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LIVE BIRTH REGISTRATIONS IN NIGERIA: ANALYTICAL APPROACH USING ARIMA MODEL

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ABSTRACT: *Data on Birth registration often comes from complex sampling designs with hierarchical structure. The study aimed at using a novel approach and expanded variables on the determinants of birth registration. Issues of live birth registration among young children in developing countries are gaining more attention of policy-makers because of the adverse effects on the wellbeing of people and economic of these nations. Civil registration provides a continuous record of vital events. This research examines the stationarity in live birth registration among the two age-groups and a model was fitted to the age-groups. The data used were analyzed using R programming language. Time series analysis was used to analyze and forecast from the data presented. Research results showed that group under 1 year and 5 years are stationary, only under 5 years forecast indicated that there is a constant in the data and Box- Ljung showed that the residual plots are dependent. It was concluded that there is substantial growth in the registration of live birth in Nigeria despite the instability in the system during the specified period. Also, the Augmented Dickey-Fuller (ADF) test and Philip Perron (PP) test imply that the more negative the test, the stronger is the model. Seasonal autoregressive integrated moving average (SARIMA) approach model stands as the best model for prediction based on this series.*

KEYWORDS: Live Birth Registration, Augmented Dickey-Fuller Test, Stationarity, Civil Registration System, ARIMA Model

INTRODUCTION

Civil registration is an aspect of demographic data, according to Acts and Regulations, Civil Registration is the continuous, permanent, and compulsory recording of the occurrence and characteristics of vital events in accordance with the legal requirements of a country. Civil registration provides a continuous record of vital events. Since the data on civil registration is on continuous basis, it serves as a mean of generating data even for census and are inherent in other sources of data. Furthermore, such data is needed for population estimation and projection and other analytical studies useful for planning and research. In Nigeria, Civil registration on the aspect of Live birth was made compulsory as acted by the Federal Government of Nigeria. Birth Registration is the official recording of birth of a child by some

administrative level of the state and coordinated by a particular branch of government. It is a permanent and official record of a child existence.

Birth Registration of children may be required for access to health, education and other services in some places; it allows accurate estimation of age; it helps in reuniting separated children and parents; and it can provide important population information for planning of services (UNICEF, 2013; UNDESASD, 1998; Ezra e tal, 2017 and Dettling, 2002). A motivational factor for researchers is to develop new predictive models (Appiah and Menya, 2003; Durya e tal, 2002; Akomolafe e tal, 2019 and Marcek, 2004). Many economic time series are seasonal, its volatility notwithstanding, and some series tend to exhibit some seasonality. Box and Jenkins (1976), Anyawu (1998), Box- George (1994), Brito e tal (2013); Akomolafe and Awogbemi, 2017 and Fuse (2010) are a few of authors that have written extensively on Seasonal Auto-Regressive Integrated Moving Average (SARIMA) models which are specially articulated for seasonal time series. This paper focused on birth registration in children (age 0 - under 5 years) by a seasonal ARIMA model. The approach adopted is the Seasonal Auto-Regressive Integrated Moving Average (SARIMA) approach which is sequel to an observation of a seasonal tendency in the time series tending to increase during some specific seasons. In statistics, time series data is data collected at regular intervals. When there are patterns that repeat over known, fixed periods of time within a data set, it is considered to be seasonality, seasonal variation, periodic variation, or periodic fluctuations. Prediction will continue to be an interesting area of research making researchers in the domain field always desiring to improve existing predictive models. The reason is that institutions and individuals are empowered to make investment decisions and ability to plan and develop effective strategy about their daily and future endeavors. The significance of birth registration in global, regional and national development cannot be over-emphasized. A holistic look at the phenomenon suggests that there are certain factors that enhance or inhibit birth registration. The empirical literature finds that the maternal education levels, place of delivery, age of the child, household wealth index and urban location all affect birth registration status of a child in a given household.

Source of Data

This study relies on data available from the rapidsms dashboard, www.rapidsmsnigeria.org on the live birth registered across the 36 states in Nigeria. With the technical assistance of UNICEF, the national representative survey is being implemented by the National Population Commission (NPC). The registration was designed to provide necessary information about the children (age 0 - under 5 years) both at the state and national levels.

METHODS AND RESULTS

The first step in time series is the time plot, which is the graph of all the Live birth registrations in Nigeria which is our observed series [X_t] against the corresponding time [t] which is an interval between 2012 and 2016. This plot shows the rate of registration of the series over the years and vividly depicts the acts of the time series at a glance. Also, important in time series analysis is the need to check for the existence of seasonality in the observed series.

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The hypothesis testing is as specified:

H_0 : The Live birth registrations of under 1 in Nigeria is normally distributed versus H_1= not H_0.

Jarque Bera Test showing the normality of the Live birth registrations of under 1 year in Nigeria.

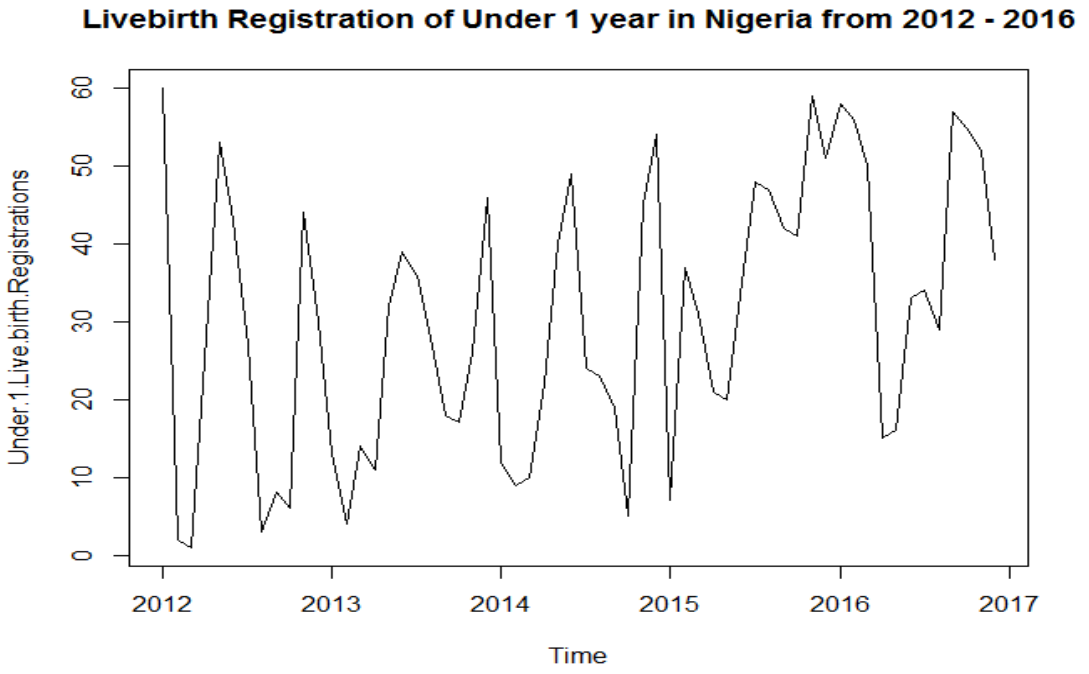

Figure 1: Plot showing the Live birth registrations of under 1 year in Nigeria

This is the graph of Live birth Registration under 1 year in Nigeria (X_t) against time (t). It could be depicted from the Time Plot that the series shows variation in the registration then sprouts a steady increase. In 2016, there was a very high peak and an almost immediate dip with the first month of 2012 and there is an upward trend with some variations in a stochastic manner.

The above Jarque Bera test, a Lagrange multiplier test which indicates that the under 1 years birth registration is normally distributed since the P-value > 0.05 which gives 0.165 with 2 degree of freedom.

We have the ACF and PACF plot of Live birth registration of under 1 in Nigeria.

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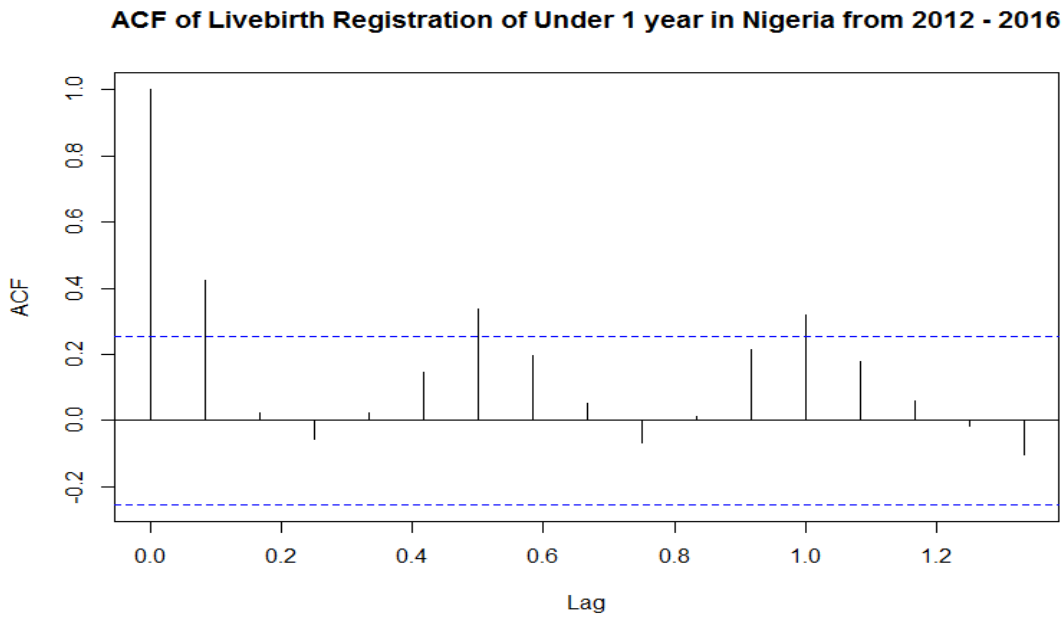

Figure 2: Plot of ACF and PACF of Live birth registration of under 1 in Nigeria

Decomposition of Series

Breaking the series down into individual components to further understand the series and grasp an idea of what is really happening in the series, the plot of the individual components of the series is shown below:

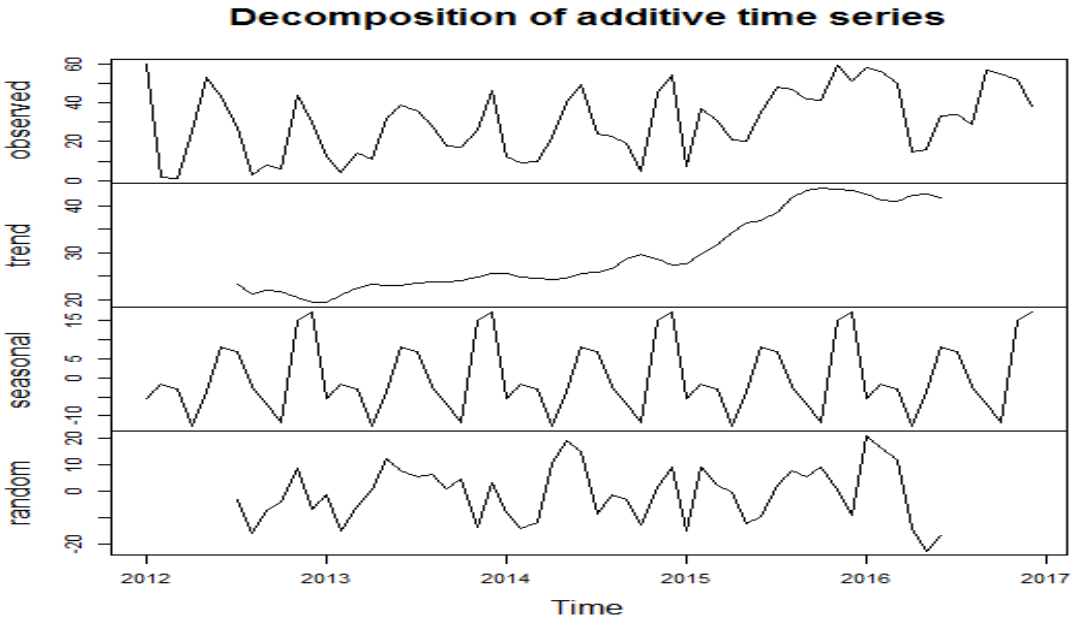

Figure 3: Plot of the individual components of the series.

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Stationarity Test

Test for stationarity is a very crucial step in our analysis. Our series has to be stationary before we can fit a model to it. Using Augmented Dickey-Fuller Test in r we can determine the nature of our series. Augmented Dickey – Fuller and Philip Perron Test used in this section is used to test differencing stationarity while KPSS trend is used to check the trend for stationarity.

Augmented Dickey -Fuller Test of Stationarity

H_0: There is no stationarity in the unit root (series) versus H_1 = not H_0

The test shows that there is stationarity in the series, since P < 0.05. Therefore, we say that there is stationarity in the livebirth registrations of Under 1 year in Nigeria. The ADF – test in R programming using the lag order of 3 showing that the P- value = 0.01 < 0.05 ($\propto$). It indicates that the data is stationary.

Philip Perron Test of Stationarity

It is used in time series analysis to test the null hypothesis that a time series is integrated of order 1. It builds on the Augmented Dickey-Fuller test of the null hypothesis.

H_0: There is no stationarity in the unit root (series) versus H_1= not H_0.

The Philip Perron Test of Stationary indicates that there is a stationarity in the data. it implies that P-value = 0.01 < 0.05 and we also say there is a unit root in the livebirth Registrations of under 1 year in Nigeria.

Checking the Kwiatkowski – Phillips – Schmidt – Shin (KPSS) Test for Trend Stationarity of the Series

H_0: Observable time series is stationary around a deterministic trend versus H_1= not H_0

From the above snip, it could be deduced that the P-value (0.1) > printed P-value (0.05). Therefore, there is a trend stationarity in the series since we do not reject Null Hypothesis.

Fitting SARIMA Model to the Original Data as First Approach

For the SARIMA process, we fit a SARIMA model directly to the original data. Using the auto.ARIMA function in r to find the best model to fit to our series, we get the model SARIMA. Since the series is stationary and the model is fit at an order of 0, 1, 2 in which it is seasoned at 1,0,0. It implies that there is no differencing in the data since d = 0 in seasonal ARIMA. We can go ahead and forecast, for the next 2 years (24 months). Below is a table showing the forecast for the next 2 years (24 months) at the confidence interval 95%.

Forecast for 2 Years using the Fitted SARIMA Model

We have the graph of the forecasted years below joined to the data showing a continuous and repetitive pattern which depicts seasonality with the ACF and PACF.

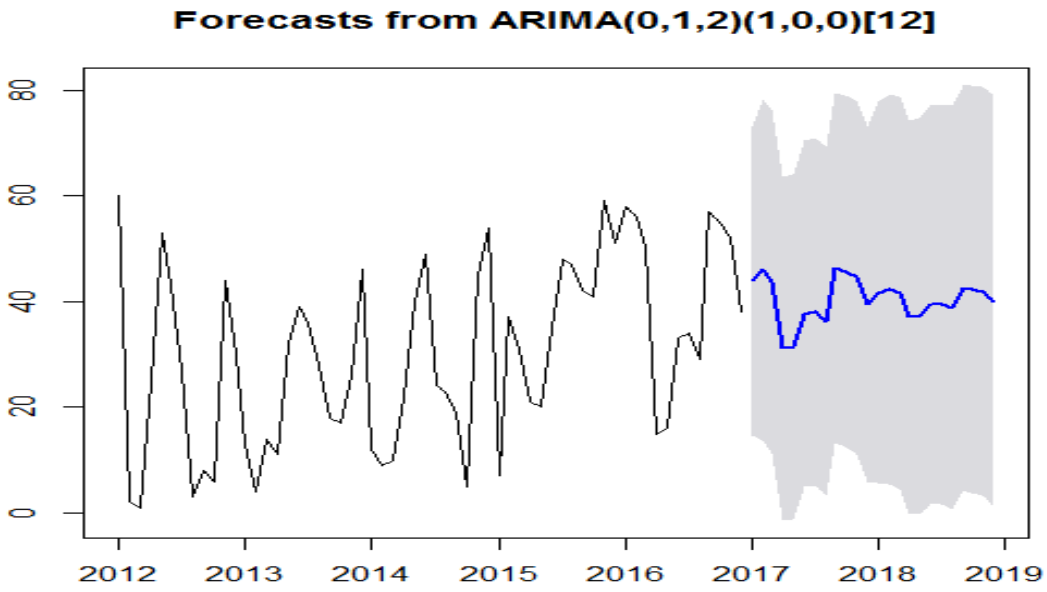

Figure 4: Plot of seasonality with the ACF and PACF

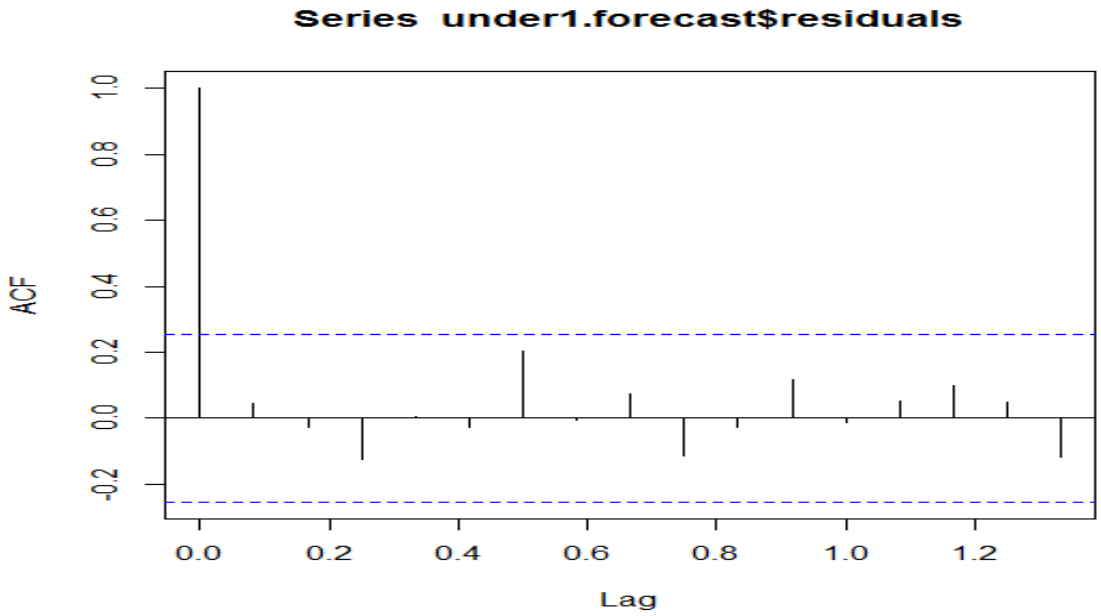

Figure 5: Plot of series under 1 forecast and residual [ACF]

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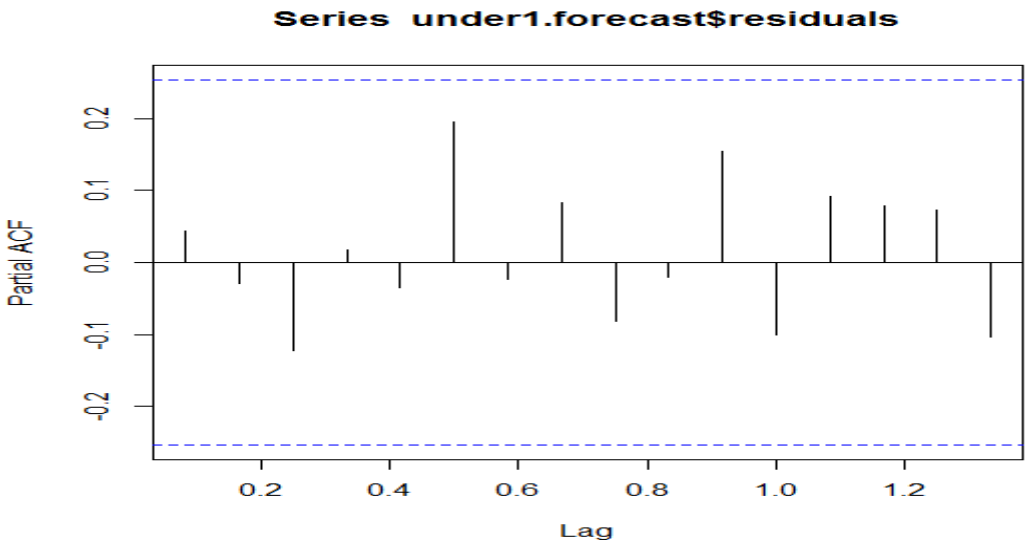
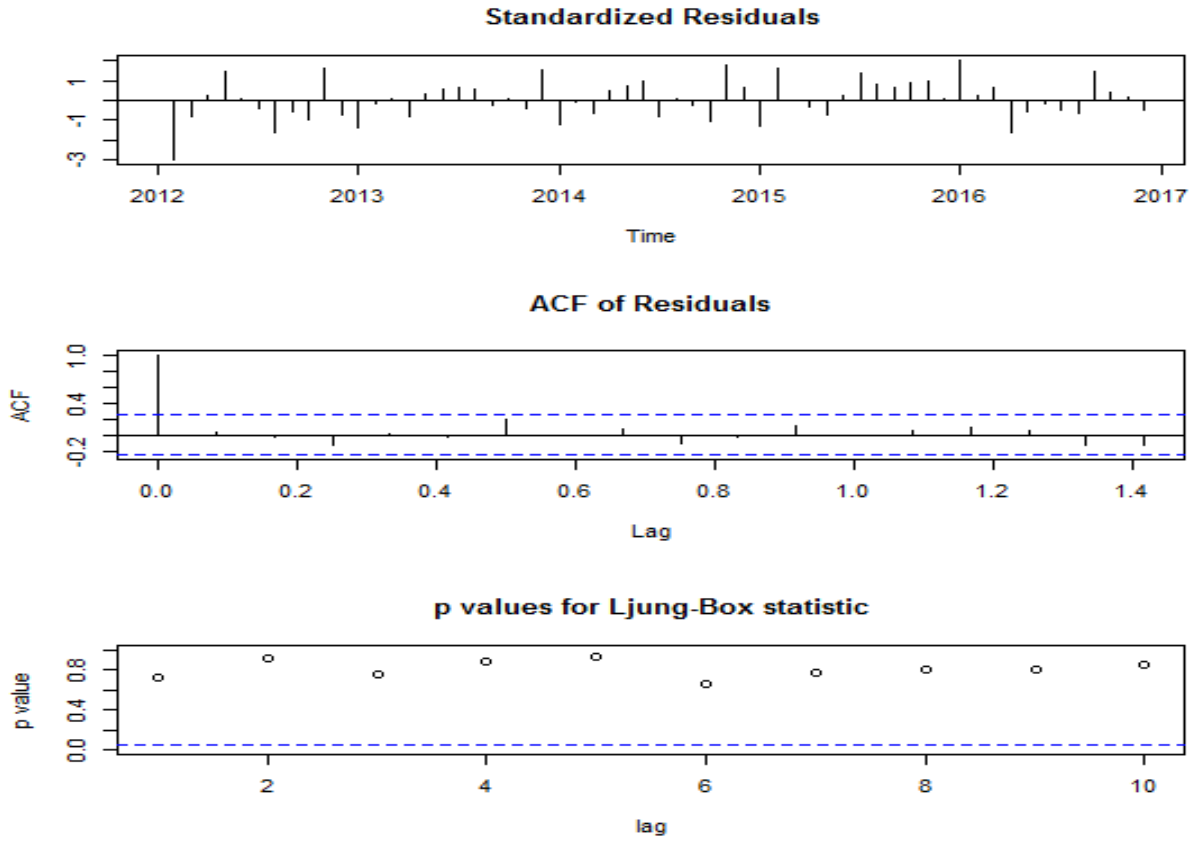


Figure 6: Plot of series under 1 forecast and residual [PACF]

Below is the plot of standardized residual, the ACF residual and the p-value of the Ljung Box**.**



The residual plot of the forecast is showing below:

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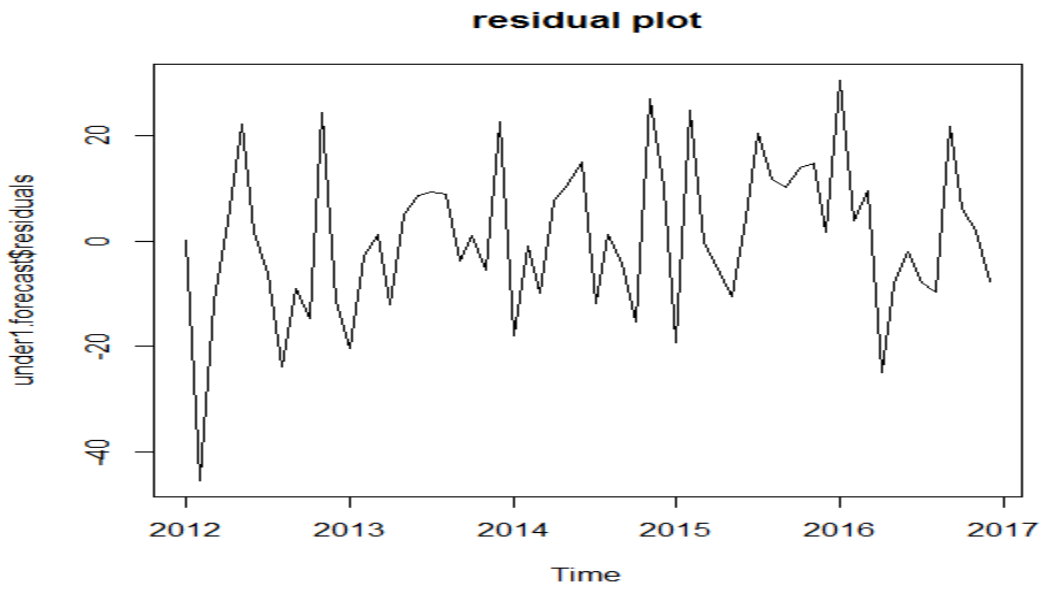

Figure 7: The residual plot of the forecast

Box-Ljung Statistics for ARIMA Residual in R

Box-Ljung tests the randomness in a time series (Independence of residuals). Box-Pierce test examines the null of independently distributed residuals. It is derived from the idea that the residuals of a "correctly specified" model are independently distributed. If the residuals are not, then they come from miss-specified model. Residuals are independent if p-value > 0.05 ($\propto$) using Ljung and Box pierce.

```
        Box-Ljung test

data:  under1.forecast$residuals
X-squared = 8.8705, df = 16, p-value = 0.9187
```

Data of Live Birth Registrations of under 5 years in Nigeria Between 2012-2016.

Jarque Bera Test showing the normality of the Live Birth *registrations of under 5 in Nigeria***.**

H_0: The Live birth Registrations of under 5 years in Nigeria is normally distributed versus H_1 = not H_0.

```
> #..Null Hypothesis for jarque bera is data is normal...
> jarque.bera.test(ts.under5)

        Jarque Bera Test

data:  ts.under5
X-squared = 3.604, df = 2, p-value = 0.165
```

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The above Jarque Bera test, a Lagrange multiplier test which indicates that the under 5 years birth registration is normally distributed since the P-value > 0.05 which gives 0.165 with 2 degrees of freedom.

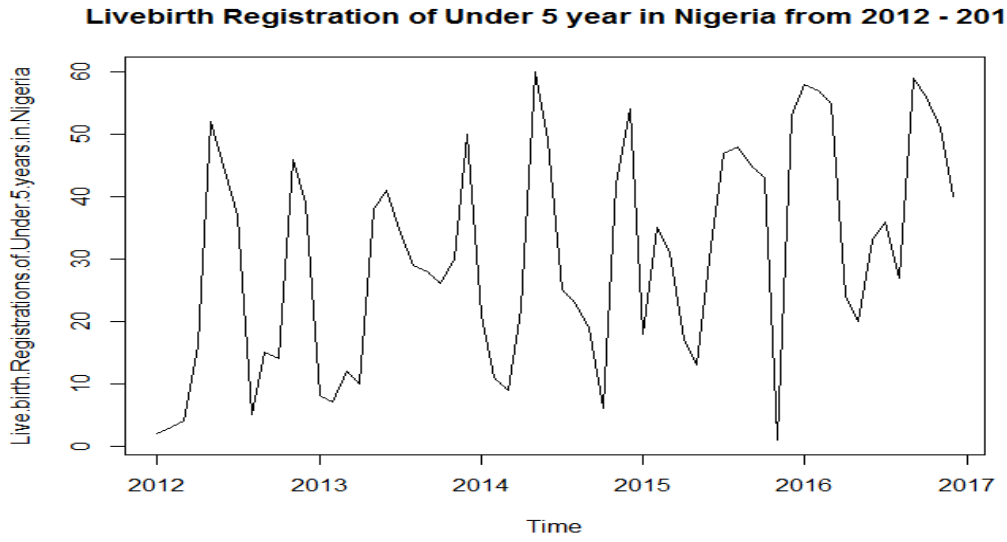

Figure 8: Plot of Live birth Registrations of under 5 year in Nigeria

This is the graph of Live Birth registration under 5 year in Nigeria (X_t) against time (t), the series shows variation in the registration then sprouts a steady increase. In 2014 and 2016, there was a very high peak and an almost immediate dip with the first month of 2012 and there is an upward trend with some variations in a stochastic manner.

Below, we have the ACF and PACF plot of Live Birth Registrations of under 5 years in Nigeria.

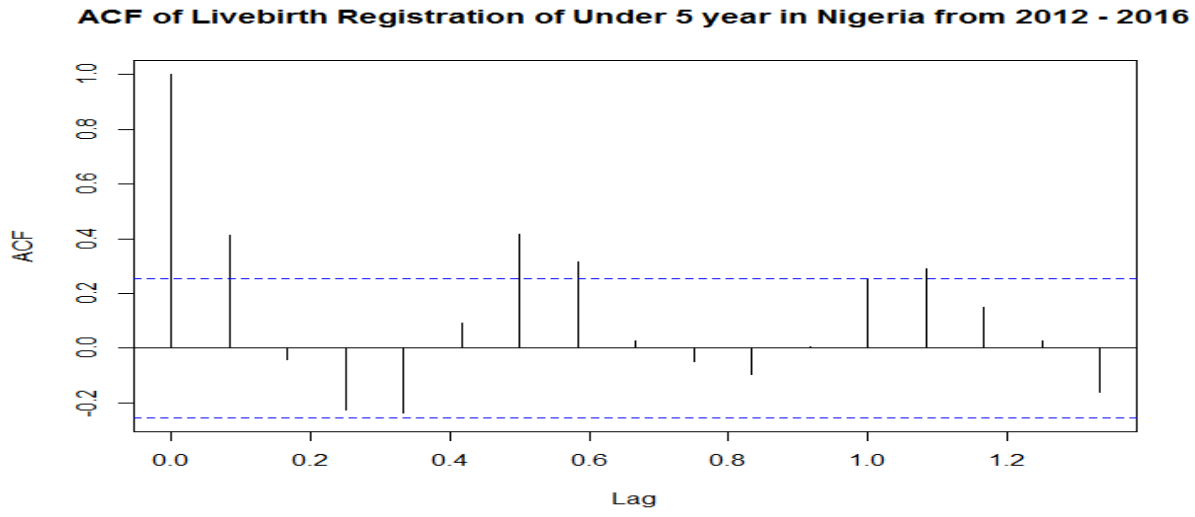

Figure 9: Plot of ACF of Live birth Registrations of under 5 years in Nigeria

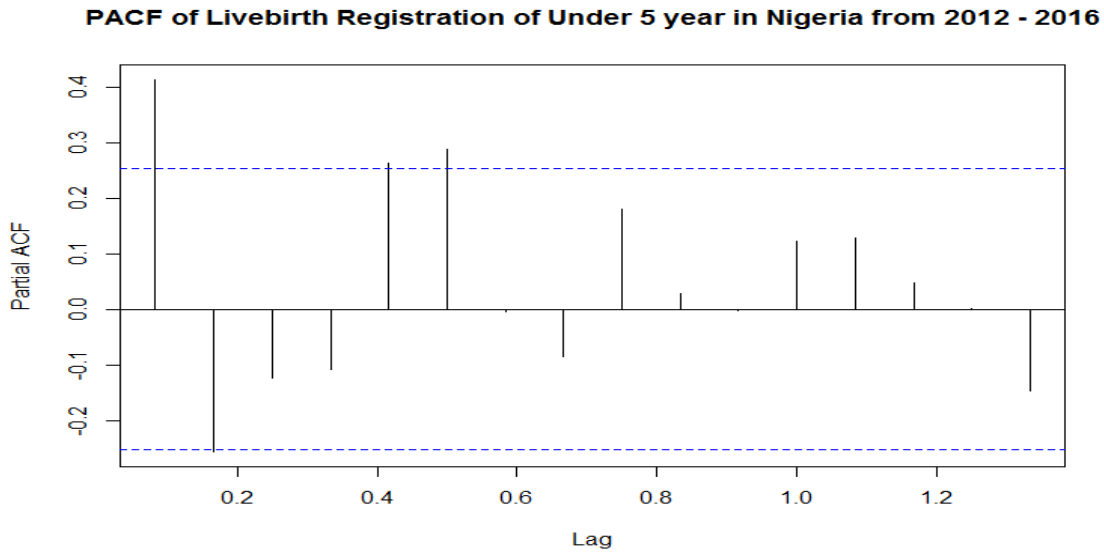

Figure 10: Plot of PACF of Live Birth Registrations of under 5 years in Nigeria

SUMMARY OF THE FINDINGS

Going through the analysis each categories of birth depicts the stationarity and the trend in the movement of registration. Considering the under 1 age-group, the Jarque Bera Test is used for testing the normality of data. Normality of under 1-year birth registration is one of the standardized assumptions that was fulfilled in this study. Jarque Bera test which also follows a Chi-square distribution can be seen from the above analysis with two (2) degrees of freedom and the p-value of 0. 165. The monthly data of under 1 year of the birth registrations in Nigeria were plotted which also shows the ACF and PACF of the Age-group (Under1). A good understanding of the stationarity was shown with Augmented Dickey -Fuller Test and Phillip-Perron Test indicating that $p < 0.05$. The SARIMA model is of order (0,1,2) and seasoned at (1,0,0) with the frequency of 12, where $p = 1$, $d = 0$ and $q = 0$. The data is already stationary and it can't be differenced since $d = 0$. We then fit a model $y = -0.5296 – 0.0736MA(2) + 0.3622$. The forecast shows that there is a variation in the under 1 year of the Live Birth Registrations in Nigeria. The residual of the forecast with the ACF and PACF were shown. Box-Ljung depicts that the residual plot which implies that there is an independent in the residual of the plot since p-value > 0.05. under 5 years in Live Birth Registrations in Nigeria also test the Jarque bera Test which implies that the age-group is normal. The forecast shows that there is a constant in the livebirth registrations of under I years and under 5 years.

CONCLUSION AND RECOMMENDATION

Determinants of birth registrations have been studied extensively in the literature. However, these authors appealed to fitting single level probit or logistic regression models which assume that the relationship of covariates to outcome variable is the same across entities in the survey design. Ignoring the hierarchical structure of data can have serious implications

because the use of alternatives such as aggregation and disaggregation of information to another level can induce high collinearity among predictors and large or biased standard errors for the estimates. This study ensures that the proportion of variance in birth registration explained by these hierarchies can be factored out by using multilevel model modeling approach. Given that good and adequate civic registration for children growth and development, and a prerequisite for national development, the results of this study are directly important to the public health policy rationales of government programmes and international donor activities. Using the results obtained from data of all Live birth registrations in Nigeria among the two (2) categories which are under 1 year and under 5 years (2012 - 2016), it was concluded that there is substantial growth in the registration of Live-birth in Nigeria despite the instability in the system during the specified period. Also, the ADF test and PP Test implies that the more negative the test is, the stronger is the model.

In conclusion it is in the interest of this study to underline that while civil registration is a compulsory practice, it is against any country's development policies to deny a child education opportunities for failure to possess a birth certificate. Education is a fundamental human right which Nigeria recognizes, through its commitments to the United Nations Convention on the Rights of the Child and the Organization of African Unity (OAU) Charter on the Rights and Welfare of the Child among others. Live Birth registration is a basic responsibility of a government to its people. Penalties for registration are only reasonable when backed up by sufficient infrastructure to ensure that every member of the public has access to registration services. As observed above, Nigeria's population faces numerous limitations to birth registration amongst them being lack of accessibility of registration services and indirect costs associated to registration. This study recommends that the government urgently looks into ways of reversing this practice, and investing into improving accessibility of registration services to its population.

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