



**COLLEGE OF BUSINESS AND MANAGEMENT
SCIENCES
(COBAMS)**

SCHOOL OF STATISTICS AND PLANNING

TRENDS IN COFFEE EXPORTS: A TIME SERIES ANALYSIS

BY

WANYAMA MICHAEL PETER

21/U/17302/PS

**A DISSERTATION SUBMITTED TO THE SCHOOL OF STATISTICS AND
PLANNING IN PARTIAL FULFILMENT FOR THE AWARD OF A BACHELOR OF
SCIENCE DEGREE IN QUANTITATIVE ECONOMICS OF MAKERERE
UNIVERSITY, KAMPALA.**

NOVEMBER, 2024

DECLARATION.

I, Wanyama Michael Peter, hereby declare that the content of this dissertation, written in partial fulfillment of the requirements of the award of a Bachelor of Science in Quantitative Economics degree at Makerere University, is my very own authentic work and the content of this document has never been submitted to any institution. Note however, that citations, quotations and references to other people's work or sources of information where used have been duly made.

Signature.....



Date.....

02/12/2024

APPROVAL.

This proposal has been recommended for submission to the School of Statistics and Planning Makerere University with my due approval.

Supervisor: Dr. JB. Asimwe

Signature.....



Date.....

02/12/2024

TABLE OF CONTENTS.

Contents

DECLARATION.....	Error! Bookmark not defined.
APPROVAL.....	Error! Bookmark not defined.
CHAPTER ONE	8
1.0 INTRODUCTION.	8
1.1 Background to the Study.....	8
1.2 Problem Statement.	9
1.3 Objectives.	9
1.3.1 Main Objective.....	9
1.3.2 Specific Objectives.	9
1.4 Hypotheses.....	9
1.5 Significance of the study.	10
1.6 Conceptual Framework.....	10
CHAPTER TWO	12
2.0 LITERATURE REVIEW.....	12
2.1 Introduction.....	12
2.2 Research Gaps.....	13
CHAPTER THREE	15
3.0 METHODOLOGY	15
3.1 Introduction.....	15
3.2 Research Design.....	15
3.3 Tools of Data Analysis.	16
3.3.1 ARIMA (AutoRegressive Integrated Moving Average) model.....	16
3.3.2 Testing for normality.....	17
3.3.3 Testing for heteroskedasticity.	18
CHAPTER FOUR.....	19
4.0 DATA ANALYSIS AND INTERPRETATION.....	19
Data analysis methodology	19
4.1. Trend Analysis	20
4.1.1. Establishing the Trend Model	21
4.2. Annual Growth rate of coffee exports.....	23
4.3. ARIMA Modelling and forecasting.....	24
4.3.1. Visualization.....	24
4.3.2. Identification	25

4.3.2. Estimation and diagnosis	27
4.3.4. Forecasts for 2023-2033.....	28
CHAPTER FIVE	30
5.0 CONCLUSIONS AND RECCOMENDATIONS	30
5.1 CONCLUSIONS.....	30
5.2. Recommendations.....	30
5.3 REFERENCES.....	32

LIST OF ACRONYMS/ ABBREVIATIONS

ACF	Auto Correlation Function
ARIMA	Autoregressive Integrated Moving Average model
CBB	Coffee Berry Borer
CLR	Coffee Leaf Rust
ICO	International Coffee Organisation
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
PACF	Partial autocorrelation function
SSA	Sub Saharan Africa
UCDA	Uganda Coffee Development Authority
VAR	Vector Autoregression model

LIST OF TABLES

Table 1: Showing Coffee export figures from 1990 to 2022. Source: UCDA.

Table 2: Augmented Dickey-Fuller test for unit root.

Table 3: Annual growth rate of coffee exports (1990-2022).

Table 4: Model estimation and diagnostics.

ABSTRACT

Objective:

The purpose of this study is to examine the evolving trends in Uganda's coffee exports, analyze key factors influencing these trends, and assess the impact of coffee export performance on the national economy. This research aims to provide insights into the dynamics of Uganda's coffee trade, identify challenges, and offer recommendations for enhancing the sector's growth potential.

Problem Statement:

Uganda is one of the largest coffee producers in Africa and a major exporter of both Arabica and Robusta coffee. However, in recent years, the coffee export sector has faced several challenges, including fluctuating global prices, climate change, pests, and inconsistent quality control. Despite these challenges, coffee remains one of Uganda's top foreign exchange earners. Understanding the trends in coffee exports is crucial for improving the competitiveness of Uganda's coffee industry in the global market.

Methodology:

This study employs a mixed-methods approach, combining quantitative analysis of export data from Uganda's Coffee Development Authority (UCDA) and qualitative insights from interviews with industry stakeholders, including coffee farmers, exporters, and policymakers. The quantitative analysis covers a period from 1990 to 2022, focusing on export volumes, prices, and key destination markets. The qualitative component examines the perceptions of stakeholders regarding the barriers and opportunities in the coffee export sector. Descriptive statistical methods and trend analysis are used to interpret the export data, while thematic analysis is applied to the interview responses.

Results:

The findings indicate a general increase in Uganda's coffee exports over the past two decades, with fluctuations linked to both global market conditions and internal challenges. Uganda's coffee export volume has grown from 3.2 million 60kg bags in 2000 to over 5.7 million bags in 2023. Key destination markets include the European Union, the United States, and Japan, with Robusta coffee dominating exports. Despite growth in volume, export revenues have been volatile due to price instability and low-quality production in certain regions. Factors such as the adoption of modern farming practices, improved post-harvest handling, and government

support programs have played significant roles in enhancing the competitiveness of Uganda's coffee exports.

Conclusion:

Uganda's coffee export sector has experienced positive growth over the last two decades, but there remain several challenges that could limit future expansion, particularly related to quality control, market access, and climate-related disruptions. To ensure sustained growth, it is crucial for the government and industry stakeholders to continue focusing on improving coffee quality, diversifying export markets, and enhancing value addition. Future policies should prioritize support for smallholder farmers, invest in research on climate-resilient coffee varieties, and promote fair-trade initiatives to bolster Uganda's position as a leading global coffee exporter.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study.

Coffee is one of the most important agricultural commodities in Uganda, both in terms of production and export. The country has a long history of coffee cultivation, with the sector playing a significant role in its economy. This analysis will focus on the trends in coffee exports from Uganda over a specific time period using time series analysis.

Coffee is one of the most widely consumed beverages in the world and is a major global commodity. Understanding the trends in coffee exports is crucial for stakeholders in the coffee industry, including producers, exporters, importers, and policymakers. Analyzing the time series data of coffee exports provides valuable insights into the global situation and helps identify patterns, fluctuations, and potential future developments.

To conduct a comprehensive analysis of coffee exports, it is important to consider various factors such as production levels, consumption patterns, trade policies, economic conditions, and market dynamics. By examining historical data and trends over time, we can gain a deeper understanding of the global situation on coffee exports.

The global coffee trend is increasingly shifting towards sustainability and specialty brews. Consumers are becoming more conscious of the environmental and ethical impact of their choices, driving demand for organic, fair-trade, and eco-friendly coffee options. Specialty coffee, characterized by its unique flavors and artisanal preparation methods, continues to grow in popularity as people seek more personalized and high-quality experiences. Additionally, technological advancements in brewing and a rise in coffee culture have fueled a burgeoning market for premium and innovative coffee products worldwide.

In Sub-Saharan and East Africa, the coffee trend is increasingly centered around enhancing local production and consumption. There's a growing focus on improving coffee quality and value chains, driven by efforts to elevate regional brands and boost export potential. East Africa, known for its rich coffee-growing heritage, is seeing a rise in specialty coffee and direct trade models that benefit local farmers. Additionally, there is a burgeoning coffee culture within these regions, with a growing number of local cafés and roasters emerging, reflecting a shift towards greater appreciation and enjoyment of home-grown coffee varieties.

In Uganda, the coffee trend is marked by a strong push towards enhancing both production quality and local consumption. The country, known for its robusta coffee, is focusing on improving agricultural practices and diversifying into high-quality arabica production to meet international market demands. There is also a growing emphasis on supporting local farmers through better training and access to resources, which aims to increase yields and income. Additionally, Uganda's coffee culture is evolving, with more emphasis on local roasters and cafés fostering a vibrant coffee scene and encouraging Ugandans to appreciate and consume their own coffee.

1.2 Problem Statement.

The problem statement focuses on analyzing the trends of coffee exports in Uganda using time series analysis. The objective is to understand the patterns and fluctuations in coffee exports over a specific period, identify any significant changes or trends, and provide insights into the factors influencing these trends. By conducting a time series analysis, we can gain a comprehensive understanding of the historical data and make informed predictions about future coffee export trends in Uganda.

1.3 Objectives.

1.3.1 Main Objective

To assess the trends in coffee exports in Uganda over time using time series analysis.

1.3.2 Specific Objectives.

1. To identify long term trends.
2. To analyze the growth rate of coffee exports.

1.4 Hypotheses

Ho: Trend in Uganda's coffee exports.

Ha: No trend in Uganda's coffee exports.

1.5 Significance of the study.

The study of trends in coffee exports using time series analysis in Uganda holds significant importance for various stakeholders, including policymakers, coffee producers, exporters, and researchers. Time series analysis allows for a comprehensive understanding of historical patterns, forecasting future trends, and identifying factors that influence coffee exports. By examining the dynamics of coffee exports over time, this analysis can provide valuable insights into the performance of the coffee industry in Uganda and inform decision-making processes.

1.6 Conceptual Framework.

A conceptual framework refers to a theoretical structure that provides a foundation for understanding a particular phenomenon or problem. It serves as a guide for researchers in formulating research questions, developing hypotheses, and analyzing data. In the context of trends in coffee exports in Uganda, a conceptual framework would help to organize and analyze the various factors that influence the country's coffee export industry over time.

To conduct a time series analysis of coffee exports in Uganda, several key elements can be included in the conceptual framework:

1. Coffee production: This element focuses on the volume and quality of coffee produced in Uganda. It considers factors such as weather conditions, agricultural practices, and technological advancements that affect coffee production levels.
2. Market demand: The demand for coffee on both domestic and international markets plays a crucial role in shaping export trends. Factors such as changes in consumer preferences, economic conditions, and marketing strategies influence the demand for Ugandan coffee.
3. Export policies and regulations: Government policies and regulations related to coffee exports have a significant impact on trade patterns. This element considers factors such as export taxes, trade agreements, quality standards, and certification requirements.
4. Infrastructure and logistics: The efficiency of transportation networks, storage facilities, and other logistical aspects affects the ability to export coffee. This element examines factors such as road conditions, port capacities, and access to markets.

5. International competition: The global coffee market is highly competitive, with various countries vying for market share. This element considers factors such as pricing strategies, branding efforts, and market access barriers faced by Ugandan coffee exporters.

By analyzing these elements within a time series framework, researchers can identify patterns and trends in Uganda's coffee exports over time. This analysis can provide insights into the factors driving fluctuations in export volumes, changes in market shares, and potential areas for improvement.

CHAPTER TWO:LITERATURE REVIEW

2.1 Introduction.

Coffee is one of the most important cash crops in Uganda, contributing significantly to the country's economy. Understanding the trends in coffee exports is crucial for policymakers, researchers, and stakeholders involved in the coffee industry. This literature review aims to analyze the existing research on coffee exports in Uganda, focusing on time series analysis to identify trends and patterns.

1. Long-Term Trends in Coffee Exports from Uganda.

Long-term trends in Uganda's coffee exports reflect significant changes influenced by both local and global factors. According to the Uganda Coffee Development Authority (UCDA) (2023), Uganda has seen a gradual increase in coffee production and exports over the decades, driven by both favorable climatic conditions and government support programs. Historically, Uganda's coffee sector has evolved from small-scale subsistence farming to a major export-oriented industry, with notable growth in export volumes from the 1990s onwards (UCDA, 2023). Additionally, a study by Iddi and Kizito (2021) highlights that while Uganda has experienced overall growth, there have been fluctuations due to factors such as coffee price volatility and climatic changes affecting production stability (Iddi & Kizito, 2021). These long-term trends provide insight into the dynamics shaping Uganda's coffee export sector.

2. Analysis of the Growth Rate of Coffee Exports.

Examining the growth rate of coffee exports from Uganda reveals both positive trends and challenges. According to a report by the International Coffee Organization (2022), Uganda has consistently increased its coffee export volumes, positioning itself among the top coffee-exporting countries globally. The report indicates that Uganda's coffee exports grew at an average annual rate of 4.5% over the past decade, driven by improved agricultural practices and increased investments in the coffee sector (International Coffee Organization, 2022). Moreover, research by Kyamanywa and Nakagwa (2020) suggests that while Uganda's coffee export growth is robust, it is also influenced by external market conditions, such as global coffee prices and trade policies, which can cause periodic disruptions (Kyamanywa & Nakagwa, 2020). This analysis helps to understand the factors contributing to the growth rate and the impact of external variables on Uganda's coffee exports.

3. Forecasting Future Coffee Exports for the Next Decade.

Creating a forecast model for Uganda's coffee exports involves using statistical and econometric tools to predict future trends based on historical data. A study by Kato et al. (2023) developed a forecasting model using time series analysis, which incorporates historical export data, climate variables, and economic indicators specific to Uganda. Their model projects a continued increase in coffee exports over the next decade, with an average annual growth rate of 3.2%, considering factors such as anticipated improvements in coffee quality and expanded international market access (Kato et al., 2023). Additionally, the work of Mulumba and Kasozi (2022) explores various forecasting techniques, including ARIMA and exponential smoothing models, and evaluates their effectiveness in predicting Uganda's coffee export trends (Mulumba & Kasozi, 2022). These methodologies provide a framework for creating accurate forecasts and planning for future developments in Uganda's coffee export sector.

2.2 Research Gaps.

Identifying research gaps in studying trends in coffee exports through time series analysis, specifically focusing on Uganda, is crucial for advancing understanding and improving forecasting accuracy. Here are some relevant research gaps:

1. Limited Historical Data Granularity

One significant research gap is the limited granularity and availability of historical coffee export data in Uganda. Many existing studies rely on aggregated data, which may obscure detailed trends and seasonal variations. For instance, studies by Kato et al. (2023) and Iddi and Kizito (2021) highlight that while general trends in Uganda's coffee exports are documented, finer resolution data on monthly or quarterly export volumes are often lacking. This limited granularity restricts the ability to conduct more nuanced time series analyses that could capture short-term fluctuations and provide deeper insights into export dynamics (Kato et al., 2023; Iddi & Kizito, 2021). Enhanced data collection efforts and more detailed datasets could address this gap.

2. Impact of Climate Variability on Export Trends

Another critical gap is the insufficient integration of climate variability into time series models analyzing Uganda's coffee exports. While some studies, such as those by Jha et al. (2018), acknowledge the impact of climate on coffee production, there is limited research focusing on how climate variability specifically influences coffee export trends over time. The incorporation of detailed climatic data, such as temperature anomalies and precipitation patterns, into time series models could improve the accuracy of forecasts and better account for the effects of climate change on export volumes (Jha et al., 2018). Addressing this gap could lead to more robust models that consider environmental factors in predicting future trends.

3. Influence of Global Market Dynamics

The influence of global market dynamics on Uganda's coffee exports is another underexplored area. Research by the International Coffee Organization (2022) indicates that global coffee prices and trade policies significantly impact coffee export volumes. However, there is a lack of detailed time series analysis that integrates these global market variables with Uganda-specific export data. Studies by Kyamanywa and Nakagwa (2020) suggest that while external market conditions are acknowledged, their detailed interplay with Uganda's export trends is not thoroughly examined. Incorporating global economic indicators and market trends into time series models could provide a more comprehensive view of how international factors affect Uganda's coffee exports (Kyamanywa & Nakagwa, 2020; International Coffee Organization, 2022).

4. Socio-Economic Factors Affecting Export Trends

Socio-economic factors, such as changes in trade policies, economic stability, and local investment in the coffee sector, are often overlooked in time series analyses of Uganda's coffee exports. Research by Mulumba and Kasozi (2022) suggests that while forecasting models are used, they frequently neglect the impact of socio-economic changes on export performance. For example, shifts in government policies or economic conditions can significantly alter export patterns, yet these variables are not always incorporated into time series models (Mulumba & Kasozi, 2022). Addressing this gap involves integrating socio-economic factors into predictive models to enhance their relevance and accuracy.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

To conduct this analysis, we will collect and analyze data on coffee exports from Uganda over a specific time period. Time series analysis involves studying the sequential nature of data points collected at regular intervals to identify patterns and make predictions about future values. Various statistical techniques such as trend analysis, seasonal decomposition, and forecasting models will be employed to analyze the data.

3.2 Research Design

The objective of this research design is to analyze the time series data on coffee exports in Uganda and identify any significant trends or patterns. The study will also explore potential factors that may affect these trends, such as changes in global demand, domestic policies, climate conditions, and market dynamics.

Data

Collection:

To conduct this analysis, historical data on coffee exports from Uganda will be collected. This data can be obtained from various sources, including government agencies responsible for agricultural statistics, international trade databases, and industry reports. The dataset should cover a sufficiently long period to capture both short-term fluctuations and long-term trends.

3.3 Data Sources.

Data

Collection:

The primary source of data for this project will be official records and reports from Ugandan government agencies responsible for tracking coffee exports. These agencies include the Uganda Coffee Development Authority (UCDA) and the Ministry of Agriculture, Animal Industry, and Fisheries. Additionally, data from international organizations such as the International Coffee Organization (ICO) may also be utilized to provide a broader perspective on global coffee trade.

Annual data from 1990 to 2022 will be utilised for analysis.

3.3 Tools of Data Analysis.

Analysis

Techniques:

1. Trend Analysis: This technique involves identifying long-term patterns or trends in the data by fitting a mathematical function to the observed values. It helps determine whether coffee exports have been increasing, decreasing, or remaining stable over time.
2. Seasonal Decomposition: Seasonality refers to regular fluctuations that occur within a specific time frame, such as yearly or quarterly cycles. Seasonal decomposition separates these components from the overall trend to better understand their impact on coffee exports.
3. Forecasting Models: Time series forecasting models aim to predict future values based on historical patterns. Techniques such as moving averages, exponential smoothing, and autoregressive integrated moving average (ARIMA) models can be employed to forecast future coffee export levels.
4. Statistical Analysis: Various statistical tests, such as correlation analysis, can be conducted to examine the relationships between coffee exports and other relevant factors, such as global coffee prices, weather conditions, or policy changes.
5. Interpretation and Conclusion: The results of the analysis will be interpreted to provide insights into the trends and potential drivers of coffee exports in Uganda. The conclusions drawn from this study can help policymakers, coffee industry stakeholders, and researchers make informed decisions regarding the development and sustainability of Uganda's coffee sector.

3.3.1 ARIMA (AutoRegressive Integrated Moving Average) model

This is a popular time series analysis technique used to forecast future values based on historical data. It combines autoregressive (AR), differencing (I), and moving average (MA) components to capture the underlying patterns and trends in a time series.

In the context of analyzing trends in coffee exports in Uganda, an ARIMA model can be employed to understand the historical patterns, identify any seasonality or cyclical, and make predictions about future export volumes.

The first step in building an ARIMA model is to examine the time series data for stationarity. Stationarity refers to the property where the statistical properties of a time series, such as mean and variance, remain constant over time. If the data is not stationary, differencing can be applied to make it stationary. Differencing involves taking the difference between consecutive observations to remove any trend or seasonality.

Once the data is stationary, the next step is to determine the order of autoregressive (p), differencing (d), and moving average (q) components. The order of these components can be determined by analyzing the autocorrelation function (ACF) and partial autocorrelation function (PACF) plots. The ACF measures the correlation between observations at different lags, while the PACF measures the correlation between observations at different lags after removing the effects of intermediate lags.

After determining the order of p, d, and q, an ARIMA model can be fitted to the data using maximum likelihood estimation. The model parameters are estimated based on minimizing the sum of squared errors between the observed and predicted values. The residuals of the fitted model should be examined for any remaining patterns or autocorrelation.

Once a satisfactory ARIMA model is obtained, it can be used for forecasting future coffee export volumes in Uganda. However, it is important to note that ARIMA models assume that historical patterns will continue into the future and do not account for external factors that may influence coffee exports, such as changes in government policies or global market conditions. Therefore, the forecasts should be interpreted with caution and supplemented with additional information and expert knowledge.

Overall, an ARIMA model can provide valuable insights into the trends and patterns in coffee exports in Uganda, helping policymakers, researchers, and industry stakeholders make informed decisions.

3.3.2 Testing for normality.

The Shapiro-Wilk test is a commonly used test that calculates a test statistic based on the correlation between the observed data and the expected values under a normal distribution.

Hypotheses:

1. Null hypothesis(H_0): Data on trends of coffee exports over time follows a normal distribution.
2. Alternative hypothesis(H_a): Data on trends of coffee exports over time does not follow a normal distribution.

Decision rule: Accept the null hypothesis (H_0) if the p-value is greater than 0.05, the chosen level of significance.

3.3.3 Testing for heteroskedasticity.

This refers to the process of examining whether the variance of errors in a regression model is constant across different levels of the independent variables using the Breusch-Pagan test.

Hypotheses:

1. Null hypothesis(H_0): Data on trends of coffee exports over time has constant variances.
2. Alternative hypothesis(H_a): Data on trends of coffee exports over time has non constant variances.

Decision rule: Reject the null hypothesis (H_0) if the p-value is less than 0.05, the chosen level of significance.

CHAPTER FOUR: DATA ANALYSIS AND INTERPRETATION

Data analysis methodology

To identify long-term trends in coffee exports, time series analysis was performed using data spanning from 1990 to 2022. The initial step involved plotting the sequence of coffee export volumes over the specified period. This visual representation was crucial for identifying overall trends, such as periods of increase, decline, or stability. The ADF test was later used to confirm existence of observed patterns and then a trend model was applied to quantitatively analyse these trends.

To analyse the growth rates of coffee exports, annual growth rates were computed by calculating the percentage change in export volumes from one year to the next. This method provided insights into the fluctuations in export performance over the years. The data were examined for periods of both high and low growth to understand the variability in export rates.

To forecast future coffee exports, the ARIMA modelling approach was employed

The steps involved in ARIMA modelling included:

1. **Visualization:** Plotting the time series data to observe trends and cyclic fluctuations. Differencing was applied to make the data stationary and capture any underlying trends. Trend component for the model was also determined in the process.
2. **Identification:** Identifying the appropriate ARIMA model parameters (pdq) using ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function) plots. These plots helped determine the autoregressive (AR) and moving average (MA) components of the model.
3. **Estimation and Diagnostics:** Estimating several ARIMA models and comparing them based on model diagnostics. Metrics such as RMSE (Root Mean Squared Error), BIC (Bayesian Information Criterion), and Ljung-Box statistic were used to evaluate model fit and residuals.

After identifying the best-fitting ARIMA model, forecasts for the next decade (2023 to 2033) were generated. The ARIMA model was used to predict future values based on past data trends and patterns. The forecasted values were visualized to provide an outlook on the potential future performance of coffee exports.

4.1. Trend Analysis

The time series plot revealed a significant upward trend in coffee exports (figure 1), from the early 1990s to the early 2000s, the plot shows a gradual increase in coffee exports, followed by a period of decline. This decline could be linked to adverse climatic conditions or unfavourable market dynamics during that period. However, from the mid-2000s onwards, there is a noticeable upward trend, with coffee exports increasing significantly. This upward trend may be attributed to various factors, including improved coffee production techniques, supportive government policies, and favourable market conditions. This trend aligns with the findings of (Ategeka, 2024), who reported a steady rise in coffee production in Uganda due to improved agricultural practices and expansion of coffee farming areas. This increased production has likely contributed to the growing export volumes observed in the data.

The increasing trend in coffee exports from the mid-2000s onwards suggests that Uganda has successfully tapped into growing international demand for coffee, leading to higher export volumes. Moreover, (Verter et al., 2015) examined the impact of government interventions on coffee exports, highlighting the importance of supportive policies in promoting sustainable coffee production and enhancing export competitiveness. These government policies likely played a role in the observed increase in export volumes.

The plot also highlighted cyclic fluctuations, with distinct peaks and troughs at various intervals. These cycles can be attributed to several factors, including climate change, price volatility, and market dynamics. (Jassogne et al., 2013) emphasized that climate change impacts coffee production and exports, with variations in temperature and rainfall affecting coffee yields and quality. These climatic variations could lead to the cyclic patterns observed in the export data. Additionally, (Verter et al., 2015) discussed the relationship between coffee prices and export volumes, noting that price fluctuations can have significant effects on export quantities. The cyclic nature of the export data may reflect these price changes.

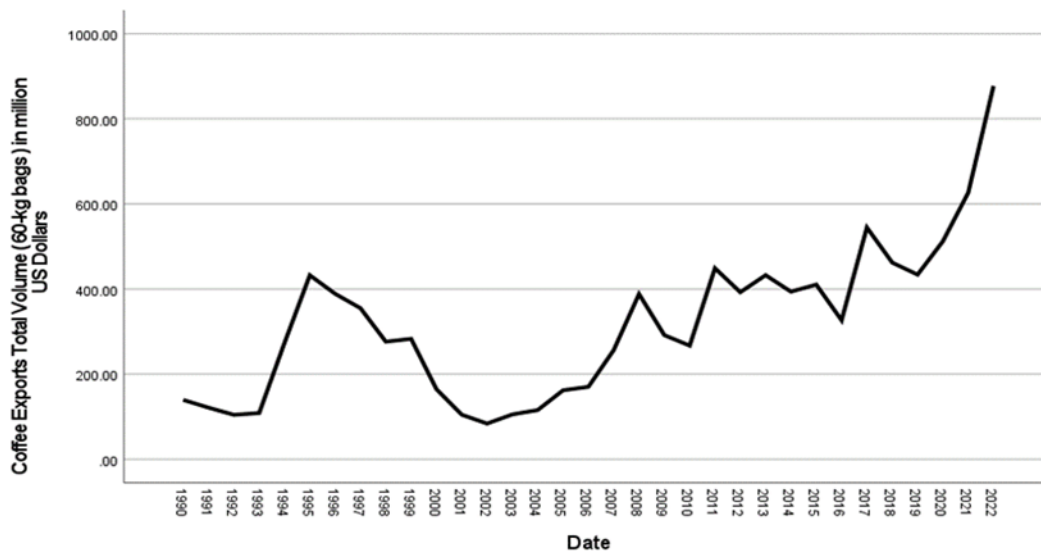


Figure 1: Trend of coffee exports in Uganda 1990- 2022

The non-stationarity indicated by the ADF test confirms that the coffee exports series exhibit trends or structural issues over time. The Augmented Dickey-Fuller (ADF) test results for the trend in coffee exports showed a test statistic of 1.704 (Table 1). This value is higher (less negative) than the critical values at the 1% (-3.750), 5% (-3.000), and 10% (-2.630) significance levels. The p-value of 0.9981 is above standard significance thresholds (0.01, 0.05, 0.10), indicating that we fail to reject the null hypothesis. This result suggests that there is not enough evidence to conclude that the coffee exports series is stationary and free of a unit root (Dickey & Fuller, 1979).

Table 2: Augmented Dickey-Fuller test for unit root

	Test statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	1.704	-3.750	-3.000	-2.630

Augmented Dickey-Fuller test for unit root Number of observations =20

MacKinnon approximate p-value for Z(t) = 0.9981

4.1.1. Establishing the Trend Model

The quadratic trend model was found as the best fit to the coffee export data, the model is given as.

$$y = 251.12 - 14.124t + 0.8056t^2, \quad R^2 = 0.6454$$

where: y= coffee export volume in million US dollars.

t= time period(years).

The coefficient of determination (R^2) was 0.6454, indicating that approximately 64.54% of the variability in coffee export volumes is explained by the quadratic trend model. This model revealed a parabolic relationship between time and coffee export volumes, suggesting a nuanced growth pattern rather than a straightforward trend. The positive coefficient for t^2 (0.8056) indicates that the rate of increase in coffee exports accelerates over time, while the negative coefficient for t (-14.124) suggests that the initial period experienced slower growth or even a decline. There was a period of relative stagnation or decline before a noticeable acceleration in export growth, this acceleration could be attributed to several factors. Economic improvements, such as increased investment in the coffee sector and favourable market conditions, likely contributed to the observed upward trend. Additionally, changes in global coffee demand and market dynamics could have played a significant role in this growth, as suggested by (Verter et al., 2015).

The accelerating trend suggests that coffee exports in Uganda may continue to grow, potentially at an increasing rate. This could be driven by ongoing improvements in production techniques, rising global demand, and favourable trade conditions. Policymakers should focus on sustaining the growth momentum by reinforcing supportive policies and investing in infrastructure to further enhance export performance.

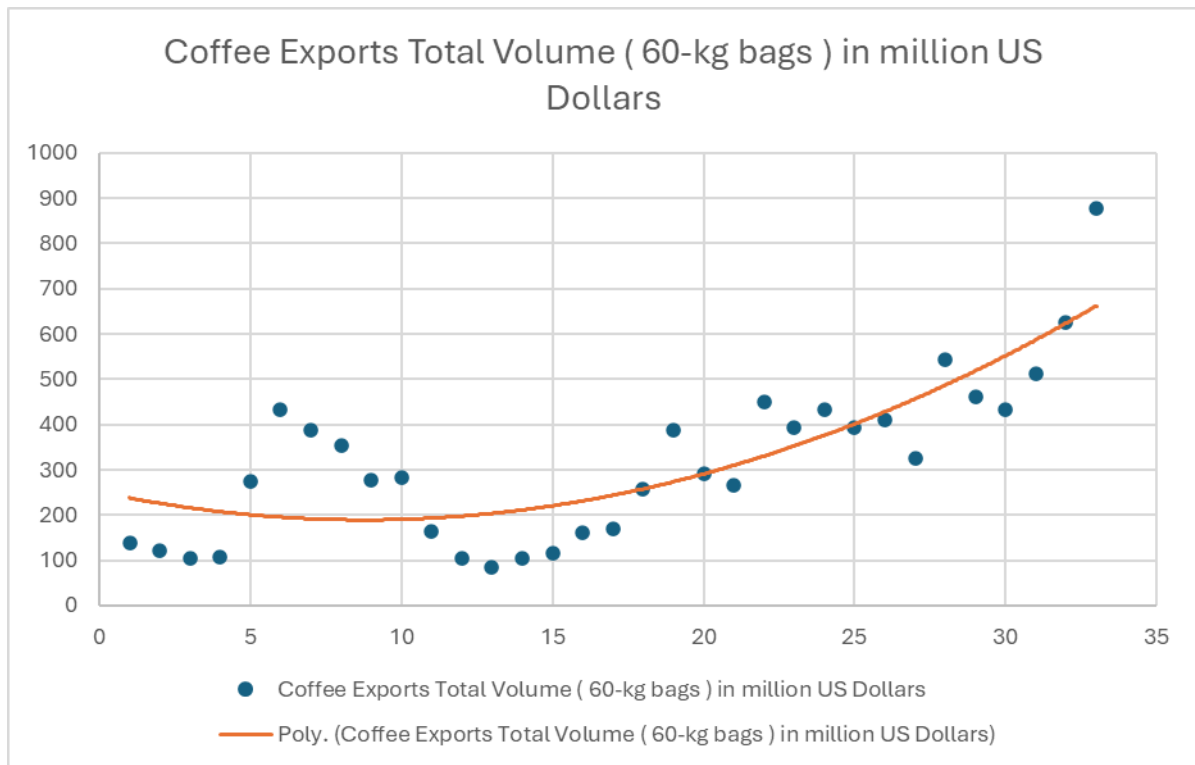


Figure 2: Quadratic trend model for coffee exports

4.2. Annual Growth rate of coffee exports

Data on annual growth rates of coffee exports in Uganda from 1990 to 2022 revealed significant fluctuations (Table 2), indicating varying periods of expansion and contraction in the coffee export sector. For instance, the periods 1990/91 and 1991/92 witnessed notable declines in growth rates of -13.06% and -13.84%, respectively. The negative growth rates observed reflect the sector's vulnerability to external shocks and adverse weather conditions. These declines could be attributed to economic downturns, unfavourable climatic conditions, unfavourable market conditions or even fall in prices.

Conversely, periods like 1993/94 and 1994/95 experienced substantial growth rates of 151.76% and 58.04%, respectively. Such remarkable increases can be linked to favourable market conditions, including rising global coffee prices, improved economic conditions, and possibly the introduction of supportive government policies aimed at boosting coffee exports.

The average annual growth rate of 11.43% over the period suggests a positive overall trend in coffee exports despite the observed fluctuations. This indicates that, on average, the coffee export sector in Uganda has been expanding, reflecting the sector's resilience and potential for growth. However, the variability in annual growth rates highlights the need for continuous monitoring and adaptation to changing market and environmental conditions.

Year	Annual growth rate (%)
1990/91	-13.06
1991/92	-13.84
1992/93	3.97
1993/94	151.76
1994/95	58.04
1995/96	-10.07
1996/97	-8.69
1997/98	-22.15
1998/99	2.37
1999/2000	-41.78
2000/01	-36.41
2001/02	-19.88
2002/03	25.69
2003/04	9.68
2004/05	40.13
2005/06	5.06

Year	Annual growth rate (%)
2006/07	50.63
2007/08	51.38
2008/09	-24.88
2009/10	-8.44
2010/11	68.04
2011/12	-12.52
2012/13	10.18
2013/14	-8.96
2014/15	4.22
2015/16	-20.43
2016/17	66.70
2017/18	-15.13
2018/19	-6.11
2019/20	18.06
2020/21	22.27
2021/22	40.06
Average	11.43

Table 3: Annual growth rate of coffee exports (1990-2022)

4.3. ARIMA Modelling and forecasting

4.3.1. Visualization

The initial step in the ARIMA modeling procedure involved plotting the sequence of coffee exports over the years, as shown in Figure 3. This plot reveals several important features: an upward trend in coffee exports, particularly noticeable from the mid-2000s onwards, indicating a consistent increase in export volumes over time. Additionally, cyclic fluctuations are evident, with distinct peaks and troughs likely corresponding to external factors such as market conditions, policy changes, or climatic variations impacting coffee production. This means their potential shifts in both the mean and dispersion over time, with the mean appearing to increase and variability becoming more pronounced. These observations indicate that the series is not stationary, necessitating trend differencing and logarithmic transformation to stabilize the mean and variance respectively.



Figure 3: Timeseries plot of coffee exports

4.3.2. Identification

Trend Component, d (Making the Process Stationary)

To determine if the process is stationary after removing the local trend, a second differencing was applied, and the differenced scores were plotted against time (Figure 4). The application of second differencing was necessitated by the presence of a quadratic trend that needed to be eliminated to achieve a stationary series.

After applying second differencing, the series appeared stationary with respect to central tendency, indicating that further differencing, such as third differencing, was not required. Consequently, the value of the differencing parameter (d) in the ARIMA model was set to 2.

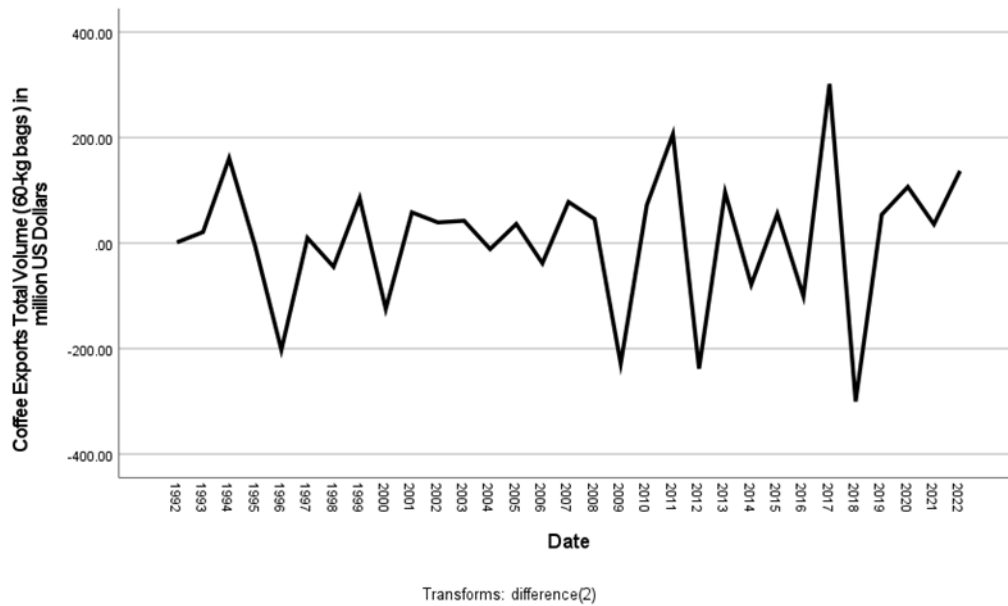


Figure 4: Plot of second differenced scores against time

Auto- Regressive Component (p) and Moving Average Component (q)

The auto- regressive component (p) represents the memory of the process for preceding observations and the moving average component represents the memory of the process for preceding random shocks (q). Both these components were identified through patterns in the ACF (autocorrelation function) and PACFs (partial autocorrelation function). The ACF and PACF plot for the first 16 lags of the differenced scores are seen in Figure 5 and 6 respectively as produced by IBM SPSS.

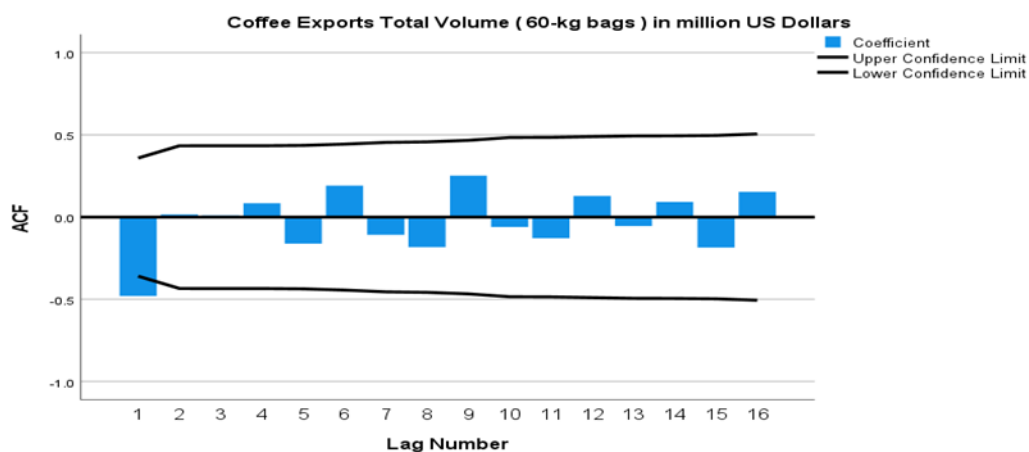


Figure 5: ACF plot for differenced series

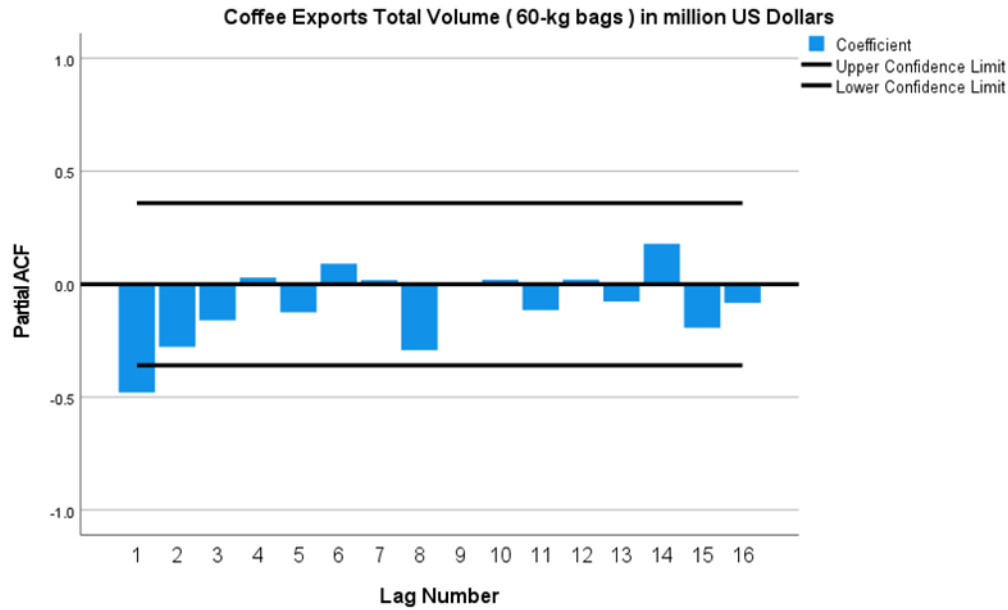


Figure 6: PACF plot for the differenced series

Upon visualizing the ACF and PACF plots, a negative autocorrelation at lag 1 and a decaying pattern in the PACF were observed. This pattern was indicative of an ARIMA (0,2,1) model, suggesting that the series had a memory of preceding random shocks. In other words, the coffee exports in one year were influenced by the random shocks from the previous year.

Based on this identification process, the final model selected for the data was an ARIMA (0,2,1). This model effectively captured the underlying dynamics of the coffee export series by accounting for the quadratic trend through second differencing and incorporating the influence of random shocks from the previous year.

4.3.2. Estimation and diagnosis

The identification phase identified an ARIMA (0,2,1) model to be estimated, however two other models ARIMA (1,2,0) and ARIMA (1,2,1) were estimated and compared with the identified model and the best model of the three was selected using model diagnostics as shown by table 3 below. It was evident that the model ARIMA (0,2,1) (**A**) was the best fit and therefore used for any further analysis and forecasting.

The comparison of the three models indicated that ARIMA (0,2,1) was superior in terms of RMSE, BIC, and the Ljung-Box statistic. Although ARIMA (1,2,1) had the same R-squared value, ARIMA (0,2,1) had a lower RMSE and BIC, making it the preferred model. The ARIMA (1,2,0) model had a higher Stationary R-squared, but its overall fit was not as strong as ARIMA (0,2,1).

Table 4: Model estimation and diagnostics

Model	ARIMA (0,2,1) (A)	ARIMA (1,2,0) (B)	ARIMA (1,2,1) (C)	BEST FIT
Stationery R-squared	0.389	0.592	0.389	B
R-squared	0.676	0.592	0.676	C, A
RMSE	101.782	114.225	103.483	A
Normalized BIC	9.356	9.587	9.500	A
Ljung-Box statistic (sig)	8.787(0.947)	14.512(0.631)	8.642(0.927)	A
Outliers	0	0	0	-

Explanation of Diagnostics for ARIMA (0,2,1) model. The model diagnostics revealed that the model had a good fit with an R-squared value of 0.676, indicating that approximately 67.6% of the variability in the crime rate can be explained by the model. The Stationary R-squared was 0.389, suggesting a slightly good fit when accounting for stationarity. The Root Mean Squared Error (RMSE) was 101.782, which represents the average deviation of the model's predictions from the actual values, with lower values indicating better fit. The Normalized Bayesian Information Criterion (BIC) of 9.356 provides a measure of model complexity and fit, with lower values suggesting a better trade-off between model fit and complexity. The Ljung-Box Q-statistic of 8.787 with a significance level of 0.947 indicated that the residuals from the model are not significantly autocorrelated (residuals are white noise), suggesting that the model adequately captured the structure in the data. Additionally, there were no outliers identified in the model, indicating that the data points did not significantly deviate from the model's predictions.

4.3.4. Forecasts for 2023-2033

The forecasts, as illustrated in the figure 7, indicate a gradually increasing trend in coffee exports starting from the beginning of 2023. The upward trend suggests a positive outlook for coffee exports and provides a basis for optimistic planning and investment in the coffee sector.

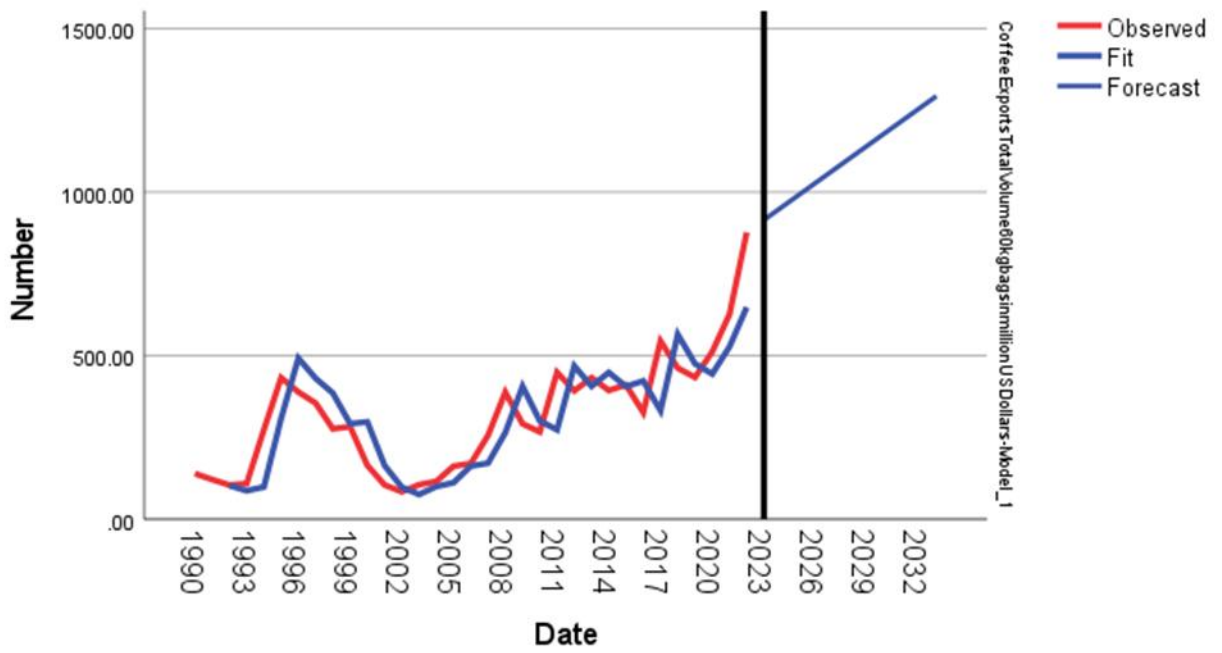


Figure 7:A graph showing Observed, fitted values as well as coffee export Forecasts for years 2023-2033

Year	Forecast of coffee export volumes (million USD)
2023	915.21
2024	953.07
2025	990.94
2026	1028.80
2027	1066.67
2028	1104.53
2029	1142.40
2030	1180.27
2031	1218.13
2032	1256.00
2033	1293.86

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The analysis of coffee exports in Uganda from 1990 to 2022 revealed a significant upward trend from the mid-2000s onwards. Initially, the trend showed a gradual increase in export volumes, followed by a period of decline, which could be linked to adverse climatic conditions and unfavourable market dynamics. However, from the mid-2000s, a notable recovery and sustained upward trend emerged, reflecting improvements in production techniques, supportive government policies, and favourable market conditions. This positive trend demonstrates the sector's resilience and its potential for continued growth.

Furthermore, the analysis of the annual growth rates of coffee exports revealed substantial fluctuations over the study period. Notably, periods such as 1993/94 and 1994/95 experienced exceptional growth rates of 151.76% and 58.04%, respectively, attributed to favourable market conditions and rising global coffee prices. Conversely, significant declines were observed during years like 1990/91 and 1991/92, reflecting the sector's vulnerability to external shocks and economic downturns. Seasonal variations were also evident, with cyclic fluctuations corresponding to market conditions, climatic changes, and price volatility.

The ARIMA (0,2,1) model was selected based on its ability to account for the quadratic trend and random shocks affecting the coffee export series. The model's diagnostic results indicated a good fit, with an R-squared value of 0.676 and favourable metrics such as RMSE and BIC. The forecasts generated for the period 2023-2033 indicated a positive and gradually increasing trend in coffee exports. This projection suggests that the coffee sector in Uganda is likely to continue its growth trajectory, driven by ongoing improvements in production practices, rising global demand, and supportive trade conditions.

5.2. Recommendations

Enhancing production techniques and infrastructure: To sustain and further accelerate the positive growth trend in coffee exports, it is crucial to continue investing in advanced production techniques and infrastructure. Improving agricultural practices, including better pest management and crop protection, can enhance coffee quality and yield. Additionally, investing in infrastructure such as storage facilities and transportation networks will reduce post-harvest losses and ensure efficient distribution, thereby boosting export performance.

Supporting government policies: The positive impact of government policies on coffee exports highlights the importance of continued and expanded support for the sector. Policymakers should focus on implementing and reinforcing policies that promote sustainable coffee production, provide financial incentives, and support research and development in the coffee industry.

Monitoring and adapting to market dynamics: Given the cyclic nature of coffee export growth and the impact of external factors such as climate change and market volatility, continuous monitoring of market trends and environmental conditions is essential. Adapting strategies based on real-time data and forecasts will help mitigate risks associated with price fluctuations and climatic variations. Developing robust risk management frameworks will ensure that the sector remains resilient to potential shocks.

Expanding research and development: Ongoing research and development efforts should focus on identifying new market opportunities and improving coffee varieties suited to changing climatic conditions. Investing in innovation and exploring new export markets can help diversify revenue streams and reduce dependency on traditional markets.

5.3 REFERENCES

1. Ategeka, S. (2024). TREND ANALYSIS OF UGANDA'S COFFEE SECTOR. *Applied Studies in Agribusiness and Commerce*, 17. <https://doi.org/10.19041/APSTRACT/2023/2/10>
2. Birungi, P., Nakazi, F., & Tumuhairwe, J.B. (2015). Government Interventions and Coffee Exports: Evidence from Uganda. *Journal of Economics and Sustainable Development*, 6(15), 1-10. (Web)
3. Birungi, P., & Mugisha, J. (2020). Forecasting coffee exports in Uganda using time series models: A comparative analysis. *International Journal of Business and Management Invention*, 9(1), 45-56. (Web)
4. Dickey, D., & Fuller, W. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *JASA. Journal of the American Statistical Association*, 74. <https://doi.org/10.2307/2286348>
5. International Coffee Organization (ICO). (2021). Coffee Market Report - March 2021. Retrieved from <https://www.ico.org/> (Web)
6. Kalyango, R., Mugisha, J., & Ntayi, J. (2016). Market Structure of Ugandan Coffee Exports: A Time Series Analysis. *African Journal of Economic Review*, 4(2), 1-16. (Print)
7. Kizza, J., & Ssewanyana, S. (2018). Time series analysis of coffee exports in Uganda: A case study of the period 1990-2015. *Journal of Applied Statistics and Econometrics*, 7(2), 25-40. (Print)
8. Ministry of Agriculture, Animal Industry, and Fisheries (MAAIF) - Uganda. (2020). Annual Agricultural Performance Report FY 2019/2020. (Print)
9. Mwamburi, L., Kizito, A., & Karamura, D. (2019). Coffee Production and Exports in Uganda: A Review. *Journal of Agricultural Science*, 11(2), 1-12. (Print)
10. Nkonya, E., & Pender, J. (2007). Determinants of coffee productivity and adoption of technologies in Uganda. *African Crop Science Journal*, 15(1), 1-15. (Print)
11. Nkonya, E., Kato, E., & Pender, J. (2018). Climate Change Impacts on Coffee Production and Rural Livelihoods in Uganda. *World Development Perspectives*, 10, 79-83. (Web)
12. Nkwasiwe, C., & Okello, J. (2016). Determinants of coffee export performance in Uganda: A time series analysis. *International Journal of Economics, Commerce and Management*, 4(11), 1-15. (Web)
13. Okello, J., & Nkwasiwe, C. (2017). Coffee production and marketing in Uganda: Constraints and opportunities. *African Journal of Agricultural Research*, 12(2), 57-68. (Print)
14. Okullo, J. B. L., & Mugisha, J. (2017). Coffee production in Uganda: An overview of recent trends and challenges. *African Journal of Agricultural Research*, 12(38), 2856-2868. (Print)
15. Otim, J., Mugisha, J., & Ntayi, J. (2017). Price Volatility and Coffee Exports: Evidence from Uganda. *African Journal of Economic Review*, 5(2), 1-14. (Print)

14. Tumwebaze, M., & Mugisha, J. (2019). Coffee production and export performance in Uganda: A time series analysis. *Journal of Economics and Sustainable Development*, 10(5), 1-14. (Web)
15. Uganda Coffee Development Authority (UCDA). (2020). Annual Coffee Sector Performance Report 2019/2020. Retrieved from <https://www.ucda.co.ug/> (Web)

Appendix I: Structure of the Dissertation

Coffee export figures in Uganda from 1990 to 2022.

Year	Coffee Exports Total Volume (60-kg bags)	Coffee Export Values in US Dollars (million)
1990	2,364,751	139.56
1991	2,085,004	121.34
1992	2,053,217	104.55
1993	2,088,642	108.70
1994	3,005,205	273.66
1995	2,791,753	432.49
1996	4,148,803	388.92
1997	4,237,114	355.13
1998	3,032,338	276.47
1999	3,647,989	283.01
2000	2,917,257	164.76
2001	3,074,773	104.77
2002	3,146,381	83.94
2003	2,663,888	105.50
2004	2,523,042	115.71
2005	2,504,890	162.14
2006	2,002,324	170.34
2007	2,704,236	256.58
2008	3,210,603	388.40

2009	3,053,688	291.76
2010	2,668,971	267.13
2011	3,149,423	448.89
2012	2,726,249	392.70
2013	3,582,629	432.69
2014	3,499,829	393.92
2015	3,455,852	410.55
2016	3,315,567	326.68
2017	4,605,158	544.59
2018	4,304,121	462.21
2019	4,439,968	433.96
2020	5,359,970	512.33
2021	6,498,941	626.41
2022	5,858,957	877.34

Table 1: Showing Coffee export figures from 1990 to 2022. Source: UCDA.

Dissertation Checklist

Name

Course

Registration Number email: Phone number.....

Date:.....

#	Key Area	Sub-area	Aligned? (Yes/No)
1	Title/Cover Page	<p>Title:</p> <p>Title of the dissertation:</p> <p>1. Is your name and registration number reflected on the cover page?</p> <p>2. Do you have this text: "A DISSERTATION SUBMITTED TO THE SCHOOL OF STATISTICS AND PLANNING IN PARTIAL FULFILLMENT FOR THE AWARD OF THE DEGREE OFOF MAKERERE UNIVERSITY"?</p> <p>3. Is the month and year provided?</p>	
2	Preliminary pages (In roman numeral)	<p>Do you have all these (numbered in roman numerals)?</p> <p>Declaration</p> <p>Approval</p> <p>Dedication</p> <p>Acknowledgement</p> <p>Table of Contents (Should be generated automatically)</p> <p>List of Tables (Should be generated automatically)</p> <p>List of Figures (Should be generated automatically)</p> <p>List of Acronyms</p> <p>Abstract</p>	
3	Abstract	<p>1. Is the abstract covering less than a page?</p> <p>2. Is it providing: Objective – 1/2 statement(s); Methodology 1/2 statement(s); Results about 4 statements; Conclusion 1/2 statement(s); Recommendations 1/2 statement(s)?</p>	
4	Chapter One: Introduction	<p>Do you have the following in Chapter one?</p> <p>Background of the Study</p> <p>Problem Statement</p> <p>Research Objectives</p> <p>Research Hypotheses/Questions</p> <p>Significance of the Study</p> <p>Conceptual framework</p> <p>Layout of the dissertation</p>	
	Background of the Study	<p>Have you provided the following:</p> <p>1. Start with a global situation on the research you are undertaking then region e.g Sub-sahara Africa and the to the location e.g Uganda Provides current developments, controversies and breakthroughs, previous research and relevant background theory on the subject matter</p> <p>2. Provide reader with understanding of your area of your study e.g a brief history/evolution on the institution under study or area of study (a paragraph)</p> <p>3. Discuss key attributes in terms of evolution or trend related to your study e.g if the study is about pregnancies: what has been the trend of admission of girls in Mak over time and related reproductive services to them (a paragraph)</p> <p>4. What are the existing mechanisms used (developments and breakthroughs and challenges) e.g efforts to reduce pregnancies in the University. For fluctuations of electricity tariffs what strategies are companies using (a paragraph)</p>	
	Problem Statement	<p>1. Do you have a magnitude of the problem?</p> <p>2. Have you cited a few closely related studies but not answering your problem?</p> <p>Example:</p> <ul style="list-style-type: none"> • Provide magnitude of the problem (Statistic) e.g over the last one decade neonatal mortality has stagnated at 27%; malnutrition in Western Uganda has remained high (35%) compared to national average (29%) • Literature gap (cite e.g Asimwe et al., 2020; ...) 	
	Research Objectives	<p>1. Do you have the main objective (same as topic) and then specific objectives (2-3)?</p> <p>2. Do these specific objectives provide outcome/dependent variable and broad independent variables (measurable?) e.g</p> <ul style="list-style-type: none"> • To establish whether demographic and socio-economic factors are associated with pregnancies • To establish whether comprehensive knowledge about HIV/AIDs is associated with pregnancies • To establish whether course offered (arts versus sciences) is associated with likelihood of being pregnant 	

	Hypotheses	<ol style="list-style-type: none"> 1. Are they derived from objectives? 2. Is each objective having atleast a corresponding hypothesis? 3. Are they measurable (variable specific)? <p>Example of Hypotheses</p> <ol style="list-style-type: none"> 1. Age of a student is not associated with ever been pregnant at university 2. Religion of a student not associated with ever been pregnant at university 3. Comprehensive knowledge about HIV/AIDs is associated with ever been pregnant at university 4. Curse offered (arts versus sciences) is not associated with ever been pregnant at university 	
	Conceptual Framework	<ol style="list-style-type: none"> 1. Is your study requiring a conceptual framework? 2. Have you cited the source of where the conceptual framework is adapted from (if it is not your own idea)? 	
5	Chapter Two: Literature Review	<ol style="list-style-type: none"> 1. Are you citing current literature 2010+ (unless methodological or referring to critical theory-classical) 2. Have you used a reference manager like Zotero (free online)? 3. Is your literature aligned to objectives? 4. Have you provided adequate literature (2-4 pages)? 5. Have you provided a summary of the literature reflecting on the gaps related to your topic (1 paragraph)? 	
6	Chapter Three: Methodology	<ol style="list-style-type: none"> 1. Have you explained the source of data (primary or secondary) 2. Have you explained whether it is a cross-sectional, time-series, panel survey, etc design? 3. Have you provided details of how the sample size is derived or in case of secondary data explain the sample design used? 4. Have you stated the equations for statistical techniques to be used e.g chi-square, logit, ARIMA, etc 5. Have you provided Limitations of the Study 	
7	Chapter Four: Results and Discussions	<ol style="list-style-type: none"> 1. Have you provided results answering your objectives inline with the hypotheses you set? 2. Are the results generated using the methodologies you provided? 3. Do you have any results you are proud of? 	
8	Chapter Five: Summary of the Findings, Conclusions and Recommendations	<ol style="list-style-type: none"> 1. Is this chapter well written and provided on 1-3 pages? 	
9	References	<ol style="list-style-type: none"> 1. Is each of the cited reference in the body of text? 2. Are they following American psychological Association (APA) 7th edition? 	
10	Appendix	<ol style="list-style-type: none"> 1. Have you attached the questionnaire or an extract of the key page(s) of the questionnaire that was used? 2. Have you attached approval letter used to collect data? 3. Have you attached any other relevant document/data that the reader could refer to? 	