.81
8	(PLYWOOD) OVERLAND	13,059.068	3,363,697.85	257.58
9	BOULES (AIR DRIED)	9,594.972	3,302,541.18	344.19
10	FLOORING	3,718.157	3,085,091.01	829.74
11	CURLS VENEER	312.780	2,752,439.96	8,799.92
12	DOWELS	1,320.322	779,874.47	590.67
13	BOULES (KILN DRIED)	1,066.346	428,469.06	401.81
14	LAYONS	134.359	163,376.59	1,215.97
15	SLEEPERS	425.020	152,827.00	359.58
16	PROFILE BOARDS	152.891	72,297.67	472.87
17	BROOMSTICKS	55.086	28,505.80	517.48
18	CURLS BOARD	67.509	13,745.69	203.61
	TOTAL	**444,388.623**	**162,992,782.73**	**18,294.66**

SUMMARY REPORT ON EXPORT PERMITS: 2004

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	115,591.227	42,064,497.66	363.91
2	SLICED VENEER	38,240.397	30,528,573.92	798.33
3	LUMBER (AIR DRIED)	94,139.050	29,600,605.82	314.43
4	PROCESSED L/MOULDING	43,423.119	17,520,884.05	403.49
5	ROTARY VENEER	64,725.499	14,285,085.94	220.70
6	PLYWOOD	57,694.280	13,487,664.60	233.78
7	BOULES (AIR DRIED)	13,171.175	5,682,706.98	431.45
8	FURNITURE PARTS	2,447.148	5,105,552.99	2,086.33
9	(PLYWOOD) OVERLAND	16,772.988	4,417,114.90	263.35
10	FLOORING	4,607.468	4,070,995.06	883.56
11	CURLS VENEER	203.477	1,714,213.38	8,424.61
12	DOWELS	898.215	567,129.47	631.40
13	SLEEPERS	1,446.499	523,418.64	361.85
14	BOULES (KILN DRIED)	1,273.078	490,808.43	385.53
15	LAYONS	152.115	229,620.46	1,509.52
16	PROFILE BOARDS	297.932	173,400.94	582.02
17	LUMBER (OVERLAND)	95.342	24,479.79	256.76
18	BROOMSTICKS	1.358	611.10	450.00
	TOTAL	**455,180.367**	**170,487,364.13**	**18,601.01**

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SUMMARY REPORT ON EXPORT PERMITS: 2005

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	125,220.207	48,472,714.22	387.10
2	LUMBER (AIR DRIED)	127,058.640	42,296,010.13	332.89
3	SLICED VENEER	38,365.070	31,375,837.14	817.82
4	ROTARY VENEER	59,186.427	13,799,570.15	233.15
5	PROCESSED L/MOULDIN	34,030.646	13,738,727.36	403.72
6	PLYWOOD	36,242.994	9,253,389.42	255.32
7	(PLYWOOD) OVERLAND	21,461.411	6,451,168.34	300.59
8	BOULES (AIR DRIED)	12,569.859	5,838,416.49	464.48
9	FLOORING	6,444.072	5,235,772.46	812.49
10	FURNITURE PARTS	1,769.231	3,531,445.28	1,996.03
11	CURLS VENEER	270.263	2,533,854.19	9,375.51
12	DOWELS	1,218.302	789,503.28	648.04
13	LUMBER (OVERLAND)	1,207.006	178,994.44	148.30
14	BOULES (KILN DRIED)	324.034	154,511.67	476.84
15	LAYONS	102.651	147,136.19	1,433.36
16	TEAK LOGS	333.210	69,798.59	209.47
17	SLEEPERS	194.688	68,000.62	349.28
18	(MOULDING) OVERLAND	29.413	13,913.43	473.04
19	PROFILE BOARDS	65.921	31,971.69	485.00
20	BROOMSTICKS	51.226	27,942.53	545.48
21	PEGS	10.000	2,645.83	264.58
	TOTAL	**466,155.271**	**184,011,323.45**	**20,412.49**

SUMMARY REPORT ON EXPORT PERMITS: 2006

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	113,523.72	44,121,821.21	388.66
2	LUMBER (AIR DRIED)	92,837.11	30,233,750.88	325.66
3	SLICED VENEER	35,676.35	27,939,951.60	783.15
4	(PLYWOOD) OVERLAND	83,787.52	24,777,376.19	295.72
5	PROCESSED L/MOULDING	30,379.30	12,171,935.89	400.67
6	ROTARY VENEER	35,280.96	8,161,351.22	231.32
7	PLYWOOD	20,114.56	5,501,827.43	273.52
8	FLOORING	3,805.41	3,561,124.02	935.81
9	BOULES (AIR DRIED)	6,517.93	3,136,819.80	481.26
10	POLES	15,103.39	3,076,282.33	203.68
11	CURLS VENEER	251.221	2,298,870.57	9,150.79
12	FURNITURE PARTS	817.819	1,799,731.11	2,200.65
13	BILLET	8,552.07	1,718,703.42	200.97
14	DOWELS	645.187	463,958.49	719.11
15	BOULES (KILN DRIED)	843.734	460,639.99	545.95
16	LAYONS	175.889	352,011.72	2,001.33
17	LUMBER (OVERLAND)	3,198.74	283,711.07	88.69
18	PROFILE BOARDS	73.209	32,699.25	446.66
19	PEGS	23.88	5,336.08	223.45
	TOTAL	**451,608.02**	170,097,902.27	**19,897.05**

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SUMMARY REPORT ON EXPORT PERMITS: 2007

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	120,477.334	47,514,150.58	394.38
2	SLICED VENEER	38,640.939	31,117,902.14	805.31
3	(PLYWOOD) OVERLAND	104,694.619	28,247,388.94	269.81
4	LUMBER (AIR DRIED)	81,669.298	24,912,449.85	305.04
5	POLES	75,364.257	14,919,264.17	197.96
6	PROCESSED L/MOULDING	28,324.280	12,360,789.39	436.40
7	ROTARY VENEER	28,895.902	6,931,501.55	239.88
8	PLYWOOD	23,964.810	6,325,987.10	263.97
9	BOULES (AIR DRIED)	6,421.823	3,108,261.99	484.02
10	FLOORING	3,834.877	2,407,692.73	627.84
11	CURLS VENEER	201.977	2,045,909.46	10,129.42
12	BILLET	9,979.857	1,766,555.33	177.01
13	FURNITURE PARTS	388.760	735,584.03	1,892.13
14	DOWELS	1,173.807	709,467.22	604.42
15	LUMBER (OVERLAND)	3,496.602	396,626.12	113.43
16	LAYONS	188.511	395,653.97	2,098.84
17	BLOCKBOARDS	471.854	119,426.36	253.10
18	BOULES (KILN DRIED)	262.715	114,508.73	435.87
19	BROOMSTICKS	109.847	35,166.30	320.14
20	PROFILE BOARDS	8.060	9,736.10	1,207.95
	TOTAL	**528,570.129**	**184,174,022.06**	**21,256.91**

SUMMARY REPORT ON EXPORT PERMITS: 2008

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	LUMBER (KILN DRIED)	117,493	46,290,694	393.99
2	(PLYWOOD) OVERLAND	124,357	36,728,767	295.35
3	SLICED VENEER	40,080	31,985,495	798.05
4	LUMBER (AIR DRIED)	70,046	20,739,982	296.09
5	POLES	87,085	16,543,993	189.97
6	PROCESSED L/MOULDIN	25,169	11,615,180	461.49
7	ROTARY VENEER	29,051	7,258,026	249.83
8	PLYWOOD	14,035	4,301,154	306.47
9	BILLET	24,614	4,032,882	163.85
10	BOULES (AIR DRIED)	4,640	2,355,381	507.65
11	FLOORING	2,510	1,863,230	742.20
12	CURLS VENEER	116	1,073,732	9,238.63
13	DOWELS	904	563,845	623.72
14	LAYONS	432	376,754	872.75
15	BLOCKBOARDS	1,255	342,786	273.07
16	LUMBER (OVERLAND)	3,843	329,583	85.76
17	FURNITURE PARTS	41	74,093	1,814.36
18	BOULES (KILN DRIED)	148	69,591	471.11
19	PROFILE BOARDS	95	59,303	626.71
20	SAWN VEENER	0.327	6,741	20,615.93
21	POWDERED BARKS	2	237	158.23
	TOTAL	**545,915**	186,611,447	39,185.21

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SUMMARY REPORT ON EXPORT PERMITS: 2009

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	(PLYWOOD) OVERLAND	140,539	39,010,304	277.58
2	LUMBER (KILN DRIED)	69,207	24,689,680	356.75
3	SLICED VENEER	29,344	20,046,995	683.17
4	LUMBER (AIR DRIED)	50,075	14,254,560	284.67
5	POLES	55,927	10,852,938	194.06
6	PROCESSED L/MOULDING	14,131	6,972,400	493.42
7	LUMBER (OVERLAND)	36,171	3,028,581	83.73
8	ROTARY VENEER	10,057	2,522,895	250.87
9	PLYWOOD	7,241	2,234,700	308.61
10	BILLET	8,345	1,760,368	210.95
11	FLOORING	1,237	912,782	737.78
12	BOULES (AIR DRIED)	1,830	860,914	470.57
13	CURLS VENEER	62	356,960	5,752.88
14	BLOCKBOARDS	798	258,996	324.65
15	DOWELS	437	240,696	550.53
16	BOULES (KILN DRIED)	188	94,395	501.69
17	LAYONS	66	92,715	1,408.83
18	KINDLING	568	35,836	63.12
19	CURLS BOARD	1	269	337.84
	TOTAL	**426,222**	**128,226,984**	**13,291.68**

SUMMARY REPORT ON EXPORT PERMITS: 2010

	PRODUCT	VOLUME.(M3)	VALUE.(EURO)	PRICE (EURO/M3)
1	(PLYWOOD) OVERLAND	136,812	41,725,193	304.98
2	LUMBER (KILN DRIED)	78,154	29,506,530	377.54
3	SLICED VENEER	31,527	23,492,186	745.15
4	LUMBER (AIR DRIED)	51,259	16,356,503	319.10
5	PROCESSED L/MOULDING	17,821	8,901,649	499.51
6	POLES	22,019	3,915,998	177.85
7	BILLET	13,411	2,863,915	213.55
8	LUMBER (OVERLAND)	30,249	2,640,848	87.30
9	ROTARY VENEER	8,904	2,524,333	283.52
10	PLYWOOD	6,234	2,153,483	345.43
11	BOULES (AIR DRIED)	3,980	1,849,831	464.77
12	FLOORING	817	793,502	971.19
13	DOWELS	834	466,071	558.95
14	LAYONS	158	267,898	1,696.54
15	CURLS VENEER	31	148,785	4,865.28
16	BLOCKBOARDS	544	147,362	271.11
17	PROFILE BOARDS	102	62,058	611.03
18	KINDLING	400	31,693	79.24
	TOTAL	**403,254**	**137,847,837**	**12,872.03**

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