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Livebirth Registrations in Nigeria: Analytical Approach Using Arima Model

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Abstract
Livebirth registration is an aspect of civil registration system which is the continuous 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. This paper examines the stationarity in Livebrith registration among the two age – groups and a model was fitted to the age – groups. Data on www.rapidsmsnigeria.org was used. The data were analyzed using R programming language version 3.4.0. Time series analysis was used to analyze and forecast from the data presented. It shows that group Under 1 and Under 5 years are stationary. Only Under 5 years forecast shows that there is a constant in the data and Box – Ljung shows that the residual plots are dependent. It was concluded that there is substantial growth in the registration of livebirth in Nigeria despite the instability in the system during the specified period. Also, the Augmented Dickey – Fuller Test (ADF) test and Philip Perron (PP) Test implies that the more negative the test is 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, Time series, Nigeria, Civil Registration system, ARIMA model
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1 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 Livebirth 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.

According to United Nation, “Complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy, which after such separation, breathes or shows any other evidence of life such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered LIVE BIRTH”. UNICEF recognizes the important role of birth registration in its medium term strategic plan which states: 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 2005). A motivational factor for researchers to evolve and develop new predictive models (Ayodele A. Adebiyi et al, 2014). Many economic time series are seasonal, its volatility notwithstanding, and some series tends to exhibit some seasonality. Box and Jenkins (1976), Madsen (2008) and Boubaker (2011) are a few of authors that have written extensively on Seasonal autoregressive integrated moving average(SARIMA) models which are specially articulated for seasonal time series. This paper is focused on Birth registration in children (0 – undet 5 years) by a seasonal ARIMA model. The approach adopted is the seasonal autoregressive integrated moving average (SARIMA) approach. This is sequel to an observation of a seasonal tendency in the time series, 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.

2. Source of Data

This study relies on data available from the rapidsms dashboard, www.rapidsmsnigeria.org on the livebirth 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 level.

3. Data Analysis 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 – 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.

Jarque Bera Test showing the normality of the Live birth Registrations of Under 1 year in Nigeria.

Below is the sniper and the Hypothesis testing:

H_0 : The livebirth registrations of under 1 in Nigeria is normally distributed vs $H_{1=}$ not H_0.

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 is > 0.05 which gives 0.165 with 2 degree of freedom.

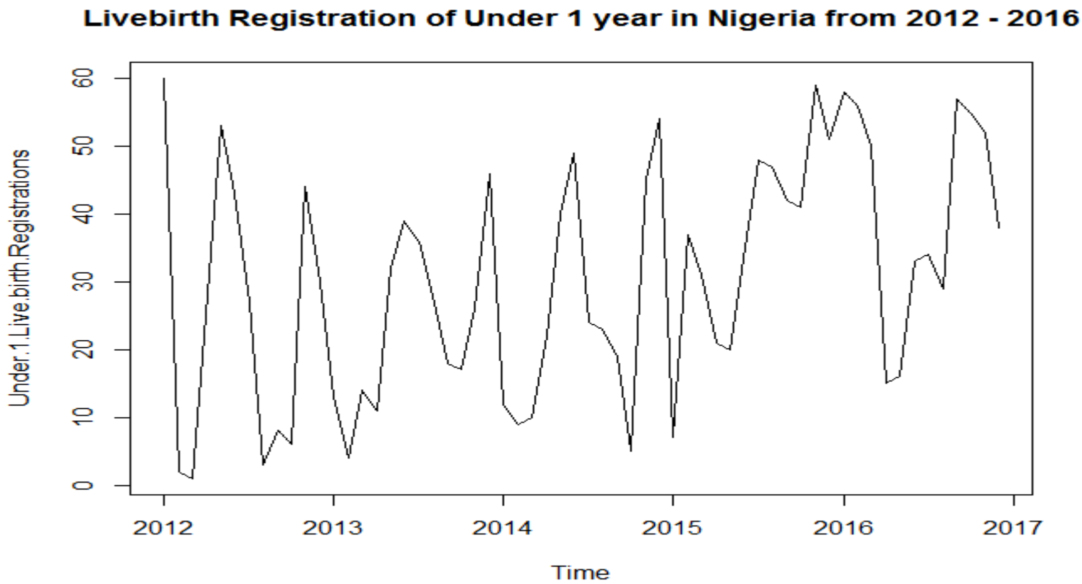

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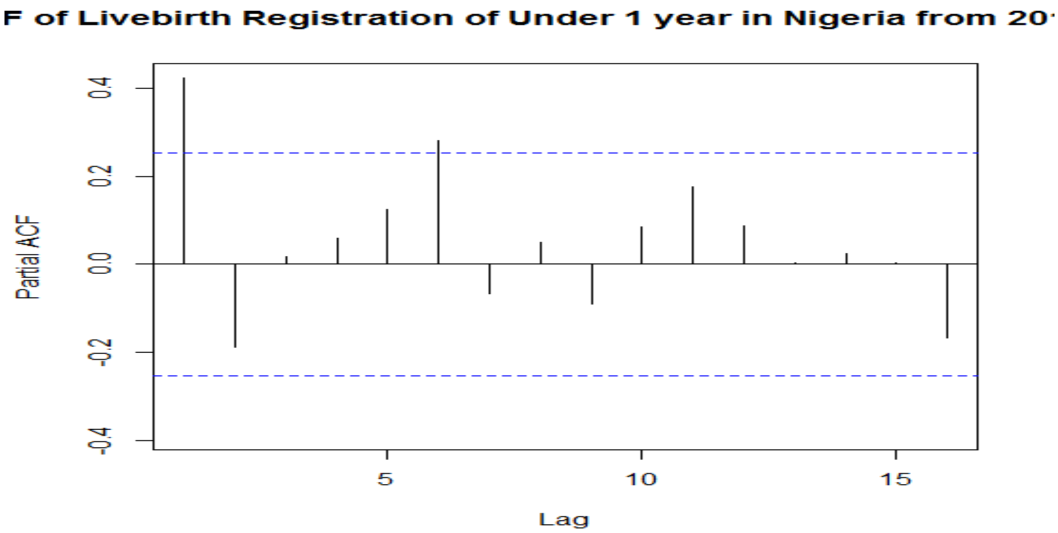
Figure 1: Showing the Live birth Registrations of Under 1 year in Nigeria

This is the graph of Live birth Registration under 1 year in Nigeria (Xt) 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.

Below, we have the ACF and PACF plot of Live Birth Registration of Under 1 in Nigeria.



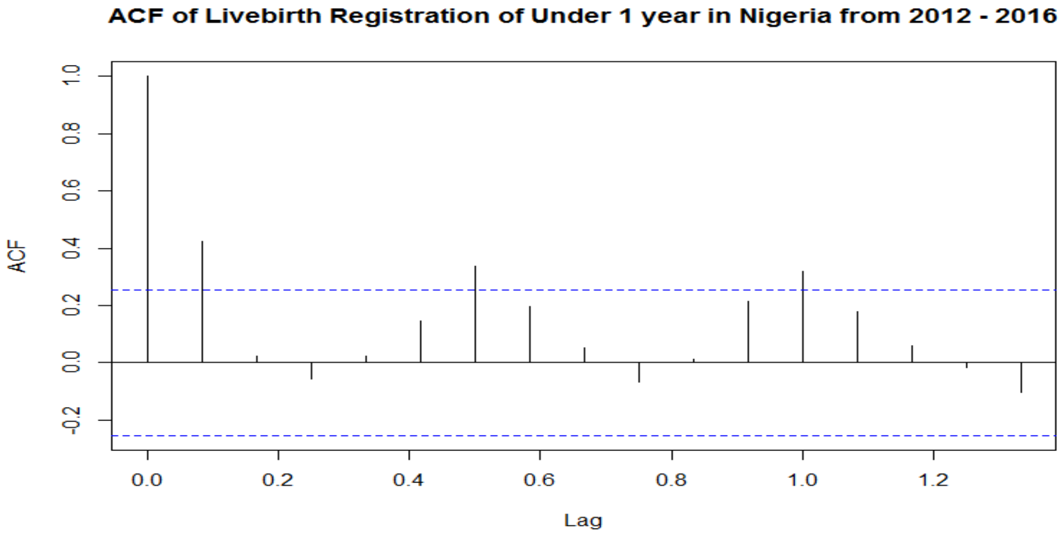


Figure 2: Plot of ACF and PACF of Live Birth Registration of Under 1 in Nigeria

Decomposing the series: Breaking the series down into individual components to further understanding the series and grasp an idea of what is really happening in the series. Below is the plot of the individual components of the series.

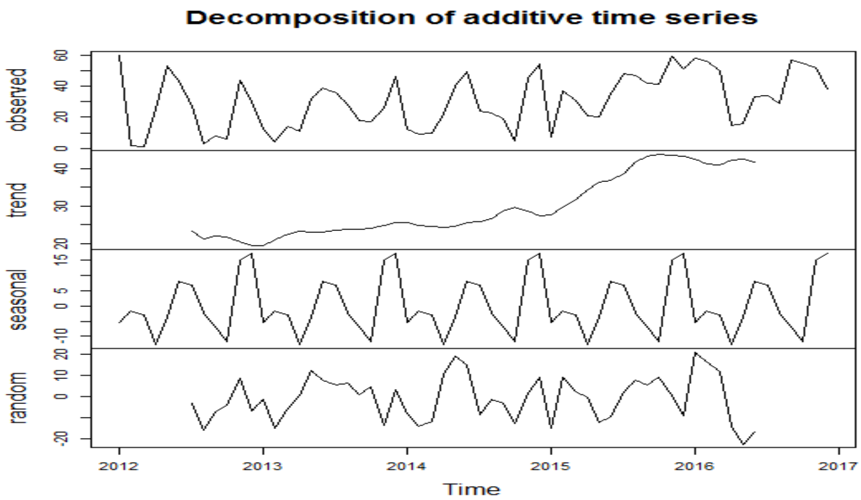


Figure 3: Plot of the individual components of the series.

STATIONARY TEST

Test for stationary 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 Stationarity.

Test 1

Augmented Dickey – Fuller Test of Stationarity

H_0: There is no stationarity in the unit root (series) vs 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) vs 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 vs 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, we say that there is a trend stationarity in the series since we do not reject H_0 (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.

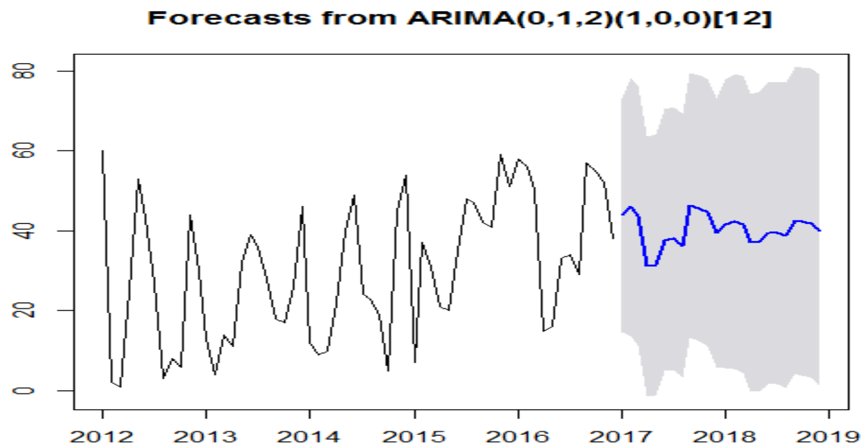


Figure 4:Plot of seasonality with the ACF and PACF

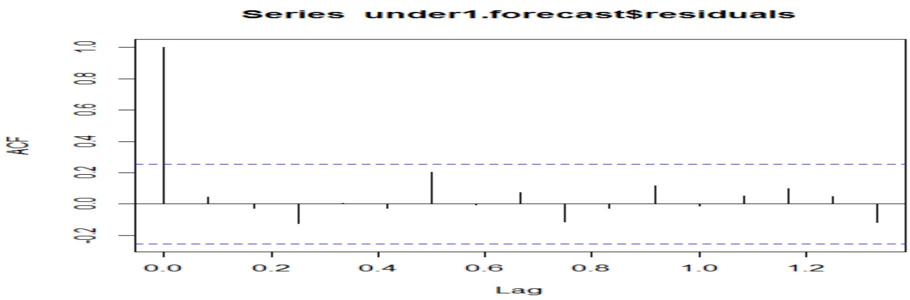


Figure 5: Plot of series under 1 forecast and residual[ACF]

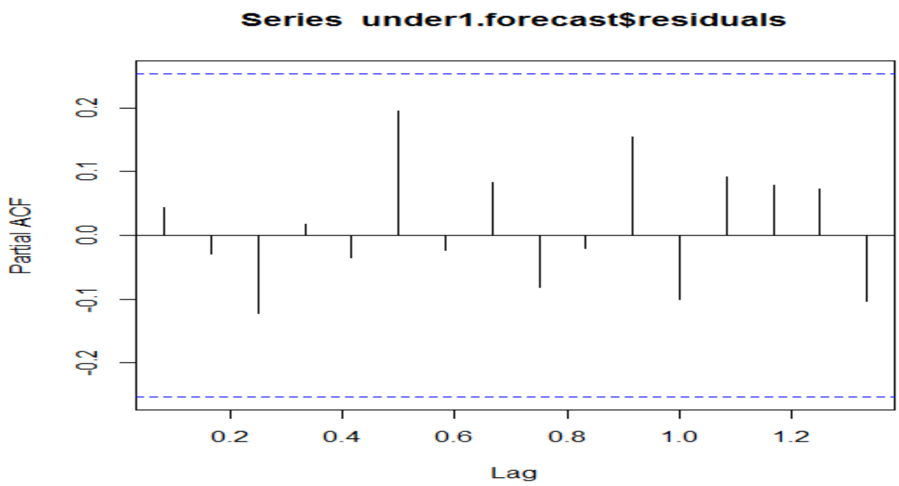
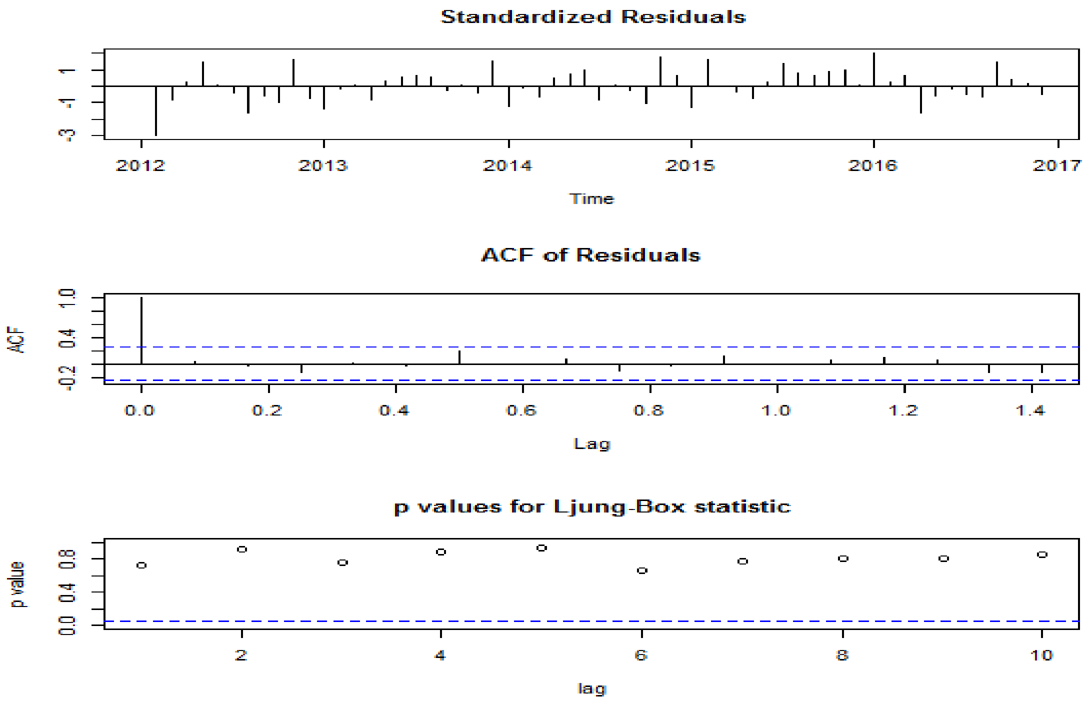


Figure 6: Plot of series under 1 forecast and residual[PACF]

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:

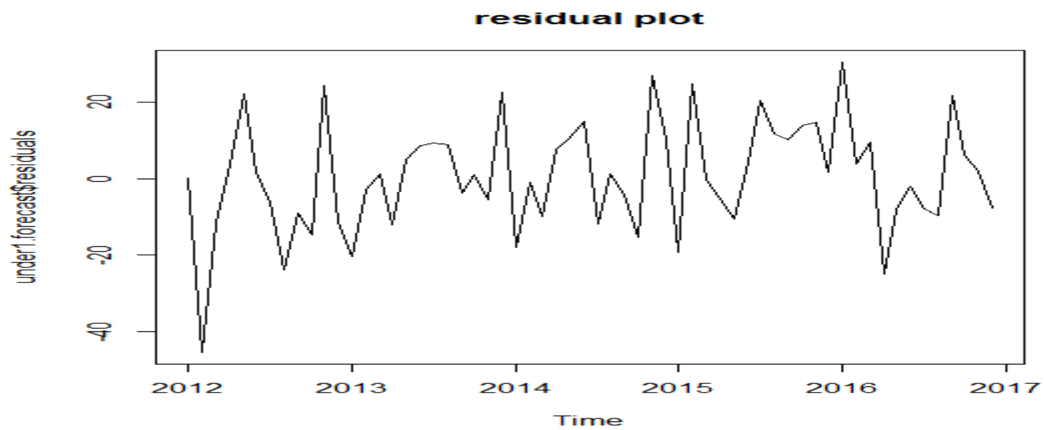


Figure 7: The residual plot of the forecast

*BOX – LJUNG STATISTICS FOR ARIMA RESIDUAL IN R***.**

Box – Ljung to test the randomness in a time series (Independence of residuals). Box – pierce (and Ljung – Box) 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 is > 0.05 (∝) using Ljung and Box pierce.

```
        Box-Ljung test

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

3.1 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 livebirth Registrations of Under 5 years in Nigeria is normally distributed. vs H_1=not H_0

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```
> #..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
```

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 is > 0.05 which gives 0.165 with 2 degree of freedom.

Graph 1: Showing the Live birth Registrations of Under 5 year in Nigeria

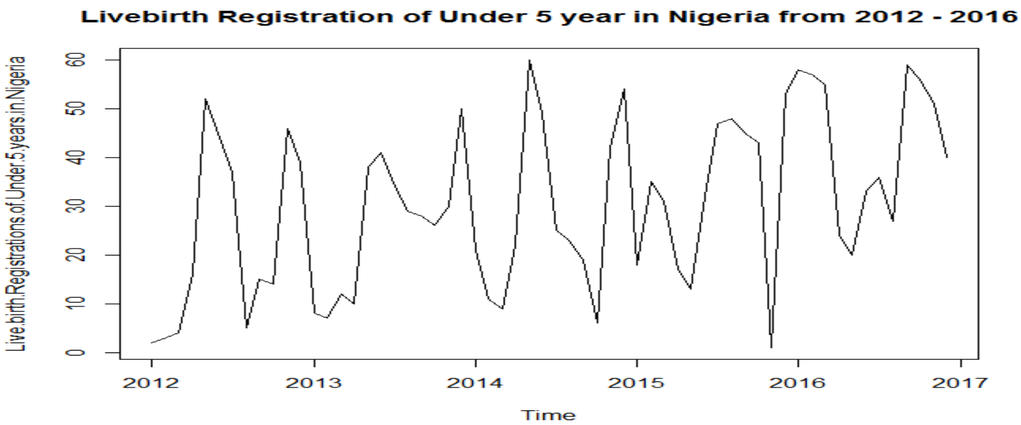


Figure 8: Plot of live birth Registrations of Under 5 year in Nigeria

This is the graph of Live birth Registration under 5 year in Nigeria (Xt) 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.

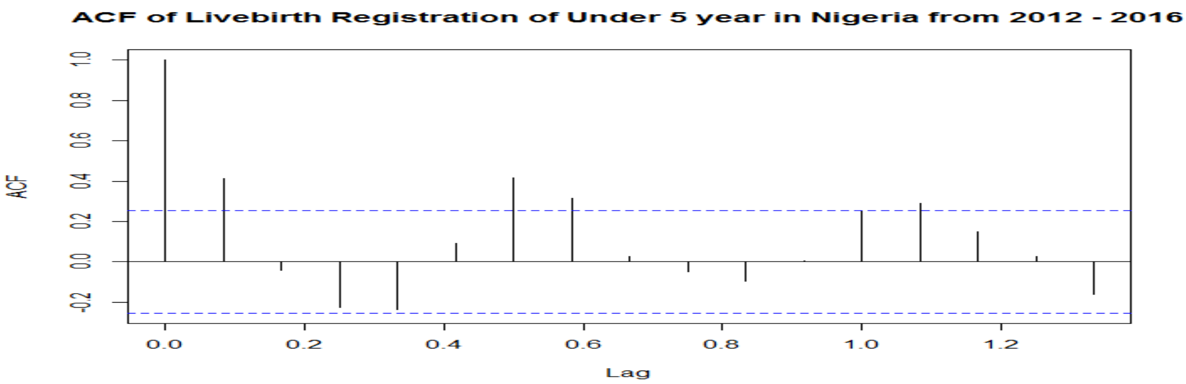


Figure 9:Plot of ACF of Live birth Registrations of Under 5 years in Nigeria

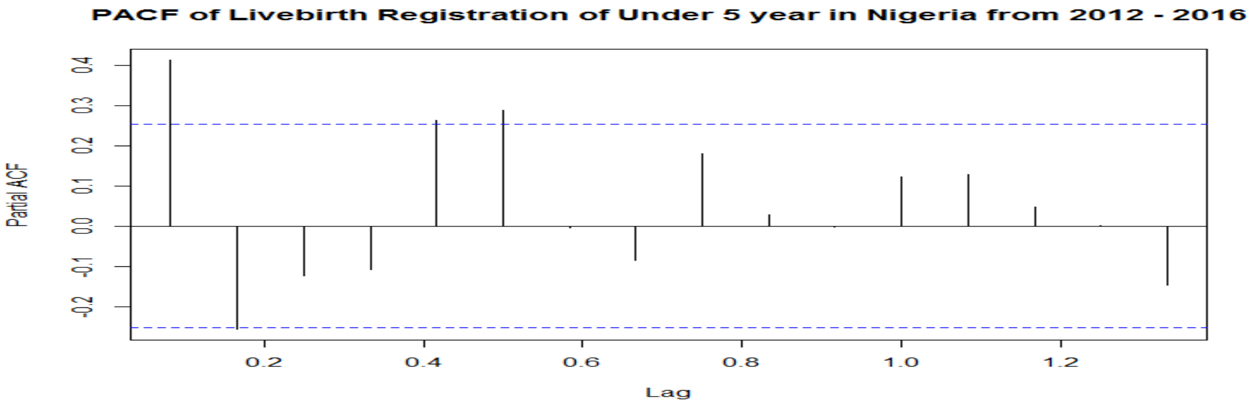
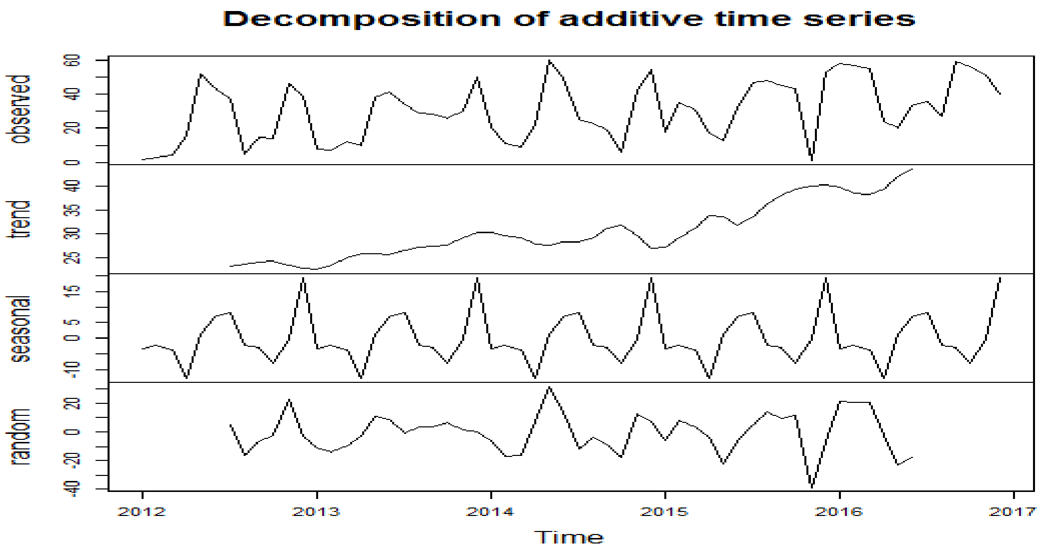


Figure 10: Plot of PACF of Live birth Registrations of Under 5 years in Nigeria

Decomposing the series

Breaking the series down into individual components to further understanding the series and grasp an idea of what is really happening in the series. Below is the plot of the individual components of the series.



STATIONARY TEST

Test for stationary 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 Stationarity.

Below is the snip of the tests and the Hypothesis testing:

Test 2

Augmented Dickey – Fuller Test of Stationarity

H_0 : There is no stationarity in the unit root (series). vs 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 5 years 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 Livebirth Registrations of under 5 years in Nigeria is stationary.

Test 3

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 (Null Hypothesis): There is no stationarity in the unit root (series). vs 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.

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 0,1,0 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

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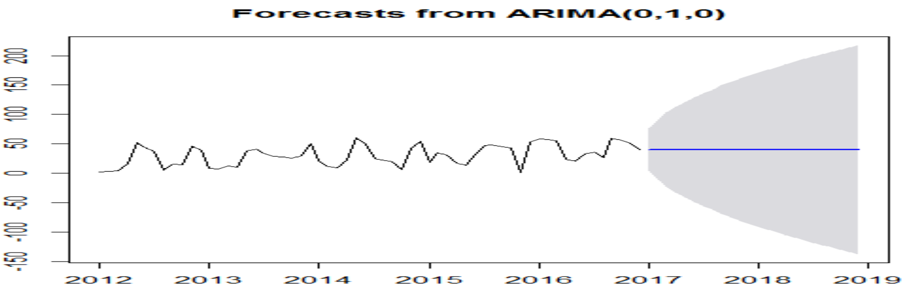
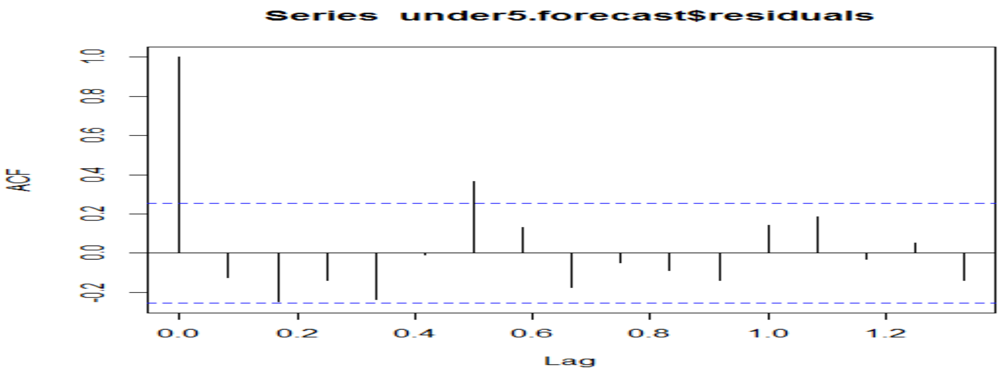
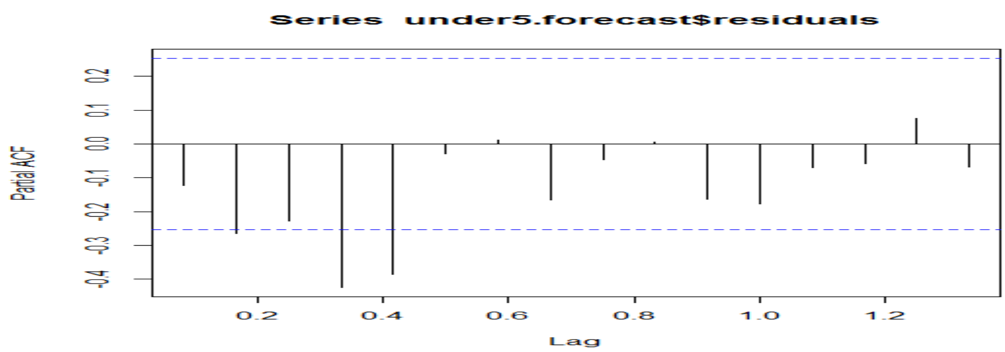
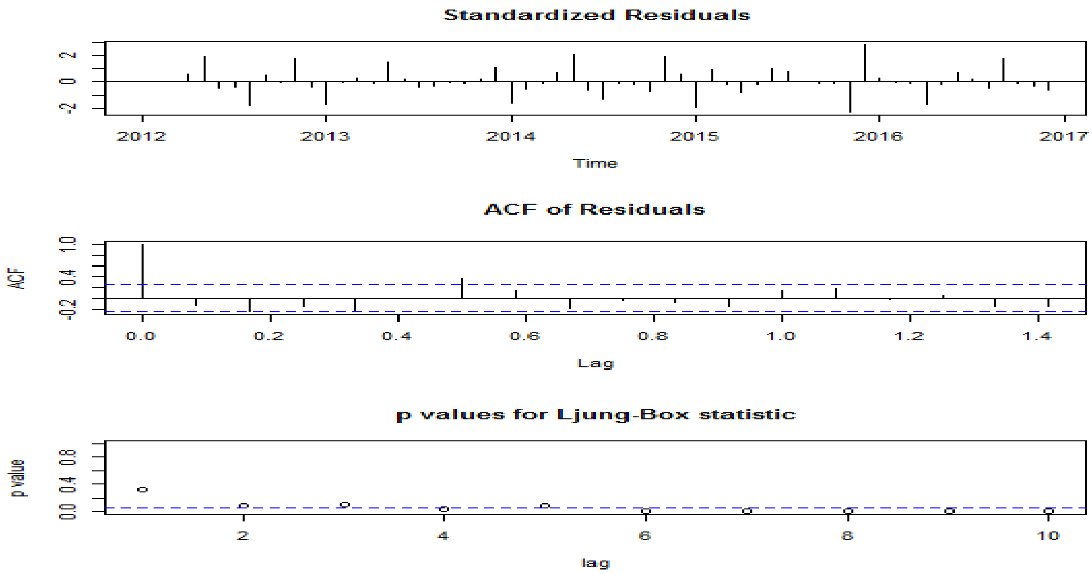


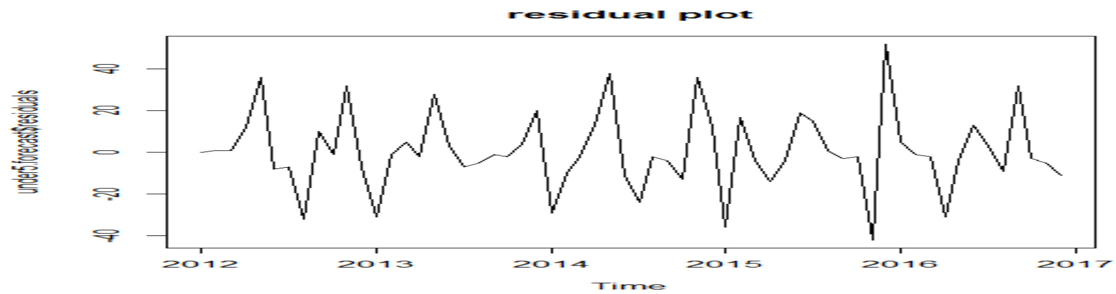
Figure 11: Forecast for 2 years using the fitted SARIMA model





Below is the snip of the standard residual, ACF Residual and the P – value of Ljung Box.





BOX – LJUNG STATISTICS FOR ARIMA RESIDUAL IN R.

Box – Ljung to test the randomness in a time series (Independence of residuals). Box – pierce (and Ljung – Box) 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 is > 0.05 (∝) using Ljung and Box pierce.

```
> Box.test(under5.forecast$residuals,lag=16,type="Ljung-Box")

        Box-Ljung test

data:  under5.forecast$residuals
X-squared = 30.789, df = 16, p-value = 0.01432
```

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```
> jarque.bera.test(ts.Above5)

        Jarque Bera Test

data:  ts.Above5
X-squared = 3.604, df = 2, p-value = 0.165
```

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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.

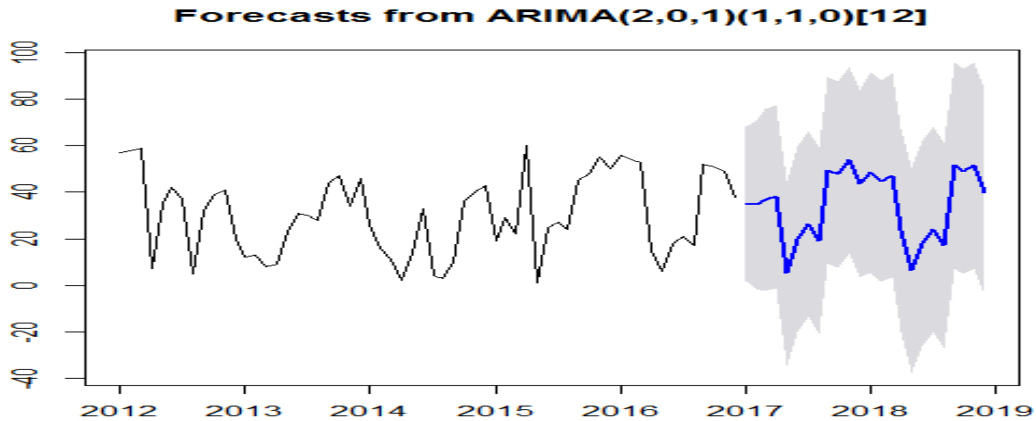


Figure 12: Plot of forecast from ARIMA(2,0,1)(1,1,0)[1,2]

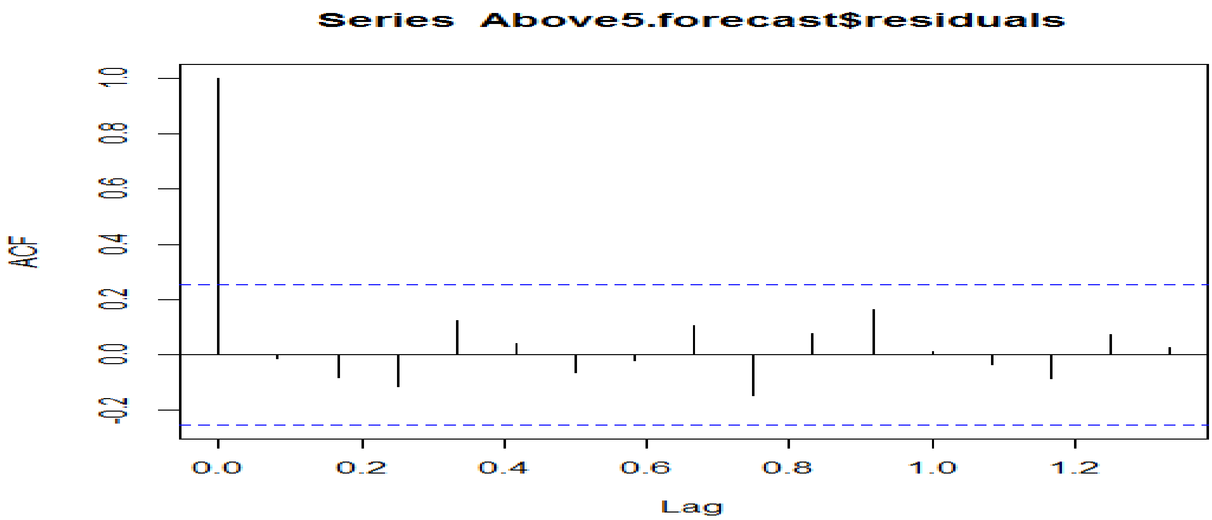


Figure 13: Plot of the Series above 5. forecast and residual.[ACF]

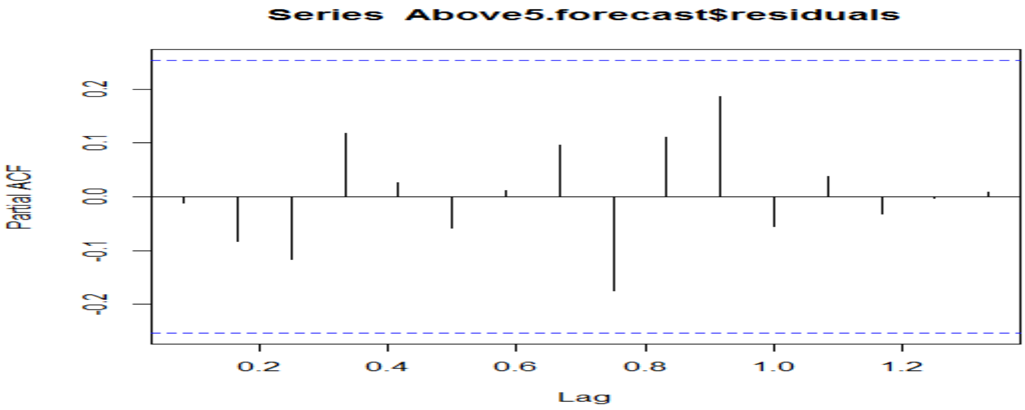
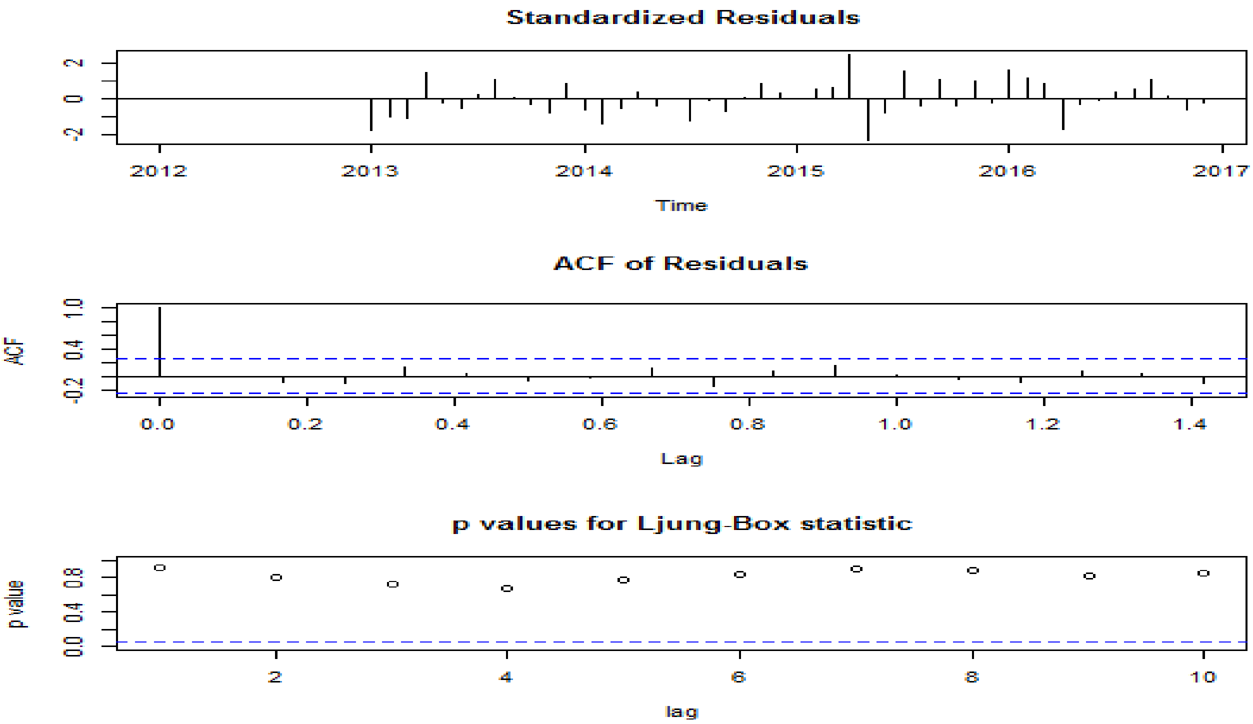
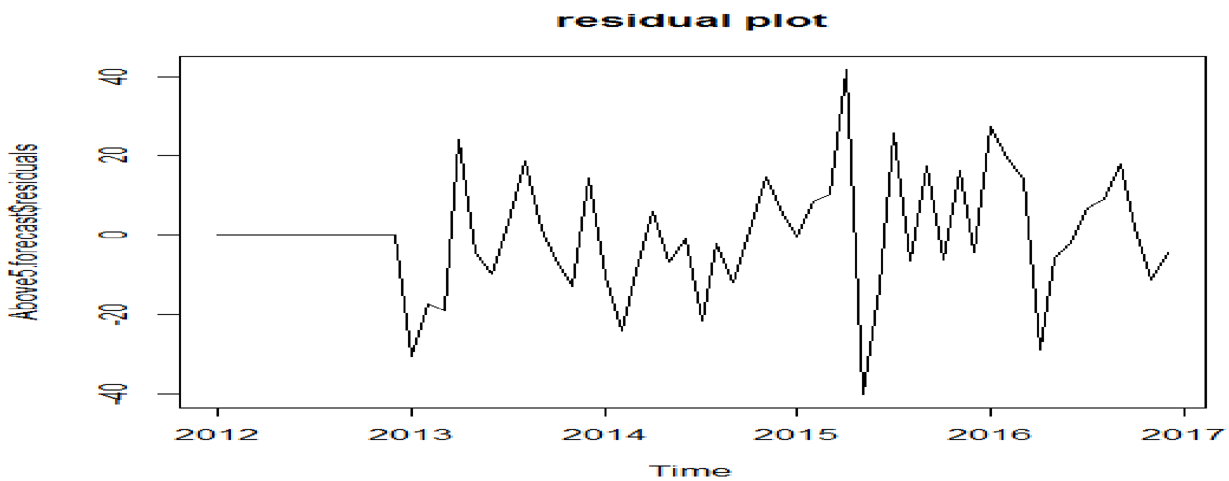


Figure 14: Plot of the Series above 5. forecast and residual[PACF]

Below is the snip of the standard residual, ACF Residual and the P – value of Ljung Box.





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Box – Ljung to test the randomness in a time series (Independence of residuals). Box – pierce (and Ljung – Box) 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 is > 0.05 (∝) using Ljung and Box pierce.

```
> Box.test(Above5.forecast$residuals,lag=16,type="Ljung-Box")

        Box-Ljung test

data:  Above5.forecast$residuals
X-squared = 8.8231, df = 16, p-value = 0.9205
```

4. Summary and Conclusion.

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) degree of freedoms 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 were shown with the test of Augmented Dickey – Fuller Test and Phillip – Perron Test shown that P < 0.05.The SARIMA model in which an auto.ARIMA with an order of (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 fit a model a

y = -0.5296 – 0.0736ma2 + 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 depict 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 Livebirth 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

Time series as a statistical tool, has proven to be reliable for assessing and analyzing time series data. Using the results obtained from data of all livebirth Registrations in Nigeria among the three (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 livebirth 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.

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