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MODELLING THE IMPACT OF POLITICAL STABILITY ON COCOA PRODUCTION

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA,

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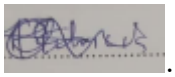
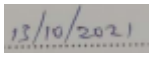
DECLARATION

I declare that this thesis was carried out by Patricia Oforiwaa under the supervision of Dr. Lotsi Anani and Dr. F. O. Mettle, and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:……  …… Date:……  ……

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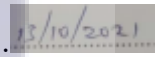
Principal Supervisor's Signature:……  …… Date……  ……

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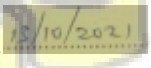
Co-Supervisor's Signature:……  …… Date… 

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ABSTRACT

Economic growth and political stability are genuinely interrelated. In Ghana, the Cocoa Production Sector is one of the main boosters of the GDP. This paper used political stability as major intervention on the cocoa production. It sought to estimate and assess the impact of Political Stability as a variation on Cocoa Production in Ghana using Bia and Tiao, intervention analysis model. Time series data on cocoa productions from the department of Monitoring, Research and Evaluation of Ghana COCOBOD spaning from the year 1968 to 2016 was uesd. The Empirical result indicates that, the pre- intervention period was modeled with ARIMAX process based on which the full intervention model was obtained. The intervention event exists but it has an insignificant impact on cocoa production. The Ljung- Box test and its residual plots were significant. It concluded that the insignificant of political stability on cocoa production means that there is no influence of political appointees on the cocoa production. The study recommends that, the cocoa production sector should be independent of political interference since it's the back bone of Ghana's GDP.

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DEDICATION

I dedicate this thesis to my parents, family members and friends.

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I dimed it a great privilege for how far my Creator has brought me. I am grateful. My heartfelt appreciation goes to my supervisors, Dr. Lotsi Anani and Dr. O. Mettle for their assistance and constant supervision. Their attitude and encouragement have helped me to achieve my goals. This thesis would not be complete without their support. I thank Dr. Iddi Samuel and all my lecturers of the Statistic Department for their sacrifices toward this project.

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LIST OF ABBREVIATION

ACF	Autocorrelation Function
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
AR	Autoregressive
ARIMA	Autoregressive Integrated Moving Average
BC	British Columbia
BIC	Bayesian Information Criterion
CACF	Cross Autocorrelation Function
CMB	Cocoa Marketing Board
CMC	Cocoa Marketing Company
CPU	Community Policing Unit
ECOWAS	Economic Community of West African States
FCUBE	Free Compulsory Universal Basic Education
FMHCP	Free Maternal Health Care Program
GDP	Gross Domestic Product
GSFP	Ghana School Feeding Program
HR	Heart Rating
LBC	License Buyers Company
MA	Movement Average
MAE	Mean Absolute Error
MAPEs	Mean Absolute Percentage Error

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MSE	Mean Square Error
OLS	Ordinary Least Squares
ON	Ontario
PACF	Partial Autocorrelation Function
PBC	Produce Buyers Company
SARIMA	Seasonal Autoregressive Integrated Moving Average
USA	United States of America
QC	Quebec
QCC	Quality Control Company

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Data acquired from observation with an equal time interval over a period, is time series data. Unique feature of such a series is that, the order of the values of its variables are always at a regular interval structure (Marohn et al., 2012). Time series data can be observing every day, weekly, monthly or annually. In practice, the concept of the series is in two folds: understanding the basic and organization that produce the data and fitting a model and proceeding to forecast for the future (Cryer & Chan, 2008). This analysis applies in many aspects of life, which includes the agricultural sector like cocoa production. Time series modelling helps to describe the pattern of the data, explain how the patterns interact with themselves and possibly serves as a control standard quality check for other production. For instance, in this study Ghana cocoa production is our time series data of interest. Sometimes, time series data is influence by external events, which are either artificial or natural made and assumed to have effect on the series. The event assumed to have a change on the mean function or trend of a series. These events need a second look. Is suppose to be model to know its effect on the data before other conclusion can make but such aspect of time series has gained little interest to researchers when dealing with time series data.

The best modelling for such a time series data is an Intervention Analysis model.

Box and Tiao, (1975) introduced Intervention Analysis as a method used for modelling the impact of special event that has an effect on the series of interest. Intervention analysis focuses on modelling the significant effect of the event on the data and forecast its future impact. For example,

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in the year 1992, Ghana's political system changed from political instability to political stability. This intervention has a total influence on all our economic growths, which include our cocoa production sector. The period before the happening of the event is the pre interventional period and after the happening of the event is the post interventional period.The period during political instability (1968 - 1991) serves as pre intervention period whiles the political stability (1993 - 2016) serves as a post interventional period. The most interesting part of the study detects the significant level of political stability on the cocoa production sector.

The inception of Political stability has no physical features, but is a great realization, that is vital to both industrialized and developing countries. A country without political coups, revolutions or civil war is said to be politically stable, since there is a high level of respect for political order, constitution and government institution (Alesina, Ozler, Roubini, & Swagel, 1992). The history of Ghanaian political instability started after the rule of our colonial masters in 1957, where Nkrumah of the Conventional People's Party was the Prime Minister. Political stability started in the year 1992 under the Rawlings regime (Ghana web, 2017) and has ensured that policies formulated by certain political dispensations can reach their desired conclusions without any friction in implementation (Alesina, Ozler, Roubini & Swagel, 1992). This stable condition helps Cocoa Board of Directors (COCOBOD) to regulate its policies in the production sector on behalf of the government. A change of government leads to a dissolution of its Board of Directors in that period. A political instability leads to its persistent change of the Board of Directors.

Cocoa as an export product has been used for the nation's growth, restructuring, and paucity relief policies. The Cocoa division of the country hasn't obtained its attainment after evolving as the

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world's leading producer. The nation experienced a major deterioration in the production sector for the year 1960s and 1970s, but nearly collapsed in the early part 1980s. Kolavalli and Vigneri (2011) confirmed in their study that, the inter-war retro marked the slowdown of cocoa production in Ghana. Production gradually improved after the economy wide reforms.The year 1990 marked the start of a restoration, where invention virtually replicated during the year 2001 and 2003 (Kolavalli & Vigneri, 2011). These fluctuations lead our interest in Ghana's cocoa production industry.

Cocoa production industry cannot achieve its ultimate aim without operating in a more sustainable way of attracting younger generations under political stability. Its agenda in recent years has adopted a sustainable practice that can support and promote the well-being of stakeholders in the cocoa value chain. However, th.is has been impeded due to the inability to propel an improved living conditions among small scale cocoa farmers in the production sector since their products are exported in their primary form (World Cocoa Conference, 2012).

Development economists such as Singer- Presbich attributed that, there has been a declining demand for primary products (Sarkar, 1986). This has been a great disincentive for increasing the volumes of production as the quantity produced will not be fairly priced. Among the prominent strides, World Cocoa Conference curb the discrepancies in the cocoa sector by brings together diverse stakeholders from all works to develop practical measures to ameliorate the fate of small scale cocoa farmers and improve their welfare. Anga, (2015) recommendations on the World Cocoa Conference shows a call for cocoa producing nations to have a national policy framework that will guide the stream of activities in the sector. The framework is proposed to encompass the private sector through Public Private Partnership and other stakeholders to add value to cocoa beans and

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coordinate activities in this sector. It is believed once this is realized, the export of primary cocoa beans will be reduced and fair prices Jsecured domestically- this will guarantee supply and enable future growth.

West Africa is the world's largest cocoa producing continent and product from this continent is usually exported in their very raw form without any value addition. Their cocoa belt is the origin of about 70% of the world's cocoa and serves as a means of securing the necessities for two million agriculturalists (Schroth et al., 2016). Ghana is the second largest cocoa producing country after its neighbouring Ivory Coast (Ecobank, 2014). Cocoa remains Ghana's most important agricultural export crop since the early 20th century (Kolavalli & Vigneri, 2011). Its contribution to the economy of Ghana cannot over emphasize. The crop contributes about 57% of the total agricultural exports of the nation and 25% to the gross domestic product. Many industrialists and scholars are of the opinion that, it can further be enhanced, if proper pricing systems are instituted to check cross border smuggling of cocoa beans to neighbouring Ivory Coast (Ecobank, 2014).

This may not be far from right; Ghana realized a one-time boost in cocoa production to one million metric tons in 2011 in the wake of political turbulence in neighbouring Ivory Coast. Cocoa production volumes declined in Ivory Coast during the period of political turbulence (Maurice, 2012). Prior to this, several policy interventions targeted at this volume of production had failed and subsequent interventions sustain this realized boast had not also yielded any meaningful results. However, many have also argued that, the achievement of the one million tons was not due to extraneous factors, but because of prudent government interventions in the immediate years to the realization of the one million tons' volume which successive governments had not been able to replicate. It is worth bringing to attention that, several administrations in Ghana, including the

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colonial masters used cocoa for development, reforms and poverty alleviation policies. COCOBOD is the sole regulator of the industry in the country under the influence of the government. Their role is to regulate the oversight responsibility over the production and marketing of the product. The licensed produce buying companies directly purchase from farmers in cocoa producing regions and sell it to the Cocoa Marketing Company (CMC) (Steijn, 2016).

1.2 Problem Statement

Globally, majority of the world cocoa producers are found in the coastal zones of West Africa. Currently, the world cocoa trade falls deeply on the West African cocoa belt for most of their raw materials. Ghana is currently known as the second producer of cocoa after La Cote D'Ivoir with a gap of almost twice of what they produce but product from Ghana is considered as a" golden standard" because of its high quality as compared to other cocoa in the world market (Fairtrade International, 2011). In Ghana, Cocoa Board of Directors are responsible for all the regulations on cocoa production and its market pricing in Ghana. They report directly the ruling government. A change of government leads to a dissolution of its Board of Directors in that period. There have been a lot of interventions such as mass spraying, Hi - tech programs and others, all aimed at boosting production by the COCOBOD but none have studied the impact of political stability on cocoa production (Steijn, 2016; Maurice, 2012).. This leads to the interest of our study: to determine the impact of political stability on cocoa production in Ghana.

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1.3 General Objective

The main aim of this study was to investigate the effect of political stability on cocoa production using the Interventional Analysis model.

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1.3.1 Specific Objectives

The study specifically seeks to:

1. examine the trend in cocoa production using time series models.
2. determine whether cocoa production in Ghana fits Additive or Multiplicative models.
3. Investigate the effect of political stability of cocoa production using ARIMAX model.

1.4 Research Questions

Now the achievement of the above objective, this study will stab to answer the following inquiries:

1. Does cocoa production in Ghana follow a particular trend?
2. To what extent does cocoa production in Ghana fit additive or multiplicative models?
3. What is the impact of political stability on cocoa production in Ghana?

1.5 Justification

The outcome of the study will inform the cocoa production industry about the impact of political stability as a factor in cocoa production and the relationship that exists between the present, the past and random values of these products. Again, researchers will be aware of the trend and decomposition of cocoa production.

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1.6 Significance of the Study

The empirical outcome and conclusions from the study would be important to industry practitioners and policy makers, academicians' researchers' as well as the public due to the following.

Firstly, the result of the study will increase the knowledge about the trend and decomposition of cocoa production level in Ghana. It will review the impact that political stability has on cocoa production. It will examine whether it is necessary for a change of political government to change the board of directors of COCOBOD. In addition, it will be beneficial to academics and researchers by contributing to existing literature on the performance of trend and interventional analysis.

1.7 Major Cocoa Production Areas in Ghana

The major cocoa production areas in Ghana are as follows: Ashanti Region, Brong -Ahafo Region, Central Region, Eastern Region, Western Region and Volta Region. The Figure 1 of the map shows the areas or regions of cocoa production in Ghana with a light pink colour and symbols indicating cocoa trees.

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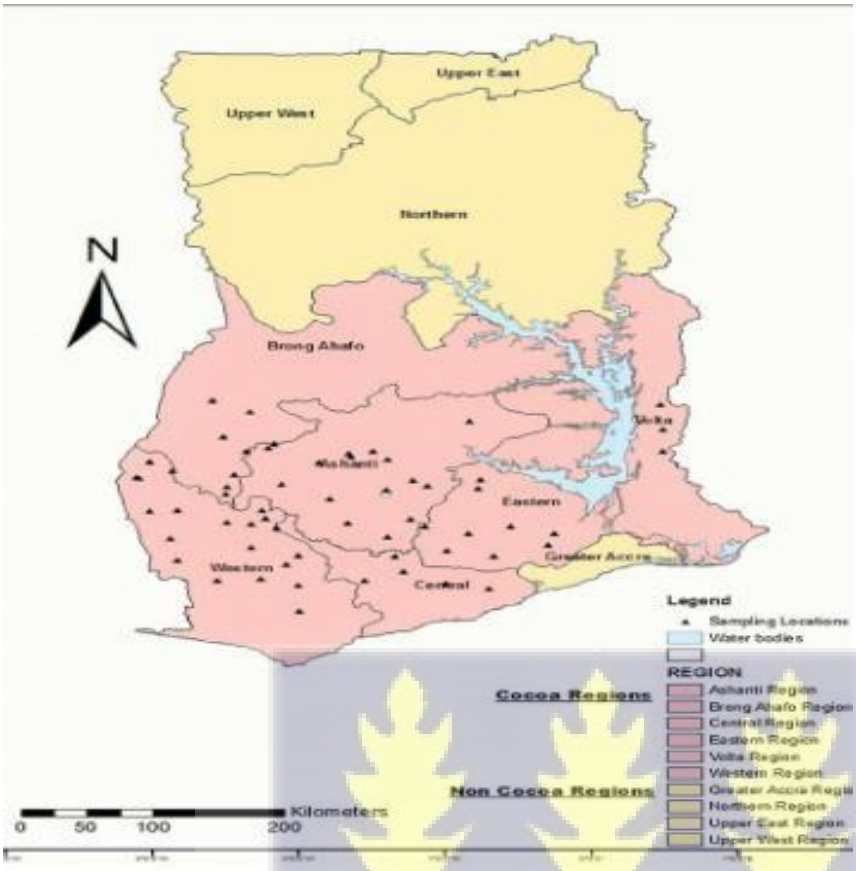

Figure 1.Map of Cocoa Production Areas in Ghana.

Source: Ghana Web, 2015

1.8 Brief Methodology of the Study

The core model for analyzing this study is the Interventional Analysis model. It will be used to analyze the effect of political stability in cocoa production. This study uses annual data from the Ghana Cocoa Board (Monitoring, Research and Evaluation Department) spanning from the year 1968 to 2016. Political stability serves as an external factor that have influence on the mean function of cocoa production. In this study, Interventional analysis introduced by Box and Tiao (1975) was used in analyzing the data. The Interventional model consists of two components: The

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Interventional function and ARIMA process with white noise, which accounts for the residual variability in the observed records. The study continues to analyze the trend and decomposition of cocoa production. R and MINTAB software packages were used for the analysis.

1.9 Limitation of the Study

The major drawback of the study is that; the data is an annual time series; the best would have been a monthly time series data.

1.10 Thesis Organization

This study consists of five chapters. This chapter introduces the background of the entire study. It discusses the research problem, the objectives, and the significance of the study, Space, a brief methodology and the organization of the research. Chapter 2 presents the literature review on theoretical and empirical works done by other researchers related to cocoa production, political stability, ARIMAX model with interventional analysis. The third chapter provides a detailed methodology, which researchers have employed in their study. The data analysis for the intervention analysis model on cocoa production is presented and discussed in Chapter 4. Chapter 5 presents the summary, conclusions and recommendations of the research work.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is a review of previous published work on Cocoa sector, time series analysis and Interventional Analysis model. The empirical reviews of the literature are based on the similarities and differences between this thesis and other related works on the subject matter.

2.2 Fair Knowledge of Cocoa Production

Cocoa (Theobroma Cacao) instigated from the Amazon zone and was introduced to Europe in the fifteenth century. It was purposely used for preparing drinks and serving as a currency (Steijn, 2016). Currently, close to 50 million people depend on cocoa as a means of securing the necessities of life (Schroth et al., 2016; Justin, 2015). Around 3.5million tons of cocoa beans are produced each year, but its expected demand will exceed 4.5 million tons (Fairtrade Foundation, 2011). Despitethe fact that demand forecasts outstrip supply from the Choco congress 2015, there will be a run out of cocoa for the next seven years, starting from the year 2020 due to a fall in its price at the world market level. This will definitely have effect on products made from cocoa (International Cocoa Organization, 2015). Ideally, this situation calls on the need for every government like Ghana in the production level to know how best they can regulate at the local level in order not to collapse the production sector (Amos & Thompson, 2015).

Today, West Africa dominates the production sector and its produce is from almost 30 countries (Justin, 2015). The leading producer of the world production sector from the above-mentioned region (West Africa) is La Cote D'Ivoire and Ghana. Their incredible output in term of production contributes about 70% from producing countries all over the world (World Cocoa Conference,

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2012). The West African industry needs to focus on climate change because the transition of forest belts to savannah and dry areas have a great impact on the production output (Amos & Thompson, 2015). In the 20th century West Africa experienced a massive drying in its climatic zone and this affected Ghana as well. As a result, some of the forest zones changed to savannah areas (Ruf, Schroth, & Doffangui, 2015). It has been proposed that by 2050, there will be a drastic change in the climate transition of cocoa areas of these two leading producing countries from West Africa (World Cocoa Conference, 2012). An ultimate attention by both private and public governance should put regulatory measures in place to help protect our cocoa belts since over 90 percent of the world's cocoa production is based on small-scale farming who directly depend on cocoa production for their livelihood (Fairtrade International, 2011). The outcome of this climate change will lead to high poverty rate and less socioeconomic development in the producing countries

2.3.1 Cocoa Production under Political Instability

Cocoa is a cash crop that originated from Middle America and its later extended to West Africa in the nineteenth century. West Africa dominates the production sector globally and Ghana is currently among the largest cocoa producers in the world. The first successful man to mature a cocoa tree in the year 1879 in Gold Coast, known as Ghana today, was Tetteh Quashie. His achievement was after the Presbyterian Missionaries under the Danish government introduced cocoa to the then Gold Coast in the year 1857. Unfortunately, the missionaries gave up since almost all the seedlings planted died and were left with a hand full to survive due to the attack of beetles and worms (Essegbey & Gyamfi, 2012).

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The first cocoa beans exported was 80 pounds in 1891 and by 1914 to 1937 Gold Coast was the world's prominent producer with total export of 300,000 tons within a year. The trend of cocoa production fellow an exponential growth (1888-1937) (Kolavalli & Vigneri, 2011). The fruitful sector of cocoa production led the colonial government to establish a Cocoa Marketing Board (CMB) in 1947, which aimed to resolve problems in the industry related to market sharing, price fixing and stabilization of domestic prices in the market. During this period, Produce Buyers Company (PBC) was the sole purchaser of cocoa on the market. After the rule of our colonial masters in the 1957, the country experienced many political coups, revolutions, and there was no respect for political order, constitution and government institution.

In the early 1960s, the inter-war period marked a slowdown in cocoa production, but in the 1980s production fell because of aged trees, rife of diseases, bad climate condition and low production values. It moved from 450000 tons each year to as low as 159,000 tons. CMB was changed and later became known as the Ghana Cocoa Board of Directors (COCOBOD) in the year 1979. COCOBOD serves as a regulatory body for the cocoa production sector and they do this on behalf of the government of Ghana. The price determination of cocoa is imperilling to the government regulation (COCOBOD) by the Cocoa Marketing Company (CMC) under COCOBOD while quality assurance of cocoa is in the hands of Quality Control Company (QCC), which is also under COCOBOD. In 1984, the government made further changes targeted at subjecting the cocoa industry to market force and became responsible for every facet of Ghana's cocoa and 40% of the staff were dismissed. The transport sector was given to private governance to buy cocoa beans while subsidies for production inputs such as fertilizer, insecticides and fungicide were cheap.

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2.3.2 Cocoa Production under the Political Stability

In 1992, Ghana walked into a new system of governance under the umbrella of political stability. Under the shade of political stability, our cocoa sector is still in the hands of the COCOBOD. Truly, no other nation comes in mind than Ghana while we talk about the production of quality cocoa (Kolavalli & Vigneri, 2011). Cocoa from Ghana is called the" golden standard". The sector offers livelihood for over 700,000 farmers in this country (Dormon et al., 2004). Currently, cocoa serves a lot of purposes, including cosmetics, but not only from beans to bar.

There have been a lot of interventions in the cocoa sector, which include an increase in partial liberalization of the internal market, certification of the cocoa beans into organic and inorganic, the LBEs providing incentives to farmers, mass spraying of farms and giving HI – Tech to improve the production level (Steijn, 2016; Maurice, 2012). Despite the fact that the (LBC) transportation aspect has been given to private management, their means to do that is sponsored by the government through the activities of COCOBOD. The top men of COCOABOD are under a political influence. A change of government leads to a dissolve of the board. The interest or motive of been influenced by government of such a body has gained little interest to researchers. The interest of this thesis is to evaluate the impact of political stability in cocoa production. We strongly believe that, the aim to increase the level of cocoa production by different political revelry under the influence of political stability have an impact on cocoa production.

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2.4 Some Problems Associated with Cocoa Productions

This is not the first paper which has gained interest to know much about the cocoa industry. However, on grounds, no one can think of cocoa production within a vicinity and leave the factors affecting the production industry out.

2.4.1 Climate Change

Climate change is an average weather condition that a locality experiences. The average weather condition includes temperature, rainfall and wind patterns. Alongside the Guinea coast, the only nation that does not harvest cocoa is Benin because it is found in the gap town which is in a savannah area (ECOWAS, 2007). Cocoa production is more preferable under lowland forest belts where there is an absence of savannah or drought-sensitivity. This means that, a change in the accumulated greenhouse gases in the atmosphere has a direct change in the specific area of production (Ruf & Siswoputranto, 1995).

Ruf, Schroth and Doffangui (2015) came with a concern that there is going to be an affiliated increase in temperature, which will lead to an increase in potential evaporation and plant water demand. This situation will further worsen the ailment of cocoa bean production. Schroth et al. (2016) confirmed in their analysis that, there will be a weather change in the cocoa belts, founded from the climate projection for the year 2050. Ghana is not exceptional, before the 20th century, she experienced a further drying in its climatic zone. It led to a decrease in its annual rainfall by 30% (Kotir, 2011) and also changed some of the forest zones to savannah areas. Ghana portrayed as the most vulnerable region because of its reliance on agriculture, has a highly sensitivity to

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weather and climate variability. The period before the happening of the event is the pre interventional period and after the happening of the event is the post interventional period.The government should adopt strategies for the cocoa production on the basis of climate change and its sustainability system. The better question is how did we benefit from the massive spraying and HI-Tech from our cocoa production sector? Do we only plan for short term and leave the long term goals at stake? After having political stability of constitutional rule for twenty–eight (28) years, where our cocoa beans are considered to be the golden star, there has not been any positive effect on our climate change toward our cocoa production in the agricultural sector. This led to the topic of interest for this study; to know the impact of political stability in cocoa production.

2.4.2 Pests and Plant Diseases

Agricultural crops, including cocoa, can be damaged due to pests and diseases if not properly controlled. The range of which pests and diseases affected cocoa production globally is 30%. They are affected mostly by fungi and insects and numerous approaches to management include host resistance, cultural, biological and chemical measures. In Ghana, mirids are the major insects that have affected cocoa since 1908 (International Cocoa Organisation, 2015). Dormo et al. (2004) discovered that in their studies and it was confirmed by Jacobi et al. (2013) that cocoa cultivation is affected by pest and plant diseases. They concluded that residence building enhanced by local organisations must further be improved than just organic certification. Sarpong, Otchere, and Anin (2013) studied the several categories of risks in the cocoa production sector and found out that the government spent a huge amount to control this but is still found to be the key factors. They recommended that the farmers should be educated on why they should treat pests and diseases because they overused it, and that alone lead to risk to our environment.

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2.4.3 Pricing and Certification of Cocoa

According to World Bank, the module of cocoa pricing in trading is influenced by traders fixing sale, time and volume. Producers profit can be reduced or increased because of the unforeseen fluctuations in the pricing module (Okyere, 2015). Cocoa production faces the risk of production deficit and risk of surplus. As there is an increase in investments to improve sustainability, it attracts more farmers and production increases but demand for the beans reduces. A surplus in supply leads to a decline in the price. A fall in price on the world market leads to a higher demand of the beans but low incentive to producers. It discourages producers of the beans to move to more attractive alternative businesses and this results in less production output in subsequent times (International Cocoa Organization, 2015). Starting from October, 2020 the world will officially run out of cocoa for seven years because cocoa supplies may run low (Anga, 2015).

Ghana is going to be affected as well and its supply is going to be low because of low prices for cocoa. Chocolate bars will be replaced by slabs of palm oil, vegetable fat packs by the year 2020. Arene and Ezea (2013) assessed the response of an export market to trade plan variation in Nigeria. It was detected that, Nigeria cocoa export trade has been fluctuating and is likely to continue over time. Solomon Islands government and other aid assistants aimed to improve small scale production of cocoa by helping the farmers earn income through policy. Their studies concluded that there was a significant improvement of the living conditions of the farmers (Hivu, 2013).

Quarminea et al. (2012) examined the impact of incentives on cocoa bean production in Ghana. They found out that, incentives to farmers led to quality cocoa production in the industry, but the problem is insufficient export premium quality policy to farmers which does not motivate them to

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reach their full potential. Economists will tell you that demand is backed by purchasing power. It dims one spirit if your reward is not given after a work done, especially to the aged men and women.

2.4.4 Child Labour

Essegbey and Eugene (2012) examined the impacts of economic growth in cocoa production. They discussed the major drivers of reforms in the cocoa industry in Ghana. This paper concluded that, there had been a significant economic growth in cocoa production in the mid-2000s with the exception of the year 2006 and 2007. But the shortcoming in the production was strongly on child labour. Their study is in line with the report from Postal (2008) that in Cote D'Ivoire, child labour is a threat on the production level. Instead of our children going to school they are now used in farms. It is vital to note that, right to education is not a finale in itself, but a means to an expiration. The outcome of an educational progression translates into value human means for the nation and it has to be the zeal of every government to invest in the education of its people. In Article 38 of the constitution bids the government to afford Free Compulsory Universal Basic Education (FCUBE) for all youngsters of school standard age for the glory of the nation in the future. (Constitution of Ghana, 1992).

2.5 Empirical Literature Review on Related Research

Time series data, which are often well collected and organised are affected by some special events that need much attention before the data can be analysed. The events have an influence on the mean function of the series. These events may be caused by natural or artificial activities which we are refers to as interventional events (Ďurka & Pastoreková, 2012). They are modelled with the Interventional Analysis Model. The initial class of test used for analysing such data is Quasi-

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experimental method (Campbell & Stanley 1966) but it is examining to be invalid due to the bias nature of the variance estimator.

Li (2013) also used difference in difference method to evaluate the impact of traffic intervention on road safety. In contemporary times, there has been more methods and techniques used to examined and projection data. One of the mostly used methodology widely used is an Autoregressive Integrated Moving average (ARIMAX) model introduced by Box and Taio. This methodology has gained more popularity due to its influence and flexibility (Pankratz, 1983). It uses historical data of univariate series to evaluate its trend and then forecast its future cycle, it is statistically valid due to the significance of the effects. This model has been used in diverse ways. For instance, in social science literature, longitudinal scrutiny is used to ration the impact of law, decriminalization, gun control laws, health, biomedicine, just to mention a few, and employs intervention methods for modelling and forecasting. Other studies have adopted the notion of interventional analysis similar to our studies. For instance, Maurice, (2012) carried out a model and estimated the influence of the national mass spraying and the cocoa Hi-technology on cocoa production in Ghana. The Interventional effect of national mass spraying and the cocoa Hi-technology was applied in 2002 and 2003 in that order, on cocoa production data. The secondary data, covering the era from 1948 to 2011 was acquired from Ghana's COCOBOD. The Effect of the mass spraying and Hi-technology programs were both abrupt and permanent. They are estimated (at 95% confidence level) to have had a significant increase. The similarity is that, both studies are into cocoa production with the difference in its application model. He had two interventional events while this study has only one. Our study continues to verify the trend and decomposition of the production sector but his work did not.

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Okyere (2015) studied the international market price for cocoa pricing modelling. The data was from Bank of Ghana on monthly price of cocoa in the international market from the year 2000 to the year 2014. He forecasted with one parameter estimator by using ARIMAX model parameter. He also compared the relative performance of the model parameter estimation with maximum likelihood and The Condition of Square Estimations. The simulation exercise found out that the validation of the method of one parameter estimator model was based on its predictive power. He concluded that any of the two methods can be adopted when one wants to estimate the model parameter because both are identical in parameter estimation.

Anderson, Remenyi, and Murray (2010) used Box –Jenkins modelling to assess the change in heart rate (HR) of ranging crossbred cows which received both programed audio cues and non - programed environmental cues. The programed audio cues were from the directional virtual fencing device. The fencing device was intended to regulate the animals' location on the landscape. The Polar Accuracy device was used to record HR in minutes. It started from 19 to 24 March, 2003. Three mature free range beef cows were formerly habituated to the virtual defense device and were confined to a brush- infested area of an arid rangeland enclosure. An electronic positioning system was used to detect each cow's location in minutes. It had 58 virtual paddock and in every second it penetrated a virtual boundary. The cows never escaped through, they penetrated a total of 26 times in 11 different events which received, programmed audio that has 30 cues to last from 1 to 56s. These data revealed that HR spikes from programmed audio cues fell within the textbook range of cow HR (40-186 beats per minute, bpm). From both audio and selected environmental events, HR spikes returned to pre-cuing "baseline" values in about one minute. However, the longest return time to baseline lasted (about 4 minutes) and this was for an environmental event. HR, animal location, for weather and other electronic data were measured at

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equally-spaced time intervals using a single time stamp so as to accurately associate HR changes with possible causes. The similarity is that both studies are in the agricultural sector with the difference in the application in the model. They had two interventional events while this study has only one. Our study continues to verify the trend and decomposition of the production sector but theirs did not.

Agyemang (2012) estimated and assessed the effect of the establishment and operations of the Community Policing Unit (CPU) of Ghana Police Community Policing Unit Service. Community Policing Unit serves as a major intervention in crime prevention and its control in Ghana. An ARIMAX interventional analysis was used in the modelling of the data. The interventional event actually had an effect of reducing crime in the region. There was an approximate reduction of 16 cases in every month. The effect was found to be statistically significant. The long-term effect was found to have an approximation reduction of 17 cases, which is virtually the same as the interventional effect. However, there was a statistically insignificant rate of decay of 0.0406 which reported a temporal nature of the duration of the effect. The study adopted a notion of interventional analysis by using time series models and their result is different from ours in particular because we exhibit the beauty of statistics by exploring the trend and the decomposition of the data. The similarity is that both studies have the application model. We both have only one interventional event.

Three Canadian provinces, precisely British Columbia (BC), Ontario (ON) and Quebec(QC) made rule to lessen drivers not to go beyond speed limits by offensive margins. The interventional event in this studies is the rule made by these three provinces. Gargoum examined the effects of this extreme speeding rule in Canada. ARIMAX time series and interventional analysis were used for analysing this data and the data used was collision data from statistical records. His studies found

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out that, in general, the policy has a significant drop of fatal collision in two of the three provinces (BC and ON) but the QC was not statistically significant. This means that the extreme speeding rule was effective in reducing wide fatal collisions in Canada indicating a general deterrence impact (Gargoum, 2015). The similarity is that both studies have the same modelling. His thesis has three interventional events while the current thesis has only one event. Our study continues to verify the trend and decomposition of the production sector but theirs did not study the trend and decomposition of their data.

On 17th February 2003, in Central London, there was an introduction of congestion charges that was aimed to reduce congestion. Noland, Quddus, and Ochieng (2007) weighed the impact of the congestion charge on traffic casualties in London and examined the impact on vulnerable road users. Box – Tiao interventional analysis has been applied in this study. The studies found out that there was a reduction in congestion, but it is not a statistically significant effect for total casualties in London. Despite the fact that both theses are in line with the same model for analysing the data, their thesis failed to study much into the trend of the data, but our study does it.

Jarret and Kyper (2011), demonstrated the usefulness of the ARIMAX – Intervention analysis as both an analytical and forecast tool. The data for the study was from the PACAP-CCR China Database, developed by the Pacif – Basin Capital Market Research Centre at the University of Rhode Island. The forecast indicated that there is a rapid drop in the value of the price index of Shanghai and of shares during the world economic debacle that started in China in the year 2008. It inferred that the stock price index contained an autoregressive component.

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The financial crises in the United States of America (U.S.A) have a great influence on the rest of the world of which China is not an exception. It led to the collapse of many manufacturing industries which reduced their export growth. Chung, Ip, and Chan (2009) in their studies modelled and analysed the effect of the financial crises on the manufacturing industry in China using data collected from the China Statistical Database of the National Bureau from March 2005 to November 2008. ARIMAX - Interventional model was used for this analysis. The result indicated that China manufacturing industry had a significant negative effect. It started from the year 2008 throughout 2009 and caused gross industrial output values to decrease continuously throughout. The interventional effect was temporary, but immediate and abrupt. This study used the same model for analysing their data, but the difference is that our data source is different. Their study did not consider the trend and decomposition of their manufacturing industry because it might be another topic of interest but this thesis does that.

Adubisi and Jolayemi (2015) estimated the impact of the financial crisis on Nigeria's crude oil export. Secondary data from Nigeria petroleum cooperation was obtained, it spun from the year 2002 to 2013. SARIMAX model with interventional analysis were used to analyze the data. They identified that the SARIMAX (0,1,1) $(\mathbf{0}, \mathbf{1}, \mathbf{1})_{12}$ model with the difference required at lag 1 and 12 to obtain stationary. The study revealed the full model was statistically at $p - value < 0.05$ significant and also 11.6 million barrels' reduction in crude oil export. This means that in its long run effect, the industry will have a reduction of 7.6 million barrels which was significant. The similarity is that both theses have interventional eventuated, but their model used Seasonal ARIMAX with white noise, but this thesis will use ARIMAX with white noise.

Also, Odame, Adebanji, and Kaka (2014) assessed the impact of women usage of maternal health care facility as a vital health issue with regards to well- being and survival of both the mother and

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her child on the policy made in April 2005 by the government of Ghana in pursuit of the Millennium Development Goal established the exemption fee Delivery Policy. This was followed by free maternal Healthcare policy (FMHCP) in July 2008 to help wrestle the high incidence of maternal mortality and replace the cash and carry health care system. They used interventional analysis of Box and Tiao, (1975), to assess the impact of these policies on monthly assisted childbirths. The findings showed that, the removal of financial barrier to seeking assisted childbirth resulted in a significant increase in the number of pregnant women seeking assisted delivery. This confirmed that the policy was a financial barrier, to difficulties associated with assisted delivery and these policies had contributed to a reduction in infant and maternal death.

Masukawa et al. (2014) investigated the bearing of Rotavirus vaccine on the hospitalization rate for acute diarrhoea in children younger than 5 years old after the intervention of the vaccine in 2006. The data were collected between the year 2000 and 2011 in 22 Regional Health Centres in Parana State, Brazil. The outcome of the vaccine was assessed by using SARIMAX - interventional analysis modelling. The findings showed that there was a reduction in the hospitalization of children due to diarrhoea cases. It was verified that there was a statistically significant reduction by the centre on hospitalization of children 1 year and younger, with averages of 47% and 50% respectively. The similarity is that both theses have interventional eventuated but their thesis uses Seasonal ARIMAX model whiles this one uses ARIMAX model and our study continues to know much about the series by knowing its trend and decomposition model.

Yendaw and Dayour (2014) demonstrated school feeding program to be the only social intervention program which was introduced to improve the educational standard of the rural communities in Ghana. The aim of the program was to measure the impact of the school feeding program on

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education in the Nyoglo community of Savlugu-Nantong district. It was concluded that there was no significant impact on education in the district. The Nyoglo community of the Savelugu-Nantong district had benefited from this social intervention since 2005, yet it had no systematic academic effect that existed looking at the effect of the school feeding program on attendance, enrollment and retention. According to Osei-Fosu (2011), there is a positive impact of the school feeding program on school enrollment, attendance and retention in Ghana.

Kamaludeen and Husein (2014) examined the effect of the school feeding program in the Ga South Municipality of the Greater Accra Region. The research revealed that there was a significant impact of such a program of education. This effect had a positive influence on enrolment, attendance and retention of children in the beneficiary Basic schools. The research has revealed some successes and failures of the GSFP. Prominent among the successes are moderate increase in enrolment, attendance and retention and increase in learning and cognitive ability of students and employment creation. The study recommended that policy makers should provide information that will translate into other educational policy frameworks that seek to achieve a better universal basic education in the long run. The aim to assess the impact of the school feeding program on education is one of the best studies of a researcher to assess the effect of the intervention of school feeding on our educational system but the methodology used for collecting and analysing the data was not the best approach. This is because education has been in the system before and after the intervention. The best data would have been recorded on enrolment to analyse the data and the best method would have been ARIMAX interventional analysis.

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McEwan (2010) examined the impact of school feeding programs which are popularly used, but with little knowledge about their effect on educational outcome. Chile operated one of the oldest and most expensive school feeding programs in Latin America, aiming at higher – calorie meals on the mainly public and index. This paper evaluated the impact of higher calorie meals on mainly public and rural schools and their students. It applied a regression – discontinuity design to administrative data, including school enrolment age, grade repetition, and fourth- grade test scores to prove that, there is no evidence, across a range of specifications and samples, that meals affect the variables.

Yang (2014) examines the rapid growth of online games by analysing the influence of new product releases on its revenue. ARIMAX with white noise interventional model and Elo rating method for the quality of the product were the models used in the methodology. They concluded that during the initial days after a new product release, the firm's daily revenue significantly increases. On the basis of quality measure, based on the rating method, determine the relative good prices based on good usage. This work serves a lot of important values for this research in terms of approach on the methodology aspect, but the only difference is that, it has two methodological approaches whiles our own has a single approach. He did not also study the trend and the decomposition of the online game but our own does.

Jennife, Hsien, and Liu (2010) used Autoregressive Integrated Moving Average (ARIMAX) with intervention model to assess the influence of different local, regional and global incidents of man – made, natural and health character in Taiwan over the last era. The events used in this study are the Asian financial crisis starting in mid1997, the September 21 earthquake in 1999, the September 11 the terrorist violence in 2001 and the outbreak of Serve Acute Respiratory Syndrome (SARS) in

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2003 Observed outcome discovered that the SARS lines had a significant impact, whereas the Asian economic crisis, the September 21 earthquake, and the September 11 terrorist attack exhibited no significant effect on air movements.

Catalanoa et al. (2015) studied an ongoing traffic management support for sustainability mobility of road vehicles in urban areas. They aimed to predict air pollution peaks (air quality forecasting). The Neural network and ARIMAX Model were used for the study. The result point out that, the prediction of extreme concentrations is best achieved by integrating the two models together.

The Neural network overtook the ARIMAX model in foreseeing peaks, but it provides a more realistic illustration of the concentration dependency upon wind characteristics. The neural network exploited to highlight the function forms and improve the ARIMAX model specification. At the end, the study shown that the ability to forecast on legal pollution limits can be enhanced by requiring traffic management actions when the predicted concentrations exceed a lower threshold than the normative one.

2.6 Summary of the Chapter

This chapter explored the history of the cocoa production sector globally. It stepped into Ghana before and after the interventional event of the political stability of the country. It also talked about the strengths and weaknesses of the related topics in this study. It continued with other related research works on cocoa production and that of the interventional related thesis.

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CHAPTR THREE

RESEARCH METHODOLOGY

3.1 Introduction

Box and Jenkins method for analyzing stationary univariate time series data will be employed in the study. The general ARIMA process to time series analysis are discussed. We will also discuss the impact analysis (intervention analysis) by transferring ARIMA function to ARIMAX. In addition, trend and decomposition model are discussed. The data for this study is an annual data from the Monitoring, Research and Evaluation Department of Ghana COCOBOD, spanning from the year 1968 to 2016 cocoa productions. The data covers all the cocoa production areas in Ghana.

3.2 Definition of Basic Concepts in Time Series

A time series data is described as a sequence of observation ordered by time parameters. The data can be discrete or continuous (Yaffee, 1999). The series should contain no missing observation. It is more necessary to know the type of data, its patterns (time series graph) and the appropriate model techniques to use.

3.2.1 Time Series Data

Time series data is a sequential measurement of a variable collected over equal space interval (ordered by time) (Sjö, 2011) . The unique feature of time series data is that; some aspect of past pattern will continue to remain in the future. Underlining models that form dependency is the key concept of time series (Rao, 2016). The data can be daily, weekly, monthly or annually. The drive of time series analysis has helped to understand the appropriate models for the stochastic process and forecast into the future by using the past values (Sjö, 2011). Box and Jenkins procedures are

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widely used to obtain the model specification, Model fitting and model diagnostics. In his procedure, the data should be stationary before the data model can be analysed.

3.2.2 Stationarity of the Data

Time series may be stationary or non-stationary. Stationary series are described with a kind of statistical equilibrium around a constant mean level as well as a constant dispersion around that mean level. There are seveal kinds of stationarity, but the mean, variance and auto covariance of the series should remain constant. When a data is non-stationary it determines to be differences or transformed with appropriate measures to make it stationary before it can be modelled.

3.2.3 Lag Operator

The lag operator, symbolized by *L*, is also used for much of this analysis. Box and Jenkins used a *B* to designate the same operator, called the backshift operator. The lag operator used on a variable at time *t* refers to the value of the same variable at time *t-1*. Using the lag operators facilitates the explanations of differencing.

3.2.4 The Difference Operator

The difference operator, del, is symbolized by the ∇. The first difference of the sample mean centered of the series y_t can be expressed as

$$v_t = \nabla y_t = y_t - y_{t-1} \qquad (3.1)$$

It is used to attain stationarity of a series; this can be done more than ones.

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3.3 Time Series Decomposition

This is one of the oldest vital methods used for forecasting in time series analysis (Ramasubramanian, 2012). In decomposition, a time series is described by using a multifactor model. The model consist of the following components: the trend component (T) in time series is the long-run generational movement caused by long-term conditions such as economic demographics, weather and technological movements. The Cyclical component (C) is an influence caused by the condition of economic demographic, weather and technological changes in an industry or economy. Currently, the cyclical and the trend are modelled together as a single component called trend-cyclical component because it is difficult to decompose a series into separate cyclical and trend components. The seasonal variation components (S) are as a result of the weather and human activities. The key to identifying the seasonal influence is either periodic or recurrent. The I represents the residual component of the series that is not explained by T, C and S.These errors are caused by an irregular events such as unusual weather condition, earthquake and all unexplained variations in the time series which are not predictable.

There are two types of decomposition models: an additive and a multiplicative model. These are presented below:

$$Y_t = T_t + C_t + S_t + I_t \qquad (3.2)$$

$$Y_t = T_t * C_t * S_t * I_t \qquad (3.3)$$

Equation (3.2) represents the additive model which is of the sum of the four components whiles equation two represents the multiplicative model which is the multiples of the components.

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3.3.1 Some Components of a Series

In many time series, movement can recognize changes more gradually than other motion. These gradual changes are described as trend and cycles. The transitory nature is called fluctuations. In some cases, the trend is regarded as an accumulated effect of fluctuation but others feel that the trend and fluctuation represent different sorts of influence. Time series can decompose into a variety of components, some or all of which may be present in a particular instance. The variations in terms of pattern classifications are into some components such as trend, seasonal variation, cyclic movement and irregular fluctuations (Ramasubramanian, 2012). If $\{Y_t\}$ is a sequence of variety of component, then its basic element is liable to be expressed as $Y_t = f(T, C, S, I)$, where $f =$ mathematical function, T= trend component,

C = cyclical component, S= seasonal component and I= Irregularity component.

3.3.2 Trend

Trend, whether deterministic or stochastic have to be considered for extracting, fitting and forecasting on the type of data pattern. Graph of the actual data helps in determining the patterns. A trend represents a well- defined formula for increment or decrement as a function characterized in a series. Trends are extracted in two ways either by Filter method, which nullify all the components that are not regarded as trends and the other way, is by fitting the function which is capable of adapting itself to whatever form the trend happens to display. Once its analytical function is extracted, it is used to extrapolate the forecast trend. Stochastic trend would be used, since cocoa production data is a stochastic time series. It results from the accumulation of small fluctuations, which are unsystematic. The simplest model that represents a stochastic trend is the random walk, which has white noise of a mean of zero, and a constant variance. The best alternative to reduce a random walk in stochastic process is by differencing or transforming (Agyemang, 2012). A trend

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can be linear or nonlinear. Whenever a series is trending, it is believed that, the trend will continue into the future, all other things being equal. Then trend model can be used to forecast future values. Regression may be used to test and model a trend, one has to plot the series against time. A trend appears to be linear or quadratic or exponential. In this study we will determine to know the trend of our cocoa production sector.

3.3.3 Seasonal Patterns

A seasonal series result from events that are periodic and recurrent. These short-term movements are influenced by both artificial and natural phenomena causes which can last for four years. The seasonal period can be days, months and years. For instance, there are high volumes of cocoa production in the main crop season (October to December) of the year than the minor crop season (January to May). Seasonal adjustment is the best used to remove seasonal patterns.

3.3.4 Cyclic Patterns

Business and Economic expansion (increase in demand) and contraction (depression and recessions) are the main causes of cyclical influence of a series. In most of the times, the period is unknown but it often lasts for two to five years. The cyclical movements are difficult to forecast because of it being recurrent but not periodic. The cyclical component can be viewed as those fluctuations in a time series, which are longer than a given threshold, but shorter than can be attributed to the trend.

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3.3.5 Irregular Fluctuations

These components are because of the many influences that act independently to yield non-systematic and non-repetitive patterns about some average values. It has a constant mean and no repetition patterns. This pattern remains after seasonal and trend patterns of a time series have been removed. In a highly irregular series, these suddenly changing occurrences can dominate the trend and seasonal patterns. This variant is also known as a residual or random component. These variations though accidental in nature, can cause a continuous change in the trend, seasonal and cyclic movement during the forthcoming period.

3.4 Autocorrelation Patterns

Another pattern often seen in time series is autocorrelation function, it measures the association of dependency between the variables in the same series. It is a standardization of auto covariance function. There can be an existing of positive, negative or no autocorrelation patterns between the variables in the same series. Autocorrelation patterns can be influenced by outliers, trends and or seasonality effects.

3.4.1 Partial Autocorrelation Pattern

The Partial Autocorrelation Pattern is another analytical function that serves as a fundamental tool of Box-Jenkins time series analysis. The Partial Autocorrelation Pattern is used in collaboration with the autocorrelation function to distinguish between a first order and a higher order autoregressive process. Partial autocorrelation works in much the same way as a Partial correlation. The partial autocorrelation pattern controls for the confounding autocorrelation in the intermediate lags when working at k lags with the effect to partial out those autocorrelation, leaving only the autocorrelation between the current and the kth observation.

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3.4.2 Intervention Patterns

Most often, the patterns of the past data reflect some planned events (price promotion) or unplanned events (earthquake). When such issues occur, its effect should be modeled so that their future impact can be anticipated. Intervention event is caused by natural or artificial activities

3.5 Univariate ARIMA Model Process

Univariate data are time series with one observation, it views the series as a function of its own past, time and random shocks (Agyemang, 2012). Annual data on cocoa production in Ghana displayed in Appendix A is a typical example. The ARIMAX technique is the model used to analyze the observed pattern of the series (Box &Tiao, 1975). The procedure used to build the model for this study is Box - Jenkins procedure, it was named after the statisticians George Box and Jenkins. They applied the combination of AR (autoregressive) and MA (moving average) models or (ARIMA) model to find a best fit time series model of its past value in a time series model based on minimizing some information criterion. This methodology comprises five stages; checking for stationary or non-stationary, identification of suitable ARIMA model, estimating parameters of the chosen model, diagnostic check for the model adequacy and forecasting (Maurice, 2012).

3.5.1 Testing for Stationarity of the Time Series

Stationary series are categorize by some kind of statistical equilibrium around a constant mean level as well as constant dispersion around that mean level. A series is said to be stationary if it has a fixed mean, a constant variance and if possible a constant autocovariance structure (Rao, 2016). Stationarity of a data is necessary in time series analysis. For instance, a time series y_t, $t = 1, \dots, T$ is called covariance stationary if

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1. Mean; E $[y_t] = \mu$, for all t,
2. Variance ; Var $[y_t] = \gamma_k$, for all t,
3. Covariance ; Cov $[y_t, y_{t-k}] = \gamma_0 (< \infty)$, for all t.

When the data is non-stationary, it is necessary to transform the series into stationary. A series could be non-stationary because is of random walk process, drift or trend. The test used in this study to determine whether the data is stationary or non-stationary is Augmented Dickey-Fuller (ADF) test. If the data is non-stationary, then there exists a unit root in the data. Non-stationary data calls for the need of differencing, taking the logarithm or necessarily fitting some curve and model the residue of the data (Agyemang, 2012). This process is repeated until the data exhibits no apparent deviations from the stationary. The number of times of differencing of the data is indicated by the parameter *d*.

3.5.2 Autoregressive (AR) Model Process

In the Autoregressive (AR) model process, the value of the series at a current period is a function of its direct previous values plus some error from the same data. The current value can also be a function of its past value at different lag plus some error. The Autoregressive relation is represented as follows;

$$y_t = c + by_{t-1} + \cdots + by_{t-k} + \varepsilon_t , \qquad (3.4)$$

where y_t is the dependent variable ε_t is the white noise iid $(0,\sigma^2)$ and (c and b) are constant. The linear dependence of the present value of the series depends not only on ε_{t-1} , but can also be on the pervious p lags. Thus, an autoregressive process of order *k* can obtained. The property mean of the AR process is a linear function of all its innovation.

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3.5.3 Moving Average (MA) Model Process

In time series data generating process, there is a constant time ordering to the data. The values of the data are equally spaced over time. This process may take several forms; it may involve shocks, innovation or error that drives the time order of the stochastic series. The previous period, plus a shock at a current time *t* drives the series to yield an output value of y_t.

$$Y_t = e_t - \theta_1 e_{t-1} \qquad (3.5)$$

Where Y_t is the dependent variable, e_t is the error tem iid $(0,\sigma^2)$ and c is the constant.

3.5.4 ARIMA Model

Another data-generation mechanism that may be at work is a combination of the autoregressive and moving average processes. They are characterized as ARMA process. The process where non-stationary series of the ARMA process undergoes differencing (integration) before the data becomes stationary is known as ARIMA processes. Correlogram review the two analytical tools, the sample autocorrelation and partial autocorrelation to be theoretically defined and derived. Their significant tests employ other basic analytical techniques that allow identification of the type.

3.5.5 Autocorrelation Function and Partial Autocorrelation Function

The coefficient of association between two variables in a time series is an autocorrelation function (ACF). It measures the linear relationship between observations in time series data in AR (p) and MA (q) processes, and it also measures the association between the current value and the previous value, which filter out the linear stimulus of the random variable that lie in between the required transformation of the data. If the parameter is positive, then, there exists always a positive value for the linear dependence between the present values and that of the past values with even lags, but if the parameter is negative then, there is always the existence of negative values of dependence between them with odd lags. It depends on the spike at its lag. The parameter of the model is often

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selected based on information criteria such as Akaike Information Criterion and Bayesian Information Criterion. These can, lead to different conclusions in the ARIMA (p, d, q) model (Durka & Pastorekova ,2012). After altering the data into a stationary time series by differencing, the ARIMA (*p, d, q*) model can be reserved as ARMA (*p, q*), it mergers the autoregressive and moving average. Generally, the ARMA (*p, q*) model can be uttered as follows

$$X_t - \emptyset_1 X_{t-1} - \cdots - \emptyset_0 X_{t-p} = Z_t + \theta_1 Z_{t-1} + \cdots + \theta_q Z_{t-q} \qquad (3.6)$$

Where $\emptyset_i$ are the bounds of the autoregressive portion of the model and θ_i are the bound of the moving average portion.

It is more appropriate to use the brief form

$$\emptyset\ (L)\ X_t = \theta Z_t \qquad (3.7)$$

Where $\phi(.)$ and $\theta(.)$ are the *p*th and *q*th degree polynomials

$$\emptyset(Z) = 1 - \emptyset_1 Z - \cdots - \emptyset_p Z^p \qquad (3.8)$$

In addition, where L is the lag operator, X_t is said to be an autoregressive process of order *p* and Z_t is the moving average process of order *q* (Okyere, 2015)

3.5.6 Model Identification

At the identification stage, the historical data of interest are statistically analyzed and an appropriate subclass model of the general ARIMA process (*p, d, q*) family is selected. The approach is summarized as follows:

The first step is to test for stationary of the data. To determine whether the data is stationary or non-stationary is Augmented Dickey-Fuller (ADF) test. If the data are non-stationary, then there exists a unit root in the data. Non-stationary data calls for the need of differencing, taking the logarithm

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or necessarily fitting some curve and model the residue of the data (Agyemang, 2012). This process is repeated until the data exhibits no apparent deviations from stationary. The number of times of differencing the data is indicated by the autoregressive and moving average order (*p, q*). The basic tools for model identification are the graphs of estimated Autocorrelation and the estimated Partial Autocorrelation obtained from the series.

For AR (*p*) process, the sample autocorrelation function should have an exponential decreasing appearance, however, in higher – order AR process the sample needs to be supplemented with the partial autocorrelation plot. The partial autocorrelation of an AR (*p*) process becomes zero (0) at lag (*p+1*) and greater. We examine the sample partial autocorrelation function if it departed from zero (0). This usually is determined by 95% confidence interval on the partial autocorrelation plot, but with software program, it is approximately $\pm 2/\sqrt{N}$ with N being the sample size.

The autocorrelation function of AR (*p*) process becomes zero (0) at lag q+1. When its greater we examine the sample autocorrelation function to see that it becomes zero. We do this by placing 95% confidence interval for the sample autocorrelation function on the autocorrelation plot.

3.5.7 Model Estimation

After identifying the tentative form of the model, AR and MA parameters are estimated using the maximum likelihood estimation method. The idea of the maximum likelihood estimator is to determine the parameters that maximize the probability of the sample data (Okyere, 2015). The confirmation of the ACF and PACF is done through justification of the three penalty function statistics. The penalty function statistics are Akaike Information Criterion (AIC), Bayesian Information criterion (BIC) and Akaike Information Criterion, which is based on principle of parsimony AICc. The statistics were one of the various checks used to verify the acceptability of

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the models. The model with the smallest adequacy (AIC or BIC) is deemed to have a residual which resembles a white noise process.

In the ARIMA model, the AIC function can be well-defined as follows:

$$AIC = -2log(L)+2(p+q) \quad (3.9)$$

Where L, shows the likelihood of the information with a certain model, *q*, *p* indicating the lag order of AR and MA terms respectively. The BIC function can be uttered as follows in ARIMA model:

$$BIC = -2\ log\ (L) + (p+q)\ log\ T \quad (3.10)$$

Where the T shows the number of observations in the stationary time series, L specifies the likelihood of the data from a certain model, *q*, and *p* indicates the lag order of AR term and the MA term respectively. The lower the AIC and the BIC the better the fit and has fewer independent variables.

Each parameter estimator reports its standard error for that particular parameter. Using the parameter estimator and its standard error, a test for that statistical significance (t - value) are then conducted., the absolute value of the t- ratio is expected to be greater than 1.96 or 2 in order for the parameter to be maintained in the model whereas parameters which are not significant are trimmed or removed from the model. The estimated AR and MA parameters must also conform to certain boundary conditions, that is, they must lie between-1 and 1. If the AR and MA parameters do not lie within those bounds of stationarity, then the parameters of the model are re- estimated or if possible, a different model is alternatively considered for estimation. All these checks when strictly adhered would lead to obtaining reliable results from the model (Agyemang, 2012).

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3.5.8 Model Diagnostics

The next most important factor to consider after estimating the model parameters is the model diagnostics, to check whether the fitted model follows a white noise process or not. The process is done by using the autocorrelation value at a time to develop a standard error formula to test whether is r_k Significantly different from zero and the coefficient of the autocorrelation of the series must be randomly must be zero. The ACF coefficient of white noise data is said to have a sampling distribution that can be approximated by a normal curve with mean zero, and standard error $1/\sqrt{N}$ where N gives the number of data points in the observed series. All the sample autocorrelation values must lie within a range of 95% mean of plus or minus 1.96 standard error range. If this condition does not hold, then the model fitted does not follow a white noise process, or the residual are not white noise. The correlogram of the ACF would therefore show lines at the critical values of plus or minus $1.96\sqrt{N}$ for easy identification.

Breusch-Godfrey LM and Ljung Box (1978) is a modified version of portmanteau test statistics developed to test whether the model residuals have a mean of zero, constant variance and serially uncorrelated. Their test – statistic is closer to the chi square distribution rather than an earlier portmanteau test statistic proposed by and pierce. The residual has a mean of zero and constant variance. It tests was used to test the adequacy of test of autocorrelation in the residuals.

It is important to check whether the residuals of the model adopted are normally distributed with constant variance and a mean of zero. A residual plot of a histogram and a normal probability graph can be used to confer normality on the series under consideration. The hypothesis test is given as:

H_0: There is no serial autocorrelation in the residuals

H_1: There is serial autocorrelation in the residuals

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The test is deemed significant if the report p- value is less than 0.05, else it is not significant. In all, if a candidate model violates these assumptions at the diagnostic stage, the analyst is advised to restart the Box- Jenkins process of identification, estimation and diagnostic checking and continues in that cycle until a plausible is obtained.

3.6 Transfer Function of Univariate ARIMA Model

The ARIMA model established by Box and Jenkins (1976) has become popular due to its advantages of influence and flexibility (Pankratz, 1983). The general transfer function of ARIMA is of the following form:

$Y_t = \Sigma[\omega\ (B)\ \delta\ (B)]B^b\ X_t + [\theta\ (B)\ \varphi\ (B)]\varepsilon_t$, (3.11) where $Y_t\ and\ X_t$ are the output and input series respectively, b is the time delay,

$\omega\ (B)\ \delta\ (B)$ is the polynomial of the transfer function and $[\theta\ (B)\ \varphi\ (B)]\varepsilon_t$ is the noise model.

3.7 Intervention Event

The study of impact response has shifted our interest from just examining the univariate history of the series, but examining the multiple times - dependent within the series. With this, the researcher assesses the response in a series to a discrete event or intervention events. The system in which the input event and the impact response take place is assumed to be closed. Apart from the noise itself, the only exogenous impact on the series is presumed to be the event. The time of onset, duration and termination of the input event have to be identified because is a deterministic phenomenon. The impact generating the events can be modeled by indicator variables $f(I_t)$.

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3.7.1 Intervention Indicators

$f(I_t)$ is a function of a deterministic (dummy) intervention indicator. There can be more than one intervention and that all of the intervention indicators are ultimately included. The indicator is an exogenous variable whose discrete coding represent the presence or absence of an input event. If the intervention function is a step function, then the value of $f(I_t)$ is 0 until the event begins at time T. At the onset of the event the intervention function $f(I_t)$ is equal to 1. The intervention remains at 1 for the duration of the presence of the event as can be seen below the

$$f(I_t) = S(t) = \begin{cases} 0, & when \quad t < T \\ 1, & when\ t \geq T \end{cases} \qquad (3.12)$$

where $S(t)$ = step function.

If $f(I_t)$ is a pulse function, then a different condition obtains. Prior to the event, the intervention indicator is coded as zero. At the instance of onset, the intervention function is coded as 1. It remains one for the duration of the presence of the event, which in the case of a conventional pulse is the only one-time period, or in the case of an extended pulse, the period spanned by the duration of the event. A pulse function is shown below

$$f(I_t) = P(t) = \begin{cases} 0, & when \quad t < T \\ 1, & when\ t \geq T \end{cases} \qquad (3.13)$$

The step and convention all pulse functions are input variables. They are interrelated. Actually, the pulse function is merely a transformed step function. The pulse function is a differenced step function

$$P_{(t)} = (1 - L)S_{(t)} \qquad (3.14)$$

3.7.2 The Intervention (Impulse Response) Function

Changes in the level or shape of a series at the time of the impact of an input indicator are presumed to be responses to the intervention. For this reason, it is important to appreciate the general structure

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of an intervention function over time. One function will be considered at a time. The structure of the intervention function determines the shape of the impact over time of the series under consideration. The dependent series responds in a particular form because it is dependent on the intervention input. The response function is characterized according to whether it is one of a step or a pulse. A step function is generally formulated as

$$f(I_t) = S\,(t) = \frac{\omega\,(L) I_{t-b}}{1-\delta_1 L}, \qquad (3.15)$$

where $\omega\,(L) = \omega_0 - \omega_1 L - \omega_2 L^2 - \cdots - \omega_s L^b$.

Whereas a simple intervention function is formulated as

$$f(I_t) = P(t) = \frac{\omega_t\,(L)\, I_{t-b}\,(1-L)}{1-\delta_1 L}. \qquad (3.16)$$

To define and explain the operation of the impulse response function $f(I_t)$ the components of the numerator of a simple step function, called a zero order function, will be addressed as

$$f(I_t) = S(\mathrm{t})\,\omega_0 I_{t-b}\,. \qquad (3.17)$$

3.7.3 Simple step functions Abrupt Onset Permanent Duration

The input event in the step function represents a permanent change in response. When the denominator of the step function reduced to unity, what remains is the simple step function equation in (3.16). The regression of coefficient of the intervention ω_0 , represent some lost or gain. The intervention indicator variable I_{t-b}, which some call the absence or presence of the intervention and the time delay involves for the impact too take effect, the subscript b. We can observe the nature of the step function of the change in the level of the series at the time of onset of the event. A positive $\omega_0$would indicate a rise in the level of the series at the time of impact of the intervention. Negative ω_0 would indicate the size of rise or drop in the level. Therefore, one could respectively the magnitude of this regression effect and its variance by

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$$\widehat{\omega} = \frac{\sum_T Y_t I_t}{\sum_T Y_t^2} \quad (3.18)$$

$$\text{Var}(\widehat{\omega}) = \frac{\sigma_t^2}{\sum_T Y_t^2} \quad (3.19)$$

A distinction can be drawn between the time of the incident of the intervention and the time of the response variable, Y_t, the *b* index in the *t-b* subscript of the intervention indicator values

3.7.4 First order step function permanent duration and decay

The first order step function can elaborated as a ratio that includes a numerator such as that already described as well as a denominator that includes a single rate (decay parameter). The single rate parameter $\delta_1$is part of the response function is equal to the number of rate parameters in the denominator.

$$S(t) = f(I_t) = \frac{\omega_0 I_{t-b}}{1-\delta_1 L} \quad (3.20)$$

Where I_t is an intervention that is expressed as follows:

$$I_t = \begin{cases} 1, t=T \\ 0, t \neq T \end{cases} \quad (3.21)$$

In this instance the intervention input begins in 1992$(t=T)$ where, it veiled as 1 , and remains 1 in the entire period. In this study the political stability is a step function and is therefore with regard to the intervening event as formulated as; $Y_t = c + \omega_t I_t + \frac{\theta(L)}{\phi(L)}\varepsilon_t$ where $I_t = S_t^{(1992)} =$

$$\begin{cases} 1, & t > 0 \\ 0, & otherwise \end{cases}$$

where *c* is a constant and Y_t is the level of change with respect to gain or loss made in the value of the reduction. The intervention variable I_t is a step function, which corresponds to the political stability governance.

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3.7.5 Significance Tests for Impulse Response Functions

Most statistical packages employ standard t- tests, in which the parameter is divided by its asymptotic standard error, to test for the statistical significance of the parameters. R-Software employ the test to evaluate the parameter significance. The likelihood ratio test is used for assessing the statistical significance of the response function.

3.8 Interventional Analysis Model

There are two basic modeling strategies used in the intervention analysis thus the formal or preferred approach and the conventional approach. This study will use the former approach. The specific modeling technique used in this study is the Intervention Analysis approach by Box and Tiao in 1975. The model provides a prior justification for the inclusion of influence (external information) that affects the dependent variables by changing the mean function of the data of interest. It is used to model special case of ARIMA transfer model and intervention event (Anderson, Remenyi, & Murray, 2010). In this study, the intervention event is the occurrence of political stability (the year 1992) on cocoa production. The general model is as follows:

$$Y_t = N_t + \omega_t I_t + \frac{\theta(L)}{\phi(L)}\varepsilon_t \qquad (3.22)$$

Where, Y_t is the intervention model, the intervention function is designated by $\omega_t I_t + \frac{\theta(L)}{\phi(L)}\varepsilon_t$ and N_t is modeled as some ARIMA process with white nose.

3.9 Assumptions of Intervention Models

The assumptions of the interventional analysis model fulfill the following:

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a. Observations should be enough: The analyst must have a vital notion of the time of onset, pre intervention series, the intervention input and the observed impact of the post intervention series. More observation should be enough in order to model the ARIMA modeling with the pre intervention series.

b. ARIMA model building: With an ARIMA building protocols, stationary, identifies, estimates and diagnoses of the optimal noise model are estimated and observed. The white noise model remains stable throughout the analysis.

c. Assessment of the impact. The impact nature must be assessed, followed the hypothesis is formulated. The first impact is indicted by the regression coefficient. Depending on the indicator either a pulse or step function has an effect on the mean function of the series.

3.10 Procedures of Full Model Development

The model valuation of ARIMA involves the succeeding of these three stages:

1. Unit root examination and identifications of the order of difference: this test leap is necessary to lessen the time-series data and analyze the residual. The Augmented Dickey-Fuller (ADF) test is often employed for the analysis of the unit root, where the null hypotheses are that the input series have a unit root.

2. Estimation and diagnosis of the parameters: transfer functions are used for estimating the parameters q and p. The autocorrelation function (ACF), partial autocorrelation function (PACF) and cross-autocorrelation function (CACF) are significant to estimate the parameters of a transfer function, while statistical events certainly provide statistical indication to sustain the fortitude of an apt transfer function. Normally, white noise diagnostic check is founded by the ACF and PACF of the residual and is usually used for residual analysis.

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3.10.1 Estimation and Diagnostic Check for the Impact Assessment

The maximum likelihood estimation method is most preferred in estimating the intervention parameters. The estimated parameters are the impact(ω_0) and the decay (δ) (Agyemang, 2012). The period of decay indicates the effect on the interventional after the event occurs usually deduced from the spikes of the time plot. The intervention parameter as well as that of residual can be estimated for $\frac{\sum_T Y_t I_t}{\sum_T Y_t^2}$ would apparently show the size of upsurge and drip in the level of the response series. Also, the delta (δ) parameter associated with the gradual, temporary and the gradual permanent effects estimates the adjustment, subsequent to the change (permanently). Moreover, the estimated effect of the parameter should imitate what is well known and observed around the effect of the intervention event.

Diagnostic drafts on the significance of the conjectured parameters and the performance of the residuals are shown on the tentative model. A t-test statistic is used to plaid the significance of all parameters testified from the estimated impact model. The investigation of the white noise procedure should confirm whether it trails a white noise procedure or else when the residuals are tested to be white noise, then the capability of the influence or intervention model will be known.

3.11 Types of Interventions

There are two types of interventions: the pulse dummy function, which is of temporary event, and the step function, which is for a characteristic of a permanent change. The Transfer function model can be extended to interventional analysis with the variable (**δ**). The response of the dependent variable to such an intervention will depend on the three dynamics modeling, which the political

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stability as intervention affect (δ_t) cocoa production (y_t) through a change in parameters (ω_t).For a permanent change in the intervention, the growth path of production. For instance, Figure 2 shows the diagram type of intervention event for both temporal (pulse function), and permanent (step function). Diagram A, B and C indicate a pulse function with a gradual change from the mean function that happened at a point and returned to its baseline or initial state. Diagram D and F indicate a step function that had the gradual change in the mean function and continued without returning to the baseline.

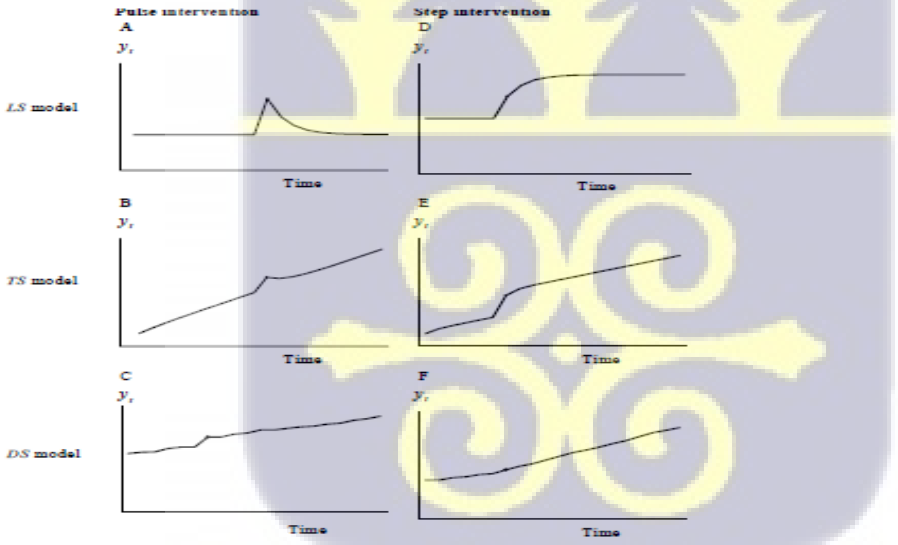

Figure 2. Types of Interventions

There can be one than one type of intervention event in a series.

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3.12 Universal Analysis of Intervention series

A flow chart in the figure below, displays the intervention modeling procedure for intervention series. The initial stage of intervention modeling is to have a substantive basis that can ratify an existence of an intervention event known at time *T*. It should not be a blind search for possibility events. There should be an existing date of the event. It is necessary to know the number of times intervention occurred. Is the intervention function a pulse function or a step function? Different interventions can occur at the same time, which needs critical attention before you can think of estimating the impact of it. Moreover, you continue to estimate the impact of the known and observed impact of the interventional event on the research question or the purpose of the forecast. Formally, null hypothesis should be that, an occurrence caused a change in the mean of the time series at a point *t*, and then the appropriate tests should be performed using t - test or the F-test on the relationship. The essential step is when an important verdict made, based on the interventional analysis.

Next step, is to model the time series without that impact. This means, modeling the pre intervention series because most often the intervention effect is so large that it distorts the ACFs and the PACFs of the full series and is represented as N_t which is the ARIMA white noise model that exists in the series. All the assumptions of ARIMA noise with parameter estimation and diagnostic checks are satisfied after a good ARIMA (p, d, q) model has been verified together.

A full model is fitted thus the ARIMAX (p, d, q) plus the intervention function. Diagnostic check is examined on the full model whether it is significant or not. The residuals are investigated to confirm whether the trails follow white noise procedures. If the residual is tested to be white noise,

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then the capability of the influence or intervention model will be known. The figure below best explains as follows,

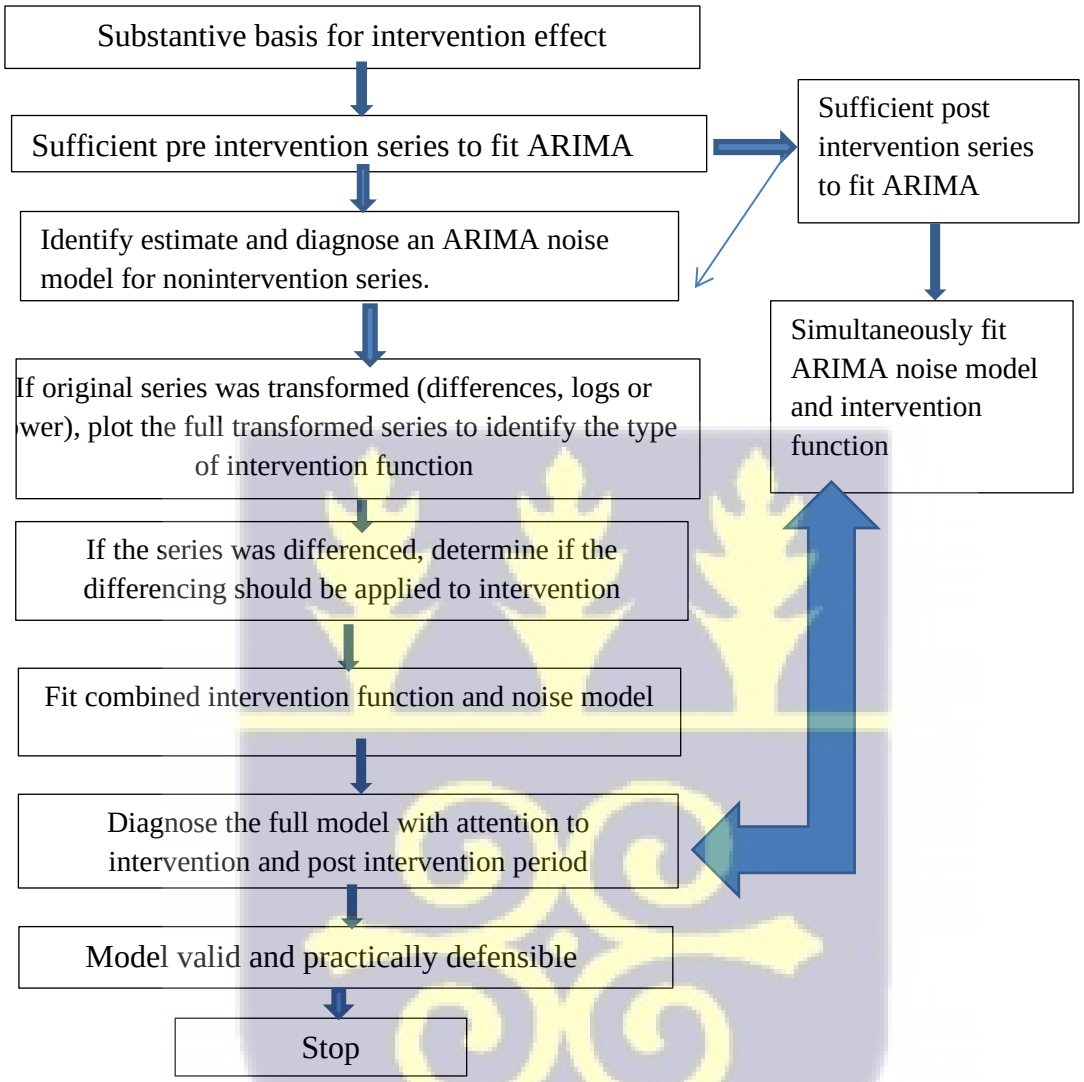

Figure 3. A digrammatic illustration of Interventin Modelling Proces

Source: Author

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3.13 Chapter Summary

In summary, this chapter presented a stochastic time series intervention analysis model in the growth of Ghana cocoa production industry through the use of a powerful methodology for measuring the impact of political Stability governance on cocoa production in Ghana. The date of the intervention is more necessary, followed by a satisfactory observation to identify the ARIMA noise model followed by the Box and Tiao intervention analysis model. A Sufficient ARIMAX model with a step function of the post intervention observations will be used to identify the type of intervention effect. This chapter continued to find the trend analysis, whether it is linear, quadratic or exponential. It explored the decomposition of the production, whether it is additive or multiplicative model.

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CHAPTER FOUR

DATA ANALYSIS

4.1 Introduction

This chapter presents the analysis and extraction of information from the patterns of cocoa production and makes inferences based on this information to produce a sound conclusion and recommendation. The analysis is in three folds: to study the appropriate time series Trend, the Decomposition models and to predict the Impact of Political Stability on Cocoa Production using Interventional analysis model. The data is an annual time series obtained from Ghana cocoa production sector, spanning from the year 1968 to the year 2016, is displayed in Appendix A.

4.2 Time Series Plot of the Data

Time series plots display dataset on the y- axis against its equal space on the x- axis. In this study, is used to evaluate the patterns and behavior of cocoa production over a given time. The data is an annual time series obtained from Ghana cocoa production sector, spanning from the year 1968 to the year 2016. The Figure 4 below shoa time series plot for cocoa production from the year 1968 to the year 2016.

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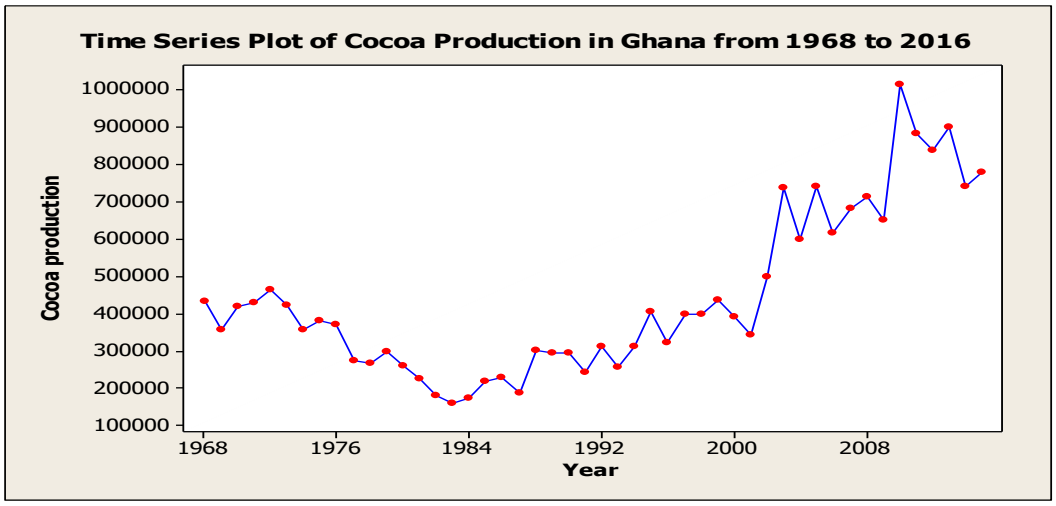

Figure 4. Time Series plot for cocoa production in Ghana

The Figure 4 reveals that, Ghana cocoa production recorded the highest yield of 1,012,839 (metric tons) in the year 2011 whiles the smallest yield of 158,886 (metric tons) was recorded in 1984. The production yield was not constant; it varied from year to year with no extreme outliers. There was a significant decrease in trend in the average from 1969 to 1984 and consequently experienced an increasing trend thereafter.

4.3 Time Series Decomposition of Cocoa production in Ghana

Another objective of the study is to identify the decomposition models of the data. The types of models fitted were the models containing only seasonal and irregular components whiles the others comprised of trend, seasonal and irregular components. The Table 1 below shows the prediction of all the fitted decomposition models.

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Table 1. Time series Decomposition models

Decomposition model	MAPE	MAE	MSE
Additive(Trend, Seasonal &Irregular components)	38.2	1.33×10^{5}	2.36×10^{10}
Multiplicative(Trend, Seasonal & Irregular components)	38.3	1.33×10^{5}	2.38×10^{10}
Additive(Seasonal & Irregular components only)	47.4	1.75×10^{5}	4.67×10^{10}
Multiplicative(Seasonal & Irregular only)	47.6	1.77×10^{5}	4.66×10^{10}

The fitted decomposition models in Table 1 above indicate the entire model. It can be observed that, the Additive model with trend, seasonal and irregular components is the most appropriate time series model since it produced the least prediction errors relative to the others.

Thus, the Additive model $Y_t = Trend + Seasonal + Irregular$

$$\hat{Y}_t = 172572 + 1094\,t$$

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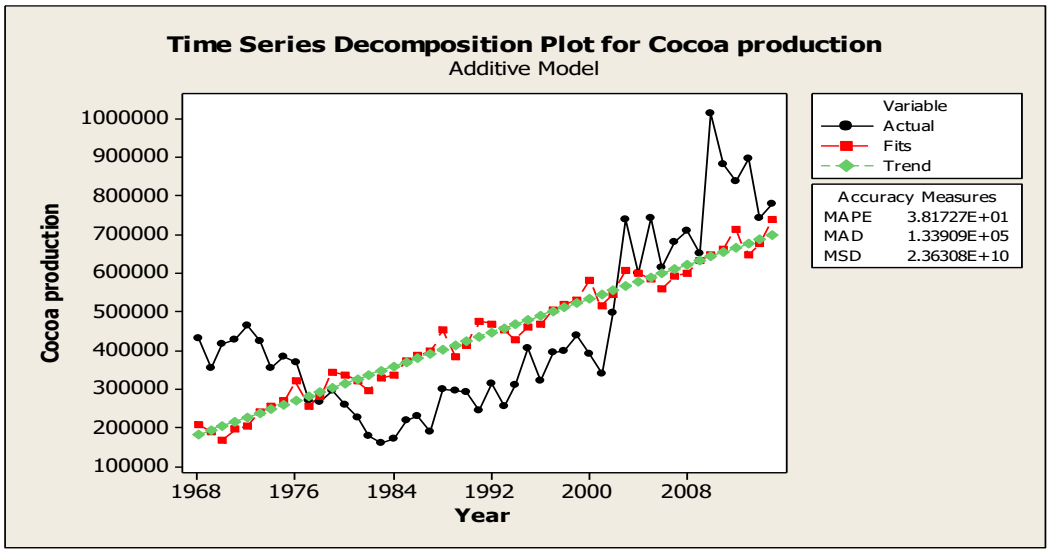

Figure 5. Additive Time Series Decomposition for Cocoa Production

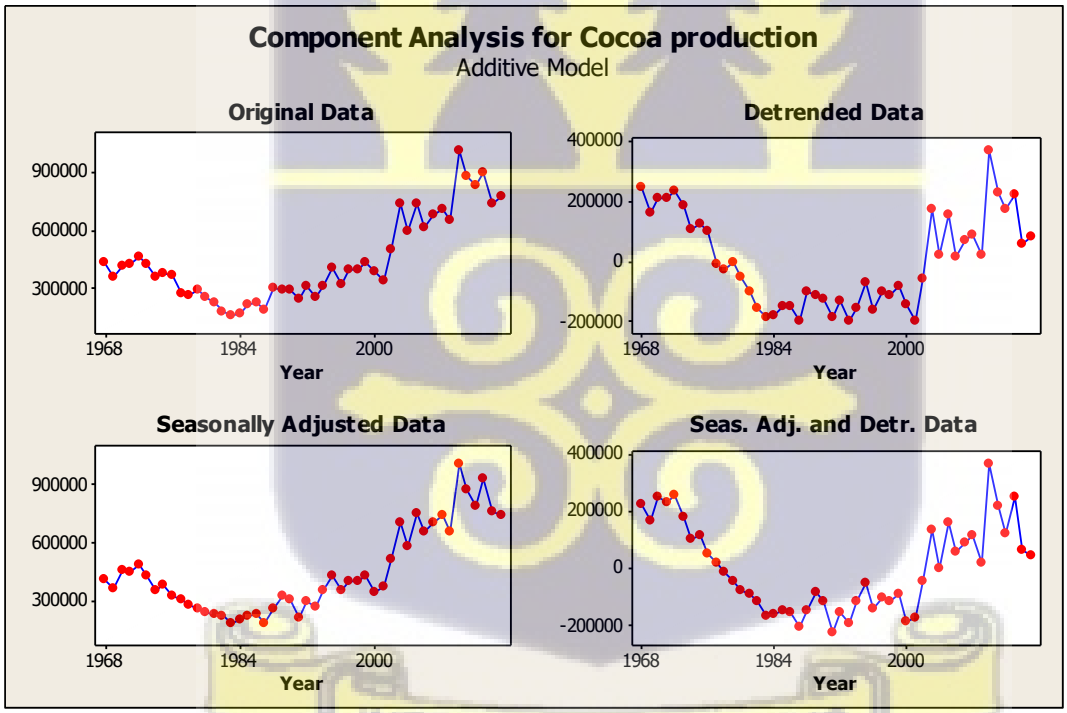

Figure 6. Composition Analysis for Cocoa production in Ghana

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4.4 Trend Analysis of Cocoa Production in Ghana

One of the objectives of this study was to identify the appropriate trend model over the years from 1968 to 2016 for cocoa production in Ghana. Even though production yield was not constant, the trend models considered were the Linear, Quadratic and Exponential trend due to their low forecast errors relatively as opposed to other models. For the purpose of this study, the Mean Absolute Percentage Error (MAPE) was used since it is more robust to the Mean Absolute Error (MAE) and the Mean Squared Error (MSE). Table 2 presents a summary of the predicting errors from the fitted trend models.

Table 2: Prediction Errors of the fitted Trend Model

Trend Analysis	MAPE	MAE	MSE
Linear	38.6	1.35×10^{5}	2.36×10^{10}
Quadratic	15.0	5.79×10^{4}	6.68×10^{9}
Exponential	32.3	1.23×10^{5}	2.11×10^{10}

Below is the fitted Quadratic trend model;

$$\hat{Y}_t = 478763 - 26074t + 758.3t^2 \qquad (4.1)$$

Below is a combined residual plot of the appropriate Quadratic model.

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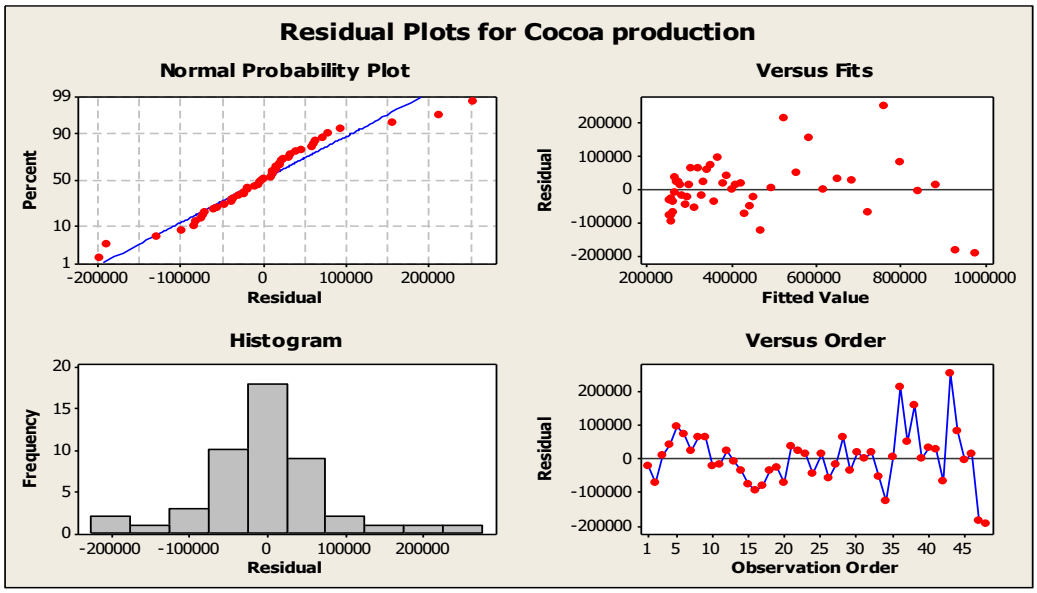

Figure 7. Rsidual plot of the Quadratic trend model

4.5 Comparing Production across Instability and Stability Regimes

It can be asserted from Figure 1 that, the cocoa production declined in values during Political Instability regime (1968 to 1991) as opposed to the average increasing trend in the production of cocoa during the Political Stability regime (1992 to 2016). Figure 8 and Figure 9 below indicate time series plots of cocoa production during political instability and political stability regimes respectively:

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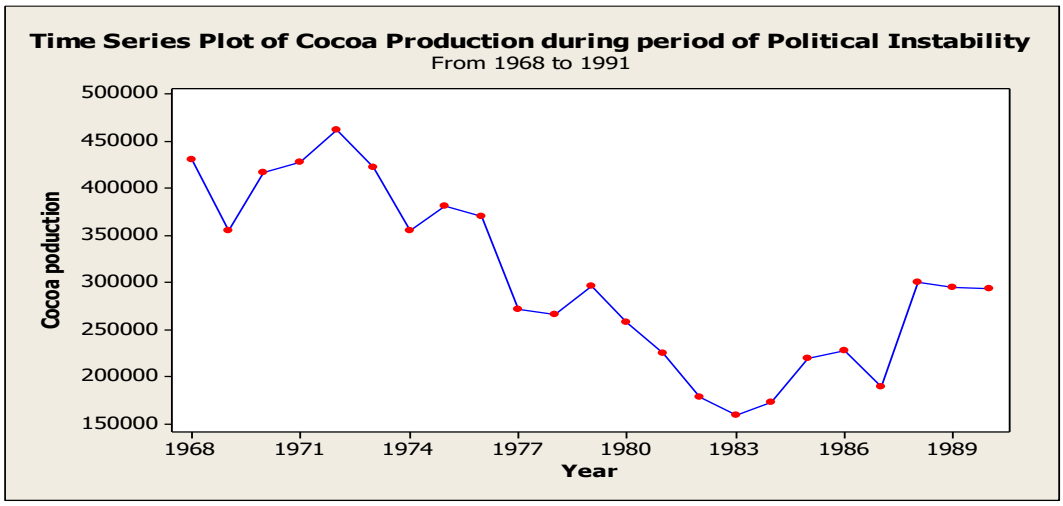

Figure 8. Time Series plot during political Instability

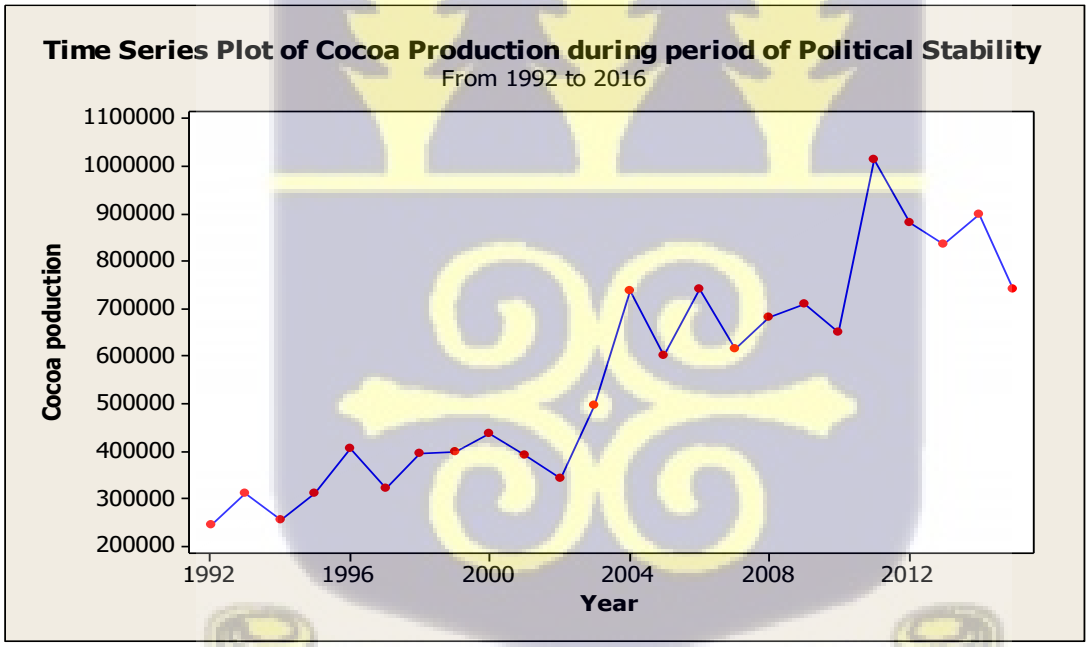

Figure 9. Time Series plot during Political Stability

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Furthermore, the Figure 8 and 9 indicates that, changes in regimes of government in Ghana appeared to have tremendous impact on the yield of cocoa. The practice of governance under Political Stability system had an increase in production yield on cocoa from the time series plot from 1992 to 2016 on the average, indicating the reverse trends observed from the political instability period). However, a normality test at 5% level of significance using the Anderson-Darling normality tests will determine whether to use a parametric test (Independent t-test) or non-parametric test (Mann-Whitney test).

4.5.1 Normality Test of the Data

H_0: The data on cocoa production in Ghana is normally distributed.

H_1: The data on cocoa production in Ghana is not normally distributed.

Decision Rule

Reject H_0 if the p-value of the test is less than 5% level of significance and fail to reject of otherwise. Below is a diagrammatic representation of the Anderson-Darling normality test;

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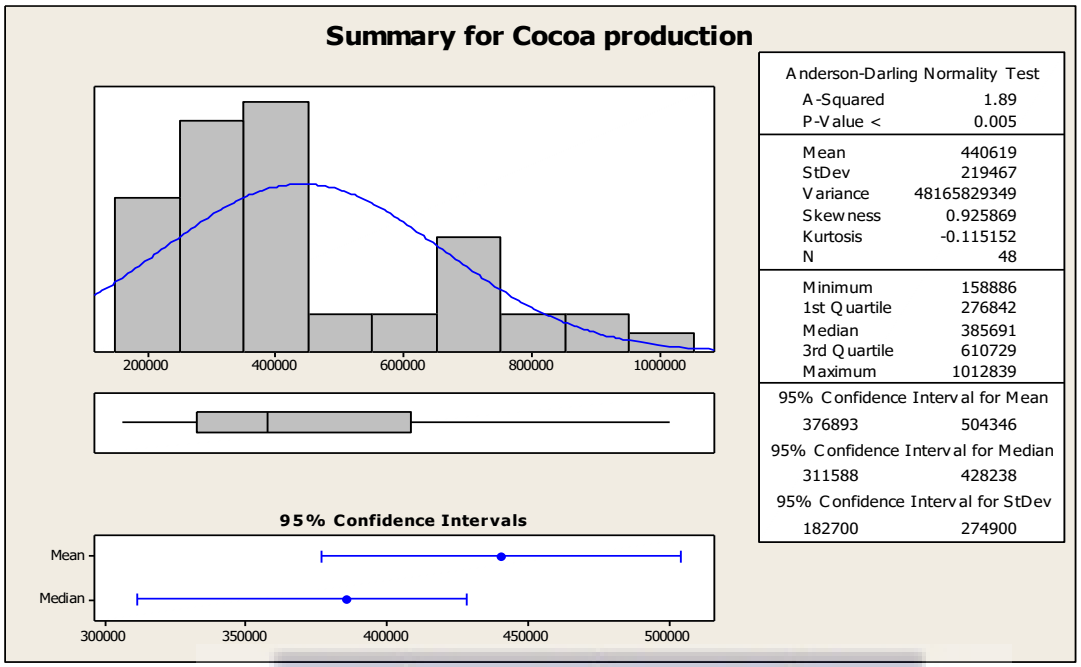

Figure 10. Output of the test for Normality of Cocoa Production

In conclusion the p-value ($p<0.005$) of the test is less than 5% level of significance which suggests that the null hypothesis must be rejected. The median of cocoa production was used instead of the mean since the data on cocoa production in Ghana is not normally distributed. The Mann-Whitney test compares the production of cocoa in Ghana across the two regimes.

4.5.2 Comparing median production of cocoa across the two regimes

Below is the hypothesis of the median test

H_0: The median cocoa production is the same across the two regimes

H_1: The median cocoa production is not the same across the two regimes

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Table 3. Output of Mann - Whitney test

Time period	Observation	Rank Sum	Expected
Political Instability	23	365	563.5
Political Stability	25	811	612.5
Combined	48	1,176	1176
Z-statistics	-4.097	Median (Stability)= 599,318	
P-value	0.000	Median (Instability)= 295,052	

In conclusion, the Mann-Whitney test above shows that, the median cocoa production in Ghana is not the same across the Political Instability and Political Stability. The median cocoa production during the second era was 599,318 tons as opposed to the value of 295,052 tons recorded during the first regime. The median cocoa production during the Political Stability period was approximately twice that recorded during the Political Instability period.

The Figure 3 and Appendix A specify that cocoa production were low between the political instability period (1968- 1991) but a significant increase from 1992 to 2016 (political stability period). This record is attributed to the intervention or impact of intervention, which remains the next objective of the study.

4.6 Modeling the Pre – Intervention Series (1968 - 1991)

The Figure 11 is the same as the time series graph of figure 4.1 above. This graph indicates the time of the intervention, which is the year 1992. Over there it can be observed that cocoa production started increasing.

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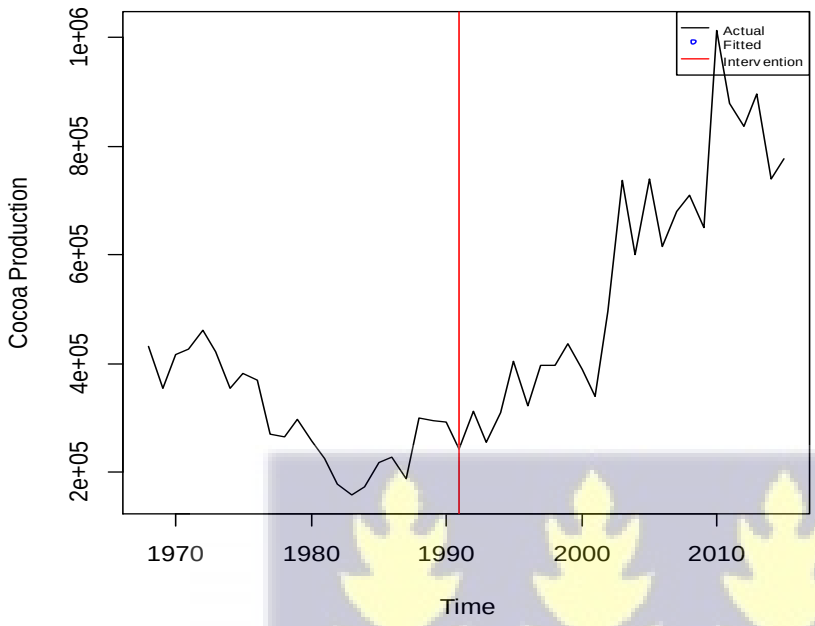

Figure 11. The trim intervention models version of cocoa production

4.6.1 Testing for Stationarity in the Data

The Augmented Dickey Fuller (ADF) unit root test was used to test the stationarity of the time series data obtained during the pre-intervention from the year 1968 to 1991. The ADF test has three hypotheses and in order to conclude on non-stationarity, the null hypothesis test must not be rejected. Stationarity simply indicates that the series does not change over time.

Hypothesis

H_0: Cocoa production during the pre-intervention period was non-stationary.

H_1: Cocoa production during the pre-intervention was stationary.

Decision rule

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Reject H_0 if the absolute value of the test statistic is $|t| > |DF_{critical}^{(0.05)}|$ or the p-value<0.05 and fail to reject if otherwise.

Table 4. Output of the Augmented Dickey Fuller test of stationary

ADF Tests	Test statistics	Critical Values	$P-value$
Intercept Only	0.044	3.000	0.962
Trend and intercept	3.707	3.600	0.022*
No trend and intercept	4.05	1.950	0.05*

*Implies significance at 5% alpha level

Since the p-values of the last two tests from Table 4.4 were rejected at 5%, it can be concluded that the series is stationary. The lag value that is stationary and attains white noise is considered an estimation of the differencing order *d* in the ARIMA (p, d, q) model.

4.6.2 Testing for White Noise in the series

White noise in a series indicates that the residuals are independently and identically distributed or has no serial autocorrelation. Thus, white noise would be tested from lag 0 to lag 3 since over differencing introduces unnecessary terms to the model. Both the Portmanteau and the Bartlett's test of white noise would be considered.

H_0: There is white noise or no serial autocorrelation in the series

H_1: There is no white noise or serial autocorrelation in the series

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Table 5. Portmanteau and the Bartlett's test.

Lag	Portmanteau test	Bartlett's test
0	0.000***	0.003**
1	0.176	0.226
2	0.055	0.177
3	0.007**	0.023*

***p<0.001 ** p <0.01 * p <0.05

It can be concluded from the two tests that there is white noise at both lag 1 and 2 at 5% level of significance. However, lag1 couldn't produce desirable estimates for both the AR(p) and MA(q) orders. Hence, the differencing order was estimated as d=2. Below is a combined time series plots from lag 0 to lag 3.

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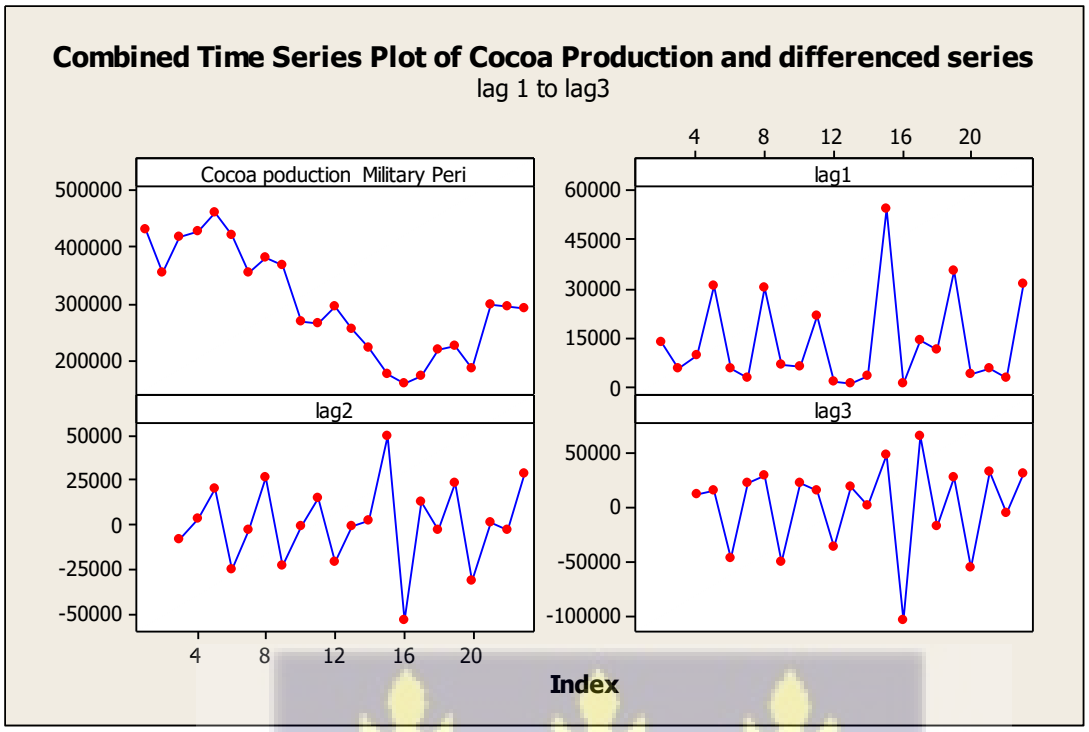

Figure 12. Time series plot of cocoa prodction at difference series

4.6.3 Identifying the ARIMA Model Parameters

A graphical approach would be used to estimate the appropriate AR (p) and MA (q) orders. The number of significant flags outside the confidence band for both the Autocorrelation function (ACF) and Partial Autocorrelation function (PACF) plots at lag 2 signifies the AR (p) and MA (q) orders respectively. In addition, the number of significance spikes or flags outside the confidence band of the PACF plot indicates the likely estimation of the AR order (p) whereas the significant spikes outside the band of the ACF indicates the possible MA (q) order for the ARIMA (p, d, q) model. However, the model with the smallest AICs and BICs (Akaike and Bayesian Information Criterion) would be considered as the best ARIMA model. Below are the PACF and ACF plots of the series at lag2.

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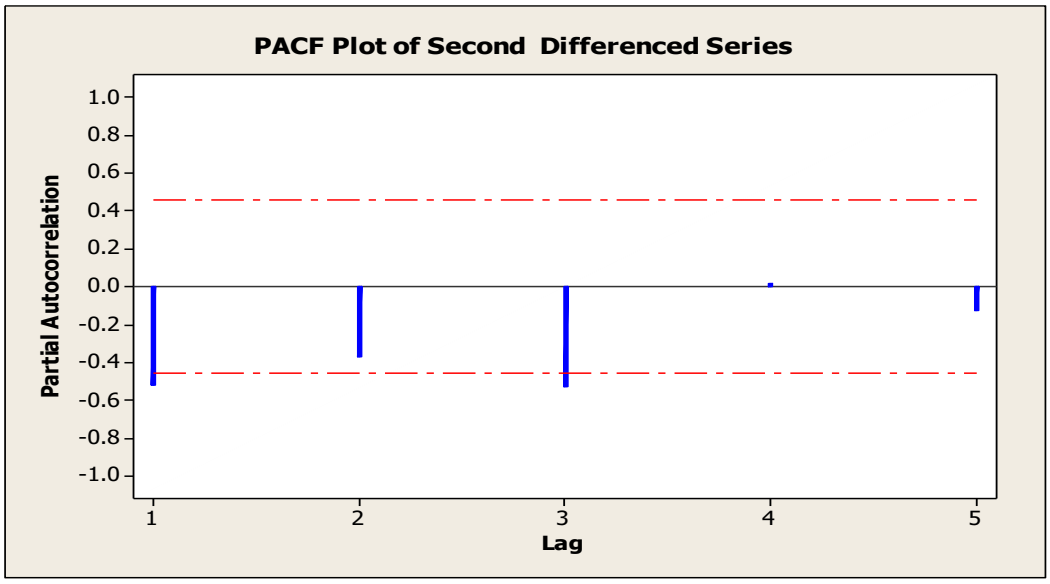

Figure 13. PACF plot at second Differenced

Deduction from Figure13

Two significant flags or spikes seemed to be outside the confidence band indicating that the possible

AR parameter estimates are p=1 or p=2

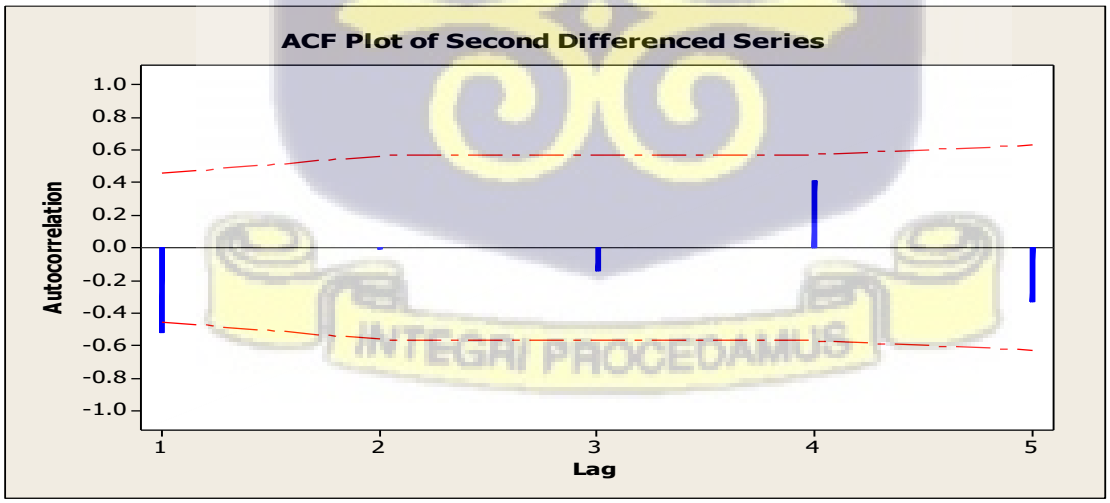

Figure 14. ACF plot at seconf Difference

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Deductions from Figure 14 One significant flags or spikes also appeared outside the confidence band indicating that the possible MA parameter estimate is q=1.

Below are AICs and BICs are fitted possible ARIMA models;

Table 6. Fitted ARIMA Model Parameter

ARIMA	AIC	BIC
(1,1,1)	479.47	488.75
(2,1,1)	483.34	488.8
(1,2,1)	468.34	471.48
(2,2,1)	467.88	470.11
(1,2,2)	471.82	475.99
(2,1,2)	469.14	475.37
(1,1,2)	483.36	488.82
(2,2,2)	483.32	488.78

Deductions from table 4 it concludes from the fitted ARIMA models that ARIMA (2, 2, 1) is the most appropriate model required to predict the production of cocoa since it has the least AIC and BIC values relatively. The estimates of the fitted ARIMA model is summarizes in Table 6.

Table 7. Summary of the fitted ARIMA model parameter

Type	Estimate	Std Error	Test statistics	P-value
AR (1)	-1.0273	0.2562	-4.01	0.001**
AR (2)	-0.5074	-0.5074	-2.01	0.061
MA (1)	-0.2446	-0.2446	-1.30	0.214
MA (2)	1.1301	1.1301	6.76	0.000***
Constant	4715.87	4.51	1046.64	0.000***

***p<0.001 **p<0.01 *p<0.05

The fitted model equation is;

$$\Delta y_t = 4715.87 - 1.027 y_{t-1} - 0.507 y_{t-2} - 0.245 \varepsilon_{t-1} + 1.130 \varepsilon_{t-2}$$

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Where $\Delta y_t = y_{t-1} - y_{t-2}$ the second differenced series is (lag 2)

ε_{t-1} and ε_{t-2} are the first and second differenced residuals or error terms

4.6.4 Residual diagnostics of fitted model

The residual assumptions that require to be tested includes test of no autocorrelation in the residuals, no ARCH (Autoregressive Conditional Heteroskedasticity) effects as well as normality assumptions of the residuals.

Below are the residual plots for the fitted ARIMA model;

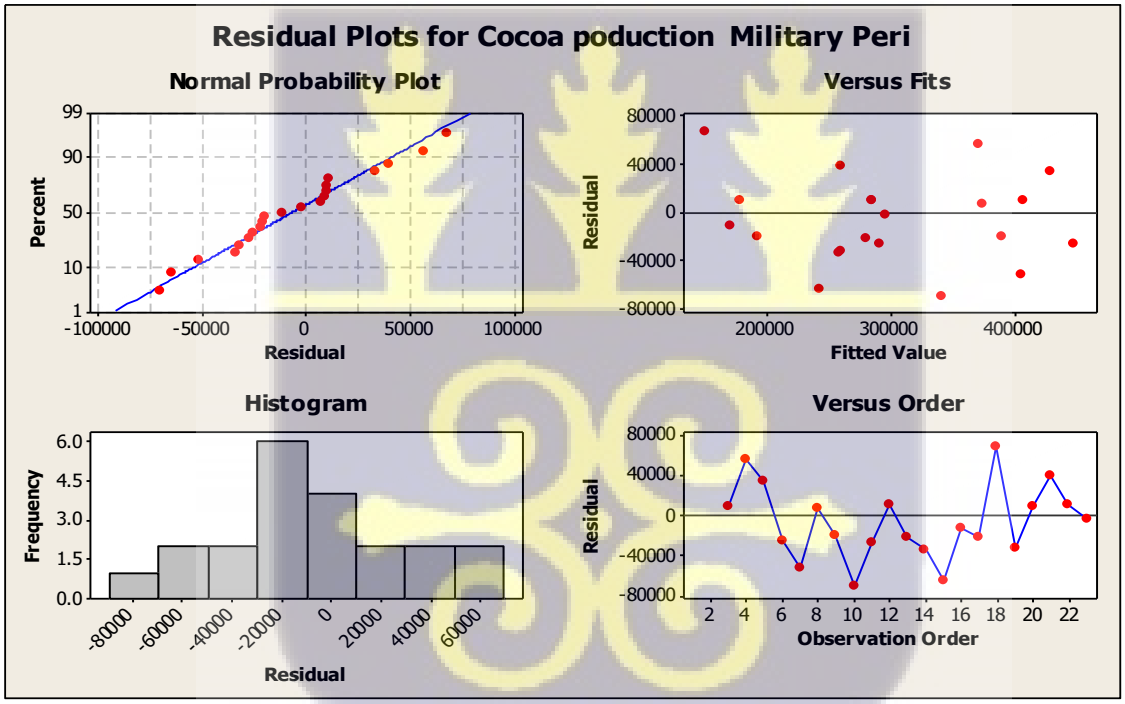

Figure 15. Residual plots for cocoa production

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Figure15 Residual plots of the fitted ARIMA (2, 2, 1) model

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The residuals appear to be independent and normally distributed. Since there is approximately equal number of points above and below the zero line, it can be concluded that the assumption of error terms having mean being zero is valid.

Breusch-Godfrey LM Test of Autocorrelation in the Residuals

H_0: There is no serial autocorrelation in the residuals

H_1: There is serial autocorrelation in the residuals

Table 8. Breusch Godfery test for Autocorrelation

lags(p)	chi2	df	P-value
1	0.574	1	0.4486

4.7 Testing for structural Break Test in the series

Table 9. Summary of test statistic of Quandt – Likelihood Ratio test

Test type	Test Statistic	Critical Value
Quandt Likelihood Ratio Test	33.509	0.01 = 7.78 0.05 = 7.20
The test break date at 1992 : 01		

Quandt – Likelihood test in the Table represents a break date point at position in the series where the intervention event took off. This indicates that the onset of the political stability intervention in

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Ghana was a characteristic by an immediate impact hence the significant structural break at the year of onset (year 1992)

4.8 Parameter Estimates for the Impact Assessed Model

Intervention analysis model of cocoa production comprises of ARIMAX with a white noise model of pre-intervention and the intervention function. We employed ARIMAX function in R to estimate ARIMAX (2, 2, 1) based on the smallest Akaike Information Criterion best model. The outcomes of the estimated parameters are presented in the Table 9 indicates with the hypothesized intervention model parameter then estimated and diagnosed as follows

Table 10. :Parameter Estimates for the Hypothesis Intervention Model

Model Fit Statistics			
AIC	AICc	BIC	
1188.915	1200.03	1196.23	
Coefficients	Estimate	STD Error	t- value
$ar1$	-0.5206	0.2562	-2.032
$ar2$	0.0668	0.3123	0.2139
Intercept	-0.6807	0.2795	-2.4354
T1- AR1 ($\boldsymbol{\delta}$.)	0.8662	3.9953	0.2168
T1- MA0 (ω_0)	52444.24	83771.63	0.6260

The Table 10 reports the parameter estimates of the full intervention model, including the penalty statistics. The coefficients of the estimated parameter ar1 and ar2 part are statistically insignificantly different from zero since its test statistics (t-value) of -2.032 and 0.2139 is less than 2 in absolute

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value while the estimated ar1 and ar2 coefficient strictly conforms to the limits of parameter stationary since 0.0668, -0.526 and its found to lie between -1 and 1.

The T1- AR1 (**δ**.) as well as T1- MA0 (ω_0) denotes the intervention decay or reduction event and interventional event (political stability) respectively. The estimate of the intervention event parameter of 52444.24 is interpreted as the magnitude of the impact of the intervention event. The positive sign indicates that the existence of political stability governance has increased the annual occurrence of cocoa production in the country. Its corresponding t- value test of 0.6260 indicates that the increase is statistically insignificant since it is less than 2 in absolute values.

The decay or the reducing component of 0.8662 is however not statistically significant since its corresponding test statistics of 0.2139 is less than 2 in absolute value but satisfies the condition of system stability since it lies between -1 and 1. The long term effect which is given by the relation *Long-term* = $\frac{\omega_0}{1-\delta}$ is 391,958 which is different from its corresponding impact parameter of 52,444 is likely to be significant. It therefore concludes that the long term effect of the intervention would be likely significant. Additionally, the penalty function statistics testified in terms of BIC, AIC and AICc with the resultant values of 1196.23, 118.915 and 1200.23 correspondingly penalizes the trim model established on the principle of parsimony.

The full intervention model, which is a step function, is given as

$y_t = \frac{52444.24}{(1-0.8662L)} I_t + 4715.87 + (y_{t-1})$.

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4.9 Diagnostic Checks for the Full Intervention Model

The diagnostics check examines the fit of the model by using Ljung-Box Test and the residual plots as reported in Table 11 and Figure 16 respectively: The results from Table 11 fails to reject the null hypothesis of the white noise of the residuals at the 5% significance level since the p – value 0.1033 is greater than the critical value of 0.05 and therefore follows that the fitted interventional model provides a decent fit for the intact cocoa production series.

Table 11. 12: Ljung - Box for the full intervention model

Summary of Test Statistic			
Test type	X – Squared (χ^2)	df	P- value
Ljung - Box	18	24	0.1033

The Figure 16 indicates that, all the three diagnostic residual plots follow random walk pattern for the fitted Intervention model, meaning, the plot of residuals appear to be randomly scattered about zero, there is no evidence that the error terms are correlated with one another. Also, there exists no significant spikes in the ACF, PACF plots of residuals as well as the probability of the residuals, indicating that, the distinct probabilities of the residuals are greater than 0.05. This shows that the residuals' full intervention model is a white noise process, thereby agreeing with the ultimate of the Ljung – Box test.

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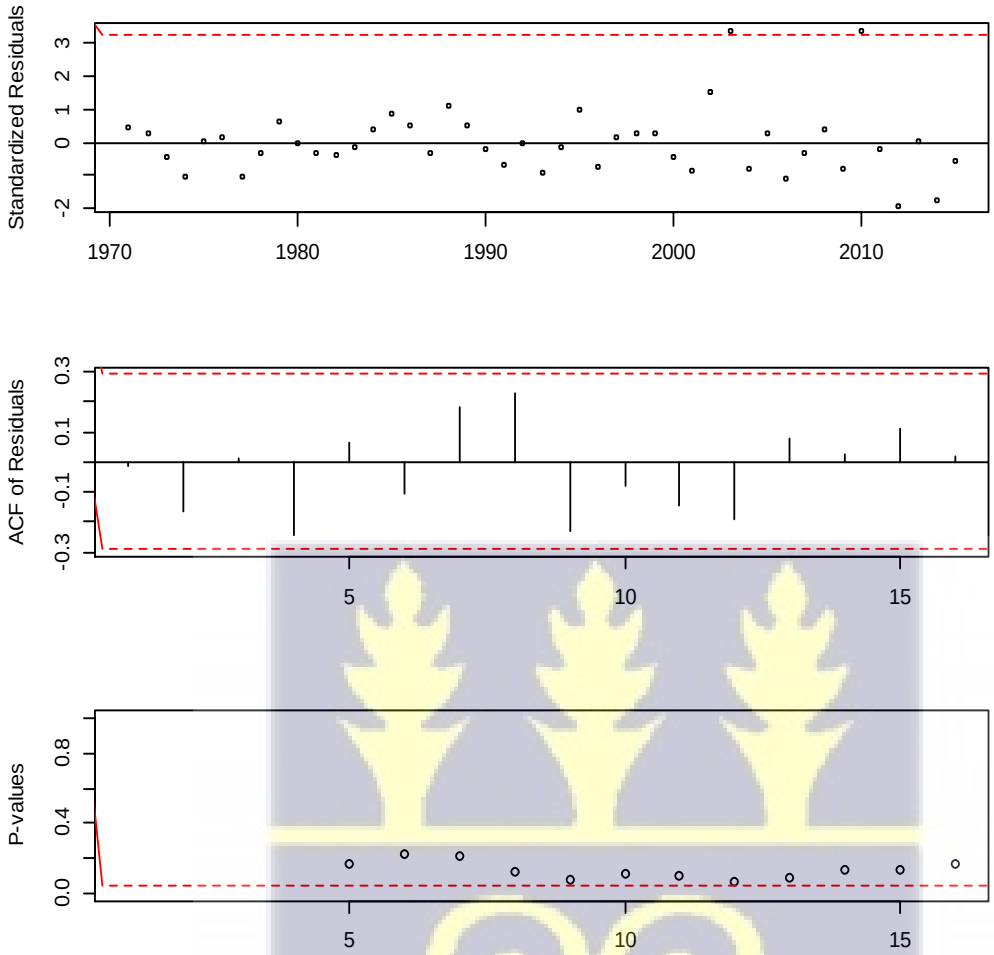

Figure 16. Ljung box plots of Residuals

Finally, the fitting a full intervention or impact assessment model is gridded as shown in Figure 17 with the thick black line indicating the cocoa production and the blue dash line indicating the impact of the Political stability governance affair.

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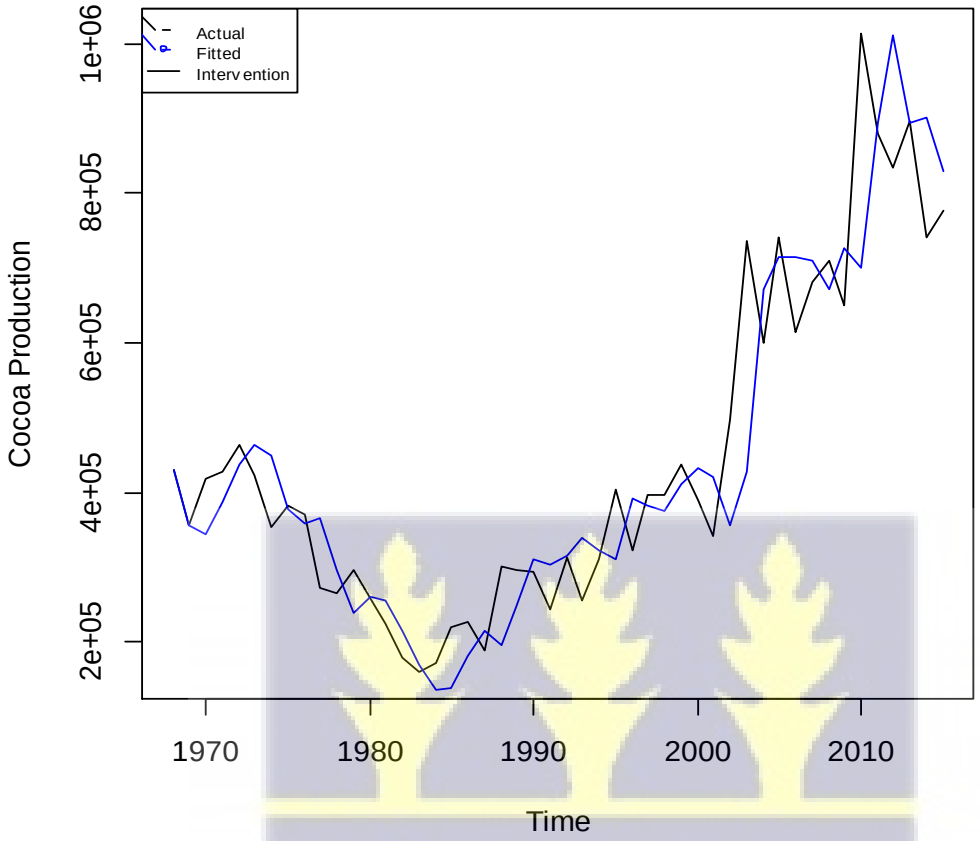

Figure 17. Plot of Intervention Event and ActualsFigure

4.10 Discussion of Outcomes

Based on the analysis and interpretation of the secondary data on cocoa production in Ghana covering the period between the years 1968 to 2016, appropriate outcomes of the study are expressed as follows.

First, the studies revealed that cocoa production in Ghana were not constant. It varied from year to year (as depicted in Figure 4.1 from the time plot of the cocoa production series). It can be deduced from the fitted trend models that the Quadratic trend model is the most appropriate trend model that

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is adequate in predicting the production of cocoa in Ghana since it yielded the least prediction errors on the average as compared to the other trend models, given as:

$\hat{Y}_t = 478763 - 26074t + 758.3t^2$.

The decomposition models of the series is that of the Additive model, with trend, seasonal and irregular components being the most appropriate time series model since it produced the least forecast or prediction errors relatively.

In addition, another two models were analyzed from the cocoa production, the first one for the pre-intervention (Political Instability) system of governance and the second one being the full intervention model. The best model for the pre-intervention was ARIMA $(2,2,1)$ which was given as y_t=4715y_{t-1}-0.507y_{t-2}- 0.245ε_{t-1} with the residuals being white noise, whilst that of the transfer function of the ARIMA plus the intervention event lead to the full intervention was modeled as $y_t=\frac{52444}{1-0.8662}I_t$ + (4715.87)+y_{t-1} with residuals found to be white noise, is achieved by Ljung-Box test as a well as its residual plots.

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CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter marks the final stage of the study. It is based on the specific objective of this thesis and makes conclusions and recommendations based on the findings.

The core objective of the research was to investigate the impact of political stability in cocoa production in Ghana using Interventional Analysis model. It continued to examine the trend and decomposition model of cocoa production.

5.1 Summary of the Findings

Based on the results we obtained from the research, it can be deduced from the fitted trend models that the Quadratic trend model is the most appropriate trend model that is adequate in predicting the production of cocoa in Ghana since it yielded the least prediction errors of 15%on the average as compared to the other trend models. Below is the fitted Quadratic trend model

$$\hat{Y}_t = 478763 - 26074t + 758.3t^2$$

Secondly, for the decomposition analysis of the series, an additive model that comprised of trend, seasonal and irregular components produced averagely smaller prediction errors as compared to those with trends eliminated since it produced the least forecast or prediction errors relatively of 38.3. Thus, the Additive model $Y_t = Trend + Seasonal + Irregular$ was fitted as;

$$\hat{Y}_t = 172572 + 1094t$$

A sharp comparative analysis was made over the period under study between political instability regimes and political stability and we observed that the series is not normally distributed and for that matter non parametric test, Mann-Whitney was used. The test finalized that, the median of

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cocoa production in Ghana was not the same across the political instability and political stability regimes. The median cocoa production during the political stability era was 599,318 tons as opposed to the value of political instability of 295,052 tons recorded.

In addition, concerning political stability as an intervention on the time series, Stationary was obtained. ARIMAX (2, 2, 1) model with white noise was diagnosed. The intervention was found to be statistically insignificant since the t- values is less than 2 in absolute term. But is likely to be significant in the long term since its parameter (391,958) is far greater than (52,444) . The full intervention was modeled as

$Y_t=\frac{52444}{1-0.8662}I_t+ (4715.87)+y_{t-1}$

with residuals found to be white noise by the use of Ljung-Box test. While the estimated ar1 and ar2 coefficient strictly conforms to the limits of parameter stationary since 0.0668, -0.526 and lie between -1 and 1.

5.2 Conclusion

The full Intervention analysis model (ARIMAX + INTERVENTION EVENT) of Political Stability n Cocoa Production $y_t = \frac{52444.24}{(1-0.8662L)} I_t + 4715.87+(y_{t-1})$ is said to be insignificant at 5%, meaning that political influence has little or no influence on cocoa production despite political appointees to the Board of Directors for the sector with their numerous intervention event made when there is a change of political rulers under political stability.

In the long term effect is likely to be significant because 391,958 which is different from its corresponding impact parameter of 52,444. It has the relation *Long-term* = $\frac{\omega_0}{1-\delta}$.

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The diagnostic residual plots follow the random walk pattern for the fitted full Intervention model, meaning, the plot of residuals appears to be randomly scattered about zero, there is no evidence that the error terms are correlated.

Quandt – Likelihood test proved that, the break date is inline with the point at position in the series where the intervention event took off. This indicates that the onset of the political stability intervention in Ghana was a characteristic by an immediate impact, hence the significant structural break at the year of onset (year 1992).

The deduced from the fitted trend models that the Quadratic trend model is the most appropriate trend model that is adequate in predicting the production of cocoa in Ghana since it yielded the least prediction errors of 15.0% on the average as compared to the other trend models. The error term is normally distributed because the residual graph has an approximately equal number of points above and below the zero line. Moreover, the plot of residuals versus the observed order suggests that the error terms are independent over time due to signature of constant variance in the error terms.

Finally, the deduction for the decomposition model the average rate of change in cocoa production by the Additive model was at 172,572 tons when the time was assumed zero (0). Moreover, the coefficient 1,094 also implies that the production of cocoa grew by an average of 1094 per year. Figure 5 and Figure 6 shows a diagrammatic representation of the model with forecasts as well as component analysis plots of the model.

5.3 Recommendations

The following recommendations are made to improve Ghana cocoa production sector.

1. The study recommends that, the appointments of the Board of Directors should be made in such away to avoid political interference.

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2. Long term polices and programmes should be made to improve cocoa production in Ghana.
3. Ghana Cocoa Board should be made independent to aviod political interference during change of government.

5.4 Future Research

1. Researchers should have much interest in evaluating the impact of political stability by using monthly time series data instead of annual time series data.

2. Researchers should have interest in evaluating the impact of political stability in various industries, especially on where there is political influence.

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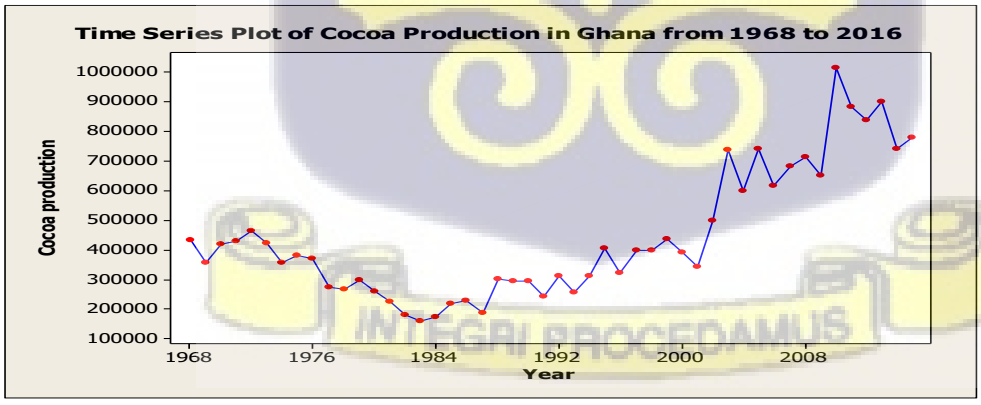
APPENDICES

APPENDIX A

Cocoa Production per Year in Ghana

Year	Quantity	Year	Quantity	Year	Quantity
1968	430665	1989	300101	2009	710642
1969	355588	1990	295052	2010	650941
1970	417457	1991	293352	2011	1012839
1971	427629	1992	242817	2012	879349
1972	462460	1993	312123	2013	835467
1973	421697	1994	254654	2014	896916
1974	354630	1995	309455	2015	740254
1975	381609	1996	403843	2016	778044
1976	370133	1997	322489		
1978	271339	1998	395674		
1979	265074	1999	397363		
1980	296419	2000	436946		
1981	257974	2001	389772		
1982	224882	2002	340563		
1983	178227	2003	496846		
1984	158886	2004	736976		
1985	172514	2005	599318		
1986	219034	2006	740458		
1987	227765	2007	614533		
1988	188171	2008	680781		

APPENDIX B



Source: Ghana COCOBOD (2016)