Forecasting Total Fertility Rate (TFR) In Gabon

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Abstract - **In this study, the ANN approach was applied to analyze TFR in Gabon. 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 Gabon. The results of the study indicate that annual total fertility rates in Gabon are likely to remain around 4.0 births per woman over the out-of-sample period. Therefore, the government of Gabon is encouraged to create more demand for sexual and reproductive health (SRH) services, address barriers to access among adolescents and young adults, and prioritize women empowerment.**

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

I. INTRODUCTION

Demography is defined as the study of human populations which includes composition, distribution, densities, growth and other characteristics as well as the causes and consequences of changes in these factors (Demena, 2005). It focuses on changes in population size, composition and distribution in space. Major sources of demographic data include census, registration of vital events, sample surveys and demographic health surveys. The size of a population is determined by births, deaths and migration. It is important that the population of a country to be kept under control as overpopulation will lead to serious consequences such as shortage of natural resources, famine, communicable diseases, malnutrition, increase in crime rates and war over limited resources (Demena, 2005).

Gabon has a total population size of about 2.2 million and a life expectancy of 67 years and 87% of its population resides in urban areas (Worldometer, 2020). Total fertility rates have been decreasing over the years from 5.7 births per woman in 1985 to 4.0 births per woman in 2020. Infant mortality rate dropped from 159.91 infant deaths per 1000 live births in 1950 to 31.05 infant deaths in 2020. Under 5 mortality rate fell from 301.39 deaths per 1000 live births in 1950 to 42.25 deaths per 1000 live births in 2020 (Worldometer, 2020). There are limited studies that have focused on examining fertility or forecasting fertility rates. Wado et al (2021) did a study to determine inequalities in physical or sexual IPV (intimate partner violence) against AYW and beliefs about gender based violence (GBV) in sub-Saharan Africa (SSA). The authors used data from the most recent Demographic and Health Surveys (DHS) conducted in 27 countries in SSA. The findings showed that IPV is pervasive among AYW, with substantial variation across and within countries reflecting the role of contextual and structural factors in shaping the vulnerability to IPV. 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. Based on an explorative qualitative study conducted by Dessalegn (2020) in five districts in Ethiopia. Sixteen key informants and eight focus group discussions were conducted among adult women and men of young adolescents and youth. The study revealed that younger and older women are the most disadvantaged groups of the society. Based on a cross-sectional study, Renzaho et al (2017) examined factors associated with comprehensive categories of sexual and reproductive health, including sexual behaviors; sexual education and access to contraceptive services; family planning; prevention of STDs; sexual consent as a right; gender based violence; as well as HIV testing, counselling, disclosure and support. The study concluded that there is need to address barriers and ensure a comprehensive and harmonized sexual and reproductive health system that is youth friendly and takes into account local socio-cultural issues.

The aim of this study is to forecast fertility trends in Gabon using a machine learning approach. The results of the study are expected to reveal likely fertility trends in the out of sample period to facilitate planning and resource mobilization for health, education and employment creation.

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

Data Issues

This study is based on annual total fertility rate (births per woman)in Gabon 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	0.078823
MSE	0.005542
MAE	0.060903

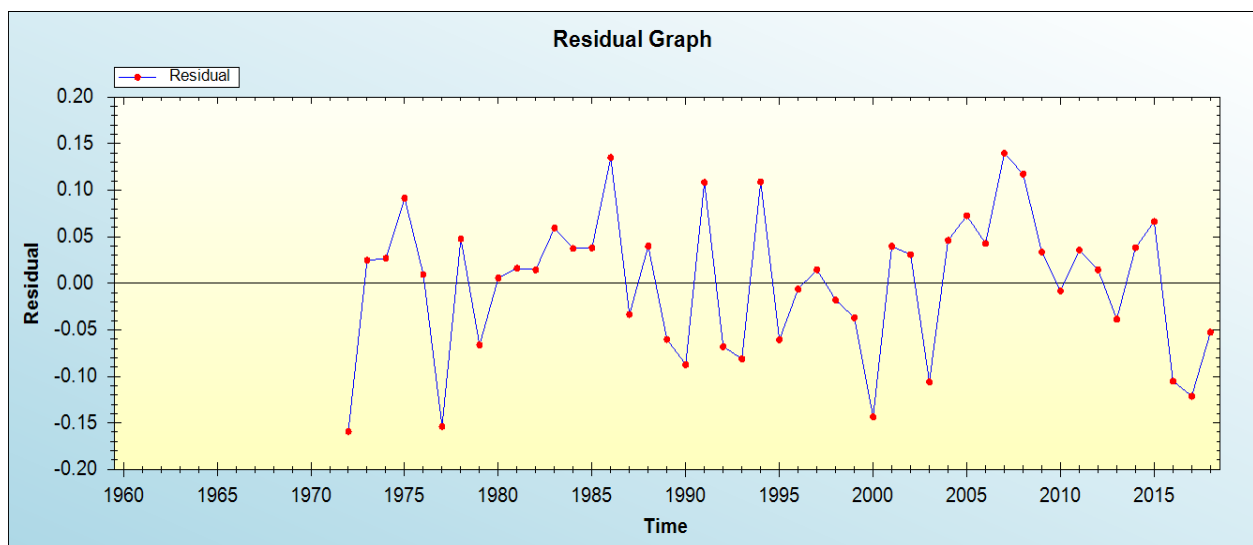*Residual Analysis for the Applied Model*

Figure 1: Residual analysis

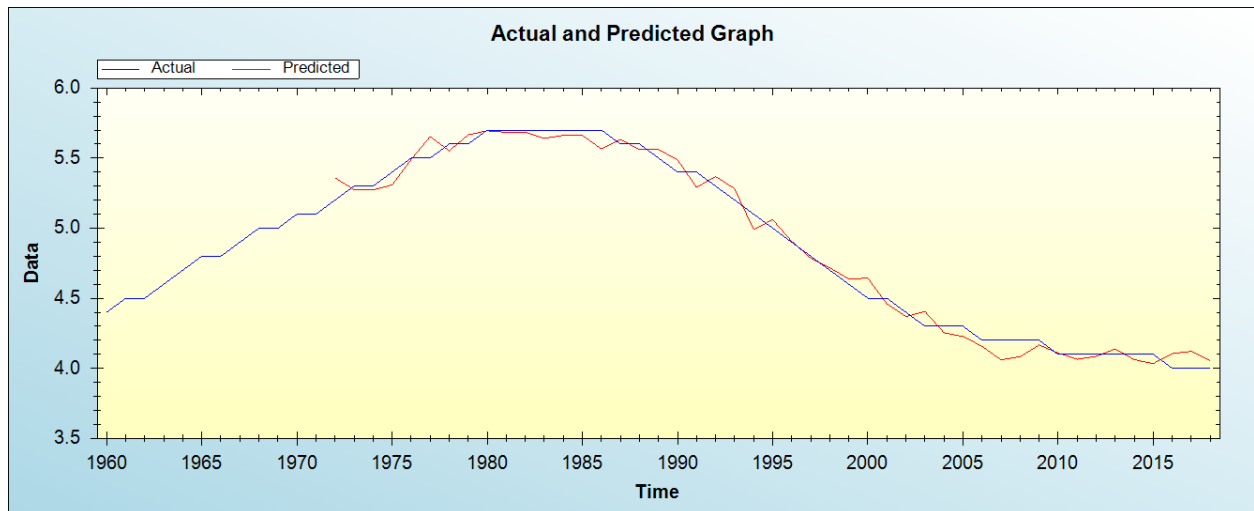*In-sample Forecast for G*

Figure 2: In-sample forecast for the G series

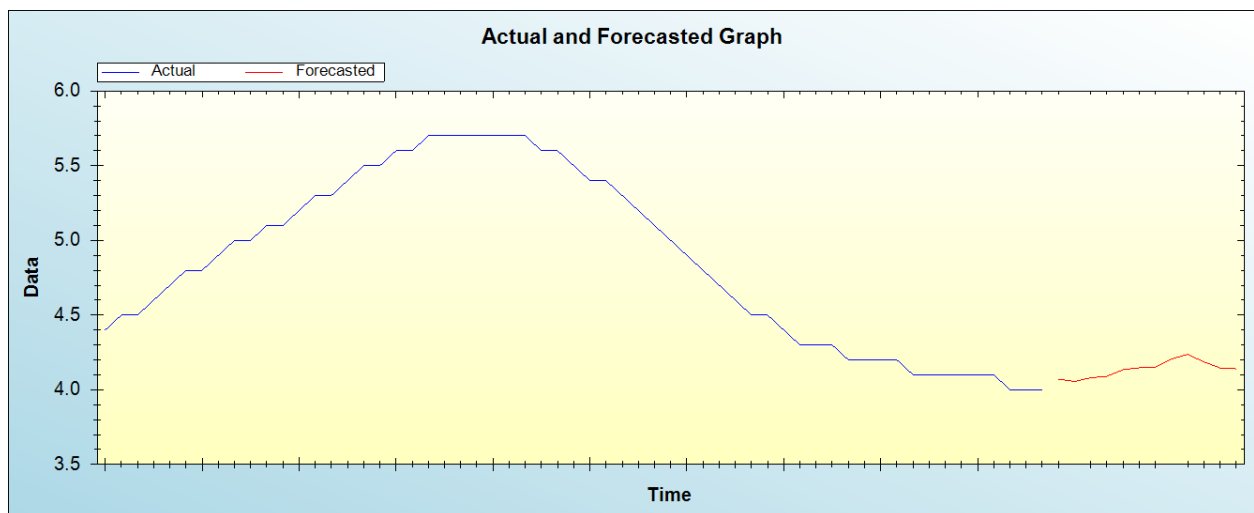*Out-of-Sample Forecast for G: Actual and Forecasted Graph*

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	4.0711
2020	4.0558
2021	4.0811
2022	4.0899
2023	4.1348
2024	4.1473
2025	4.1519
2026	4.2067
2027	4.2366
2028	4.1871
2029	4.1466
2030	4.1400

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 Gabon are likely to remain around 4.0 births per woman over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

There several models that have been applied in predicting fertility in the developed world. In this study we applied the artificial neural network approach to forecast total fertility rate in Gabon. The ANN model projections suggested that annual total fertility rates in Gabon are likely to remain around 4.0 births per woman over the out-of-sample period. Therefore, the government is encouraged to create more demand for sexual and reproductive health (SRH) services, address barriers to access among adolescents and young adults, and prioritize women empowerment.

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