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Forecasting Total Fertility Rate (TFR) In Sierra Leone Using a Machine Learning Method

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***Abstract* - In this study, the ANN approach was applied to analyze TFR in Sierra Leone. The employed 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 Sierra Leone. The results of the study indicate that annual total fertility rates in Sierra Leone are likely to remain around 4.2 births per woman throughout the out-of-sample period. Therefore, the authorities in Sierra Leone are encouraged to prioritize creating demand for family planning services, addressing challenges faced by adolescents and young adults when seeking sexual and reproductive health (SRH) services and scaling up women empowerment program activities.**

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

I. INTRODUCTION

Demography is the study of a population's characteristics such as size, density, age structure and its processes. The demographic processes of interest which determine the size of the population are births, deaths and migration. Fertility is the actual production of live children or the reproductive performance of an individual, group or population whereas fecundity refers to the capability to produce live children. A population's fertility can be measured by indicators such as crude birth rate (CBR), general fertility rate (GFR), Age specific fertility rate, gross reproduction rate and total fertility rate (TFR). Total fertility rate is an internationally recognized way of measuring fertility. It refers to the average number of children that would be born to a woman during her lifetime or child bearing years if she were to pass through her child bearing years experiencing the current age specific fertility rates. It is the summation of all the age specific fertility rates multiplied by 5 (Demena, 2005).

Fertility rates in Sierra Leone have been decreasing over the years from 6.7 births per woman in 1995 to 4.3 births per woman in 2020 (Worldometer, 2020). Infant mortality rate dropped from 237.16 infant deaths per 1000 live births in 1950 to 70.12 infant deaths per 100 live births in 2020 and under five mortality rate fell from 431.04 deaths per 1000 live births in 1950 to 96.3 deaths in 2020 (Worldometer, 2020). This drop in TFR and IMR over the years reflects improvements made by the government in reducing infant mortality and improving child survival together with maternal health. There are limited empirical studies in the region that have forecasted fertility. Genus (2020) examined the determinants of trends wanted and unwanted fertility in SSA using fixed-effects regressions of country-level data. Data came from 103 DHS surveys in 25 countries in SSA with at least two DHS surveys between 1989 and 2019. The study revealed that Women's education and family planning programs are found to be the dominant determinants of fertility decline and their effects operate by reducing both wanted and unwanted fertility. Wang (2019) conducted a time-series predictive study based on the Holt's Exponential Smoothing models to restore the deleted fertility data for 2016 and beyond, allowing a comprehensive analysis of fertility rates in China from 2003 to 2018. It was noted that the population structure was aging fast, fertility rates continued to decrease to a substantially low level, and three Northeastern provinces displayed notable socioeconomic issues associated with low-fertility trap. The study concluded that it is critical for China to urgently remove its current birth limit and implement social policies to reverse the downtrend of fertility rate. Prediction of China's total population and the trends of population structural change in 2015-2050, based on the fifth and sixth national census data was carried out by Liu et al (2016). The results indicated that since implementation of the two-child family planning policy, the aging trend of the population structure will be significantly improved, and after 2030 that is the population structure will be gradually younger.

The aim of this paper is to model and forecast TFR in Sierra Leone using a machine learning technique. The findings of this article are envisioned to highlight the likely fertility trends in the out of sample period thereby stimulating an evidence based approach in policy making, planning and allocation of resources to health, education and employment sectors.

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

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determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual total fertility rates in Sierra Leone.

Data Issues

This study is based on annual total fertility rate (births per woman)in Sierra Leone 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	S
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	0.067140
MSE	0.008014
MAE	0.075942

Residual Analysis for the Applied Model

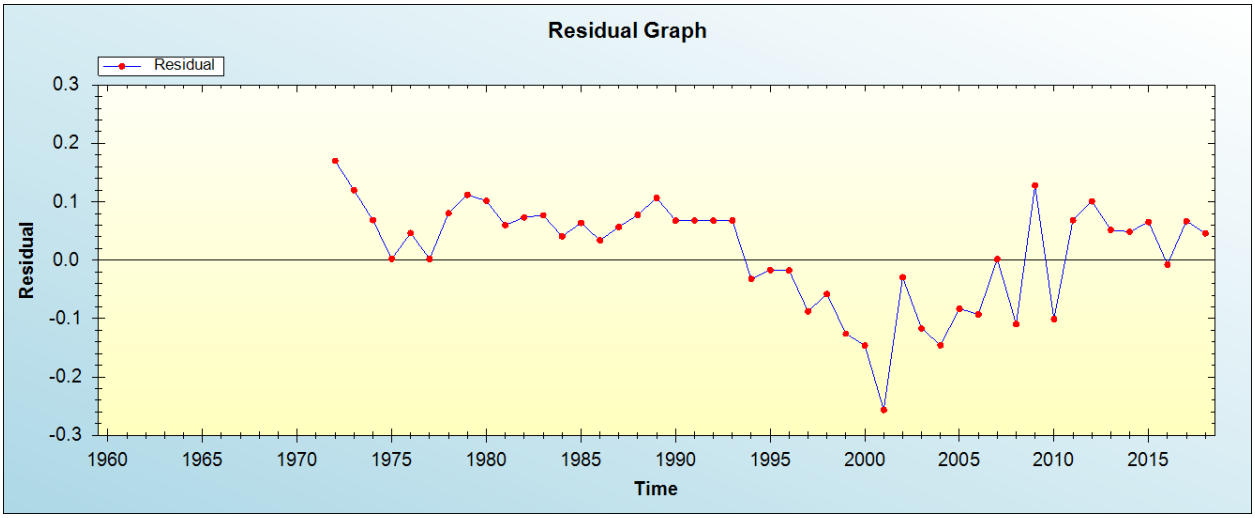

Figure 1: Residual analysis

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In-sample Forecast for S

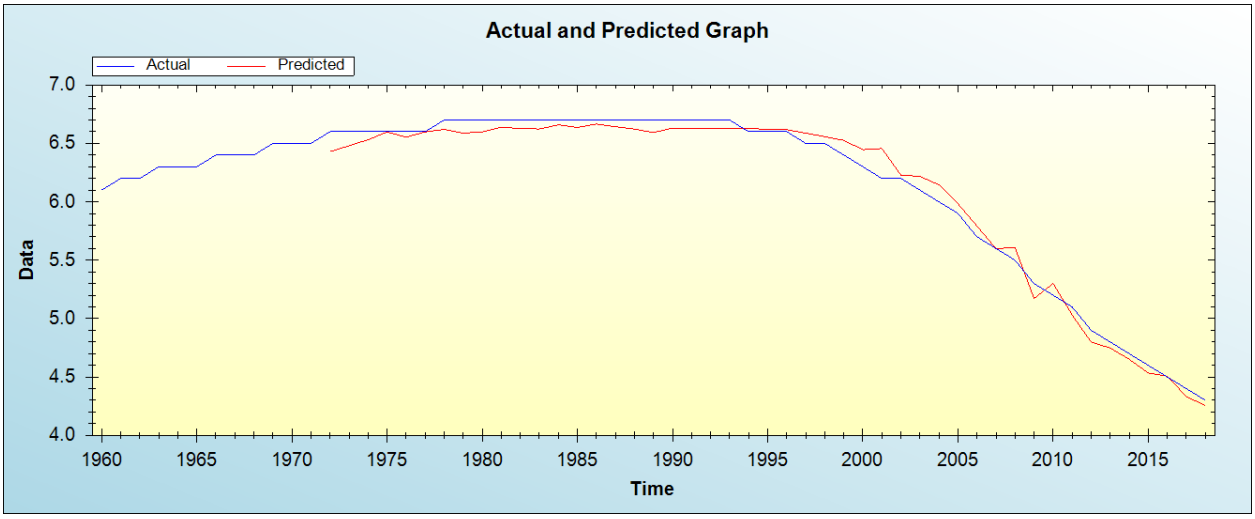

Figure 2: In-sample forecast for the S series

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

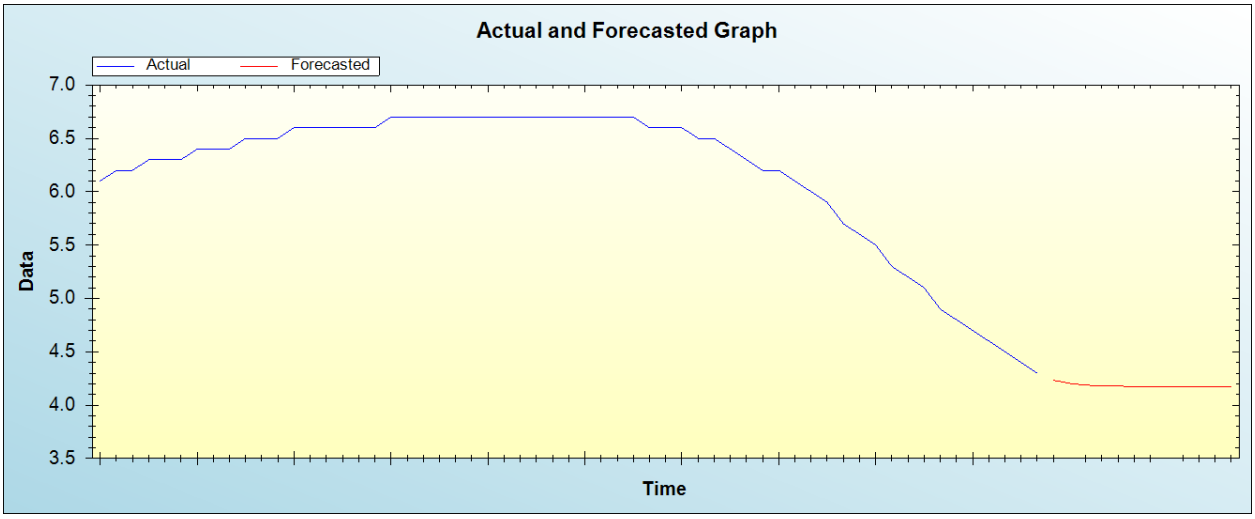

Figure 3: Out-of-sample forecast for S: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	4.2330
2020	4.2034
2021	4.1870
2022	4.1809
2023	4.1784
2024	4.1750
2025	4.1753
2026	4.1755
2027	4.1757
2028	4.1758
2029	4.1752
2030	4.1742

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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 Sierra Leone are likely to remain around 4.2 births per woman throughout the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Fertility forecasting is critical for planning and allocation of resources for anticipated healthcare, education and employment requirements of a population. In this paper we applied a machine learning technique to project TFR in Sierra Leone. The results indicate that annual total fertility rates in Sierra Leone are likely to remain around 4.2 births per woman throughout the out-of-sample period. Therefore, the government is advised to prioritize creating demand for family planning services, addressing challenges faced by adolescents and young adults when seeking sexual and reproductive health (SRH) services and scaling up women empowerment program activities.

REFERENCES

[1] Worldometer (2020). Sierra Leone demographics. https://www.worldometers.info

[2] Melake Demena (2005). Population and Development.Lecture notes for Health Science Students, pp 1-153.

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