Forecasting Total Fertility Rate (TFR) in Congo Using the Multilayer Perceptron

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Abstract - In this research paper, the ANN approach was applied to analyze TFR in Congo. 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 Congo. The results of the study indicate that annual total fertility rates in Congo are likely to increase from 4.56 births per woman in 2019 to 5.99 births per woman in 2027 and then fall to 4.50 births per woman in 2030. Therefore, the Congolese government is encouraged to (1) address challenges being faced by adolescents and young adults in accessing family planning services in order to prevent unwanted pregnancies and other undesirable sexual and reproductive health (SRH) outcomes among this age group, and (2) promote women's rights.

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

I. INTRODUCTION

The average live births per woman over her lifetime are referred to as the total fertility rate (TFR) (UN, 2020). Total fertility has declined globally from 3.2 births per woman in 1990 to 2.5 births per woman in 2019. In Africa total fertility has also fallen from 6.3 births per woman in 1990 to 4.6 births per woman in 2019 (UN, 2020). Congo has been experiencing fertility transition over the past decades. Its total fertility declined from 6.3 births per woman in 1975 to 4.5 births per woman in 2020 (Worldometer, 2020).The country recorded a downward trend in Infant and under five mortality over the past decades. IMR declined from 134.2 infant deaths per 1000 live births in 1950 to 31.16 infant deaths per 1000 live births in 2020 (Worldometer, 2020). Globally the use of the contraceptives has increased significantly. In 2019, 49% of women in the age group 15-49 years some form of contraception. This increase in contraceptive use has resulted in the decline of fertility rates across countries (UN, 2020).

There are limited studies in the country and region which have examined, investigated fertility trends or forecasted fertility rates. Based on a systematic review, Hameed et al (2020) assessed interventions to promote SRHR for persons with disabilities in low- and middle-income countries. The review highlighted that 11 interventions were from upper middle income settings. Most interventions focused on information provision and awareness raising. Yaya et al (2018) conducted a cross-sectional study to assess the prevalence of modern contraceptive use and associated factors among HIV-infected women in Togo. The study concluded that about three-quarters of sexually active HIV-infected women in Togo were using contraceptive methods, and private health facilities favored this contraceptive use. 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 study revealed that there is pressing need for information and services for young people in both urban and rural areas.

The aim of this paper is to forecast total fertility rate in Congo using the multilayer perceptron. The results of this paper are expected to reveal the likely fertility rates in the out of sample period. This will help in policy making, planning and initiate an appropriate response to the future health, education and employment needs of the Congolese population.

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 inCongo.

Data Issues

This study is based on annual total fertility rate (births per woman)in Congo 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	C
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	0.092214
MSE	0.009475
MAE	0.078563

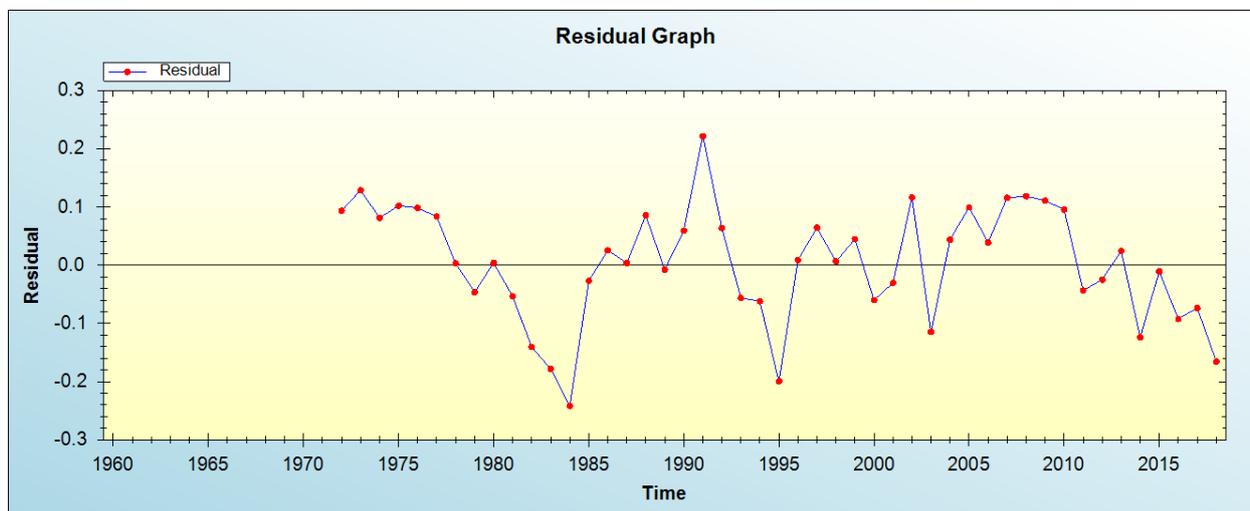*Residual Analysis for the Applied Model*

Figure 1: Residual analysis
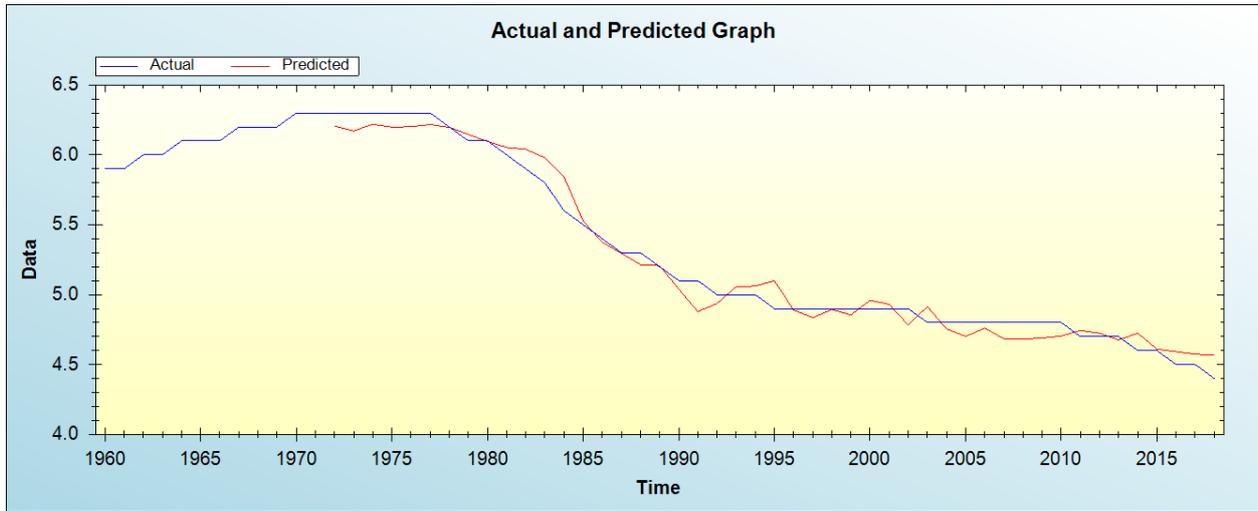
In-sample Forecast for C

Figure 2: In-sample forecast for the C series

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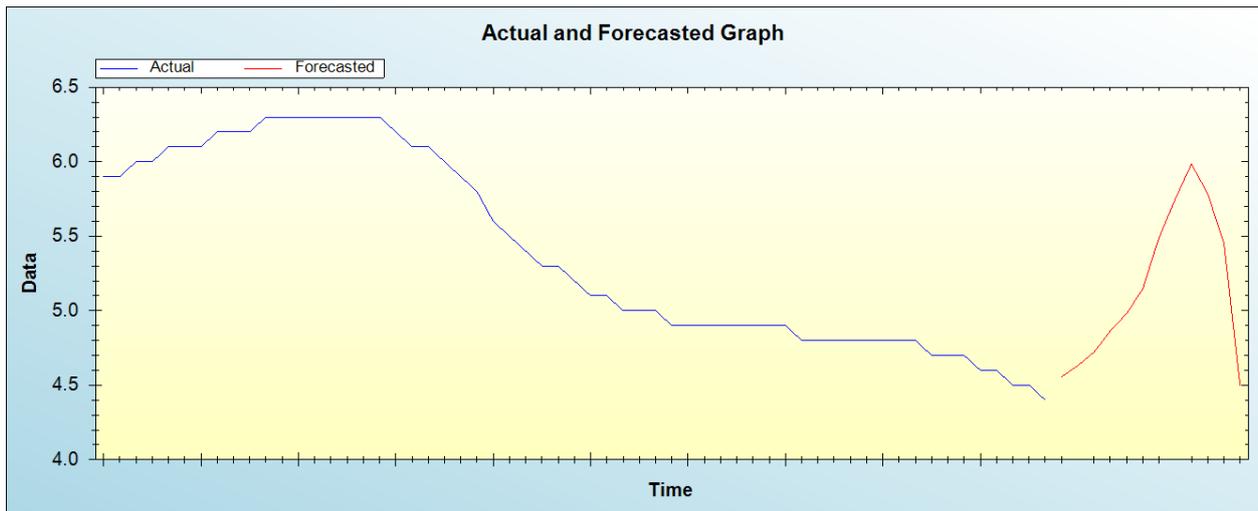

Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	4.5565
2020	4.6318
2021	4.7218
2022	4.8637
2023	4.9802
2024	5.1455
2025	5.4903
2026	5.7497
2027	5.9852
2028	5.7845
2029	5.4529
2030	4.4971

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 Congo are likely to increase from 4.56 births per woman in 2019 to 5.99 births per woman in 2027 and then fall to 4.50 births per woman in 2030.

IV. CONCLUSION & RECOMMENDATIONS

Machine learning techniques are being under-utilized in developing countries hence this paper has applied an artificial neural network approach to predict total fertility rate in Congo. The ANN (12, 12, 1) model predictions suggest that annual total fertility rates in Congo are likely to increase from 4.56 births per woman in 2019 to 5.99 births per woman in 2027 and then fall to 4.50 births per woman in 2030. Therefore, the Congolese government must address challenges being faced by adolescents and young adults in accessing family planning services in order to prevent unwanted pregnancies and other undesirable sexual and reproductive (SRH) outcomes among this age group. In addition the government must prioritize women empowerment programs.

REFERENCES

[1]   UN (2020). World Fertility and Family Planning 2020Highlight, pp 1-42

[2]   Worldometer (2020). Guinea demographics. https://www.worldometers.info

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