

Forecasting Total Fertility Rate (TFR) In Niger

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Abstract - The high fertility rates being witnessed in Niger are a reflection of an urgent need to aggressively implement population control measures to mitigate undesirable consequences of uncontrolled population growth by 2050. In this research paper, the ANN approach was applied to analyze TFR in Niger. 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 Niger. The results of the study indicate that annual total fertility rates in Niger are likely to slightly decline over the out-of-sample period. Therefore, the Niger government must create a high demand for family planning services, address challenges that hinder access to sexual and reproductive health (SRH) services particularly among adolescents and young adults and engage on an aggressive women empowerment program.

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

I. INTRODUCTION

Niger's population is fast growing with the highest total fertility rate in the world (Potts et al, 2011). In 2019 the country had a population of approximately 23.3 million and a TFR of 6.9 births per woman (World Bank, 2019). The country's population size was projected to be 58.2 million in 2050 which means that it will become the second most populous country in West Africa (Turner, 2011; UN, 2006; UN, 2002). Approximately 49% of the population is aged 15 years and below, and 3% 65 years and above (PRB, 2009). In 2019 approximately 20.7% of woman had unmet need for family planning (Niger FP 2020). Niger has a maternal mortality ratio of 590 deaths per 100 000 live births (WHO, 2010) and an infant mortality rate of 39.3 infant deaths per 1000 live births (Worldometer, 2020).

There are limited previous studies in the region that have focused on examining fertility and fertility rates. 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. Samandari et al (2019) carried out a qualitative study to examine the underlying social, individual and structural factors influencing married girls' early first birth and participation in alternative opportunities (such as education or economic pursuits) in Niger. Participants recognized the health benefits of delaying first birth, but stigma around infertility and contraceptive use, desire for children, and belief that childbirth is "God's will" interfere with a girl's ability to delay.

The aim of this paper is to project total fertility rates in Niger using an artificial neural network approach. The results of the study are envisioned to highlight likely fertility trends in the out of sample period to facilitate planning and resource mobilization for 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 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 Niger.

Data Issues

This study is based on annual total fertility rate (births per woman) in Niger 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	N
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	0.099909
MSE	0.002495
MAE	0.040900

Residual Analysis for the Applied Model

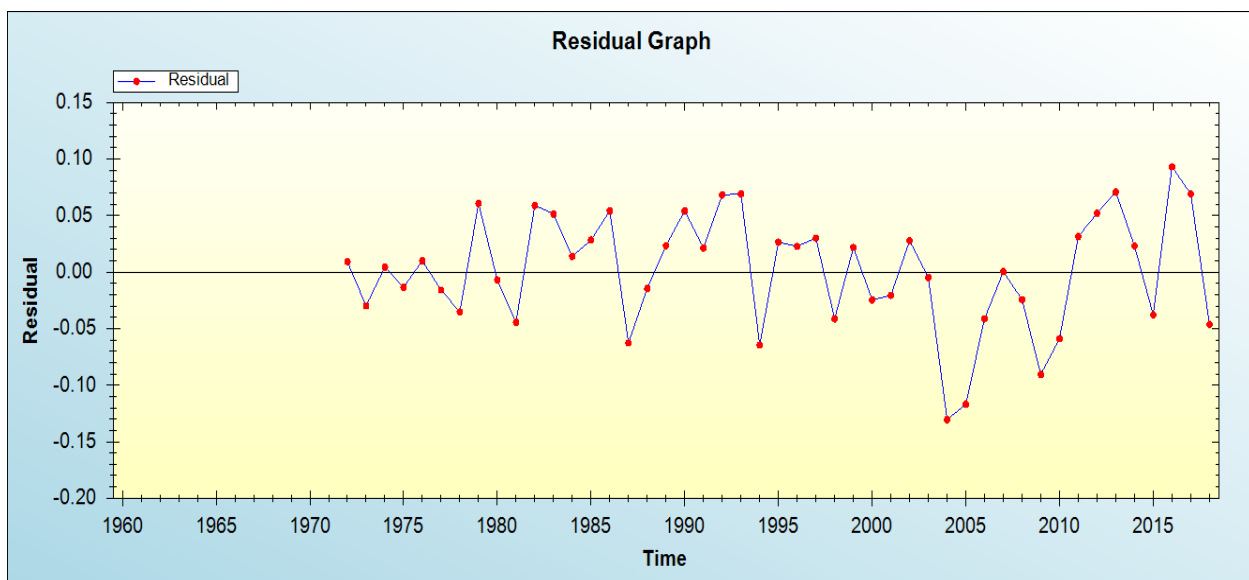


Figure 1: Residual analysis

In-sample Forecast for N

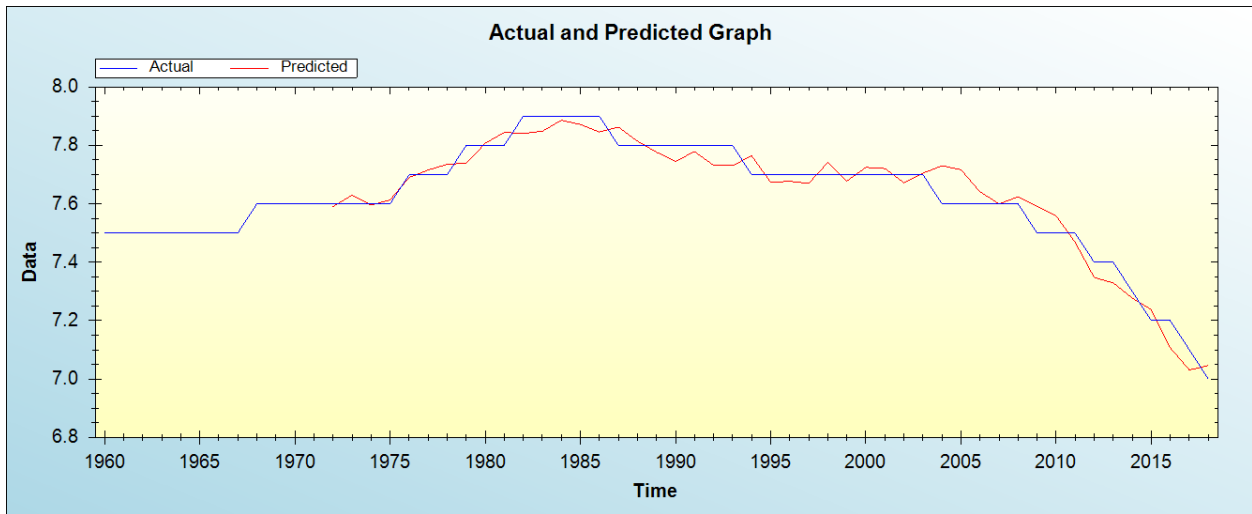


Figure 2: In-sample forecast for the N series

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

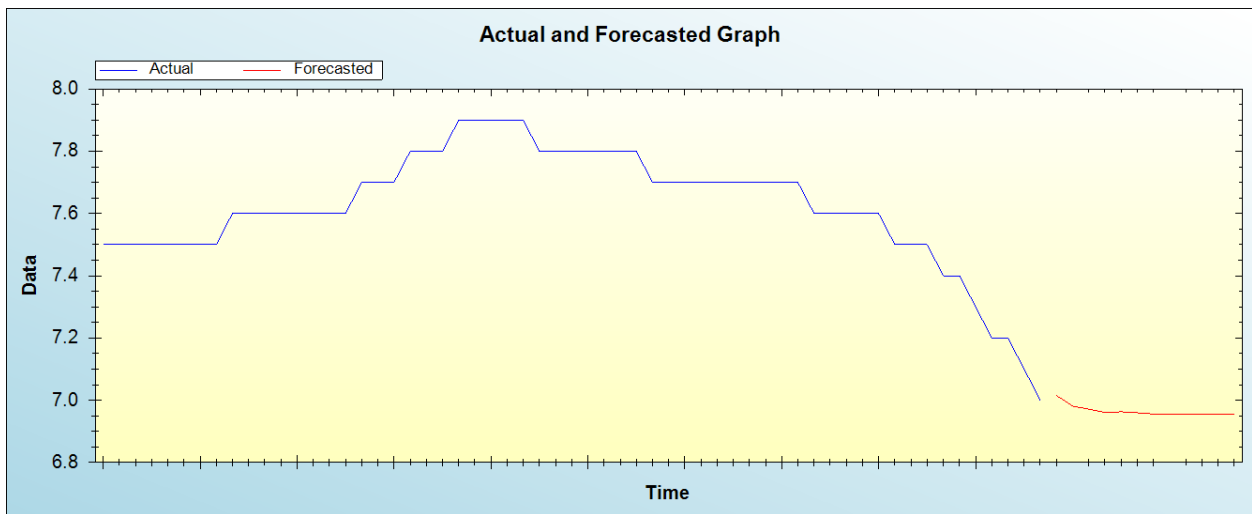


Figure 3: Out-of-sample forecast for N: actual and forecasted graph

Out-of-Sample Forecast for N: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecast
2019	7.0154
2020	6.9810
2021	6.9717
2022	6.9605
2023	6.9630
2024	6.9599
2025	6.9559
2026	6.9553
2027	6.9549
2028	6.9548
2029	6.9547
2030	6.9543

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 Niger are likely to slightly decline over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Niger has the highest TFR in the world and its population size is projected to be 58.2 million in 2050. In this paper we applied an artificial neural network approach to predict TFR in Niger. The ANN model projections revealed that annual total fertility rates in Niger are likely to slightly decline over the out-of-sample period. Therefore the government of Niger is encouraged to create a high demand for family planning services, address challenges that hinder access to sexual and reproductive health (SRH) services particularly among adolescents and young adults, and engage on an aggressive women empowerment program.

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