KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

A SEGMENTED INTERVENTION ANALYSIS OF MATERNAL HEALTH POLICY ON ASSISTED DELIVERY IN KUMASI : A CASE STUDY OF KNUST HOSPITAL (2000-2011).

By

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A Thesis submitted to the Department of Mathematics, Kwame Nkrumah University of Science and Technology in partial fulfilment of the requirements for the degree of

Master of Philosophy

College of science

APRIL, 2013

Declaration

I hereby declare that this submission is my own work towards the award of the M.Phil degree and that, to the best of my knowledge, it contains no material previously published by another person nor material which had been accepted for the award of any other degree of the university, except where due acknowledgement had been made in the text.

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Acknowledgement

Thanks To the Almighty God for taking me through the two year program successfully. To Dr. Atinuke O. Adebanji for her time, guidance and patience through out the research. To Bio-Statistics Department of the Obstetrics & Gynecology directorate department of KNUST Hospital for making the data readily accessible to me.

Dedication

To Almighty God, my parent Mr./Mrs Odame not forgetting my siblings: Rebecca, Felicia, Regina and Rose

Abstract

This study assessed the impact of the Exemption Fee Delivery (2005, April - June 2008) and Free Maternal Health Care Policy (July 2008 - 2011) on assisted child-births using KNUST Hospital, as case study. Segmented intervention analysis of Box and Tiao was used for modeling the data and assessment of the impact. In April 2005, the government of Ghana in pursuit of(Millennium Development Goal 5) MDG 5 established a national policy to exempt women from delivery fees. Under this policy, pregnant women were exempted from only delivery charges, but was later replaced with the Free Maternal Health Care Policy (FMHCP), instituted in July 2008. The preintervention series (2000 - March,2005) exhibited stationarity as KPSS test statistics of 0.1609 is less than critical valve of 0.4630. Both pre and post -intervention period could best modelled with an ARIMA (1, 0, 1) process. The Ljung-Box test (of p-value 0.6401 and 0.2217 respectively > 0.05) indicating normality of residuals. The impact of the Exemption Fee Delivery policy (EFDP) on monthly childbirth was felt in April 2006 whilst FMHCP was felt in the same year of it's implementation. The estimated intervention model showed an insignificant approximate increase of 9 (t-value of 1.887< 1.96) childbirths from the EFDP. The FMHCP showed a significant additional 60 (t-value of 12.7432 > 1.96) childbirths at the hospital. Results of the analysis shows that first intervention did not result in a significant increases in the number of assisted deliveries where as the FMHCP of 2008 resulted in a significant average monthly increases of 60 deliveries.

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List of abbreviations

ACF	preintervention series
KNUST	Kwame Nkrumah University of Science and Technology
ARIMA	Autoregressive Integrated Moving Average
NHIS	Nation Health Insurance Scheme
NHIA	Nation Health Insurance Authority
ICD-10	Tenth Revision of the International Classification of Diseases
WHO	Wealth Health Organization
GHS	Ghana Health Service
MDG 5	Millennium Development Goal 5
MMR	Maternal Mortality Rate
PNDC	Provisional National Defence Council
NDC	National Democratic Congress
NPP	New Patriotic Party
UN	United Nations
KATH	Komfo Anokye T eaching Hospital
ITSA	Interrupted time series analysis
CIA	Clean Indoor Air Ordinances
CHD	Coronary Heart Disease
DF	Dickey-Fuller
KPSS	Kwiatkowski, Phillips, Schmidt and Shin Test
AIC	Akaike Information Criterion
PACF	Partial Autocorrelation function

FMHCP	Free Maternal Health Care Policy
EFDP	Exemption Fee Delivery policy
BIC	Bayesian information criteria
PHII	Australian Private Health Insurance Incentive
WA	Western Australia
C-RCT	Cluster Randomized Controlled Trials
CS	Caesarean Section

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Chapter 1

Introduction

This study assessed the impact of the Exemption Fee Delivery and Maternal Health Care policy on the incidence of childbirth from 2000 to 2011 in KNUST Hospital, using Segmented Intervention Time Series. One of the commitments made at the United Nations Millennium Summit, New York, September 6-8, 2000 by sister nations was to improve maternal health care. It is against this backdrop that Ghana and other sister countries approved the Millennium Development Goal 5, to help improve maternal health care. In April 2005, the government of Ghana established a national policy to exempting women from delivery fees. Under this policy, pregnant women were exempted from delivery charges but were still made to pay fees through the NHIS or out-of-pocket payments. The policy was shortly replaced with the Free Maternal Care Policy, instituted in July 2008. In this new policy all financial commitment on the part of the pregnant women in accessing health care were removed. Pregnant mothers who could not attend maternity services due to financial constraints would now have free access to full maternity services such as antenatal, perinatal and postnatal care (NHIA, 2008).

Prior to the implementation of the policy, a lot of pregnant women in most communities had to wait for last minute to their delivery before seeking medical assistance, whiles others completely fail to seek for medical treatment, basically because of lack of financial resource. These maternal health policy targeted primarily the poor pregnant mothers in society to abstain from self-medication or use of concoction which to a large extent contribute to maternal/neonatal mortality, but instead seek free and quality healthcare during and after delivery (Adjepong et al., 2012). This chapter consists of a brief background of the study, Ghana health care financing and the free health care policy. It also takes a look at the problem statement, research questions, objectives, research methodology, justification, scope and limitations of the study as well as organization of the thesis.

1.1 Background of the Study

Childbirth is a major event in a woman's life and a woman's death during childbirth is even more traumatic for the people she leaves behind (Reviani, 2010). Childbirth is the shortest and most critical period of the pregnancy-childbirth continuum because most maternal deaths arise from complications during childbirth, even with the best possible antenatal care, any childbirth can become a complicated one (Agar and Noemi, 2010). The threat for a woman in this state is worsen when she has no access to proper health service due to poverty. More than 600,000 women die due to childbirth or pregnancy related complications around the world annually (Zozulya, 2010). The lifetime risk of dying due to maternal health causes is about one in six in the poorest countries, compared with about one in 30,000 in the Western World (Fiagbe, Asamoah, and Oduro, 2012). Women's utilization of maternal health care facility is a vital health issue with regard to the well-being and survival of both the mother and her child.

In (Reviani, 2010), the Tenth Revision of the International Classification of Diseases (ICD−10) defined Maternal death as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. More than 40% of the pregnancies in developing countries result in complications, illnesses, or permanent disability for the mother or the child (Lule et al., 2005). Major complications contributing to maternal death are : severe bleeding/hemorrhage (24%), infections (15%), unsafe abortions (13%), eclampsia (12%), obstructed labour (8%), other direct causes (8%) and indirect causes (20%)(Reviani, 2010). This situation is further worsened by the three delays which are: Delay in the home, delay in accessing the health facility or receiving care at a health facility, lack of health centre, poverty, shortage of health workers, believes and tradition, teenage pregnancy (Mba and Aboh, 2009). Complications of pregnancy and Childbirth that are a major cause of death in women of reproductive age in Ghana according to Ghana Health service are: Hemorrhages, breaking of water, hypertensive disorders, induced and inevitable abortion, Eclampsia,Vaginal bleeding, Ruptured Ectopic pregnancy, preterm birth, Foetal death etc. The World Health Report (WHO, 2005) estimate that, more than 536,000 women die yearly, while more than 1,500 women die every day in the world from pregnancy or childbirth- related complications because of poor access to delivery and obstetric services.

About 800 women die from pregnancy- or childbirth-related complications around the world every day and in 2010, 287 000 women died during and following pregnancy and childbirth (WHO,2010). Also World Health Report (WHO, 2007) indicates that 15 per cent of pregnant women may develop complications during pregnancy and childbirth as against 85 per cent who will go through pregnancy and childbirth without any complications. This means that out of every 100 pregnancies, there is likelihood that 15 of them will develop complications that contribute to the maternal deaths due to lack access to delivery and health care. The Ghana Health Survey(GHS, 2009) indicates that maternal mortality ratio in Ghana is 350 deaths per 100,000 live births. In addition, statistics from the Ghana Health Service (GHS) also point out that 953 women died in 2008 from pregnancy and delivery complications in health facilities.

This figure, according to the GHS, did not include those women who died in communities and were quietly buried without registration. In recent times there have being growing concern about whether various sub-regions of the country will be able to achieve the MDG 5 target. It is critical that strategy be put into operation because many African countries are lagging behind in achieving MDG 5, i.e. to improve maternal health by reducing MMR to 185 per 100000 live birth in 2015 (WDR, 2012). Nonetheless death from pregnancy-related causes represents one of the most preventable sort of female death worldwide (Fiagbe et al., 2012). Financial barrier is seen one of the most significant factors or restriction to seeking skilled care during deliveries (Graham, 2004). Subsequently, (Bennis and De-Brouwere, 2012) also confirmed that financial barriers as an important obstacle for access to emergency obstetric care and delivery service as well as contributing factor to too slow a reduction in the level of maternal mortality.

According to (AbouZahr, 1998) major Contributory factors to maternal mortality are lack of access to good quality maternal and neonatal health services and strong adherence to negative cultural beliefs and practices . If this obstacle is removed then it is believed that more pregnant women will have access to skilled attendance during labour thereby reducing maternal mortality and the household income spent on delivery cost. Healthcare expenditure affect accessible resources by reducing the share of income available to be spent on other sector of the country which normally put pressure on the nations funds. The fee exemption delivery policy, may play a very significant role in increasing the rates of skilled attendance and protect households from making disastrous expenditure for maternal delivery and consequently from falling into poverty (Asante et. al.,2007).

Many countries and the world at large have then seen the need to pay attention to maternal health issues resulting in a series of conferences and programs. In

Burundi, for example, free services for pregnant women and under-five children was launched in 2006, and it's operation appeared to have increased facility delivery by 12% , though no formal evaluation has been undertaken (Witter et. al. ,2009). Subsequently, the safe motherhood Initiative launched in 1987 by United Nations (UN) agency- UNFPA, raised consciousness about the numbers of women dying each year from complication of pregnancy and childbirth has being a major at all UN meetings. The significance of maternal health was once more addressed by international community when they meet in 2000 and agree on the eight MDGs aimed at ending extreme poverty worldwide by the year 2015. MDG5 focused specially on improving maternal health setting target of reducing maternal mortality to less than 185 per 100,000 by 2015 through the removal of barriers such health charges.

As part of government of Ghana's dedication to the health status of pregnant women, led to the introduction of the Exemption Fee Delivery and Free Maternal Health Care Policy. The Exemption Fee Delivery policy was first introduced in September 2003 in central region and the three northern regions. It was later expanded to the whole country in April 2005 and later replace with the Free Maternal Care Policy, instituted in July 2008. This medical care for pregnant women was provided under the Country's National Health Insurance scheme (NHIS) which made it possible for pregnant women to enjoy free medical care during pregnancy (Aikins, 2010). The NHIS came into being under Act 650 of 2003 by the Ghanaian government to make available to all residence of Ghana basic health care services, (NHIS, 2009). These policies aimed at reducing financial barriers in assessing maternal services as well as increasing the rate of skilled attendance during delivery, reduce maternal and perinatal mortality rates and contribute to reducing poverty (Asante et. al.,2007).

There is therefore the need to assess the impact of these policies and how the targeted population is responding to evaluate it effectiveness and make recommendation and adjustment if necessary. The maternal health policies also help the ministry of health get a true picture of the various complications during delivery as it is expected to increase delivery skilled assisted cases. Intervention time series design is normally employed to estimate program impact and analysis such policies to determine if shifts occurred are not well known. Such policies in the Ghana health service is the Exemption Fee Delivery and Free Maternal Health Care to address the high maternal mortality issue and to also replace the cash and carry system (Adjepong et al., 2012). Response by pregnant to the policy is the most essential indicator for monitoring the progress of any maternal health program. Subsequently, it will also help to confirm the accession that financial factor as a key obstacle that prevents pregnant women from assessing health services.

1.1.1 Ghana Healthcare Financing

The subject of healthcare financing in Ghana is dated back to colonial times through to the first republic under the great Osagyefo Dr. Kwame Nkrumah, Provisional National Defence Council (PNDC), the National Democratic Congress (NDC) and New Patriotic Party (NPP) regime under which the present health insurance scheme was introduced. Prior to the NHIS was the Cash and Carry era of healthcare financing, where patients were mandated to cover the cost for drugs and some medical consumables. The government bore all other costs including consultation, salaries as well as remunerations for Doctors, Nurses and other healthcare workers in state hospitals. This prevented most people go for health assistance and in the case of pregnant women their resort was traditional services mostly associated with delivery complications.

The quest for a substitute to cash and carry, as a means of healthcare financing in Ghana originated in the second term of the National Democratic Congress(NDC) administration under former President J. J. Rawlings between 1996 to 2000, but could not materialize for operation though the foundation was laid with some pilot projects in the Dangme West District in the Greater Accra Region and Nkoranza District of the Brong Ahafo Region. The New Patriotic Party (NPP) Government under former President J. A. Kuffuor finally implemented the perceived new health insurance scheme under the National Health Insurance Act, Act 650 in 2003. Subsequently the establishment of a National Health Insurance Scheme (NHIS) in 2004 under a National Health Insurance Authority (NHIA) with a governing council. To address the issue of maternal health delivery the NHIA introduced Exemption Fee Delivery in April 2005 and later replaced with a Free Health Care policy in July 2008 (www.nhis.gov.gh, 2012).

1.1.2 The Maternal Health Care Policy

Prior to the institution of the Exemption Fee Delivery and Free Maternal Care Policy, some pregnant women waited till very last minute to their delivery before reporting for ante-natal care while others failed to go for laboratory test because of lack of funds(Adjepong et al., 2012). In Ghana, most pregnant mothers failed to seek medical treatment but relied on unskilled assistance during childbirth or wait until the last 2 or 3 days in pregnancy before enrolling for antenatal care largely because of lack of funds. Maternal mortality was on ascendancy due to complications of pregnancy or delivery. The Exemption Fee Delivery and Free Maternal Health Care Policy were introduced in Ghana as part of measures to help achieve the MDGs goal 5 which aim at reducing maternal mortality adopted by UN member countries in the year 2000.

Pregnant women are eligible for free health service in all NHIS accredited healthcare facilities public, mission or private. The basic objective of theses policies is to provide free and quality maternal health care delivery service in accredited facilities. In addition it is expected to reduce infant and maternal mortality and inspire women to seek antenatal and post natal care at health facilities. All pregnant women and nursing mother registered as well as babies born to mothers registered under the program up to 90 days after birth can benefit from the policy once certified by a doctor/nurse/midwife. Below are some of the fee exemptions of the policy:

a. Exemption from payment of the NHIS premium and registration fee.

b. Free medical services and medicines during postnatal and antenatal period.

c. Free medical services and medicines during delivery (including Caesarean delivery).

d. Free medical services and care for the newly born baby on the mother's ticket (as a member of NHIS) for 90days after which baby must be registered (ghanahealthnest.com, 2012)

1.1.3 Scope of Study

KNUST Hospital is situated on the premises of Kwame Nkrumah University of Science and Technology on the northwest part of the main Accra-Kumasi Road, about 15 minutes drive from the City centre, Kumasi. KNUST Hospital started as a dressing station in 1952. and has since then grown to become a major health service center in the Ashanti Region. In 1972, the female, children and male wards were built to enable the hospital receive more in-patients. Subsequently, the out-patient department and the theatre were added in 1973. The maternity ward was initially an isolation ward which was converted for maternal purposes later. At its inception in 1952 the total University population was barely 1000 in with a corresponding low hospital attendance. The KNUST Hospital was primarily set up to cater for the health needs of staff, their dependants and students of the university. However, it has now extended its services to the general public and provides health services to the neighbouring communities with a swiftly growing population. Thus, the hospital plays the role of a District Hospital. The hospital currently caters for a population of over 205,000. This is made of: 25000 Students ,30000 Staff and dependants and about 150,000 people from over 30 surrounding communities, including Ayigya, Bomso, Ayeduase, Kotei, Boadi, Top High, Susanso, Oduom, Deduako,Maxima etc. the hospital currently have a full-fledged 100 beds, 76 nurses and 14 medical Doctor with Dr. Fred Yaw Bio as the director. It is the medical arm of the Kwame Nkrumah University of Science and Technology community and the surrounding villages (www.knust.edu.gh).

1.2 Research Problem

The significance of maternal health was addressed by international community of 189 countries when they met in 2000 and agreed on the eight MDGs aimed at ending extreme poverty worldwide by the year 2015(WHO, 2008). A key dimension of the goals was MDG5 that focused on improving maternal health by setting target of reducing maternal mortality to less than 185 per 100,000 by 2015. In 2007 in appreciation to the close links between maternal health and other reproductive condition, a second target of ensuring universal access to reproductive health service was added to the MDG5 (Coeytaux, Bingham, and Langer, 2011). Of the estimated yearly total of 536,000 maternal deaths worldwide a total of 99% of all maternal deaths unfortunately happens in developing countries, where 85% of the population of the world lives because of no access to health delivery due to poverty (WHO, 2005). Maternal deaths are unevenly distributed throughout the world, and obstetric risk is highest by far in sub-Saharan Africa was estimated to be nearly 1000 per 100,000 live births. This is approximately twice that of south Asia, four times as high as in Latin America and the Caribbean, and almost 50 times higher than in developed countries(Opoku, 2009). Maternal mortality is not the only adverse outcome of pregnancy but also miscarriages, induced abortion, and other factors.

Ghana's maternal mortality ratio reduced from 740 per 100000 in 1990 to 590 in 1996, 540/100000 in 2000, to 541/100000 in 2005, 451/100000 in 2007, 350/100000 in 2008 and 360/100000 in 2010. This reduction is estimated to be at a rate of 3.3% annually compared to 5.5% annual rate required to attain MDG 5 target of 185/100000 or less by 2015 (WHO, 2008). Statistics from Kumasi show that maternal deaths are rising. In 2007, Kumasi's MMR was 359 out of 100,000 live births, while in 2008 it was 397 out of 100,000 (Asomaning, 2012). In spite of all this higher maternal mortality in the region KNUST Hospital has not recorded any maternal death since 2010. In 2003, in an effort to improve maternal health and survival, the government of Ghana implemented a new policy that removed delivery fees in Health facilities in the country (Opoku, 2009). The policy was initially introduced in the four most deprived region of Ghana that is the Central, Northern, Upper West and Upper East Regions. Later it was extended to the remaining six regions of Ghana in April 2005 and replaced wit the Free Maternal Health Care in July 2008 (Agar and Noemi, 2010). In addition, other measures including inter-sectorial actions, a move on family planning and training, and repositioning of reproductive and child health staff, have been introduced.

It is about 9 years since the introduction of the Exemption Fee Policy and Free Maternal Health Care Policy but maternal health care is still a major health problem confronting the nation but little has gone into finding out the impact of the policy. This is because there had been little statistical evidence to justify or otherwise of these policies especially in Kumasi with reference to the impact of these policies by the government to address this global pandemic. This study evaluates the impact of the Exemption Fee Delivery and Free Maternal Health Care policy on incidence of childbirth recorded in Kumasi using KNUST Hospital as a case study.

1.3 Objectives of the Research

In light of these the principal objectives of the study is to use intervention analysis of Box and Tiao to enumerate the impact of the policy on incidence of childbirth recorded at KNUST Hospital from 2000 to 2011. Specific objective of the study that will help realized this main objective therefore is:

1. To examine and assess the nature of impact of free maternal policy on facility delivery in the hospital.
2. To fit an invention model to assess the monthly deliveries in the from 2000 to 2011 using the Box-Tioa model.
3. Interpreting the result of the fitted intervention model in relation to the effectiveness of such policies in the country.

1.4 Justification of The Research

Maternal mortality is one of the most sensitive indicators of the health difference between richer and poorer citizen of a nation. The lifetime risk of dying due to maternal causes is about one in six in the poorest countries, compared with about one in 30,000 in Northern Europe (Ronsmans and Graham., 2006).Women in developing countries such Ghana have higher parity, as a result are exposed to maternal death, thus women in developing countries have higher mortality rate than those in developed countries. Lack of access to quality care, particularly the lack of financial access, is a constant headache in poor countries where households are sometimes forced to borrow heavily to pay for transportation and obstetric care if they manage to reach the hospital on time (Bennis and De-Brouwere, 2012)

The Exemption Fee Delivery and Free Maternal Health policy was introduced as a way of increasing women assess to health service thereby increasing facility delivery to reduce the mortality rate in Ghana. Access to health services for the poor and vulnerable pregnant women in Ghana has been a problem prior to the introduction of user fees delivery policy in the country. This is so because healthcare expenditure affect considerable accessible resources of the family by reducing the share of income available to be spent on other commodities. This most at times have resulted in the decreasing number of women seeking skilled assistance during delivery. The government through Ministry of Health to secure continuity of the fee exemption policy in Ghana established a Health committee. The committee is to set refund rates according to the type of delivery and the facility type to be made to service provided due to the amount of the countries resource committed to maternal health.

Government continue to implement programmes to bridge equity gaps in Access to health care and also ensure sustainable Financing arrangements that protect the poor for the free delivery policy in the country. From the Budget Statement and Economic Policy Of the Government of Ghana for the 2012 financial year an amount of GH textcentoldstyle 1,799,434,809.00 was allocated to fund interventions in the Health sector.

For the past three years the KNUST Hospital has not recorded any maternal death associated with high facility delivery. This could probably due to the good quality medical care and service delivery by the staff of the hospital and its state-of-the-art equipment. The empirical basis for defending these policies is weak in-spite of the government commitment to make health services assessable to vulnerable pregnant women in the region. This is so, because it has not been evaluated using rigorous mathematical methods. It is against this background that the current study was undertaken to evaluate and estimate the impact of the free maternal policy on the incidence of childbirth in the hospital .

1.5 Data Collection and Methodology

In order to achieve the objectives of the study, two set of secondary data were collected Kwame Nkrumah University of Science and Technology Hospital. The analyses would be centered on data accessible at the Bio-Statistics Department of the Obstetrics & Gynecology directorate of KNUST Hospital in Kumasi form the period 2000-2011. The data is;

1. Monthly recorded deliveries.

The Box-Jenkins ARIMA modeling procedure was used for the pre- intervention model. The intervention time series analysis technique was later applied to obtain a model in the form

$$Y_t = \sum_{t=1}^{n}(\sum_{i=1}^{m} f(I_{it})) + N_t \quad (1.1)$$

Where $f(I_t)$ is the intervention function of a discrete deterministic interrupted indicator at time t, N_t is the function of the ARIMA preintervention noise model, Y_t is the level of change with respect to gains or losses made in the delivery cases. In this study, the nature of impact (abrupt or steady) of the policy on facility delivery will be assessed. The goodness-of-fit was based on the Ljung-Box Q statistic, residuals analyses and Normality Q-Q plots to determine the adequacies of the models chosen. R-consol software was used to run the whole data.

1.6 Limitation of the Research

The research focused on impact of the Exemption Fee Delivery and Free Maternal Health Care on assisted deliveries in KNUST Hospital and KATH in kumasi. By using data set from 2000 to 2012 on monthly recorded childbirth in Bio-Statistics

Department of the Obstetrics & Gynecology directorate of these hospital. It is also envisage resource inadequacy and unavailability of relevant literature was also a major limitation. The study was structured within the borders of the thesis objectives.

1.7 Thesis Organization

This thesis is organized into five chapters. The first chapter provides the introduction which consists of background of the study, research problem, research question, research objective, justification, scope and limitation of the study, data analysis and data collection. The second chapter consists of a literature review on previous intervention time series analyses that have been used to assess policies. Method of intervention time series analysis proposed by Box and Tiao (1975) used was discussed in third chapter. The fourth chapter presents the result of the analysis of the monthly delivery patterns in the hospital and pre- and post-intervention models obtained and data collection. Fifth chapter provides the findings, conclusion and recommendations

Chapter 2

Literature Review

2.0 Introduction

Certainly segmented intervention analysis has been applied in a lot of research works to assess the impact of policies implemented. This chapter principally reviews previous applications of intervention analysis undertaken by different authors with much emphasis in the health sector. There will also be a review of user free policy introduced in other part of the world and outcome so far as well as reforms made to these policies.

2.1 Intervention Analysis

Intervention analysis by (McDowall, et. al.,1980) presented a set of techniques for the analysis of the impact of intervention upon single time series of data which complement the earlier work in time series by Charles Ostrom Jr (1978). Analyst should be very knowledgeable in elementary time series techniques, regression analysis or algebra before undertaking such analysis. Interrupted time series technique suggested by Campbell and Stanley (1966) sometime known as quasi-experimental time series and currently intervention analysis require the development of model of the process underlying a time series of data. Thus, one has to model a single time series of data using the general class of ARIMA models as discussed in the next chapter. This work was initially advanced by Box and Tiao (1975); Glass, Wilson and Gottman (1975); and McCleary and Hay (1980). The models developed are passed through various processes to identify best out of the lot. The second part of the process is to estimate ARIMA model to assess the impact of external intervention on time series of data. The impact can be Abrupt, permanent and abrupt, temporary intervention in contrast to gradual and permanent.

It applications can be seen in the some of the sector below:

1. Political scientists might find them appropriate for assessing the impact of change in laws that govern the behaviour of individuals in the nation.

2. Economists use(interrupted Time Series) ITS for determining whether changes in credit control produce changes in the borrowing behaviour of business and consumers.

3. Sociologists employ ITS for evaluating how income maintenance experiments affect the behaviour of individuals participating in welfare program.

4. Psychologist and educator might wish to use this technique (ITS) to test and measure the impact of treatment in quasi-experimental setting where more conventional experimental techniques would be inappropriate (McDowall et. al. 1980).

This method of analysis is also associated with Health professionals and administrators when it's employed assess whether major treatment or health policy had an impact on the behavior of the targeted group which will be our focus in this section.

According to (Biglan, Ary, and Wagenaar., 2000), Countless number community interventional research is advocated to use of intervention analysis. He further stated that intervention analysis facilitate the development of knowledge about the effects of community interventions and policies in circumstances which randomized controlled trials are too expensive, premature or simply impractical. Mostly, a multiple baseline time-series design which involves two or more communities or periods are repeatedly assessed, with the intervention introduced in one community at a time. It is predominantly appropriate for evaluation of community interventions and the modification of those interventions.

In (Michielutte et. al., 2000), although not yet widely used in health sector, studies which have reported successful use of regression analysis to analyze single-group interrupted time-series designs include an evaluation of alcohol treatment programs (Berman et. al., 1984), assessment of the effects of changes in Medicaid reimbursement procedures on nursing home costs (Coburn et. al., 1993) and evaluation of a program to improve the diet of elementary school students (Coates et al., 1981). Other studies had also used an interrupted time-series design with non-equivalent control groups to evaluate the effectiveness of a perinatal care program in North Carolina (Gillings et. al., 1981) and a program to increase the participation of volunteers in hospital care for elderly patients (Laitinen et. al., 1996). The addition of a control group to an interrupted time-series design results in a particularly strong design that allows control for history if the intervention and control groups are exposed to the same non-program influences.

According to Fretheim et. al. (2009), crediting an observational change to a programme or policy require a comparison between the individuals or groups exposed to it at different time period of these policies with those not involved. It is also essential that the compared group or periods are identical as possible in order to rule out influence of external factors as well as ensure fairness. One may resort to randomization which is not always possible because of its complexity. Alternatively, intervention analysis may be used in which data are collected from numerous time points before, during, and after programme implementation.

Khuder et. al. (2007), employed intervention analysis to assess the impact of clean indoor air ordinance banning smoking in workplaces and open places on hospital admittance for smoking-related diseases in March 2002, the city of Bowling Green, Ohio. A quasi-experimental design with interrupted time-series was used including a matched control city (Kent, Ohio) with no clean indoor air ordinance. He concluded that there was a decline in admission rates for smoking-related diseases in Bowling Green compare to Kent. The Clean Indoor Air Ordinances (CIA) ordinance in Bowling Green Ohio was associated with a statistically significant decrease 39% after 1 year and by 47% after 3 years in hospital admission rates for Coronary Heart Disease (CHD). In the light of this civil and public health leaders at the local and state levels should be encourage to keep on promoting clean indoor air ordinances as an efficient method of protecting and supporting the health of the American public.

Madden et. al. (2004), conducted a research to assess the effects of an early postpartum discharge program and a subsequent legislative mandate for 48 hours of hospital coverage on incidence of newborn jaundice and feeding problems. Interrupted time series design (Box and Tiao, 1975) was carried out on retrospective data from the automated medical records of Massachusetts Health Maintenance Organization (MHMO). A population of 20,366 mothers to infant pairs with normal vaginal deliveries between October 1990 and March 1998 was used. They found an abrupt surge in jaundice -related measures and identification of infant feeding difficulty was not related to changes in length of stay in health facilities. Instead, these increases seem to be as a result of more frequent appraisal of newborns during the critical period of 3 to 4 days and may also have been elevated by a new climate of concern about neonatal susceptibility.

According to Ikeda do-Carmo et. al. (2011) in 2006, Brazil began routine immunization of infants less than 15weeks of age with a single-strain rota-virus vaccine. The program was assessed to determine whether the rota-virus vaccination program was related with decline in childhood diarrhoea deaths and hospital attendance. Intervention analysis was used to analysis monthly mortality and admission rates valued for the years after the introduction of the rota-virus vaccination (2007-2009). This was paralleled with expected rates calculated from pre-vaccine years (2002-2005) modifying for secular and cyclic trends. The result was that during the three years succeeding rota-virus vaccination, the rates of diarrhoea-related mortality and admissions among children less than 5years of age were 22% and 17% lower than estimated, respectively. There were 130,000 fewer admissions and approximately 1,500 fewer diarrhoea deaths were detected among children under 5years during the three years after rota-virus vaccination. The prevalent declines in diarrhoea-related mortality and hospital admissions for diarrhoea were among children younger than 2 years, who were qualified for vaccination as infants compare to those unqualified. He concluded that the reduced diarrhoea burden in this age group was accompanied with introduction of the rota-virus vaccine.

Morgan (2007), employed intervention analysis of Box and Tiao to evaluate whether the recent reduction in the number of paracetamol deaths is different to trends in fatal poisoning involving aspirin, paracetamol compounds, antidepressants, or non-drug poisoning suicide. Using ordinary least-squares regression the model generated from age-standardized mortality rates data for paracetamol poisoning in England and Wales between 1993 and 2004 there were about 2,200 deaths involving paracetamol. The age-standardized mortality rate rose from 8.1 per million in 1993 to 8.8 per million in 1997, afterwards it fell to about 5.3

per million in 2004. After the regulations were introduced, deaths decreases by 2.69 per million. In conclusion introduction of regulations to limit availability of paracetamol concurred with a decline in paracetamol poisoning mortality. Conversely, fatal poisoning involving aspirin, antidepressants, and to a lesser degree, paracetamol compounds, also showed similar trends.

Adjepong (2012), used the intervention time series analysis of Box and Tiao to estimate the level and nature of impact of the national mass spraying and the cocoa Hi-technology Government intervention programmes, implemented in 2002 and 2003 respectively, on cocoa production in Ghana. Annual time series cocoa production data obtained from the Monitoring, Research and Evaluation Department of Ghana's COCOBOD between the period of 1948 and 2011 was used. Outcome from the study indicated that the preintevention period could best be modelled with an AR (1) process. The effects of both intervention programmes were found to be abrupt and permanent. The impact of the mass spraying programme was estimated to have had a significant increase of 182,398.2 metric tonnes annually. It was also found that the cocoa Hi-technology programme significantly increased production by 266,515.1 metric tonnes per annum. The government is therefore encouraged to expand the policy to cover all corners of the country to increase cocoa production in the country.

According Fleming and Becker (1992), the State of Texas implemented a mandatory total motorcycle helmet law for all operators and passengers, effective September 1, 1989. To measure the impact of this intervention on incidence of both total and head-related fatalities, Box-Tiao time-series intervention analysis was used to estimate secular trends before and changes after the implementation of the law. Since failure to consider trends prior to the law's implementation would lead to bias estimation of the true effect. The data was gathered from Department of Public Safety monthly injury accident over a six year period of the traffic accident reports filed for each motorcycle injury accident. The resulting estimated trends in total fatalities prior to the law approximated the 9.4% average annual decline in motorcycle registrations. Additional declines of 12.6% and 57.0% were estimated for total and head-related fatalities during the year after the law was introduced. While previous findings show that there was no statistically significant decline in head-related deaths prior to the implementation of the law ($t = -.80$). The t-values of the intervention effect (-.845) and autoregressive effect of order 12 (-.558) reveal statistically significant influences with the one-tailed t = -5.34, $P < .0005$ for the law's effect.

The above discussion has mainly highlighted the use of intervention analysis as an analytical and a forecast tool in a wide variety of applications. It reviews a range of previous applications of intervention analysis that have been used by various researchers since its original development by Box and Tiao (1975). From the review, we could affirm that the intervention analysis, as being used by many analysts is a powerful statistical technique in evaluating or assessing the impact of events, policies or shocks on time series data.

2.2 Health Delivery Policies

Presently, there is a debate about whether maternal health can be improved by removing the financial barrier in assessing health services through the implementation efficient interventions via large scaled facilities and community-based services. Resent study have disclosed that fee exemption policy for pregnant women has really helped to improve maternal health especially in sub-Saharan Africa (SSA) where maternal health is a serious problem. The following are some studies confirming the success of these health policies.

The importance of provision and utilization of maternal health care in enhancing child survival and reducing maternal mortality has long been recognized. To establish the level of awareness of antenatal care, the timing of antenatal clinic visit, the level of utilization of maternal health care a study was conducted in Teso District between 2000 and 2001. The results obtained indicated that though most of the respondents were aware of the importance of antenatal care, majority sought antenatal care, late in pregnancy, made few antenatal visits, and most of the childbirths took place at home. The traditional birth attendants and nurse/midwives were the main providers of maternal health care. The obstacles to utilization of maternal health care are manifold. The major constraints are unavailability and inaccessibility of health facilities, poverty, and exorbitant user charges and associated cost, and poor service offered at local health facilities. Reducing or removal of these obstacles would result in increased utilization off maternal health care among pregnant women to reduce maternal mortality and increase childbirth survival in the district (Ikamari, 2004).

Montagu et. al. (2011), conducted a research to find the best way of making interventions accessible to larger proportion of pregnant women globally. The study examined delivery location and attendance and the reasons women report for giving birth at home with maternal delivery data from Demographic and Health Surveys in 48 developing countries from 2003 to 2011. For sub-Saharan Africa (SSA), where mortality rates, they considered a subsample analysis of motivations for giving birth at home. In SSA, 54.1% of the richest women reported using public facilities compared with only 17.7% of the poorest women. Among home births in SSA, 56% in the poorest quintile were unattended while 41% were attended by a traditional birth attendant (TBA), 40% in the wealthiest quintile were unattended, while 33% were attended by a TBA. Seven per cent of the poorest women reported cost as a reason for not delivering in a facility, while 27% reported lack of access as a reason. In Conclusions poor women deliver at home because of poverty or cost in health facilities. This advocate that, in efforts to reduce maternal deaths free delivery policy should be efficiently implemented or prioritizing community-based interventions aimed at making home births safer.

In another development a pilot study was conducted in Punjab, Pakistan sponsored by FIGO in the "Save the Mothers" maternal mortality project for exemption free delivery policy. The purpose of the project was to bring and improve basic extensive emergency obstetric care (EmOC) in a partial urban settlement and rural area of about 30 km from Lahore. Existing facilities within the rural health system without the deployment of additional specialist staff was used other than existing specialist. During the period of the study proportion of births at health care facilities of the project area increased by 283.25% (442 to 1694) and complications treated was 174.8% (379 to 1091). In addition the numbers of caesarean section increase from 62 to 310 in periods January-June 2000 and July 2001-June 2002. It was concluded the removal of financial barriers is essential for the accessibility of health care services by pregnant women. In addition the building of quality accessible local capacity for EmOC; the essential components being the premises, trained personnel, equipment, and availability of drugs and blood will help in the reduction of maternal mortality. Availability and provision of EmOC coupled with changes in the attitude of the population resulted in marked improvement of process (S.K.Lodhi, R.Sohail, F.Zaman, M.Tayyeb, and Bashir., 2004).

According to Ridde et. al. (2012), Burkina Faso have been subsidizing 80% costs of child birth since 2007.Thus Women are required to pay 20%, except the needy, who are exempted. The objective of the policy is to increase service utilization and reduce costs for households. To analyze the efficiency of the policy and the distribution of its benefits, a study was carried out in Ouargaye district. The analysis was based on two distinct cross-sectional household surveys, conducted before (2006) and after (2010 the policy, of all women who had had a vaginal delivery in a public health centre. Medical expenditure for delivery decreased from a median of 4,060 F CFA in 2006 to 900 F CFA in 2010 ($p < 0.001$). There was pronounced reduction in the distribution of expenses and a decrease in interquartile range. The greatest reduction in risk of excessive expenses was seen in women in the bottom quintile living less than 5 km from the health centers. This subsidy have been was more effective in Burkina Faso than in other African countries. All sort of the inhabitants benefited from this policy, including the poorest. Yet despite the subvention, women still carry a considerable cost burden; half of them pay more than they should, and few poor are fully exempted. Efforts must therefore be made to fully cover the poorest and also remove geographic barriers for all women.

Einarsdttir et. al. (2012), examined the effect of Australian Private Health Insurance Incentive (PHII) policy introduced in Western Australia (WA). Data was collected from January 1995 to March 2004 of about 230,276 birth admissions in administrative birth and hospital data-systems held by the WA Department of Health. They estimated and compared the average quarterly birth rates after the PHII introduction with expected rates had the reforms not occurred in public and private hospitals. The PHII policy introduction accounted for 51% raise in private birth rates as compared 20% decrease in public health without the policy. Unassisted and assisted vaginal deliveries decreases by 5% an and 8% respectively with a 5% increase in caesarean sections with labour and 10% increase in caesarean sections without labour . Likewise, rates of births with less than 3 days in hospital increased by 15% but birth rates of infant stayed 0-3 days in hospital following birth decreased by 20%. The conclusion was that PHII is associated with an increase in births in privately insured patients, caesarean deliveries and births with longer infant hospital stays. The reforms may not have been advantageous for quality obstetric care in Australia or the burden of Australian hospitals.

Renaudin et. al. (2007), stated that the high cost of emergency obstetric care

(EmOC) is a disastrous health expenses for households, causing delay in seeking and providing care in poor countries resulting in high prevalence of maternal death. To address this problem, the Nouakchott Ministry of Health introduced an Obstetric Risk Insurance to allow obstetric risk sharing among all pregnant women on a voluntary basis. The fixed premium (US$21.60) entitles women to an obstetric package including EmOC and hospital care as well as post-natal care. The poorest are enrolled at no charge, addressing the problem of equity. Even in this system where pregnant women were expected to make little payment the result was enormous. Utilization rates increased over the 3-year period of implementation resulting in 95% of pregnant women in the catchment area (48.3% of the city's deliveries) enrolled. Basic and comprehensive EmOC were now provided 24 hours a day. In conclusion the program generated US$382,320 revenues, more than twice as much as current user fees. All recurrent costs other than salaries are covered. It also guaranteed access to obstetric care to all women at an affordable cost.

Lagarde and Palmer (2008), assessed the effect of the intervention by measuring its impact in terms of changes in service utilization (including equity outcomes), household expenditure or health outcomes. Quasi-experimental study designs were considered: Cluster Randomized Controlled Trials (C-RCT),Controlled Before and After (CBA) studies and interrupted time series (ITS) studies. Only studies reporting effects on health service utilization, sometimes across socio-economic groups, were acknowledged. Removing or reducing user fees was found to increase the utilization of health-giving services and perhaps preventive services as well, but may have negatively impacted service quality. Increasing fees reduced the utilization of some health-giving services, even though quality upgrading may have helped maintain utilization in some cases. When fees were either introduced or removed, the impact was immediate and abrupt. Studies did not adequately show whether such an increase or reduction in utilization was continuous over a longer period. There is a need for more high-quality research investigating the effect of changes in user fees for health services in low- and middle-income countries.

Adjepong et. al. (2012), employed intervention analysis of Box and Tiao to access effects of the free maternal health care policy on maternal enrollment at the Mampong Government Hospital from January 2001 to December 2011. The police had two phase implementation, exemption from delivery fees in April 2005 and a free maternal care in July 2008. The aim was to help address the high maternal mortality issue and to also replace the cash and carry healthcare system. The policy confirms government of Ghana and other sister countries commitment to the Millennium Development Goal 5, to help improve maternal healthcare. Results from the estimated intervention model showed an insignificant change of approximately 9 pregnant women from the first policy. The free maternal care policy rather showed a significant additional enrollment of 90 women at the hospital. Providing quality maternal and neonatal healthcare can effectively for vulnerable women achieve if financial barriers are removed.

Aikins (2010), revealed in her study title "Female Health and Development; A case study regarding a maternal Health Scheme in Ghana" that maternal deaths have not actually even since the inception of the Free Maternal Health Care policy at Komfo Anokye Teaching Hospital (KATH) in Kumasi. The study brought to bare the poor skilled birth attendants delivery to pregnant woman ratio. The ratio is one doctor is to 17,733 and the Nurse-Population ratio is 1: 1,510 with disparities between urban and rural settings and dwellers. In Kumasi for instance, the Ratio of Midwives to Women of Reproductive Age is 1:427. She was endeavoring to find out whether the free antenatal and delivery care made available by the Ghanaian government was encouraging pregnant women to access the facility in order to improve maternal health and also contribute to the reduction in maternal deaths. A total of three health personnel's and fifty-five pregnant women where involve in study. Semi structured interviews and observation were the main tools employed for data collection.

Furthermore in Asante et. al. (2007), there was a statistically significant reduction in the mean out-of-pocket payments for Caesarean Section (CS) and normal delivery at health facilities after the introduction of the reduced user fee policy. The percentage decline in normal delivery was 25.80% while CS reduced by 28.40% reflecting a decrease in incidence of disastrous out-of-pocket payments. At lower threshold, the incidence of catastrophic delivery payment was concentrated more amongst the poor. For the poorest group household out-of-pocket payments in excess of 2.5% of their pre-payment income dropped from 54.54% of the households to 46.38% after the exemption policy. The policy had a more positive impact on the extreme poor than the poor. The richest households had a decline in out-of-pocket payments of 21.51% while the poor households had a 13.18% decline. In conclusion the policy was favorable to users of the service. Nonetheless, the rich benefited more than the poor. There is need for proper targeting to recognize the poorest of the poor before policies are executed to ensure utmost benefit by the target group.

Witter et.al. (2009), examined the impact of the implementing a national policy exempting pregnant women from paying delivery cost in public, mission and private health facilities in Ghana between 2005-2006. Delivery exemptions in the country can be effective and cost-effective, and that despite being universal in application, they can benefit the poor. Nonetheless these policies are faced with certain challenges such as inadequate funding, and lack of strong institutional ownership. It is therefore important to supervise that financial transfers reach service provided and also to ensure that providers are passing on benefits in full, while being adequately reimbursed for their loss of revenue. Heedful thought should also be given to staff motivation and the role of different providers, as well as quality of care constraints, when designing the exemptions policy. All of this should be supported with realistic approach for monitoring and assessment. They concluded that recent movement towards making delivery care free to all women is a courageous and appropriate action which is supported by evidence from within and beyond Ghana. However, the potential of translating into reduced mortality for mothers and babies basically depends on the effectiveness of its implementation.

According Dzakpasu et. al. (2012), many sub-Saharan countries, including Ghana, have introduced policies to provide free medical care to pregnant women. Time-series analysis was used to assess t he impact of 2005 policy on free delivery care and its 2008 policy on free national health insurance for pregnant women in the Brong Ahafo Region of Ghana .The impacts on facility delivery and insurance coverage, and on socio-economic differentials in these outcomes after controlling for temporal trends and seasonality was estimated. During the period under review Facility delivery increased by 2.3% and 7.5% for the 2005 and 2008 policies respectively after the policies were introduced. Health insurance coverage also jumped significantly 17.5%, after the 2008 policy. The increases in facility delivery and insurance were utmost among the poorest, leading to a decrease in socio-economic inequality in the region. In Conclusion Providing free care, mostly through free health insurance has been efficient way of increasing facility delivery in the Brong Ahafo Region, particularly among the poor. This finding should be considered when evaluating the impact of the National Health Insurance Scheme and in supporting the maintenance and extension of free delivery care.

Arthur (2012), conducted a study to examined the effect of free maternal health care policy, to eliminate the cost obstacles to the use of Antenatal care (ANC) in Ghana using data from the 2008 Ghana Demographic and Health Survey (GDHS 2008). The minimum recommended number of four visits ANC per the World

Health Organization (W.H.O) protocol before delivery. The study was pivoted on the institution of the free maternal health care policy in April 2005 in Ghana with the intention of decreasing the financial obstacle to the use of maternal health care services and to help reduce the high rate of maternal mortality. He concluded that the free maternal health policy may had increased the utilization of ANC. Nonetheless adequate utilization has still not been achieved because affordability as proxies by wealth is still a problem to some expectant mothers, especially, those within the lowest wealth quantiles.

Ameyaw (2001), conducted a study to assess the impact of the free maternal care policy on women of child bearing age (10-49) with sample size of six hundred under utilization of care services in the New Juaben municipality. The findings review a small decrease in maternal mortality as compared with the number of death in 2007 and antenatal attendance also increased over the years. This was attributed to the introduction of the free maternal healthcare policy. Nonetheless, quality of care still remains a problem due to the massive attendance. Findings show that there is still a great need to introduce other measures to reduce maternal mortality in the municipality. It was recommended that quality of care must be addressed to improve maternal health survival and steady and secure funding must be in place to ensure that the policy is sustainable, so that the policy can be strengthened.

Penfold et. al. (2007), carried out a study to establish changes in the proportion of deliveries at health facilities and the percentage assisted by health professionals after delivery fee exemption implementation. Cluster-sampled household survey of Central and Volta regions of Ghana based on Pre and post intervention data was collected . The data was collected from women who had delivered in these regions during the fee exemption policy and a corresponding period of time preceding to it. After fee exemption implementation the possibility of delivering in a health facility improved significantly in both Central ($1.83, p < 0.001$) and Volta ($1.34, p < 0.05$) region. Outcome from Central Region showed increases in facility deliveries mostly occurred in health centres (from 13.7% to 22.3% of deliveries), and were attended by midwives (from 49.0% to 59.7%). The greatest increase in the proportion of deliveries taking place in facilities occurred among women with the lowest levels of education and wealth in both region . They concluded that, after the implementation of fee exemption the proportion of deliveries in health facilities increased in both regions. Particularly , this occurred among the poorest and least educated women in the regions. Therefore ensuring the sustenance of the policy would particularly benefit women with the greatest financial barrier to health care and at the greatest risk of maternal mortality.

Agar and Noemi (2010), conducted a study to assess the potential effect of health insurance on access to health service in Africa. They focused on the National Health Insurance Scheme (NHIS) introduced in Ghana in 2003. The study used the national-representative household data from the Ghana Demographic and Health Survey in 2008. Their results revealed that the NHIS has had a positive and significant effect on utilization of health care services. Particularly in areas like: antenatal checkup before delivery, delivery in institution (public or private hospital), and number of assisted delivery by a trained person. They concluded that since a greater utilization of health care services,especially during the peri-natal period, have a positive effect on current and future health status of the women and their children, the health care authorities in Ghana should make any effort in extending coverage. Enrolment cost was also seen as one of the major obstacle to enrolment.

From the above it can be seen that Maternal Health Care policy is very beneficial to all categories of pregnant women especially the poor by reducing the financial barrier in accessing health care.

Chapter 3

Methodology

Introduction

This chapter discusses the fundamental theory of Time Series with regards to its definition, formulation, component, objectives and the method of analysis of the current data to arrive at the objective. It also examines the theory of Univariate Time Series process with much emphasis on the generally known Box and Tiao Intervention Analysis. The Box and Tiao segmented Intervention procedure for time series which will be used comprehensively to model the impacts of the policy using the R-console software.

3.1 Basic Definitions

Time series are sequentially repeated measurements or observations of one or more variables over time. Sometimes the observations are from a single case, but more often they are aggregate scores from many cases at equal time interval. For example, daily sale or number of customer in shop and monthly childbirth recorded in a hospital all of these observations tracked over substantial time. In notation, it can be stated as $\{Y_t\}$, where $t = 1, 2, 3, 4, 5, \ldots, T$.

The expected value and variance of Y at t is given by,

$$mean : E(Y_t) = \mu_t \tag{3.1}$$

$$variance : E\{(Y_t - \mu_t)^2\} = \sigma_t^2 \tag{3.2}$$

3.1.1 Elements of Time Series

Monitoring, forecasting, Description and comparison are the fundamental reasons for under taking time series analysis. Before this can be done the pattern of the data as observed in a time plots, mostly cyclic, seasonal, trend and irregular patterns have to be determine.

Trend Pattern (T)

It's difficult to define a trend because of the length magnitude attached to it. Basically it's the rise and fall in a data over a long period. For example the impact of a product introduced by an industry on daily sales. This type of variation is present when a series exhibits steady upward growth or a downward decline, at least over several successive time period . Trend can also be considered long-term change in the mean level (Chatfield ,2000).

Seasonal Pattern(S)

This is when series are subjected to periodic or seasonal influence for data collected daily, weekly, monthly, quarterly or annually. Such a pattern is normally observed in the marketing sector. For example increase in the sale of jackets during winter, high voltage recorded in the evening and sales of books when school re-opens. These pattern may "not repeat" themselves exactly over each period.

Cyclic Pattern(C)

A cyclic variation occurs when data increases and decreases in an irregular period. This is mostly associated with the business sector where sales of product exhibit such type of pattern in the business cycle. This may be due to factor such as social, Religious, economic, political or weather. Cyclical pattern occurs at a longer and a variable degree than seasonal pattern. Another major distinction between a seasonal and a cyclical pattern is that the former is of a constant length and recurs on a regular periodic basis, while the latter varies in length and magnitude.

Irregular Variations

The expression 'irregular variations' is often used to illustrate any variation in a series after trend, seasonality and other regular effects have been removed. As such, they may be absolutely random in which case they cannot be forecast. However, such series may demonstrate short-term correlation .

3.2 Basic Objective of Time Series Analysis

Time series analysis may be undertaken for numerous reasons. Below are some basic reasons for performing time series analysis.

Forecasting : is one of the essential practices in time series analysis thus, foretelling future values for an observed series. Forecasting into the future is a means of monitoring progress toward a national or local objective or simply providing an estimate of the rate of future occurrence. Projecting the potential number of future cases can aid in the planning needed (Rosenberg, 1997).

Description : In time series analysis one has to plot the data set against time to study the descriptive nature of the series. These plots may show trend, seasonal and cyclic variations as explained earlier in the series. Other key features that can be observe in the plot of time series are turning points, where, for example, an increasing trend has suddenly changed to be a decreasing trend and outliers which do not appear to be more consistent with the rest of the data.

Monitoring : The utmost general goal of trend analysis is to determine whether the level of an observed variable for example health status, services provided, production quantity or quality and systems indicator has increased or decreased over time, and if it has, how quickly or slowly the raise or fall has occurred. Thus in monitoring the analyst tries to study the steady impact of a policy on a series.

Comparison: Comparing one time period to another time period, for instance, assessing the level of an indicator before and after an introduction of a policy and analysis of the population differences is another basic reason for time series analysis. Analysing the trend over time can provide information about the changing rates and disparities in the rates (Rosenberg,1997).

3.3 Models of Time Series Analysis

3.3.1 Dependent Variable

In time series modeling the dependent variable is a score at one time period (Y_t). The score can be from a single case or an aggregate score from numerous cases. For instance assessing the incidence of childbirth recorded in a health facility is an example of a single case. A multiple case may be how deficiency in nutrients like protein, vitamin and calcium that accounts for malnutrition in children.

3.3.2 Random Shock

The random shocks in time series analysis are reflected by the residuals after an adequate model is identified. Shocks are similar to the error terms in regression analysis. The error term may exhibit the following potential pattern over time: linear (where the mean is steadily increasing or decreasing over time), quadratic (where the mean first increases and then decreases over time, or verse versa), or something more complex. These patterns are not mutually exclusive; two or all more can be superimposed on the random process.

3.3.3 The Autoregressive Model (AR)

AR is the simplest form of the ARIMA model based on the idea that current valves of the series Y_t can be explained by past valves, $Y_{t-1}, Y_{t-2}, \ldots\ldots Y_{t-p}$. The number of terms in the model that describe the dependency among successive observations is "P". Each term has an associated correlation coefficient that describes the magnitude of the dependency. Let Y_t stand for the value of a stationary time series at time t , that's, a time series that fluctuates about a constant mean and variance value . By autoregressive, we assume that current Y_t values depend on past values (lags) from the same series thus $Y_{t-1}, Y_{t-2}, \ldots, Y_{t-n}$. In symbol AR model is represented as

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} + \varepsilon_t \tag{3.3}$$

where α is the constant term, $\beta_1, \beta_2, \ldots, \beta_p$ is the coefficients to be estimated and ε_t is the random error with mean zero and constant variance. If Y_{t-p} is the furthest value with a non zero coefficient, the AR model is said to be of order p, denoted by AR (p) (Hartmann et al, 1980).

3.3.4 The Moving Average (MA) Models

An AR model where the current observation depends on all past observations would have too many parameters (β_s) to make estimation possible. However, if the parameters themselves are given by few parameters, then estimation becomes simple. For instance, if ($\beta_i = -\Theta^i$) in equation 3.4

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_p Y_{t-p} + \varepsilon_t \tag{3.4}$$

such that;

$$Y_t = -\Theta Y_{t-1} - \Theta^2 Y_{t-2} - \Theta^3 Y_{t-3} - \ldots.. - \Theta^p Y_{t-p} + \varepsilon_t \quad (3.5)$$

(we assume α is zero without loss of generality)

Solving for ε_t gives

$$\varepsilon_t = Y_t + \Theta Y_{t-1} + \Theta^2 Y_{t-2} + \Theta^3 Y_{t-3} + \ldots\cdots + \Theta^p Y_{t-p} \quad (3.6)$$

Similarly for the expression ε_{t-1} multiply by Θ we get

$$\Theta\varepsilon_{t-1} = \Theta Y_{t-1} + \Theta^2 Y_{t-2} + \Theta^3 Y_{t-3} + \ldots\ldots + \Theta^p Y_{t-p} \quad (3.7)$$

Equation (3.6) -(3.7)

$$Y_t = \varepsilon_t - \Theta\varepsilon_{t-1} \quad (3.8)$$

From the above it is clear that Y_t as a linear function of all past lags is equivalent to Y_t as a linear function of only few past shock thus, depends only on current input and q prior inputs. Y_t is the weighted average of the uncorrelated ε_t (errors). In general

$$Y_t = \varepsilon_t - \Theta_1\varepsilon_{t-1} - \Theta_2\varepsilon_{t-2} - \Theta_3\varepsilon_{t-3} - \ldots\ldots - \Theta_q\varepsilon_{t-p} \quad (3.9)$$

Hence moving average of order q or MA(q)

3.3.5 Autoregressive Moving Average (ARMA) Models

We can combine the AR and MA models for stationary series to account for both past values and past shocks. Such a model is called an ARMA (p, q) model with p order AR terms and q order MA terms. For example, one ARMA (3, 2) model is written as

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \varepsilon_t - \Theta_1 \varepsilon_{t-1} - \Theta_2 \varepsilon_{t-2} \tag{3.10}$$

By permitting AR and MA terms in one model, we often need only limited parameters to describe a complex stationary series.

3.3.6 Continuous Versus Discrete-Time Series Modeling

An essential choice that have to be made is the question of discrete versus continuous time modeling. Some argue that life and event unfolds continuously proposing that a continuous time structure of measurement is more accurate (eg. modeling the arrival time of tourists in the airport). Others however maintain that discrete time modeling should be used since decisions are made and data released at discrete or specific equal time interval (Carlstrom, 2003). This study is a discrete time series model of monthly childbirth at KNUST hospital to assess the impact of the Maternal healthcare policy.

3.4 White Noise

A time series Y_t is called a white noise if Y_t is a sequence of independent and identically distributed random variable with finite mean and variance. In particular if Y_t is normally distributed with mean of zero and variance σ^2 the series is called a Gaussian white noise. For a white noise series all the autocorrelation functions (ACF) are zero. In practice if all sample ACFs are close to zero then the series is a white noise series. White noise draws its name from white light in which the power spectral density of the light is distributed over the visible band in such a way that the eye's three color receptors (cones) are approximately equally stimulated. In statistical sense, a time series Y_t is characterized as having weak white noise if Y_t is a sequence of serially uncorrelated $cov(Y_t, Y_{t-2}) = 0$ random variables with zero mean and finite variance. Strong white noise also has the quality of being independent and identically distributed, which implies no autocorrelation. White noise is used as a basic building block for intervention analysis.

3.5 Stationary and Non Stationary Time Series

A non-stationary data have mean, variance and covariance that change over time. This behaviour can be trends, cycles, random walks or combinations of the three. Hence the results obtained by using non-stationary time series may be unauthentic, in that they may indicate a relationship between two variables which do not exist. If a time series is not stationary then it is said to be non-stationary. On the other hand a stationary series will return to its mean (mean reversion) and fluctuations around this mean will have broadly constant amplitude. Thus time series is said to be strictly stationary if the joint distribution of $Y_{t1}, Y_{t2}, Y_{t3}, \ldots\ldots\ldots Y_{tn}$ is identical to the joint distribution of $Y_{t1+T}, Y_{t2+T}, Y_{t3+T}, \ldots\ldots\ldots, Y_{tn+T}$ for all $t_{1+T}, t_{2+T}, \ldots\ldots, t_{n+T}$ .Thus, shifting the time position by T periods has no impact on the joint distributions. If a series is stationary, the magnitude of the autocorrelation decreases fairly rapidly, whereas that of a nonstationary series reduces gradually over time. This means stationarity condition ensures that the autoregressive parameters in the estimated model are stable within a certain range and the moving average parameters also invertible (Asomaning, 2012).

3.6 Forms of non-stationary processes.

Normally non-stationary processes may be random walk with or without a drift (a slow steady change or a random variation around a non zero mean) and deterministic trends (trends that are constant, positive or negative, independent of time for the whole life of the series).

3.6.1 Pure Random Walk

$$Y_t = Y_{t-1} + \varepsilon_t \tag{3.11}$$

Equation (3.11) is a random walk at "t" with a stochastic component ε_t which is a white noise, thus idd $\sim(0,\sigma^2)$ can be considered as a process merged of some order, a unit root or a process with a stochastic trend. It is a non-mean reverting process that can move away from the mean either in a positive or negative direction. It's variance evolves over time and goes to infinity as time goes to infinity.

Example : $Y_1 = Y_0 + \varepsilon_1, Y_2 = Y_1 + \varepsilon_2, Y_3 = Y_2 + \varepsilon_3$.

thus,

$$Y_3 = Y_0 + \varepsilon_1 + \varepsilon_2 + \varepsilon_3 \tag{3.12}$$

such that

$$Y_t = Y_0 + \Sigma\varepsilon_t \tag{3.13}$$

Therefore, $E(Y_t) = Y_0$, since errors have zero expectation and var $(Y_t) = t\sigma^2$ i.e. it's dependent on time. Thus, Random Walk Model (RWM) without a drift is a nonstationary process. Although it's mean is constant over time, its variance increases over time.

3.6.2 Random Walk with Drift

$$Y_t = \alpha + Y_{t-1} + \varepsilon_t \tag{3.14}$$

If a random walk model predicts that the value at time "t" will equal the last period's value plus a constant (α), and a white noise term (ε_t), then the process is random walk with a drift. Example :

$$Y_1 = \alpha + Y_0 + \varepsilon_1, Y_2 = \alpha + Y_1 + \varepsilon_2, Y_3 = \alpha + Y_2 + \varepsilon_3, \tag{3.15}$$

by simple substitution,

$$Y_3 = Y_0 + \alpha + \alpha + \alpha + \varepsilon_1 + \varepsilon_2 + \varepsilon_3 \tag{3.16}$$

such that

$$Y_3 = Y_0 + \Sigma\alpha + \Sigma\varepsilon_t \tag{3.17}$$

Therefore, $E(Y_t) = E(\alpha t + Y_0)$, since errors have zero expectation. Similarly, $var(Y_t) = t\sigma^2$. Hence, RWM with a drift is a non stationary process: both its mean and variance changes over time.

3.6.3 Determinstic trend

$$Y_t = \alpha + Y_{t-1} + \beta t + \varepsilon_t \tag{3.18}$$

Often a random walk with a drift is confused for a deterministic trend. Both include a drift and a white noise component, but the value at time "t" in the case of a random walk is regressed on the last period's value (Y_{t-1}), while in the case of a deterministic trend it is regressed on a time trend βt. If the trend in a time series is a deterministic function of time, such as t , we call it a deterministic trend (predictable). A non-stationary process with a deterministic trend has a mean that grows around a fixed trend, which is constant and independent of time.

To organize such series for statistical modeling, the series has transformed to stationarity either by taking the natural log, difference, or by taking residuals from a regression. If one can transform the series to stationarity by de-trending it in a regression and using the residuals, then we say the series is trend-stationary (Yaffee and McGee, 2000).

3.7 Differencing

Is Calculating the differences among pairs of observations at some lag to make a non- stationary series stationary. We can remove trends and cycles from a series through differencing. For example, suppose t is in months and Y_t is a series with a linear trend. That is, every month the series increase on average by some constant C. Since $Y_t = C + Y_{t-1} + \varepsilon_t$, where ε_t is a " random noise" with expectation zero. By differencing we get, $Y_t - Y_{t-1} = C + \varepsilon_t$. Thus, $C + \varepsilon_t$ is stationary series with linear trend removed. We can now apply the ARMA model to $Z_t = C + \varepsilon_t$, even though it was not appropriate to do so to Y_t directly. Once an ARMA model for Z_t is known, we could reverse the differencing to the original Y_t by the process integration.

3.7.1 Bachshift Operator

Backshift operator, B operates on an observation Y_t by shifting it one point back in time thus, $B(Y_t) = Y_{t-1}$. B may be exponentiated as:

$$B^2 = B[B(bY_t)] = B(Y_{t-1}) = Y_{t-2}. \tag{3.19}$$

In general $B^p(Y_t) = Y_{t-p}$. For example, in backshift notation, differencing once is $Z_t = (1 - B)Y_t$. For the general case, involving differencing 'd' times $Z_t = (1 - B)^d Y_t$ Using backshift notation, the ARIMA model equation,

$$Z_t = \alpha + (\beta_1 Z_{t-1} + \ldots\ldots + \beta_p Z_{t-p}) - (\Theta_1 \varepsilon_{t-1} + \cdots + \Theta_q \varepsilon_{t-p} + \varepsilon_t) \tag{3.20}$$

Becomes

$$Z_t = \alpha + (\beta_1 B + \ldots\ldots + \beta_p B^p) Z_t + (1 - \Theta_1 B - \cdots + \Theta_q B^q)\varepsilon_t \tag{3.21}$$

rearranged eqt (3.20) and substituting $Z_t = (1-B)^d Y_t$

$$(1-\beta_1 B - \ldots\ldots - \beta_p B^p)(1-B)^d Y_t = \alpha + (1-\Theta_1 B - \cdots - \Theta_q B^q)\varepsilon_t \quad (3.22)$$

To simplify notation further, the autoregressive polynomial,
$(1-\beta_1 B - \ldots\ldots - \beta_p B^p)$ is often abbreviated as $\beta(B)$

$\Theta(B)$ for the moving average polynomial 1- $\Theta_1 B - \cdots - \Theta_q B^q)\varepsilon_t$
Finally, $(1-B)^d Y_t = \frac{\alpha}{\beta(B)} + \frac{\Theta(B)}{\beta(B)}\varepsilon_t$

3.7.2 Lag

A lag is the time period between two observations, example, lag 1 is between Y_t and Y_{t-1}. Time series can also be lagged forward, Y_t and Y_{t+1}. The p^{th} order differencing is illustrate as similar to a number of lag as shown below

$Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \cdots + \phi_p Y_{t-p} + \varepsilon_t$, for all t. But $Y_{t-j} = L^j Y_t$
So $Y_t = \phi_1 L Y_t + \phi_2 L^2 Y_t + \ldots\ldots + \phi_p L^p Y_t + \varepsilon_t$

3.8 Building an Arima model

Building an ARIMA (p, d, q) model requires us to first determine the differencing (d orders), the AR terms needed (AR orders, p) and the MA terms needed (MA orders, q). This process is called model identification. We try to use the fewest number of these terms as possible. Once they have been identified, we can estimate the AR and MA parameters and check that the model fits adequately. When a reasonably fitting model has been derived, it can be used to generate forecasts, test for interventions, and predict the values of and explore the relationship with other series.

3.8.1 Test of stationarity and unit root test

In order to prevent spurious regression one has to test for the stastionarity of any data set before using it. Stationarity order guarantee that the autoregressive parameters in the estimated model are stable within a certain range as well as the moving average parameters invertible. Below is some of the proposed test for existence of stationarity or non stationarity .

Dickey-Fuller (Df test)

Time series data could be nonstationary due to the existence of deterministic trend, pure random walk and random walk with drift as discuss in section 3.7. We begin with the autoregressive process$Y_t = \rho Y t_1 + \varepsilon_t$. In theory, we can run this regression as in equation 3.11, 3.14, 3.17 and see if $\rho = 1$ to check for a nonstationary random walk (unit root) process, because of the presence of a unit root, the test-statistics for the ρ coefficient is severely biased. To eliminate this problem we take the first difference for these three equation by subtracting Y_{t-1} from each side of the equation to obtain :

1) $\phi Y_t = (\rho - 1)Y_{t-1} + \varepsilon_t$ A random walk (no drift and time trend)

2) $\phi Y_t = \alpha + (\rho - 1)Y_{t-1} + \varepsilon_t$ A random walk (with drift, no time trend)

3) $\phi Y_t = \alpha + (\rho - 1)Y_{t-1} + \beta t + \varepsilon_t$ A random walk (with drift and time trend)

where $\varepsilon_t \sim iid(0, \sigma^2)$. These models forms the basis of the Dickey-Fuller unit root test. The application of the DF test mainly depends on the regression context in which the lagged dependent variable is tested thus regressing ϕY_t on Y_{t-1}.

We test these equation with the hypothesis, let $\delta = (\rho - 1)$

$H_0 : \delta = 0$ (i.e there is unit root, and the series is non stationary)

$H_1 : \delta < 0$ (i.e there is no unit root and the series is stationary)

If $\delta = 0$ then from $\rho - 1 = \delta$ we can conclude that $\rho = 1$ as such that there is a unit root and we cannot reject the null. The alternative hypothesis is accepted for $\rho < 1$.

3.9 The Augmented Dickey-Fuller test

The test is conducted under the assumption that the errors (residuals) may be serially correlated. This test is performed "augmenting" the preceding 3 equations by adding the lagged values of the dependent variable, ϕY_t to eliminate the serial correlation.

The test is based on the following equation.

$$\phi Y_t = \alpha + \delta Y_{t-1} + \mu t + \sum_{i-1}^{m} \beta_i \phi Y_{t-i} + \varepsilon_t \qquad (3.23)$$

where α is the intercept, ε_t is the white noise and β_i, μ and δ are coefficients to be estimated. $\delta Y_{t-1} + \sum_{i-1}^{m} \beta_i \phi Y_{t-i}$ is the Augmented part, Y_{t-i} is the lagged term for Y_t and ϕY_{t-i} shows the lagged change. ADF equation has higher order lags of the differenced dependent variable which take cater for serial correlation. The number of lagged differenced terms is often determined empirically, the idea being to include enough terms so that we can obtain unbiased estimates of the δ, β_i and μ. Higher order differencing will be required in order to change the residuals into white noise, utmost care should be taken since over differenced series might also result to an MA unit root. Normally lag is set based on minimizing the Akaike Information Criterion (AIC) (Said and Dickey,1984).

3.10 Kwiatkowski, Phillips, Schmidt and Shin Test

Kwiatkowski et al(1992), provided straightforward test of the null hypothesis of trend stationarity against the alternative of a unit root. For this, they considered three-component representation of the observed time series $Y_1, Y_2, \ldots, Y_n$ as the sum of a deterministic time trend, a random walk and a stationary residual:

$Y_t = \beta t + (r_t + \alpha) + \varepsilon_t$

where: $r_t = r_{t-1} + u_t$ is a random walk, the initial value $r_o = \alpha$ serve as an intercept, t is the time index and u_i are independent identically distributed $(0, \sigma_u^2)$

$H_0 : Y_t$ is a stationary series

$H_1 : Y_t$ is a unit root process

3.11 Box-Jenkins ARIMA Process.

The Box and Jenkins (1970) procedure is the milestone of the modern approach to time series analysis. Given an observed time series, the aim of the Box and Jenkins procedure is to build an ARIMA model. The method suggested by Box and Jenkins came to be known as the Box-Jenkins methodology to ARIMA models, where the letter "I", flanked by AR and MA, stands for the expression "Integrated". Autoregressive (AR) models were first introduced by Yule in 1926; later in 1937 Slutsky subsequently complemented it with the moving Average (MA) model. It was Wald (1938), combined AR and MA schemes and showed that ARMA processes can be used to model all stationary time series as long as the appropriate order of "p ", the number of AR terms, and q, the number of MA terms are specified.. This means that any series Y_t can be modeled as a combination of past Y_t values and/or past (ε_t) errors (Makridakis and Hibon, 1993).

3.11.1 The Box-Jenkins Approach Proposes:

1. Short and seasonal (long) differencing to attain stationarity in the mean, and power transformation or logarithmic to realize stationarity in the variance.

2. Suggesting the use of autocorrelations and partial autocorrelation coefficients for determining appropriate values of p and q (and their seasonal equivalent P and Q when the series exhibited seasonality),

3. Providing a set of computer programs to help users identify appropriate values for p and q, as well as P and Q, and estimate the parameters involved. (Makridakis and Hibon, 1993).

These are three primary stages in building a Box-Jenkins time series model

1. Model Identification

2. Model Estimation

3. Model Validation

3.12 Model Identification

The class of ARIMA models is quite large, and in practice we must decide which of these models is most appropriate for the data at hand $Y_1, Y_2, Y_3, \ldots\ldots, Y_p$. For this minute we will presume that our series is stationary thus no unit root. The preliminary model identification is carried out by evaluating the sample autocorrelations and partial autocorrelations and comparing the resulting sample autocorrelogram and partial autocorrelograms.

BOX-JENKINS MODEL

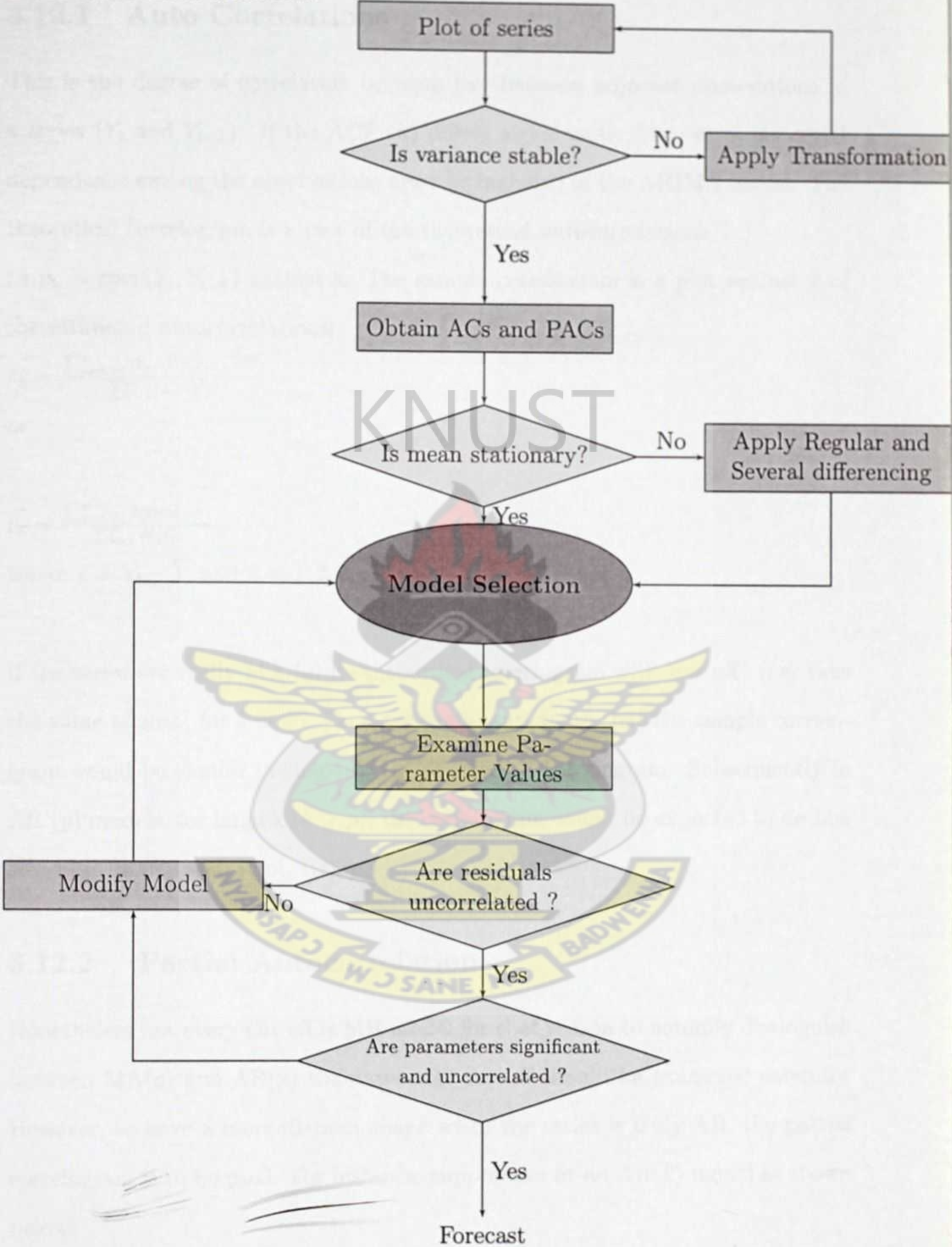


Figure 3.1: Source: BOX G. E. P. and G. M. JENKINS(1970), Time series analysis

3.12.1 Auto Correlations

This is the degree of correlation between two between adjacent observations in a series (Y_t and Y_{t-k}). If the ACF (k) differs significantly from zero, the serial dependence among the observations must be included in the ARIMA model. The theoretical correlogram is a plot of the theoretical autocorrelations
i.e $\rho_k = corr(Y_t, Y_{t-k})$ against k. The sample correlogram is a plot against k of the estimated autocorrelations;

$$r_k = \frac{\sum_{t=k+1}^{n}(Y_t-\overline{Y})(Y_{t-k}-\overline{Y})}{\sum_{t-1}^{n}(Y_t-\overline{Y})^2}$$

or

$$\overline{r_k} = \frac{\sum_{t=k+1}^{n}\hat{e}(t)\hat{e}(t-k)}{\sum_{t=1}^{n}\hat{e}^2(t),}$$

where $\hat{e} = Y_t - \overline{Y}$ and $k = 1, 2, 3, ...$

If the series are really MA (q) its theoretical correlogram will "cut off" (i.e. take the value of zero) for $k > q$. Thus, we would anticipate that the sample correlogram would be similar in shape to the theoretical correlogram. Subsequently in AR (p) models, for large k ($k \geq p$), the correlogram would be expected to decline steadily (Stoffer and Toloi, 1992).

3.12.2 Partial Autocorrelation

Nonetheless not every cut off is MR model for that reason to actually distinguish between MA(q) and AR(p) the pattern of cut off should be examined carefully. However, to have a more distinct shape when the series is truly AR, the partial correlogram is to be used. For instance, suppose we fit an AR(k) model as shown below;

$$Y_t = \overline{\beta}_{k1}Y_{t-1} + \overline{\beta}_{k2}Y_{t-2} + \ldots\ldots + \overline{\beta}_{kk}Y_{t-k} + \varepsilon_t \qquad (3.24)$$

It is the estimated correlation between Y_t and Y_{t-k} after the effects of all intermediate $Y_t'S$ on this correlation is held constant. If the partial correlogram cuts off for $k > p$, then the appropriate model is AR (p). The partial correlogram for an MA model dies down as well. Correlogram can also be used to identify stationary or unit root series (a series that needs to be differenced to generate stationary series). Moreover the autocorrelation function for a mixed process of ARMA, having a pth order autoregressive component and qth order moving average components, is a mixture of exponentials and damped sine waves after the first $q - p$ lags.The partial autocorrelation function for a mixed process is also a mixture of exponentials and damped sine waves after the first $p - q$ lags.

Another guiding principle in model identification is that of parsimony: Thus the total number of parameters in the model should be as small as possible (i.e., 3 or less, in the view of Box and Jenkins)

Summary of the Behavior of Correlogram and Partial Correlogram for Various Model.

Model	Correlogram	Partial Correlogram
AR	Dies Down	Cuts Off
MA	Cuts Off	Dies Down
ARMA	Dies Down	Dies Down

3.13 Model Estimation

Model identification consists of deciding the form of the model to be considered, but not the numerical values of its parameters. In fact, there exist many other estimation techniques including the very popular maximum likelihood method which will be used in this study. Other methods are least squares estimate and the method of moment estimation. The two key penalty function statistics which the final fitted models based on are the Akaike information criteria (AIC) and the Schwarz Bayesian information criteria (BIC). (Stoffer ,and Toloi, 1992). In estimating model parameters Θ and β for AR and MA in equation 3.9 the following rule must be applied:

1. Parameters must differ significantly from zero if it's to be included in the model.

2. Because all AR parameter, β are correlation, they must be between -1 and 1. If there are two such parameter ($p = 2$) they must also meet the following condition ;

   i. $|\beta_1| < 1$ and $|\beta_2| < 1$

   ii. $\beta_1 + \beta_2 < 1$

   iii. $\beta_1 - \beta_2 < 1$

   These are called bounds of stationarity for the AR parameter(s)

3. The moving average parameters must be between -1 and 1 because they are also correlated. If there are two of such parameter($q = 2$) they must also meet the following requirement ;

   i. $|\Theta_1| < 1$ and $|\Theta_2| < 1$

   ii. $\Theta_1 + \Theta_2 < 1$

   iii. $\Theta_1 - \Theta_2 < 1$

   These are called bounds of invertibility for the MA parameter(s)

The test statistics for the above parameters are

$t = \frac{\beta_p}{s.e(\beta_p)}$, where $s.e(\beta_p)$ is the standard error for β_p

$t = \frac{\Theta_p}{s.e(\Theta_p)}$ where $s.e(\Theta_p)$ is the standard error for Θ_p

For statistically significant parameters, the absolute value of the t-ratios are expected to be greater than 1.96. Given a data set, several competing models may be ranked according to their AIC or BIC with the one having the minimum information criterion value as the finest. These information criterion judges the model in terms of how closer the fitted values are to the true values of the data. The criterion endeavour to discover the model that best explain the data with a minimum of parameters (principle of parsimony). The AIC and BIC is computed as show below

$BIC = -2\ln(L) + \ln(n)k$

$AIC = 2K - 2\ln(L)$

L - is the value of the maximum likelihood function for the estimated model.

K - is the number of parameter in the model.

N - is the number of observations, or the sample size of the data.

l_n - is natural log.

3.14 Diagnostic Checks

Diagnostic check determines whether or not the residuals ε_t are white noise or not. Once an appropriate model had been selected and its parameters estimated, the Box-Jenkins methodology required examining the residuals of the actual values of the model. If such residuals are random, it is assumed that the model is appropriate. If not, another model is entertained, its parameters estimated, and its residuals checked for randomness. Several tests have been suggested to help analyst determine if overall the residuals are indeed random.

The Ljung - Box Q statistic was used to test for the adequacy of the model selected to see if the residuals have a mean of zero, constant variance and are serially uncorrelated.

$$Q = n(n+2)\sum_{i=1}^{k}\frac{r_i^2}{n-i}\ldots\ldots \sim \chi^2(k-p-q,n) \tag{3.25}$$

Where n is the sample size, p is the order of the AR process, q is the order of the MA process, k is the first k autocorrelation being checked and r_i is the estimated autocorrelation coefficient of the i^{th} random error. The value of calculated "Q " is compared with a Chi-square distribution at a given α level stated as $\chi^2(\alpha, k-p-q)$

H_0 : The autocorrelation for residuals is white noise.

H_1 : The autocorrelation for residuals is not white noise.

If $Q < \chi^2(\alpha, k-p-q)$ accept the null hypothesis H_0 and reject if otherwise. In other words accept H_1 if $Q > \chi^2(\alpha, k-p-q)$. If the p-value associated with the Q statistic is small (P-value $< \alpha$) , the model is considered inadequate. Another important test is the normality test of the residuals of the model. This can be done through a residual plot against time, histogram plot of the residuals and the Q-Q Normal probability graph. (Makridakis et al., 1998).

3.15 Intervention Time Series Analysis

Time series data may be collected and analyzed purposely to evaluate the impact of some intervention or change upon the series. A big difference here from ordinary time series analysis is that, with the building of the noise model we are not very concerned with the theoretical implications but impact assessment is done so that we can interpret the effects of events on the series. Intervention analysis is mostly concerned with assessing the impact of an event on a time series by comparing the preintervention with the post intervention series. This is not so in Ordinary Time Series analysis as any unusual pattern is the series is not factor in the model formulation process. Again intervention analysis estimate the value of increase or decrease in the series associated with the implemented policy and hence divide the series into segment(s). Ordinary Time Series analysis consider the entire as whole with no segmental divisions.

Campbell and Stanley (1966) called this design the "interrupted time series quasi-experiment". While the methods of analysis originally suggested by Campbell and Stanley was invalid (because of the bias of variance estimates produced by serial dependence). ARIMA model is statistically valid for the assessment of the significance of these effects. This work was developed by Box and Tiao (1975); Glass, Willson, and Gottman (1975); and McCleary and Hay (1980). The Box-Tiao (1975) intervention analysis is based on the Box-Jenkins autoregressive, integrated, moving average (ARIMA) model that considers the time dependent nature of the data to produce efficient estimation (Fleming, 1992). The Box-Jenkins ARIMA has been explain in details in the previous section of this chapter so we will move on to Box-Tiao (1975) intervention analysis to access the impact of the exemption fee delivery policy on incidence of childbirth .

3.16 Assumptions of intervention Analysis

1. Impact assessment is concerned only with events that is assumed to have effect on the series.
2. The period in which the impact of the policy is to be accessed is assumed to be closed. Thus, with the exception of the noise model, the only exogenous event on the series is assumed to be the intervention.
3. The time of inception, the period, and the time of termination of the input event have to be certain.
4. There should be enough observations in the series before and after the onset of the event for the independent modeling of pre and post intervention series.

The model is of the general form

$$Y_t = \sum_{t=1}^{n} f(I_t) + N_t \tag{3.26}$$

Where $f(I_t)$ is the intervention function of a discrete deterministic interrupted indicator at time t, N_t is the function of the ARIMA preintervention noise model Y_t is the level of change with respect to gains or losses made in the delivery cases. A simple way to study intervention analysis is to consider some simple dynamic models. These are (a) the pulse function and (b) the step function.

A pulse function $f(I_t)$ indicates that the intervention only occurs in the single time index t_0 thus, one large increase that lasts a very short time. The intervention indicator is coded 0 prior to the policy and immediately afterwards. As 1 at the point of the policy.

$$f(I_t) = P_t^{to} = \begin{cases} 0 & \text{if } t = t_0 \\ 1 & \text{if } t \neq t_0 \end{cases} \tag{3.27}$$

Where P_t^{to} is the pulse function and t_0 is the policy time. Consider a monthly delivery in a hospital as used in this study. If a free delivery policy is in effect only for a given month , then we use a pulse function to indicate the existence of the policy. On the other hand if $f(I_t)$ is a step function then the intervention continues to exist starting with the time index t_0 thus, one large step leading to a new level. The intervention indicator is coded 0 prior to the commencement of the event and as 1 at both the onset (t_0) and for the entire duration of the presence of the event.

$$f(I_t) = S_t^{to} = \begin{cases} 0 & \text{if } t < t_0 \\ 1 & \text{if } t \geq t_0 \end{cases} \tag{3.28}$$

Table 3.1: Intervention Indicator coding for the pulse and step input functions

Time	(Step) Function..Coded $S_t^{t_0}$	(Pulse) Function..coded $P_t^{t_0}$
January(2000)	0	0
February(2000)	0	0
March(2000)	0	0
⋮	⋮	⋮
March(2005)	0	0
April(2005)	1	1
May(2005)	1	0
June(2005)	1	0
⋮	⋮	⋮
September(2011)	1	0
October(2011)	1	0
November(2011)	1	0
December(2011)	1	0

3.16.1 Intervention Model Specification

The aim of this study is to quantify the impact of exemption fee delivery and Free Maternal Care policy on the incidence of childbirth implemented by the Government via the National Health Insurance Scheme (NHIS) to improve maternal health care in the country more specifically at KNUST Hospital. The intervention programmes were implemented in April 2005 and July,2008 directing all healthcare delivery facilities to exempt pregnant women from delivery and total treatment charges respectively. The event is modelled with step intervention functions due to the form of its occurrences. The hypothesized intervention model for this study is written as;

$$Y_t = c + w_1 I_{(1t)} + w_2 I_{(2t)} + N_t \tag{3.29}$$

where,

$$I_{(1t)} = S_t = \begin{cases} 1 & April, 2005 \leq t \leq June, 2008 \\ 0 & \text{otherwise} \end{cases} \tag{3.30}$$

$$I_{(2t)} = S_t = \begin{cases} 1, & t \geq July, 2008 \\ 0 & \text{otherwise} \end{cases} \quad (3.31)$$

Y_t is the increase or decrease in monthly deliveries recorded at the hospital; I_{1t} represents a step function for the exemption from delivery fee, I_{2t} represent a step function for the Free Maternal Care Policy, w_1 and w_2 are the impact parameters which indicates the magnitude of the impact and c is a constant term.

3.16.2 Impact Assessment or Intervention Models

The impact assessment of a policy with intervention time series can be specified by two main dimensions. These are duration and nature of the impact of the policy on the series been studied. Now with respect to duration the impact may have a temporary or permanent effects on the series while it's nature might be immediate or gradual progression. Abrupt permanent impact is usually modelled with step function whilst an abrupt temporary impact are modelled with pulse function. Gradual and permanent impact are generally modelled with step function with first-order decay rate.

There is a simple relationship between step function and the pulse function. Given the step function $S_t^{(to)}$ its corresponding temporal pulse function is given by $(1-B)S_t^{(to)} = P_t$

For example, a step function specified as follows:

$I_t = \{........0,0,0,0,0,1,1,1,1,1,.....\}$

Can be converted to a pulse function by differencing:

$= \{.....(0-0),(0-0),(0-0),(0-0),(1-0)(1-1),(1-1),(1-1).........\}$

$= \{.....0,0,0,0,1,0,0,0,0,.........\}$

However the impact of a policy is usually formulated as

$$Y_t = \frac{\omega_0}{(1-\delta B)} I_{(t-b)} + N_t \tag{3.32}$$

where $I_{(t-b)}$ is the intervention indicator variable usually known as the change variable, scored 0 or 1 (before and after the intervention event respectively), b is the possible time delay for the impact to take off (the valve assigned indicate the delay period before the impact is felt), N_t is the noise model, δ is the decay parameter (slope parameter) , ω_0 is the impact parameter that indicates the degree of the impact and Y_t is the increase or decrease in monthly deliveries. If after fitting a model the denominator reduce to unity, then the model will be a simple step function with a zero-order decay, $Y_t = \omega_0 I_t + N_t$. This is abrupt onset and permanent duration effects.

If we subtract the noise model from the dependent variable;

$$Y_t - N_t = \omega_0 I_t = Z_t \tag{3.33}$$

Z_t is the deviation from the noise model.

So, prior to the event, when I=0, $Z_t = \omega(0) = 0$

After the intervention

$Z_t = \omega_0(1) = \omega_0$

Gradual permanent effect

A slow change that leads to a new permanent level, example the effect of a medication on a patient. This can be modelled as a step function below ;

$$Y_t = \frac{\omega_0}{(1-\delta B)} I_t + N_t, where, -1 < \delta < 1 \tag{3.34}$$

From equation(3.31)

$Z_t(1 - \delta B) = \omega_0 I_t$

$Z_t - \delta B Z_t = \omega_0 I_t$

$Z_t - \delta Z_{(t-1)} = \omega_0 I_t$

Impact at t is equal to ω_0

Now the impact at time $t + 1$

$Z_{(t+1)} - \delta Z_{(t)} = \omega_0 I_{(t+1)}$

$Z_{(t+1)} = \delta Z_{(t)} + \omega_0 I_{(t+1)}$

$= \omega_0(1 + \delta)$

Thus, impact over time is $= \omega_0(1 + \delta + \delta^2 + \delta^2 + \dots)$

Because $\delta < 1$ the impact as $t \longrightarrow \infty$ diminishes.

Hence the long term change produce by a gradual permanent intervention ; $\frac{\omega_0}{1-\delta}$

The closer δ is to 1 the longer it takes for full impact realization.

Gradual Temporary Effect

A very quick change followed by a gradual shift back to its original position or expected value before the intervention. this is commonly called Pulse decay.

Impact at $t = \omega_0$

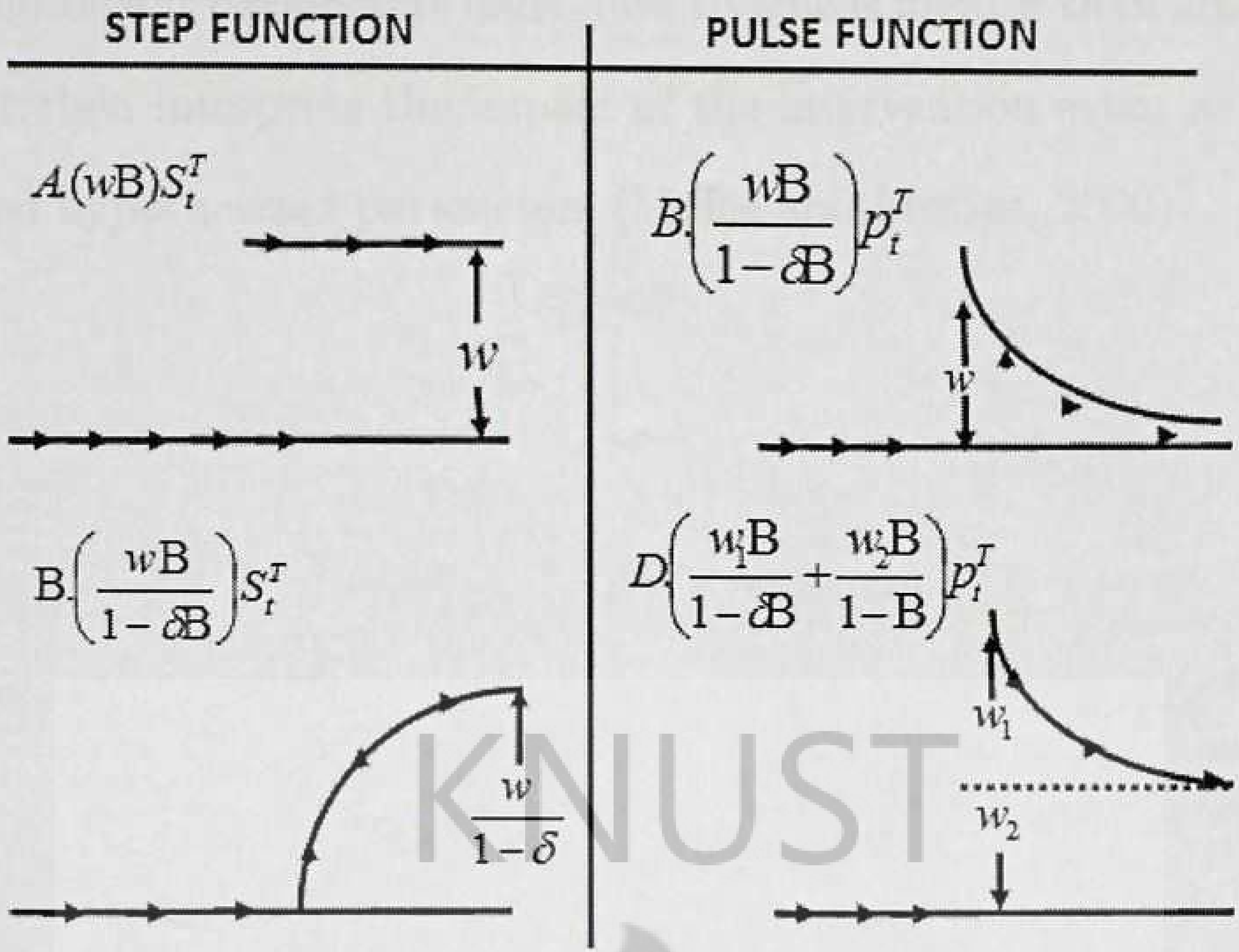
At $t + 1 = \delta\omega$

At $t + 2 = \delta^2\omega$

At $t + i = \delta^i\omega$

so, the δ parameter indicates how much of the initial impact remains in the first period after the intervention and subsequent period.

Figure 3.2: A summary of the graphical outputs of various intervention models.



3.17 Estimation and Diagnostic Check

The usual maximum likelihood estimation method was used to estimate the parameters (ω, δ) of the noise and the intervention model in (3.32). The coefficient δ must satisfy limits referred to as the "bound of stability" of $(-1 < \delta < 1)$ which ensure that the post-intervention series is stationary about its mean. The parameter β of the full intervention model should also be bounded $(-1 < \beta < 1)$ bounds of stationarity. The time delayed, denoted by b is set based on the pronounced spike in the time plot after the policy.

The valve of impact parameter (ω_0) is estimated as

$$\omega_0 = \frac{\sum_{T=t}^{n} Y_t I_t}{\sum_{T=t}^{n} Y_t^2} \tag{3.35}$$

After identifying an adequate impact model, the next is to conduct diagnostic checks on the significance of the hypothesized parameters and the behaviour of the residuals with the same procedural as discuss in the previous section for the noise model(all significant parameters must have t-value is greater than absolute (1.96). The analyst then interprets the impact of the intervention event as reported by its estimated hypothesized parameters (Yaffee and McGee, 2000).

Chapter 4

Data Collection and Analysis

4.0 Introduction

The chapter discusses the data used in this thesis : the monthly observations childbirth at the Kwame Nkrumah University of Science and Technology Hospital from 2000 to 2011. The data was obtained from the Bio-Statistics Department of the Obstetrics & Gynaecology directorate of KNUST Hospital. Secondary data obtained from hospitals was plotted and the pattern of deliveries for each facilities over the twelve (12) years period under study was observed. Afterwards, the pre-intervention period (2000-March,2005) was analyzed and compared to the post-intervention period (April,2005- June,2008) for the Exemption Fee Delivery policy and (July 2008 -2011) for the Free Maternal Heath Care policy. This chapter also presents the analyses the results obtained from the analyses carried out, preintervention data and the fully-fitted intervention model for the selected data set.

4.1 Empirical Analyses of the Data Sets

4.1.1 KNUST Hospital

Figure 4.1 shows the time plot of monthly deliveries recorded in the hospital from 2000 to 2011. The highest number of childbirth during the preintervention period (2000-April 2005) was recorded in January 2000 (98) and the minimum may 2003 (21). The time plot is had an oscillatory pattern with a downward slope during the pre-intervention period and even after the implementation of the exemption free delivery policy in April 2005. From the time plot, it can also be seen that it took a while before the impact of the policy was really felt in the year 2006 but dropped towards the end of 2006 to the beginning of 2007. The series showed a reversal from negative to positive trend in 2008 and maintained a steady gradient. The highest monthly delivery was recorded in June 2009 (171) which fell in the Free Maternal Health Care policy period. The policy year recorded minimum delivery (41) in June 2005 early period of the Exemption Fee Delivery policy.

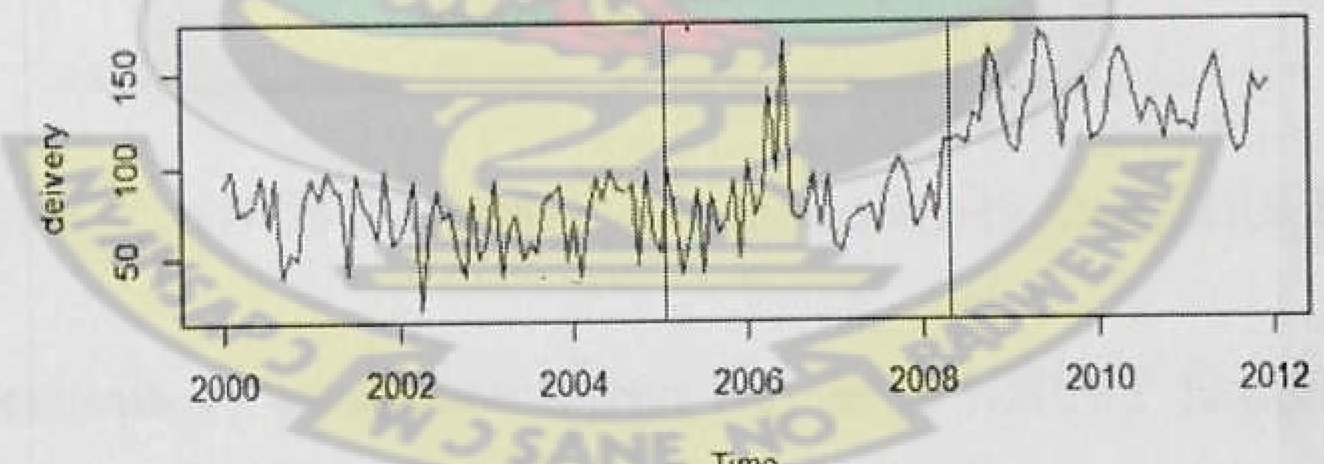


Figure 4.1: Time plot of Monthly Deliveries 2000 to 2011

From the KNUST Hospital plot in figure 4.1 it can be seen that the pattern of monthly deliveries was falling before the implementation of the policy. The fitted trend equation confirms this as it had a negative gradient of 0.1057 with an average monthly delivery of 75. Thus, trend in the series before the policy will provide a true impact assessment of the policy on recorded deliveries as it was meant to reverse the falling assisted facility deliveries.

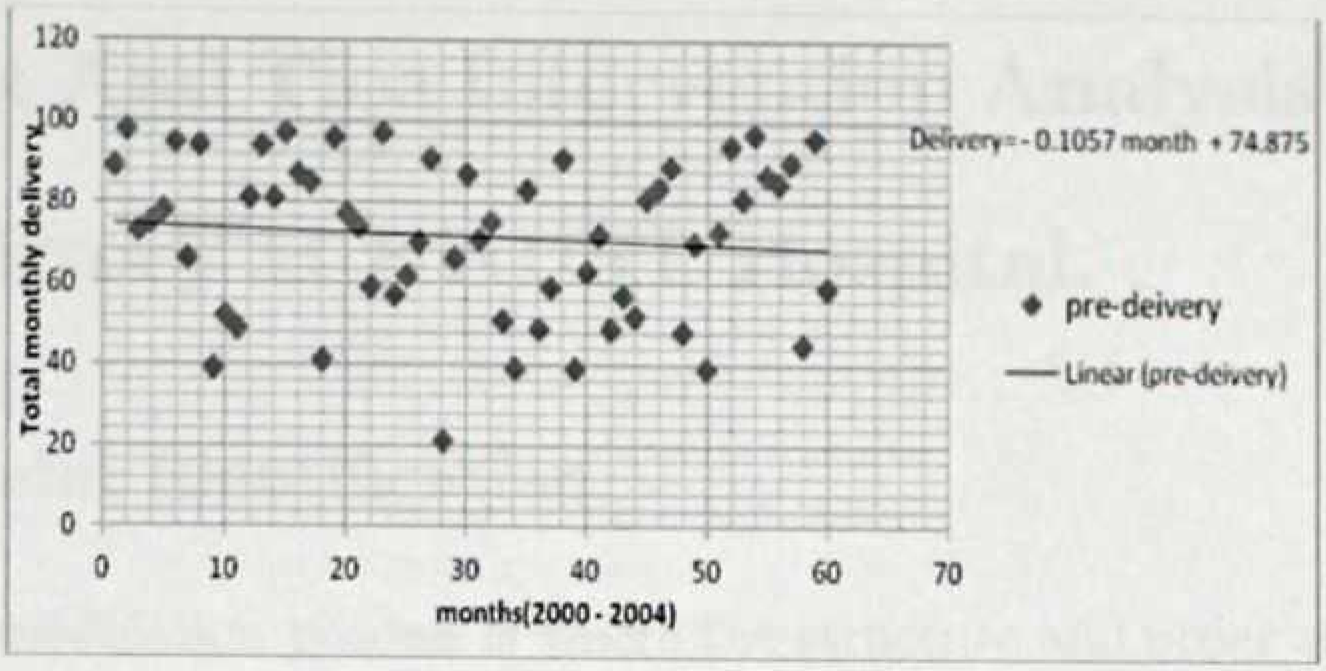


Figure 4.2: KNUST Trend of monthly delivery from 2000 to 2004

The KNUST Hospital plot in figure 4.2 can be seen that the falling trend in monthly deliveries in the pre- policy period is now rising in the policy period. The fitted trend equation confirms this with a positive of gradient of 0.4843 with an average monthly delivery of 116.

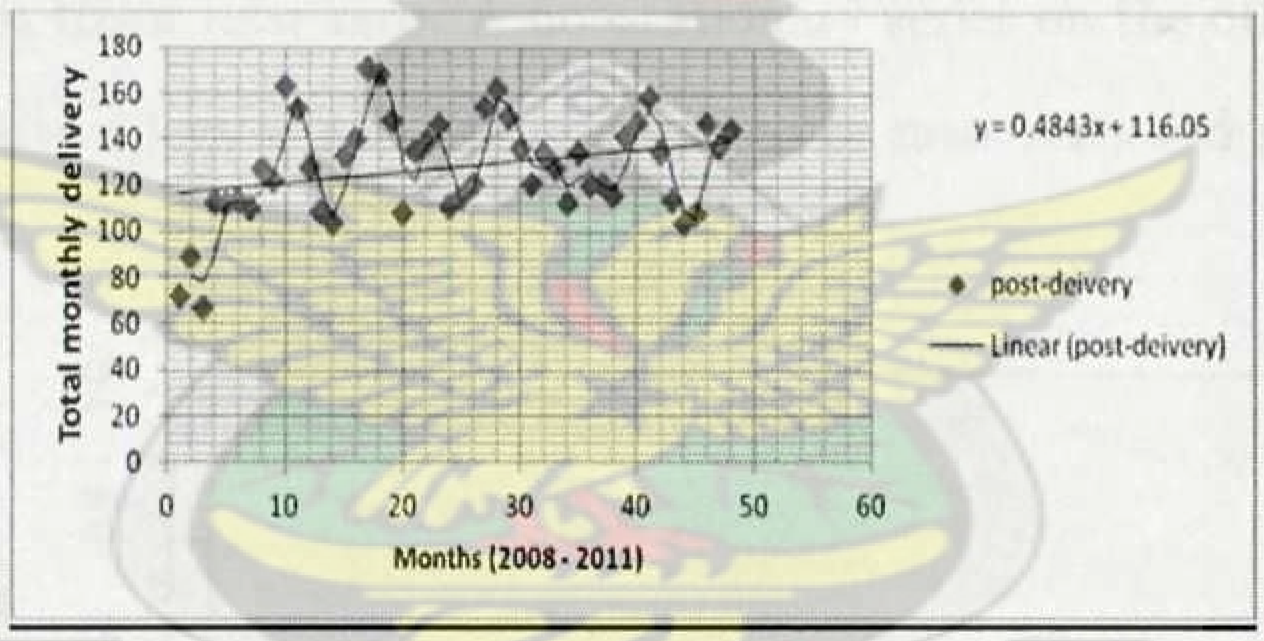


Figure 4.3: KNUST Trend of monthly delivery from 2008 to 2011

The above preliminary analyses confirms the use of KNUST Hospital data for assessing the impact of the policies, thus Exemption Fee Delivery policy (April,2005 - June, 2008) and (July, 2008 - 2011) for the free Heath Care..

4.2 Box And Tioa Intervention Analysis for Monthly Delivery at KNUST Hospital.

4.2.1 Model Identification

The model identification process is where the structure and order of the possible models are mainly selected. The structure and order of the models are selected from the sample partial autocorrelation function for the AR part and autocorrelation function for the MA part of the observed series. Nonetheless, the observed series must be stationary before tentative models are selected. Furthermore, we use the ACF plots and two objective test statistics to check whether the preintervention part of the series is stationary or not. If a series is stationary, its ACF rapidly die out to/or near zero. A nonstationary series on the other hand mostly have high positive lags which slowly decay to or near zero and may not cut out to zero.

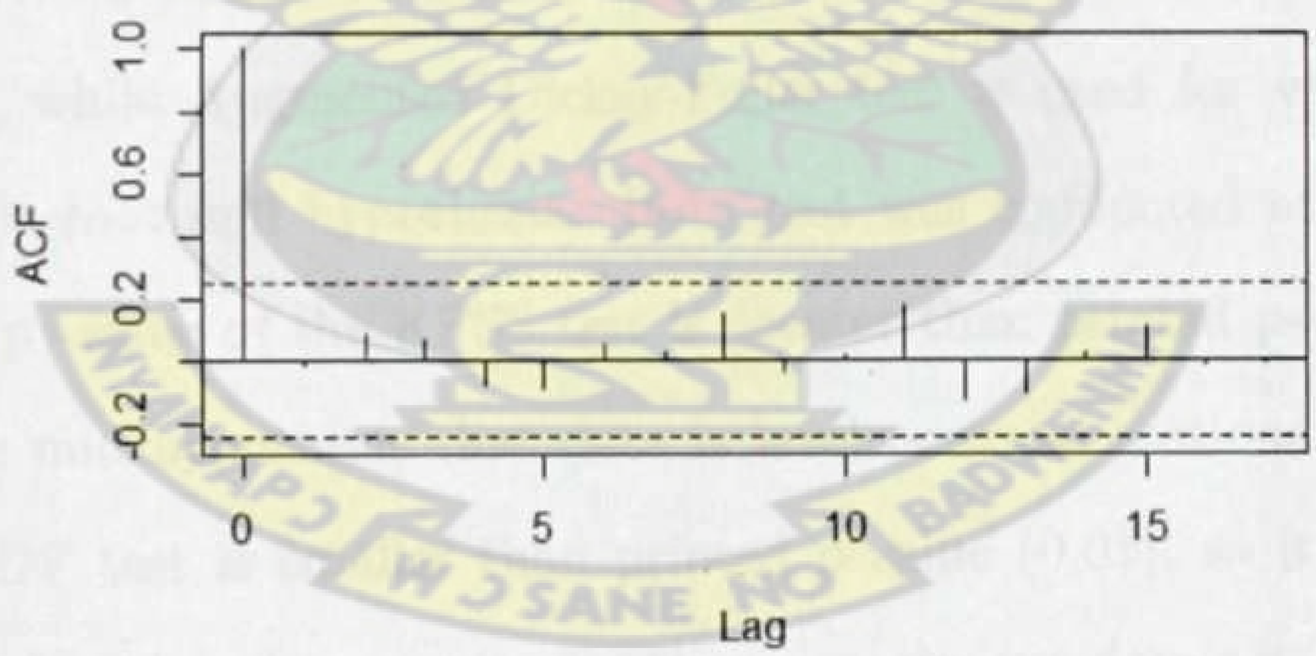


Figure 4.4: ACF of predelivery series

From figure 4.4 we can see from the correlogram that all lags lies within the significance bound. Higher spike with the bound significant tail off to zero afterwards this exhibit stationarity in the data set for the pre-intervention model.

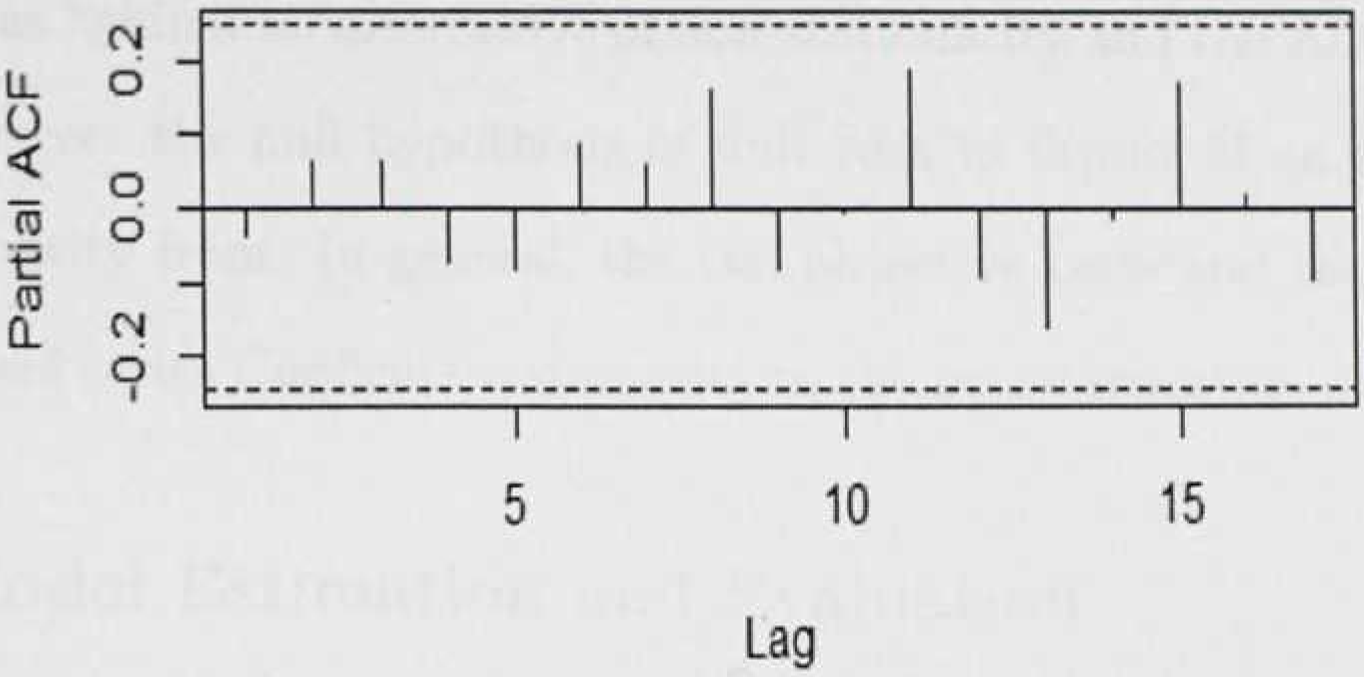


Figure 4.5: PACF of predelivery series

The partial correlogram from figure 4.5 above also shows the partial autocorrelation decreases and tails off to zero for lags even within the bound significant .This depicts a clear situation of a series which is stationary in the mean and does not require any form of differencing or transformation.

Next, Kwiatkowski-Phillips-Schmidt-Shin (KPSS) and Augmented Dickey- Fuller (ADF) test were carried out to confirm the stationarity of the pre-intervention data set. KPSS test is used for verifying whether series is stationary for null hypothesis, while Augmented Dickey-Fuller test is used for verifying whether there is unit root null hypothesis. Both test was conducted at 5 % significant level. The p -value of the KPSS test is greater than printed p-value (0.1), so it accepts the null hypothesis that data is level or trend stationary. While the p value of ADF test is smaller than printed p-value (0.01), so it rejects the null hypothesis that data has a unit root thus a stationary data set.

Table 4.1: Unit Root and Stationarity Tests for preintervention series

Type of Test	Test Statistic	Critical Value	Lag order	$\alpha - level$
ADF	-5.2295	-3.45	12	0.05
KPSS	0.1609	0.4630	12	0.05

Once again from Table 4.1 the KPSS test fail to reject the null hypothesis of trend stationarity as against an alternative of non-stationarity and the ADF test on the other hand reject the null hypothesis of unit root in favour of an alternative of trend stationarity from. In general, the two objective tests and the correlogram of the observed series Confirms stationarity in the preintervention delivery series.

4.2.2 Model Estimation and Evaluation

The following non-seasonal candid models were selected for investigations: ARIMA (1, 0, 0); ARIMA (1, 0, 1); ARIMA (1, 0, 2) and ARIMA (2, 0, 1). The procedure for choosing these models relies on choosing the model with the minimum AIC, AICc and BIC.

Table 4.2: AIC, AICc and BIC for the Suggested ARIMA Models

Model	AIC	AICc	BIC
Arima (1,0,0)	555.2	555.51	561.63
Arima(1,0,1)	557.23	557.92	565.8
Arima(2,0,1)	559.87	559.92	569.58
Arima(1,0,2)	559.96	560.01	569.68

From the Table 4.2 the Arima(1,0,1) and Arima(1,0,0) were selected.
After selecting an adequate model, the parameters of the model are then tested. All the parameters of the model must lie within the bound significant of $|\beta| < 1$ and all their absolute t-value greater than 1.96 at 5% significant level. Parameter that passes the above test will be maintained in the final model whiles the non-significant parameters are removed and another model considered.

Table 4.3: Estimate of Parameters for ARIMA (1, 0, 0)

Coefficients	Estimate	STD error	t-value
Ar(1)	- 0.0366	0.1257	0.2911
Intercept	71.7668	2.3368	30.7116

From Table 4.3 it can be observed that the parameter Ar(1) lie with the bound significant with an absolute value of 0.0366 which is less than one but the t-value is less than 1.96. Hence Arima(1,0,0) cannot be considered as an adequate model and must be dropped.

Table 4.4: Estimate of Parameters for ARIMA (1, 0, 1)

Coefficients	Estimate	STD error	t-value
Ar(1)	0.8449	0.3972	2.1271
Ma(1)	-0.8282	0.4069	-2.0354
Intercept	71.8959	2.7263	26.3712

From table 4.4 it can be observed that the parameters Ar(1) and Ma(1) lie with the bound significant with an absolute value of 0.8449 and 0.8282 respectively. All the parameters had t-value is greater than 1.96. Hence Arima(1,0,1) can be considered as an adequate model and must be maintained as an adequate pre-intervention noise model.

4.2.3 Goodness of Fit Test

After parameter estimation of the selected model the next step is to check for the adequacy of the model selected. One of the assumptions of ARIMA model is that, for an adequate model, the residuals must follow a white noise process. That is, the residuals have zero mean, constant variance and also uncorrelated. At this point, the residuals of ARIMA(1, 0, 1) checked for adequacy using the ACF, PACF and Q-Q Normality plot of the residuals. Ljung-Box test was also used to confirm the normality of the error term.

Figure 4.9 gives the ACF plot of the residuals, there is no evidence of a significant spike in the ACF plot. Thus there is therefore little evidence of autocorrelation at lags 1-15 for the residuals and the model residuals appeared to be uncorrelated and normally distributed with mean zero and constant variance over time. This shows that the residuals of ARIMA (1, 0, 1) follow a white noise process.

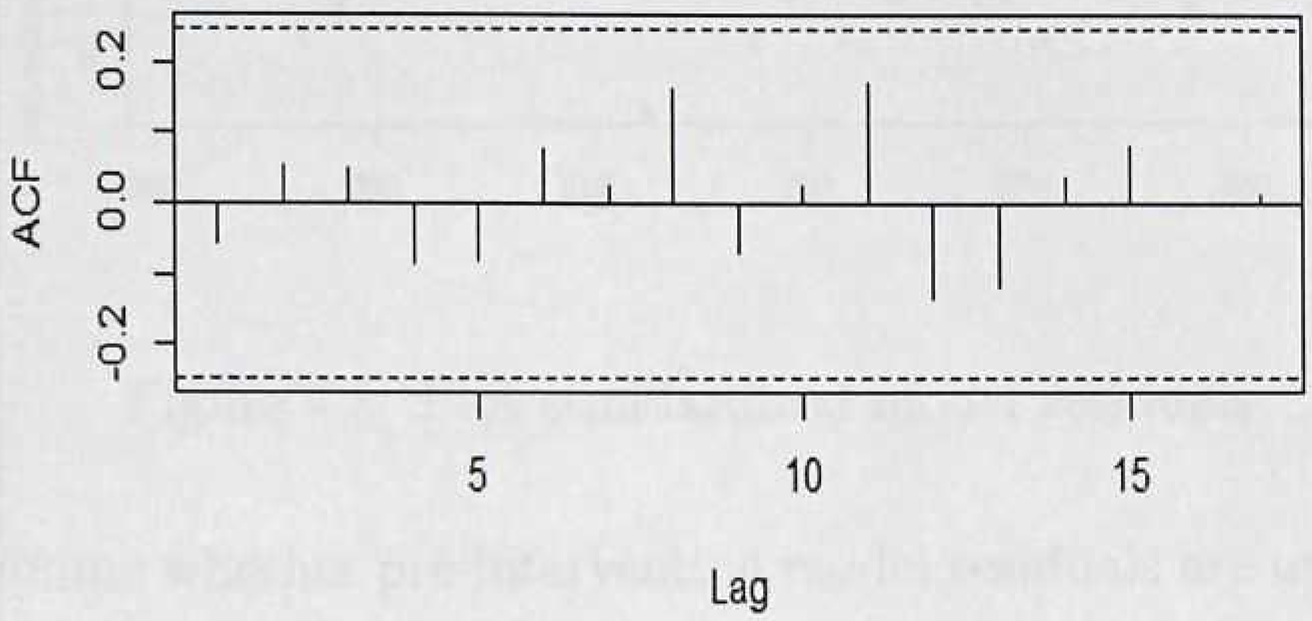


Figure 4.6: ACF plot of model residuals

Also, the PACF plot displayed in Figure 4.10 confirms white noise residuals for the fitted model. Thus the error term is normally distributed with mean zero and constant variance over time uncorrelated.

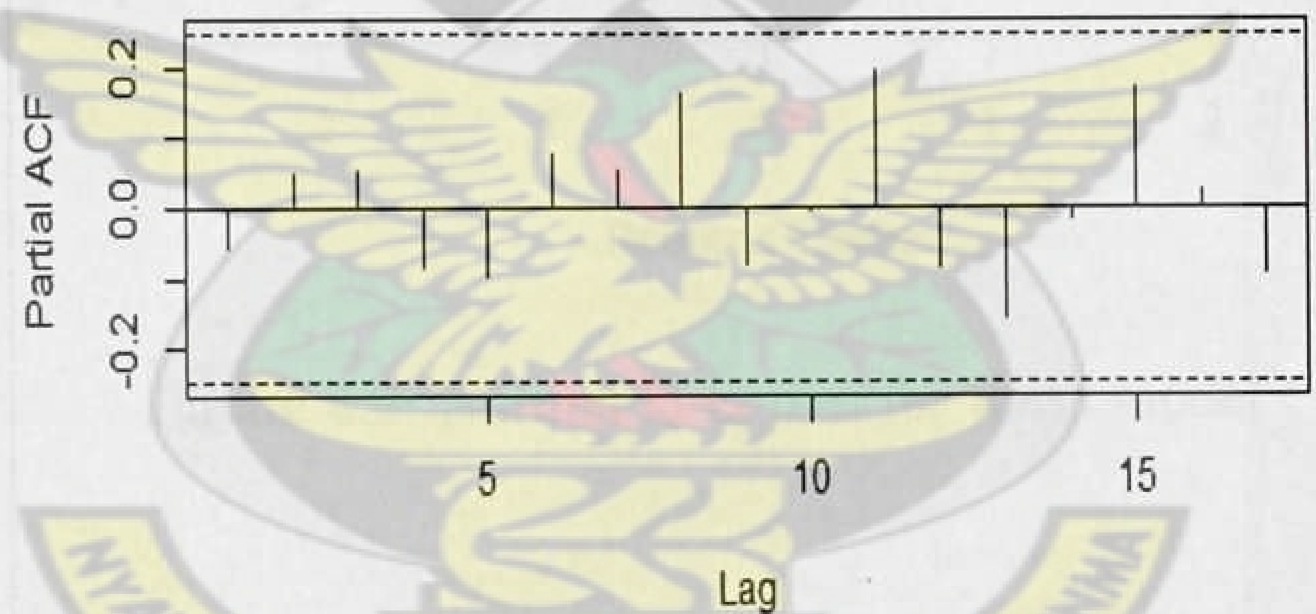


Figure 4.7: PACF plot of model residuals

The standardized residual plot shows that there was no clear pattern in the plot thus the error terms are uncorrelated and does not deviate from normality. The only possible outlier (21) was recorded in April 2002.

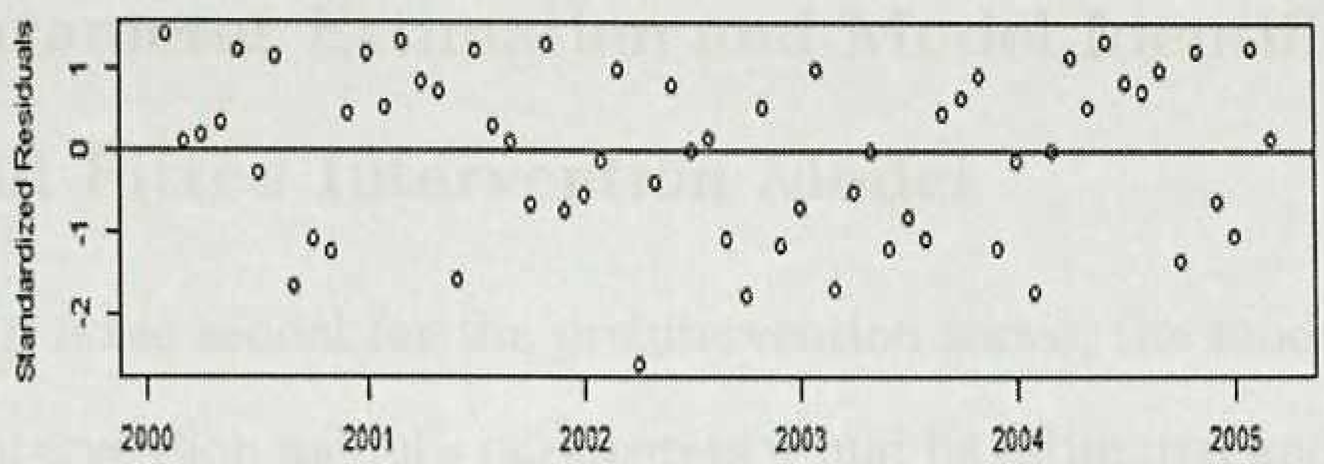


Figure 4.8: Plot standardized model residuals

Again we examine whether pre-intervention model residuals are uncorrelated and normally distributed with mean zero and constant variance from normality probability plot standardized residuals plot and Ljung-Box test for residual normality.

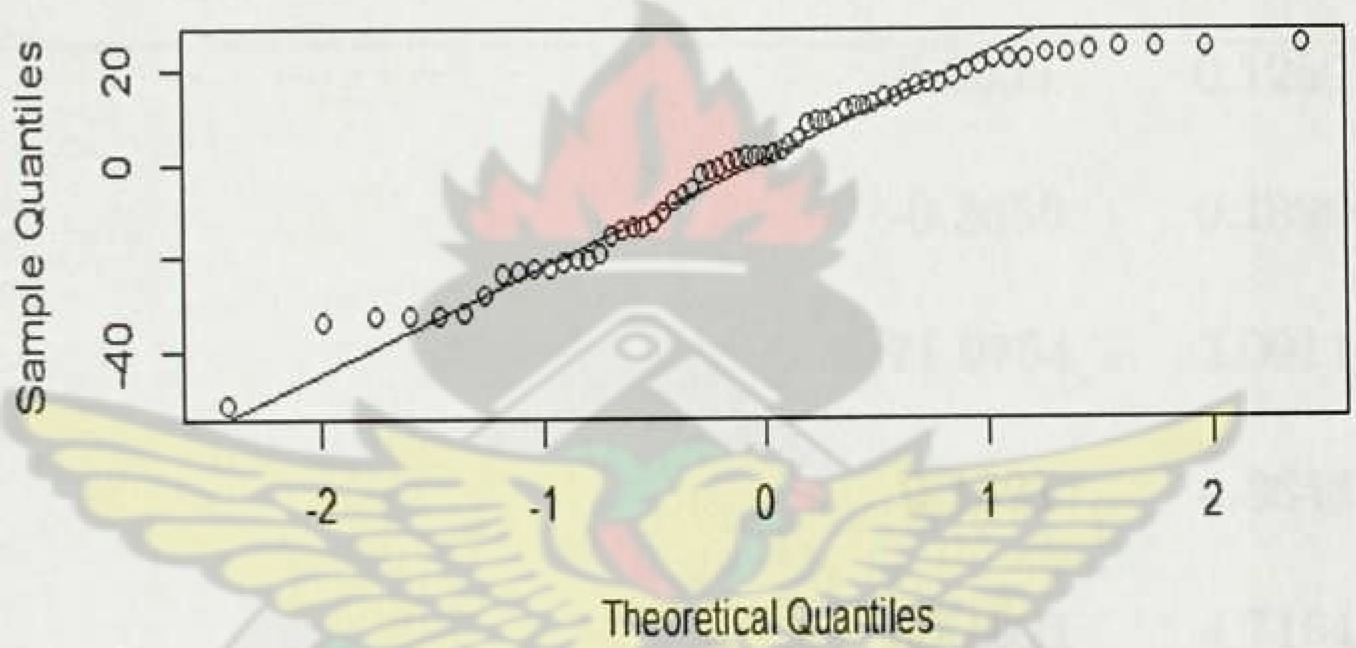


Figure 4.9: Normal Q-Q plot for noise model

Table 4.5: Ljung-Box Test for ARIMA(1, 0, 1) model

Test Type	Summary	of	Test Statistic
Ljung-Box	χ^2	df	p-value
	24.8091	24	0.6401

The Q-Q Normality plot of the residuals seems plausible thus, the residuals are quiet normally distributed ~~with no~~ sufficient evidence to reject normality. This is also confirmed by the Ljung-Box test of p-value of 0.6401 > the significant level of 0.05.

4.2.4 Parameter Estimation and Model Identification For Full Fitted Intervention Model

After fitting a noise model for the preintervention series, the model and the hypothesized Intervention model's parameters would be estimated and later checked for adequacies. From here, the noise ARIMA(1, 0, 1) model of the preintervention monthly delivery series evaluated jointly with a dichotomous intervention function using the R software package.

Table 4.6: Parameter Estimates for the hypothesized Impact model

Coefficients	Estimate	STD error	t-value
Ar(1)	0.3633	0.1259	2.8856
Ma(1)	-0.3656	0.1390	-2.6302
Intercept	71.9754	3.0011	23.9830
Delivery	9.1821	4.8648	1.88745
Care	60.1021	4.7164	12.7432

AIC=1288.39 AICc=1289.01 BIC=1306.21

From Table 4.6 all the coefficient of the intervention model is significantly different from zero. Delivery denote the exemption fee delivery policy and Care denote Free Health Care policy. Generally, the full-fitted impact assessment model exhibits a stationary process.

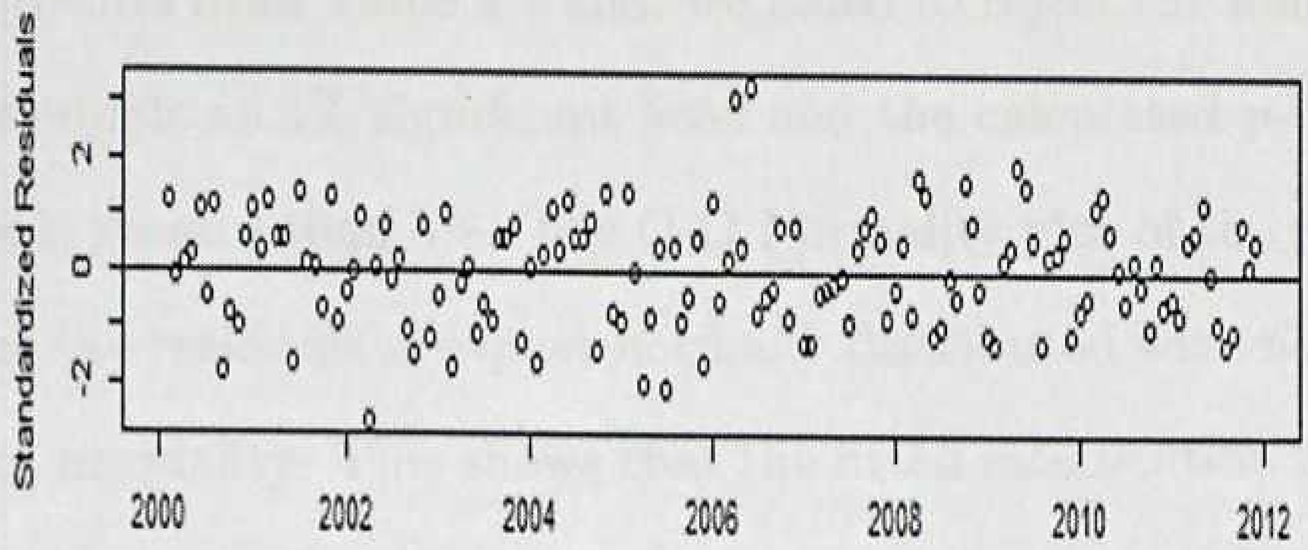


Figure 4.10: Plot standardized Intervention model residuals

From the standardized Residual plot in figure 4.10 there is no clear pattern in the series thus the residuals are uncorrelated. The possible outliers were in April 2006 and June 2006 with recorded monthly delivery of 142 and 168 respectively. These values however did not distort normality of the residuals .

4.3 Diagnostic Checks for the Full Intervention Model

Table 4.7: Ljung-Box Test for the full impact Intervention model

Test Type	Summary	of	Test Statistic
Ljung-Box	χ^2	df	p-value
	15.3718	12	0.2217

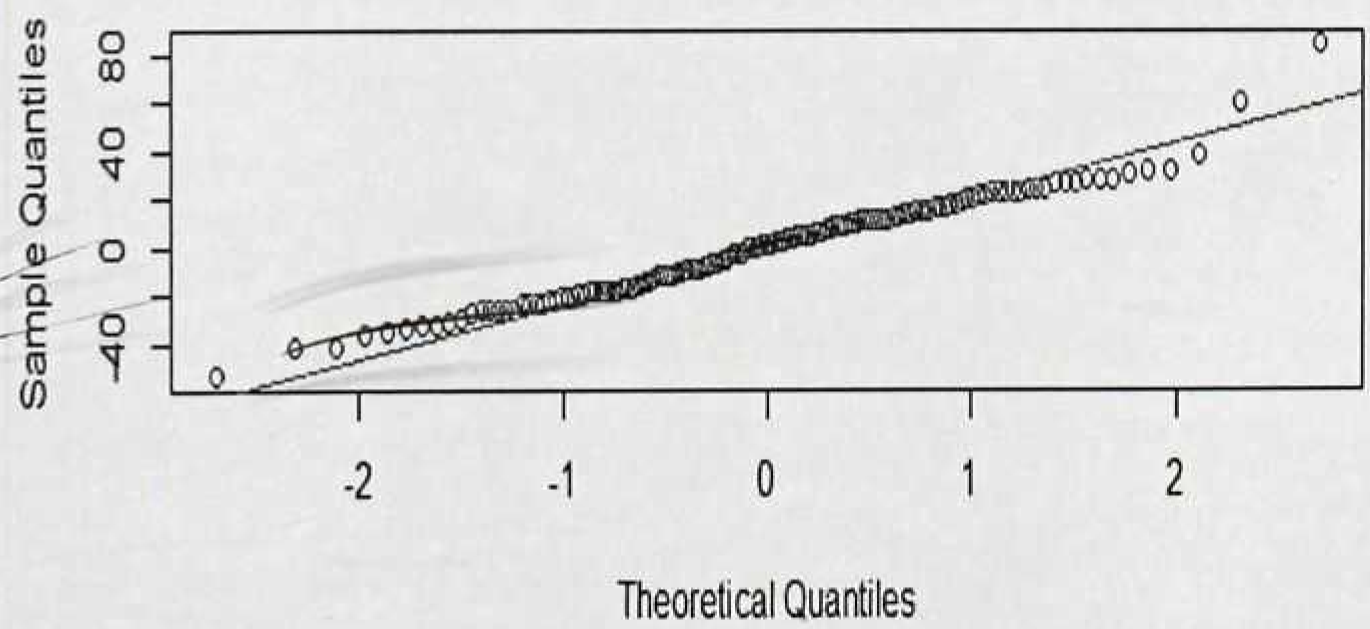


Figure 4.11: Normal Q-Q plot for Intervention model

Based on the results from Table 4.7 and, we failed to reject the null hypothesis of white noise residuals at 5% significant level and the calculated p-value of 0.2271 for Ljung-Box is greater than 5%. The Q-Q Normality plot of the residuals seems plausible, thus the residuals are quiet normally distributed with no sufficient evidence to reject normality. This shows that the fitted intervention model provides a good fit for the monthly delivery series.

Chapter 5

Summary,Conclusion and Recommendations

5.0 Introduction

This Chapter five presents signergises this thesis, summary of findings from the study and gives a conclusion statement based on the findings. It also suggests further research areas for other researchers.

5.1 Summary of Findings from the Study.

The principal objective of the study is to use intervention analysis of Box and Tiao (1975) to evaluate the impact Exemption Fee Delivery policy (April,2005 - June, 2008) and (July, 2008 - 2011) for the Free Maternal Heath Care policy on incidence of childbirth at KNUST Hospital. The impact of the Exemption Fee Delivery policy impact on monthly delivery was felt in April 2006 but fell in December 2006 close to preintervention period. The Free Health Care policy exhibited an abrupt impact on monthly recorded delivery in the health facility. In chapter two various literature work on the methodology used and study on health policies were reviewed. The methodology was discussed extensively in chapter three with analyses of the results presented in chapter four.

Monthly childbirth recorded from 2000 to March 2005 were used to obtain a model for the pre- intervention series. Preintervention series could best be fitted with an ARMA model:

$$Y_t = 71.8959 + 0.8449y_{t-1} - 0.8282\varepsilon_{t-1} + \varepsilon_t \quad (5.1)$$

Where the errors (ε_t) were found to be white noise, y_{t-1} in the model expresses the previous observations with respect to t in the series.

Afterwards, the ARIMA (1, 0, 1) process plus a deterministic intervention input event was estimated together to obtain parameter estimates for the hypothesized intervention model. The result of the fully-fitted intervention model as shown in Table 4.9 could also be written as:

$$Y_t = 71.9754 + 9.1821_{1t} + 60.1021_{2t} + 0.3633y_{1-t} - 0.3656\varepsilon_{t-1} + \varepsilon_t \quad (5.2)$$

Practical results indicate that the impact of both policies could best be modelled with a permanent change with a zero-order transfer function. Where the errors (ε_t) were found to be white noise, $1t$ denote the Exemption Fee Delivery variable, $2t$ denote the Free Maternal Health Care and y_{t-1} in the model expresses the previous observations with respect to t in the series. From Table 4.6, the Exemption Fee Delivery policy recorded non- significant increase of about 9 monthly delivery whilst Free Health Care policy recorded significant increase of about 60 monthly delivery .

5.2 Conclusion

The impact of the Exemption Fee Delivery and Free Maternal Health Care policy could best be fitted to a simple step function with Zero-order decay. Nonetheless, the Exemption fee delivery demonstrated a delayed abrupt nature of impact on the monthly delivery series. Free Health Care policy exhibited a sudden permanent impact on the monthly delivery series. These results effectively helped in achieving the set objectives for the study and agreed with other findings from the previous works reviewed in chapter 2 .

It can then be concluded that, the policies had contributed in reducing the financial barrier of assessing health care during delivery by pregnant women.

Recommendations

1. A further study could be carried out to find out how the Free Health Care policy could be improved to help remove any remaining financial barriers in assessing health care by pregnant women.

2. Future researchers could also be focus on the forecast performance of ARIMA-Intervention models and compare it to other forecasting procedures.

References

AbouZahr, C. (1998). *Maternal mortality overview. health dimensions of sex and reproduction, geneva: World health organization.*

Adjepong, M. O. (2012). Estimating the impact of the cocoa hi-tech and mass spraying programmes on cocoa production in ghana: An application of intervention analysis. *International Journal of Applied Science and Technology*, *2(8)*, 71-79.

Adjepong, M. O., Ababiob, A. K., Aidoo, N., Boateng, A., Munyakazi, L., and Nsowah-Nuamah, N. (2012). Intervention analysis of maternal healthcare enrollment at mampong government hospital. *Ghana Journal of Natural Sciences Research*, *2(7)*, 2224-3186.

Agar, B., and Noemi, P. (2010). *Contribution to the european report on development extending health insurance: Effects of the national health insurance scheme in. ghana .*

Aikins, L. (2010). *Female health and development : A case study regarding a maternal health scheme in .ghana.* Unpublished master's thesis, University of Agder.

Ameyaw, A. E. (2001). *An assessment of the effect of the free maternal care policy on the utilisation of maternal care services in the new juaben municipality.* Unpublished master's thesis, Kwame Nkrumah University of Science and Technology.

Arthur, E. (2012). Wealth and antenatal care use: implications for maternal health care utilisation in ghana. *Health Economics Journal*, *2(14)*.

Asante, F. . A., Chikwama, C., Daniels, A., and Armar-Klemesu, M. (2007). Evaluating the economic outcomes of the policy of fee exemption for maternal delivery care in ghana. *Ghana Med Journal*, *41(3)*, 110-117.

Bennis, I., and De-Brouwere, V. (2012). Fee exemption for caesarean section in morocco. fee exemption for caesarean section in morocco. *Arch Public Health*, *70(1)*, 1-6.

Biglan, A., Ary, D., and Wagenaar., A. C. (2000). The value of interrupted time-series experiments for community intervention research prevention science. *BMC Health Services Research*, *1(1)*, 31-39.

Box, G. E. P., and Pierce, D. A. (1970). Distribution of residual correlations in autoregressive-integrated moving average time series models. *Journal of the American Statistical Association*, *65*, 1509 - 1526.

Chatfield, C. (1996). *The analysis of time series: an introduction, 5th ed., london.* Chapman and Hall.

Coeytaux, F., Bingham, D., and Langer, A. (2011). Association of reproduction health professionals contraception editorial reducing maternal mortality. *PLoS One*, *83*, 95 - 98.

Do-Carmo, G., C.Yen, Cortes, J., Siqueira, A. A., and De'Oliveira, W. K. (2011). Decline in diarrhea mortality and admissions after routine childhood rotavirus immunization in brazil: A time-series analysis. *PLoSone Med*, *8(4)*, 6-5 e1001024. doi:10.1371/journal.pmed.1001024.

Dzakpasu, S., Soremekun, S., Manu, A., Asbroek, G. T., Tawiah, C., and Hurt, L. (2012). Impact of free delivery care on health facility delivery and insurance coverage in ghanas brong ahafo region. *PLoS One*, *7(11)*, 5-7.

Einarsdttir, K., Kemp, A., Fatima, A. H., Moorin, E. R., S.Gunnell, A., and Preen, D. B. (2012). Increase in caesarean deliveries after the australian private health insurance incentive policy reforms. *PLoS ONE*, *7(7)*, 1-2.

Fiagbe, P., Asamoah, D., and Oduro, F. T. (2012). Assessing the role of transport in the achievement of maternal mortality reduction in ghana. *International*

Journal of Business and Management, *7(5)*, 256-268.

Fretheim, A., Oxman, D. A., lavis, J. N., and lewinn., S. (2009). Support tool for evidence informed policy marking in health:planning monitoring and evaluating of policies. *Health Research Policy and System*, *7(18)*, 1-8.

GHS. (2009). *Ghana maternal health survey 2007. calverton, maryland, usa: Gss. ghs. and macro international.*

Graham, W. (2004). *Poverty and maternal mortality: What is the link?; keynote address delivered at annual research meeting, nmimr, university of ghana; legon.*

Hartmann, D. P., Gotrman, J. M., Jones, R., W.Gardner, Kazdin, A. E., and Vaught., R. (1980). Interrupted time-series analysis and its application to behavioral data. *Journal of Applied Behavior Analysis*, *13*, 543-559.

Ikamari, L. D. E. (2004). Maternal health care utilization in teso district. *African Journal of Health Science*, *11(1)*, 21-32.

Khuder, A., Milz, S., Jordan, T., KathiSilvestri, J. P., and Butler, P. (2007). The impact of a smoking ban on hospital admissions for coronary heart disease. *Elsevier Inc*, *45(1)*, 3-8.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P., and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*, *54*, 159 -178.

Lagarde, M., and Palmer, N. (2008). The impact of user fees on health service utilization in low- and middle-income countries: how strong is the evidence? *Bull World Health Organ.*, *86(11)*, 839-848.

Lule, E., Ramana, G., Oomman, N., Joanne, E., Huntington, D., and Rosen., J. (2005). *Achieving the millennium development goal of improving maternal health: Determinants, interventions and challenges.*

Madden, M. J., Soumerai, S., Lieu, A. T., Mandl, K. D., Zhang, F., and Ross-Degnan., D. (2004). Length-of-stay policies and ascertainment of post discharge problems in newborns. *Pediatrics*, *113(1)*, 42-49.

Makridakis, S., Wheelwright, S. C., and Hyndman., R. J. (1998). *Forecasting methods and applications, 3rd ed.* Wiley.

Mba, C. J., and Aboh, I. K. (2009). Improving maternal health in ghana: Resource availability for safe delivery in akatsi and keta districts of volta region.

Michielutte, R., Shelton, B., Paskett, D. E., Tatum, M. C., and Velez, R. (2000). Use of an interrupted time-series design to evaluate a cancer screening program. *oxfordjournal*, *15(5)*, 615-623.

Montagu, D., Yamey, G., Visconti, A., Harding, A., and Yoong, J. (2011). Where do poor women in developing countries give birth? a multi-country analysis of demographic and health survey data. *PLoS ONE*, *6(2)*, e17155. doi:10.1371/journal.pone.0017155.

Opoku, E. A. (2009). *Utilization of maternal care services in ghana by region after the implementation of the free maternal care policy.* Unpublished master's thesis, University of North Texas Health Science Center at Fort Worth.

Penfold, S., Harrison, E., Bell, J., and Fitzmaurice, A. (2007). Evaluation of the delivery fee exemption policy in ghana: Population estimates of changes in delivery service utilization in two regions. *Ghana Med J*, *41(3)*, 100109.

Renaudin, P., Prual, A., Vangeenderhuysen, C., Abdelkader, M. O., Mohamed, V. O., and Joud, D. O. E. (2007). Ensuring financial access to emergency obstetric care: three years of experience with obstetric risk insurance in nouakchott, mauritania. *Int J. Gynaecol Obstetic*, *90(2)*, 183-90.

Reviani, N. (2010). *Factors influencing complications during delivery in indonesia 2007.* Unpublished master's thesis, TheFlindersUniversityofSouthAustralia Adelaide.

Ridde, V., Kouanda, S., Bado, A., Bado, N., and Haddad, S. (2012). Reducing the medical cost of deliveries in burkina faso is good for everyone, including the poor. *PLoS One*, *7(3)*.

Ronsmans, C., and Graham., W. (2006). Maternal mortality: Who, when, where, and why.keynote address delivered at annual research meeting, nmimr, university of ghana; legon. *The Lancet*, *368*, 1189-1200.

Rosenberg, D. (1997). *Trend analysis and interpretation: Key concepts and methods for maternal and child health professionals. u.s. department of health and human services, health resources and services administration, division of science, education and analysis maternal and child health bureau.rockville, md.*

S.K.Lodhi, R.Sohail, F.Zaman, M.Tayyeb, and Bashir., T. (2004). Figo save the mothers initiative: the pakistan-uk collaboration. *Int. J. Obs & Gyn*, *8(7)*, 79-87.

Stoffer, D. S., and Toloi, M. C. (1992). A note on the ljung- box pierce portmantean statistic with missing data statistics & probability letters. , *13(5)*, 391- 400.

Tiao, G. C., and Box, G. E. P. (1975). Intervention analysis with applications to economic and environmental problems,. *Journal of American Statistical Association*, *2*, 70-79.

WDR. (2012). *world development report.*

WHO. (2005). *Report on maternal mortality.* World Health Organization.

WHO. (2007). *Millennium development goal 5.*

WHO. (2008). *Maternal mortality in 2007: Estimates developed by who, unicef, unfpa and the world bank. geneva: World health organization.*

Witter, S., Sam-Adjei, S., Armar-Klemesu, M., and Graham, W. (2009). Providing free maternal health care: ten lessons from an evaluation of the national delivery exemption policy in ghana. *Global Health Action*, 1-2.

Yaffee, R. A., and McGee, M. (2000). *Introduction to time series analysis and forecasting with applications of sas and spss.* Academic Press Inc., San Dieg.

Zozulya, M. (2010, August). *Mortality in nigeria: An indicator of womens status.* Available from gender.issues@consultancyafrica.com

Appendix A

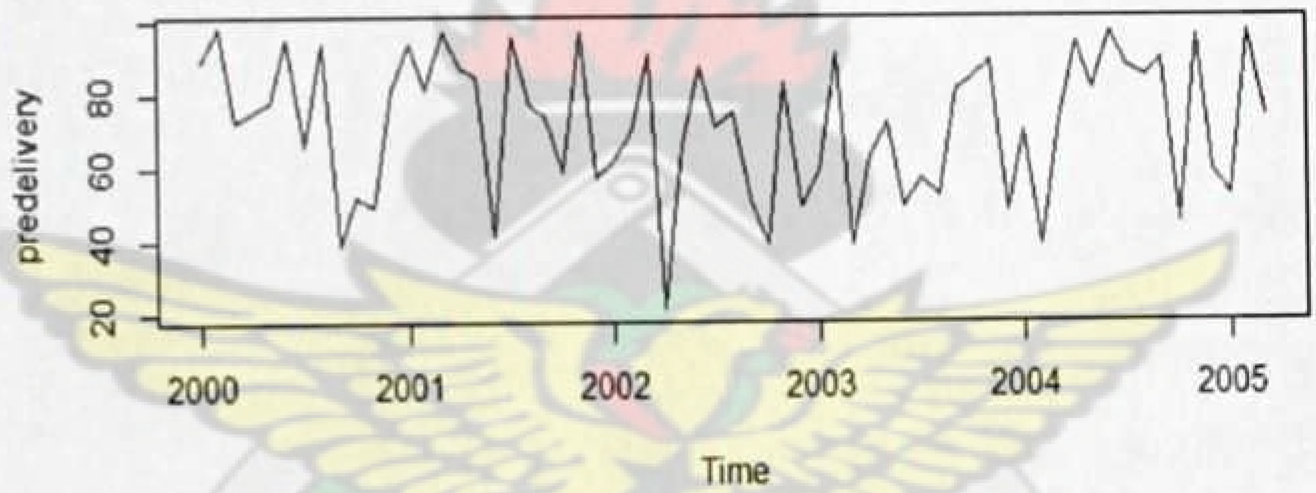


Figure A.1: Time plot of pre-intervention series

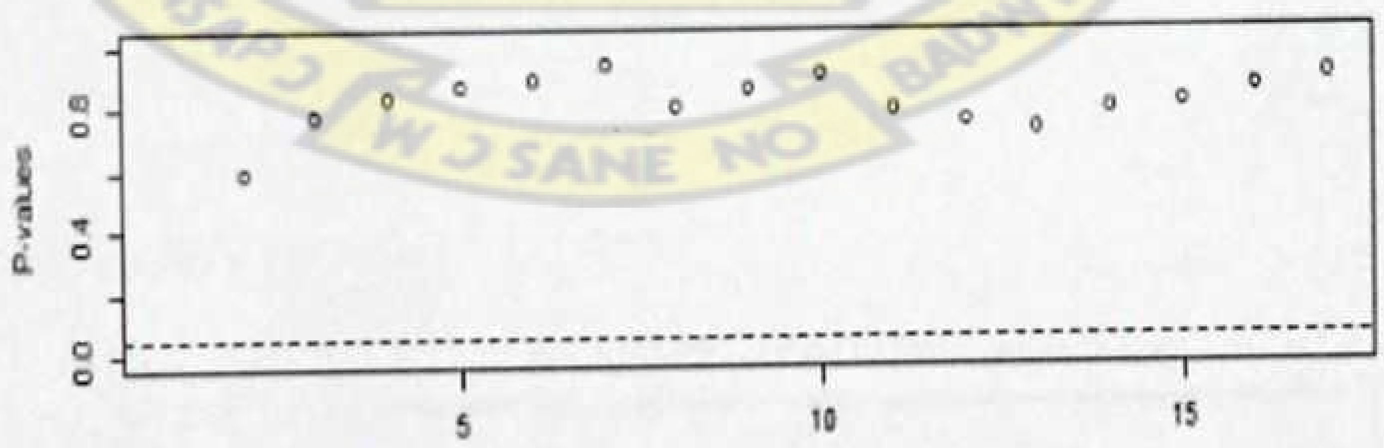


Figure A.2: P-value of Ljung-Box for Noise Model

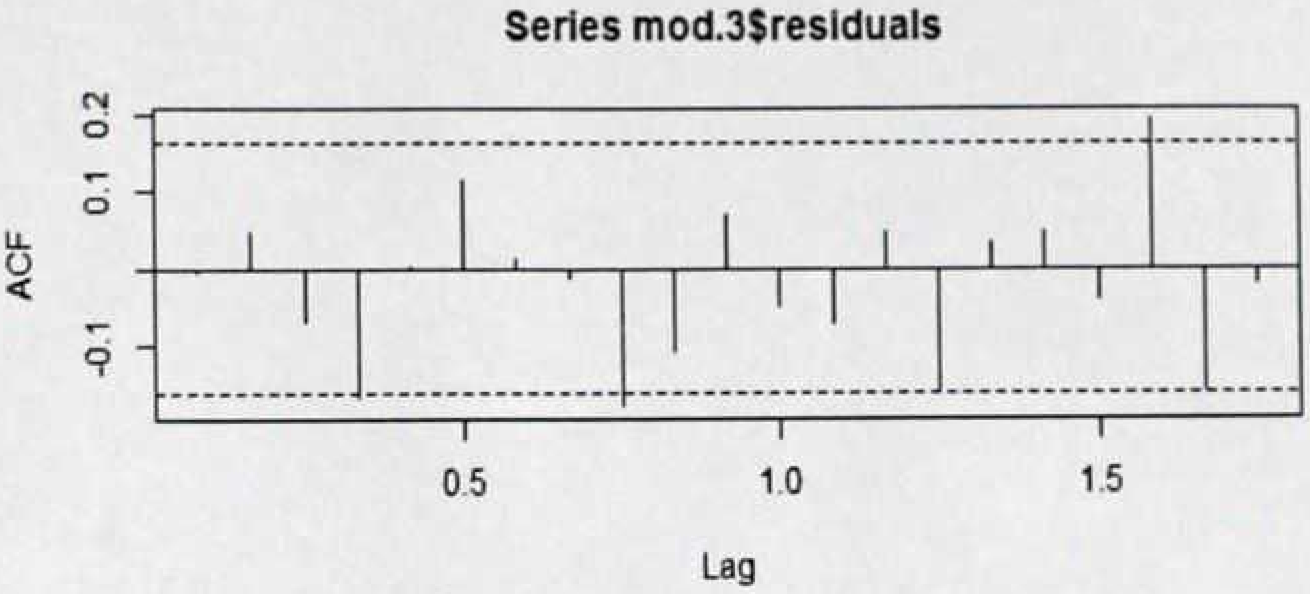


Figure A.3: ACF of selected intervention model's residuals

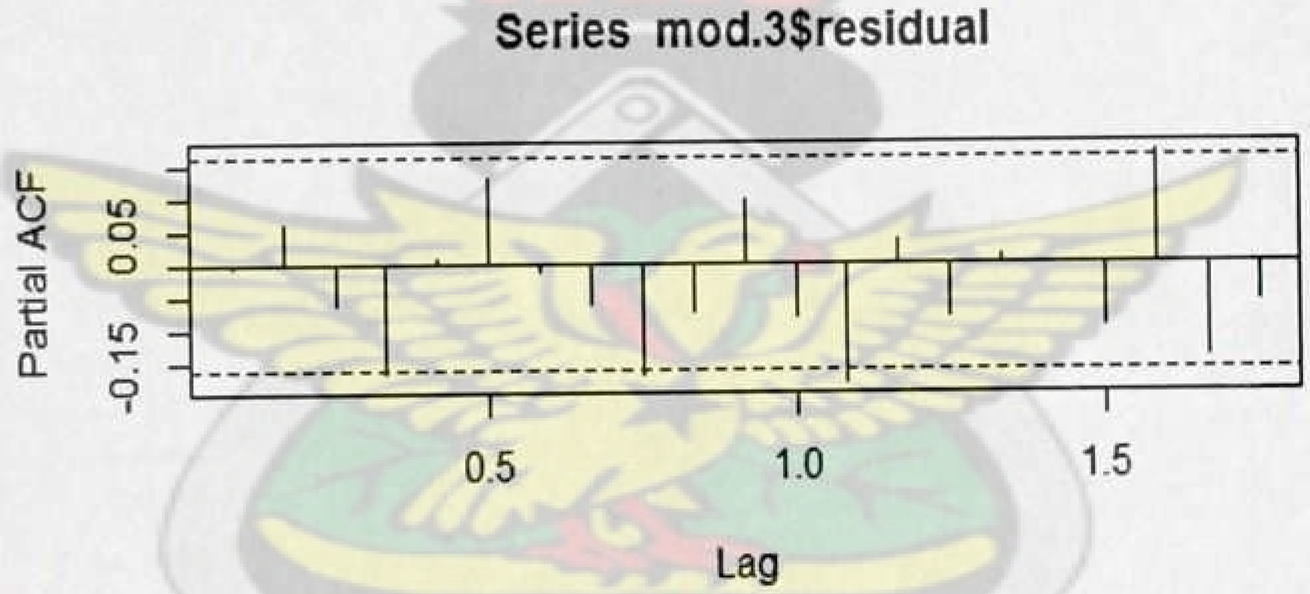


Figure A.4: PACF of selected intervention model's residuals

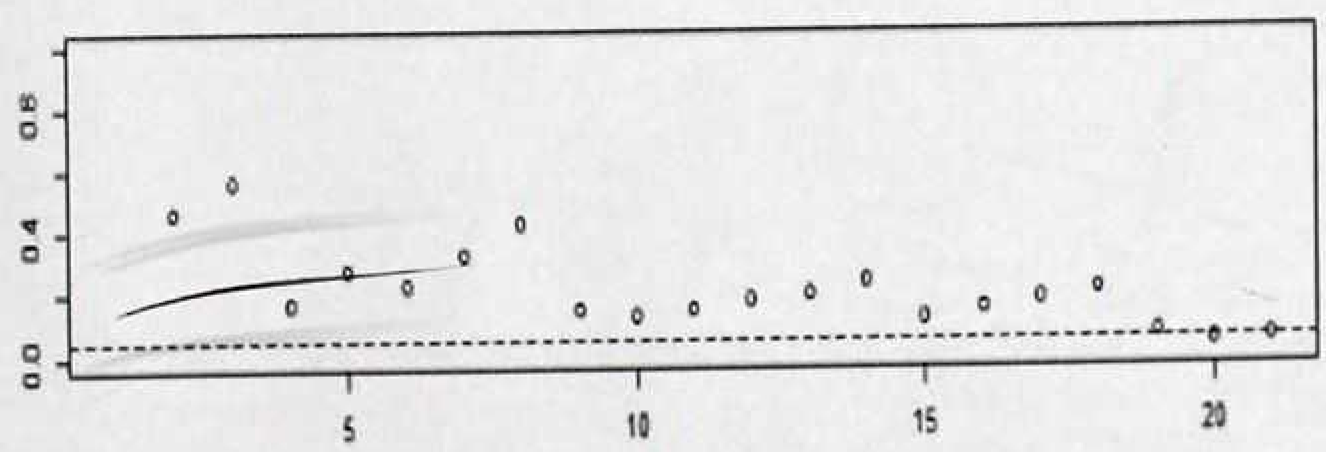


Figure A.5: P-value of Ljung-Box for intervention Model