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Projection of Total Fertility Rate (TFR) in Guinea Using a Machine Learning Technique

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***Abstract* - In this research paper, the ANN approach was applied to analyze TFR in Guinea. The employed annual data covers the period 1960-2018 and the out-of-sample period ranges over the period 2019-2030. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting TFR in Guinea. The model projections revealed that annual total fertility rates in Guinea are generally likely to remain around 4.6 births per woman throughout the out-of-sample period. Therefore, the government of Guinea is encouraged to focus on creating more demand for family planning services, address barriers to access among adolescents and young adults, and promote women empowerment.**

Keywords: ANN, Forecasting, Total fertility rate (TFR).

I. INTRODUCTION

The three demographic processes which influence population size and composition are births (fertility), mortality and migration (Gunawan et al, 2019). There is a positive correlation between fertility factors and population growth rates. This implies that fertility is the major determinant of population growth, therefore population control can be achieved by family planning programs (Azizah Nur & Gunawan, 2015). The most widely used fertility measure is total fertility rate (TFR) (Demena, 2005). TFR represents the average number of children that would be born to a woman if she were to live up to the end of her childbearing years experiencing the current age specific fertility rates (SESRIC, 2020). The TFR of 2.1 is the replacement fertility level. It is the average number of children born to a woman in order to replace itself in the absence of migration assuming mortality remains constant.

According to Worldometer, Guinea has an estimated population size of about 13million and 38.3% of its population is urban. The country's life expectancy at birth is 62.6 years. Total fertility decline from 6.6 births per woman in 1990 to 4.7 births per woman in 2020. Infant mortality rate dropped from 206.75 infant deaths per 1000 live births in 1950 to 44.86 infant deaths per 1000 live births in 2020. Under five mortality rate fell from 345.77 deaths per 1000 live births in 1950 to 70.23 deaths per 1000 live births in 2020. There are limited empirical studies that have investigated fertility trends. Based on multivariable logistic regression, Apanga et al (2020) assessed the prevalence and factors associated with modern contraceptive (CP) use among women of the reproductive age. The study concluded that the results can improve our understanding on relevant factors essential to increasing modern CP use. Gunawan et al (2019) demonstrated an indirect way of calculating fertility where this can determine the prevalent birth rate as an indicator of successful control of population through family planning program. The results of the research showed that the higher the effectiveness of the use of contraceptives, the higher the number of preventable births resulting in the least possible birth rate, and this calculation can be determined total fertility rate based on the effectiveness of the use of contraceptives. In another study, Muanda et al (2018) examined adolescents' and young people's insights on their cultural norms, practices and attitudes towards SRH services. Fourteen focus group discussions were conducted with a total of 224 adolescents and young people aged 15–24 years in urban and rural areas of the DRC. The topics discussed and age groups of participants differed somewhat in the urban and rural areas. Data were analyzed to identify themes in the participants' discussion of their attitudes towards SRH. The authors concluded that there is pressing need for information and services for young people in both urban and rural areas.

The aim of this study is forecast TFR in Guinea using a machine learning technique. The findings of this paper are expected to reveal the likely fertility trends in the out of sample period. This will assist in policy making and stimulate an early response to the future health, education and employment needs of the people in Guinea

II. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent

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activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual total fertility rates in Guinea.

Data Issues

This study is based on annual total fertility rate (births per woman)in Guinea for the period 1960 – 2018.The out-of-sample forecast covers the period 2019 – 2030.All the data employed in this research paper was gathered from the World Bank online database.

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	G
Observations	47 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.089673
MSE	0.008960
MAE	0.076960

Residual Analysis for the Applied Model

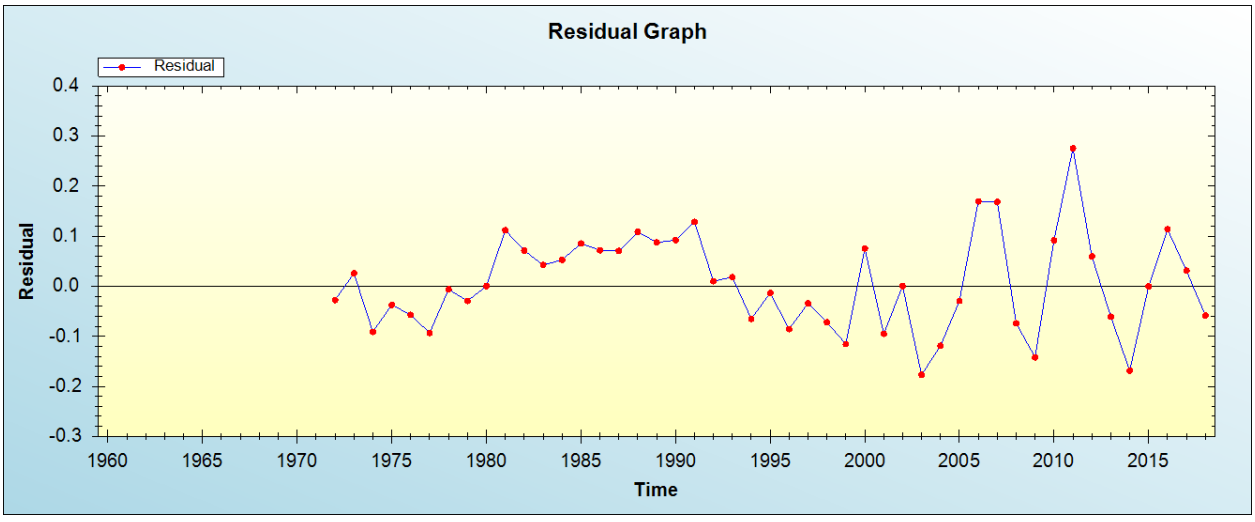

Figure 1: Residual analysis

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In-sample Forecast for G

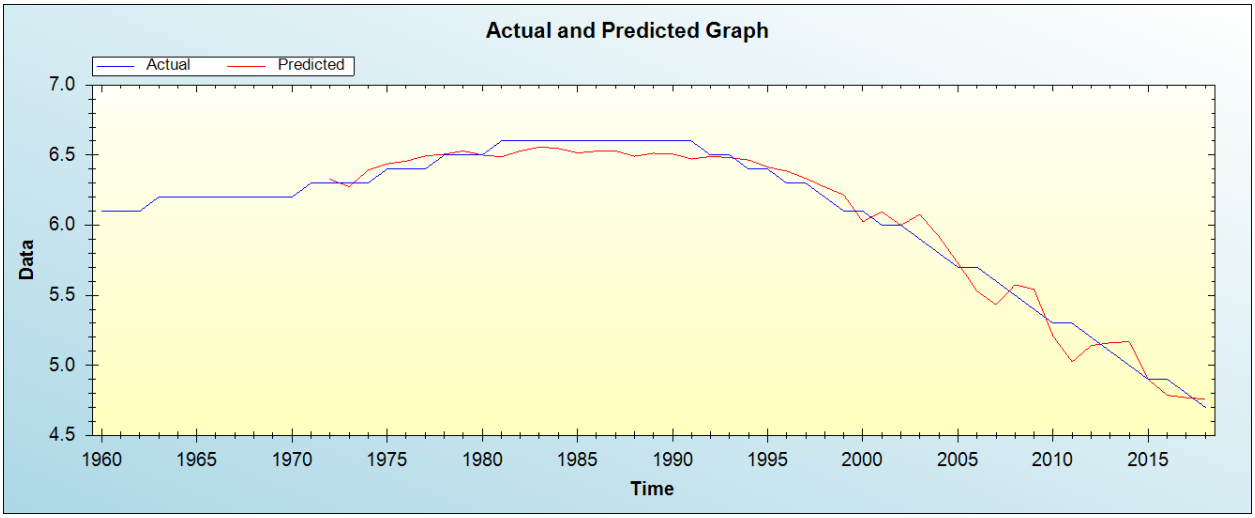

Figure 2: In-sample forecast for the T series

Out-of-Sample Forecast for G: Actual and Forecasted Graph

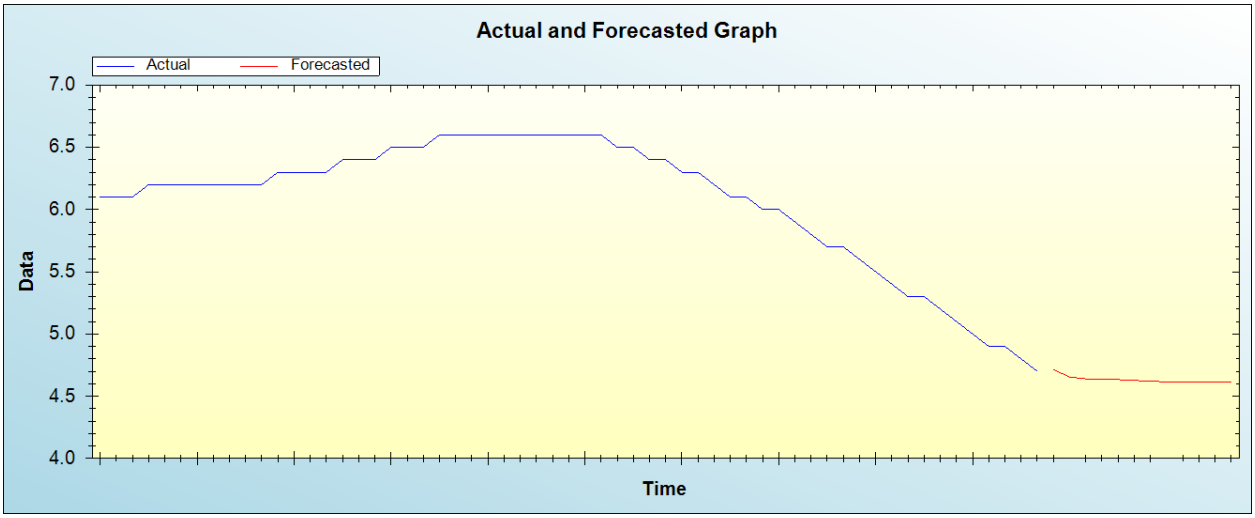

Figure 3: Out-of-sample forecast for G: actual and forecasted graph

Out-of-Sample Forecast for G: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	4.7131
2020	4.6554
2021	4.6400
2022	4.6380
2023	4.6336
2024	4.6274
2025	4.6194
2026	4.6163
2027	4.6159
2028	4.6141
2029	4.6115
2030	4.6105

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The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual total fertility rates in Guinea are generally likely to remain around 4.6 births per woman throughout the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Guinea continues to record high maternal, infant and child mortality rates as well as high fertility rates. In this study we employed the artificial neural network approach to project total fertility rate in Guinea using a machine learning algorithm. The findings of this study revealed that annual total fertility rates in Guinea are generally likely to remain around 4.6 births per woman throughout the out-of-sample period. Therefore the government of Guinea is encouraged to focus on creating more demand for family planning services, address barriers to access among adolescents and young adults, and promote women empowerment.

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