

Forecasting Total Fertility Rate (TFR) in Bangladesh

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Abstract - In this research article, the ANN approach was applied to analyze TFR in Bangladesh. 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 Bangladesh. The results of the study indicate that annual total fertility rates in Bangladesh are likely to be around 2.2 births per woman over the out-of-sample period. Therefore, we encourage the authorities in Bangladesh to continue improving the quality of family planning services to minimize adverse maternal and child health outcomes.

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

I. INTRODUCTION

The future size and composition of a population are determined by fertility, mortality and migration rates (Arbu et al, 2021). Forecasting of fertility rates remains crucial in understanding the future population dynamics. TFR is the frequently used fertility measure in time series forecasting of fertility trends (Ali et al, 2001). It is the average number of children born to a woman throughout her life time if she were to pass through her child bearing years at the current age specific fertility rates. Fertility is the most determinant of population change (Caldwell, 1982; Easterlin, 1975; Becker, 1965). It does not only determine population growth but it is a major determinant for change in age composition of a population (Rabbi, 2015; Khuda & Hussain, 1996). The fertility of a population is determined by biological, social and behavioral factors (Dougall et al, 2012). Determinants of fertility can also be classified into demographic, socio-economic, cultural and spatial determinants (BBS & SID, 2015). Early age marriage, low levels of education and unemployment have been seen to be associated with higher fertility rates. Rural areas generally have higher fertility rates when compared to urban settings (BBS & SID, 2015).

Bangladesh has recorded a decline in fertility rates over the past decades from 6.9 births per woman in 1970 to 2.1 births per woman in 2020 (Worldometer, 2020). A total fertility rate of 2.1 represents the Replacement level fertility which is the average number of children per woman needed for each generation to exactly replace itself without requiring international migration. Bangladesh's infant mortality rate declined from 210.9 infant deaths per 1000 live births in 1950 to 21.56 infant deaths in 2020. Under five mortality rate decreased from 314.71 infant deaths per 1000 live births in 1950 to 26.13 in 2020 (Worldometer, 2020). There are few studies on fertility trends that have done in the region. Based on linear regression, Arbu et al (2021) investigated ASFR trends and forecasted the ASFR of India, Bangladesh, and Pakistan from 2020 to 2100. The results revealed that the change in fertility in these three countries from low stable population to high population will occur within next 40 years from 2020. Based on a cross-sectional study, Ranatunga and Jayaratne (2020), described the proportion of unplanned pregnancies, their determinants and the health outcomes of women delivering at Colombo North Teaching Hospital-Ragama (CNTH). The study revealed that inadequate pre-pregnancy preparation and antenatal care were associated with an unplanned pregnancy. Bandyopadhyay and Chattopadhyay (2008) applied the artificial neural network approach to forecast India's population. The study revealed that the model performed more efficiently in predicting female population than the male population.

The aim of this study is to project TFR in Bangladesh using a machine learning approach. The findings of this piece of work are envisioned to reflect the likely fertility trends in the out of sample period. This will guide policy and initiate an early response to the future health, education and employment needs of the people in Bangladesh.

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 Bangladesh.

Data Issues

This study is based on annual total fertility rate (births per woman) in Bangladesh 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	B
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	0.110365
MSE	0.041032
MAE	0.136156

Residual Analysis for the Applied Model

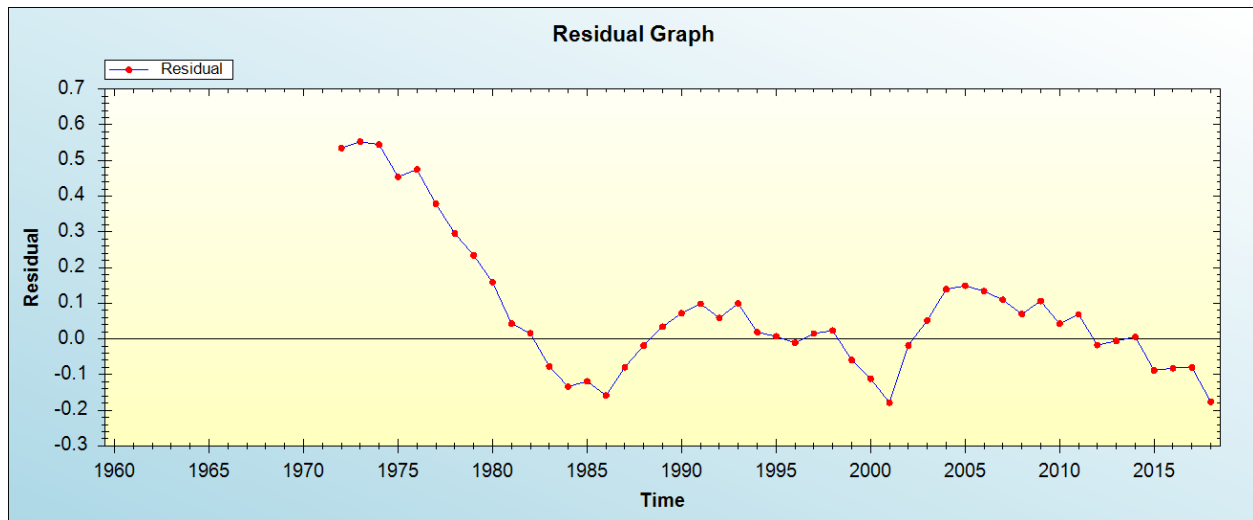


Figure 1: Residual analysis

In-sample Forecast for B

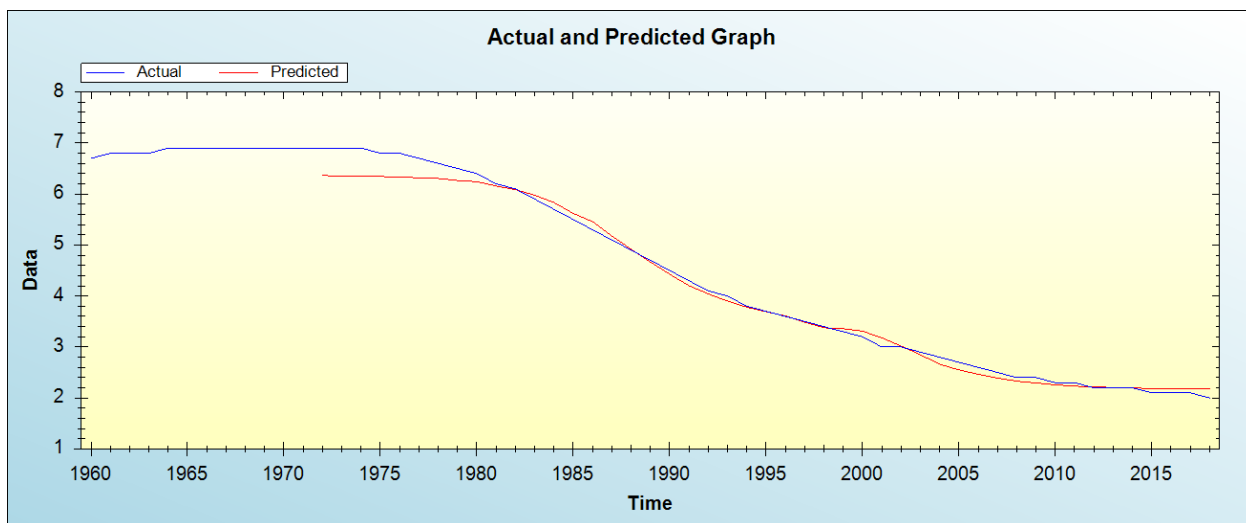


Figure 2: In-sample forecast for the B series

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

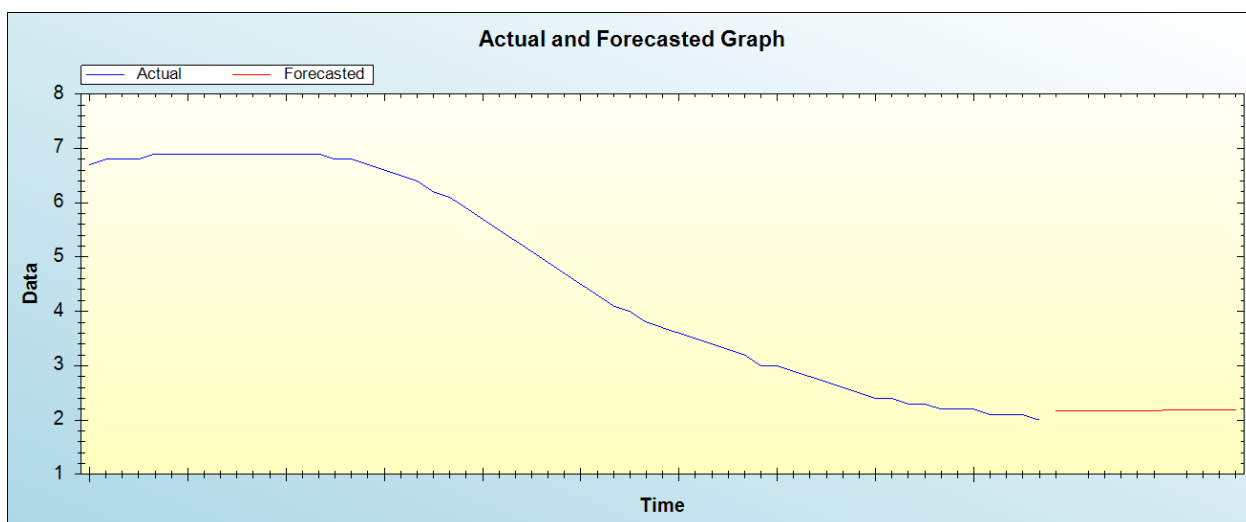


Figure 3: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted TFR values
2019	2.1741
2020	2.1743
2021	2.1720
2022	2.1718
2023	2.1774
2024	2.1770
2025	2.1788
2026	2.1804
2027	2.1817
2028	2.1808
2029	2.1841
2030	2.1844

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 Bangladesh are likely to be around 2.2 births per woman over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Fertility forecasting is important to understand the future population dynamics especially population composition and size. It provides an insight of the future labor force and demand for housing, education and health services. In this paper we apply the artificial neural network approach to forecast total fertility rate in Bangladesh. The results of the study revealed that annual total fertility rates in Bangladesh are likely to be around 2.2 births per woman over the out-of-sample period. Therefore, we encourage the authorities in Bangladesh to continue improving the quality of family planning services to minimize adverse maternal and child health outcomes.

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