

Projection of Total Fertility Rate in Belize

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Abstract - In this research article, the ANN approach was applied to analyze TFR in Belize. 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 Belize. The results of the study indicate that annual total fertility rates in Belize are likely to be around 2 births per woman over the out-of-sample period. Therefore, the government is encouraged to continue with its current population control policy.

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

I. INTRODUCTION

Universal access to sexual and reproductive health services is a fundamental human right for every individual or couple. The 1994 international conference on population and development focused on the sexual and reproductive health rights of both sexes. However, having observed the violations of women rights in many countries, the signatories agreed to recognize SRH rights of adolescent girls and women who are usually the victims of physical and sexual abuse (Anand et al, 2017). It is estimated that 213 million pregnancies occur annually of these 40% are unplanned (Sedgh et al, 2014). Fertility is the major determinant of size and composition of a population hence total fertility rate is used as an indicator fertility. Total fertility rate (TFR) is the average number of children born to a woman during her reproductive lifetime if she were to experience the exact current age specific fertility rates. The aim of this study is to project TFR in Belize using the multilayer perceptron neural network. The findings of this paper will reveal the likely future trends of TFR in the out of sample period. This will facilitate resource mobilization for the future health, education and employment needs of the Belize 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 in Belize.

Data Issues

This study is based on annual total fertility rate (births per woman) in Belize 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	A
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	0.108887
MSE	0.091485
MAE	0.237308

Residual Analysis for the Applied Model

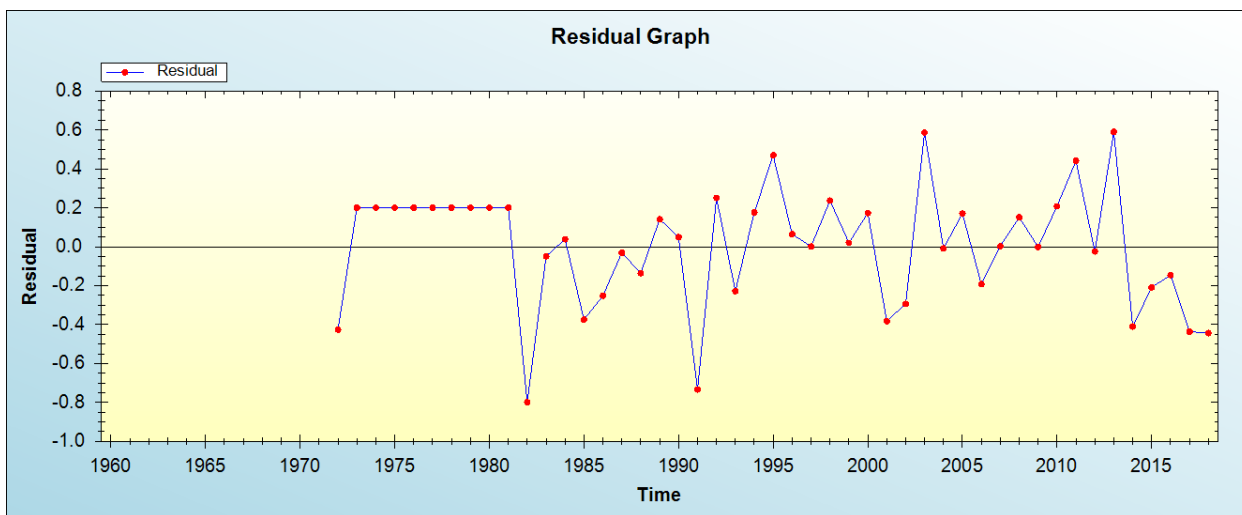


Figure 1: Residual analysis

In-sample Forecast for A

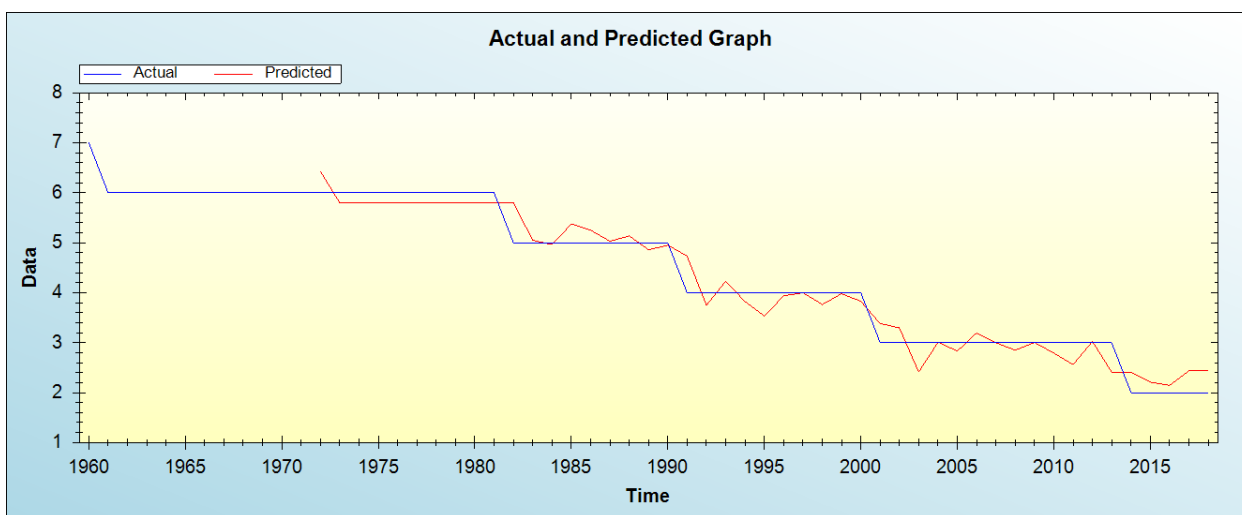


Figure 2: In-sample forecast for the A series

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

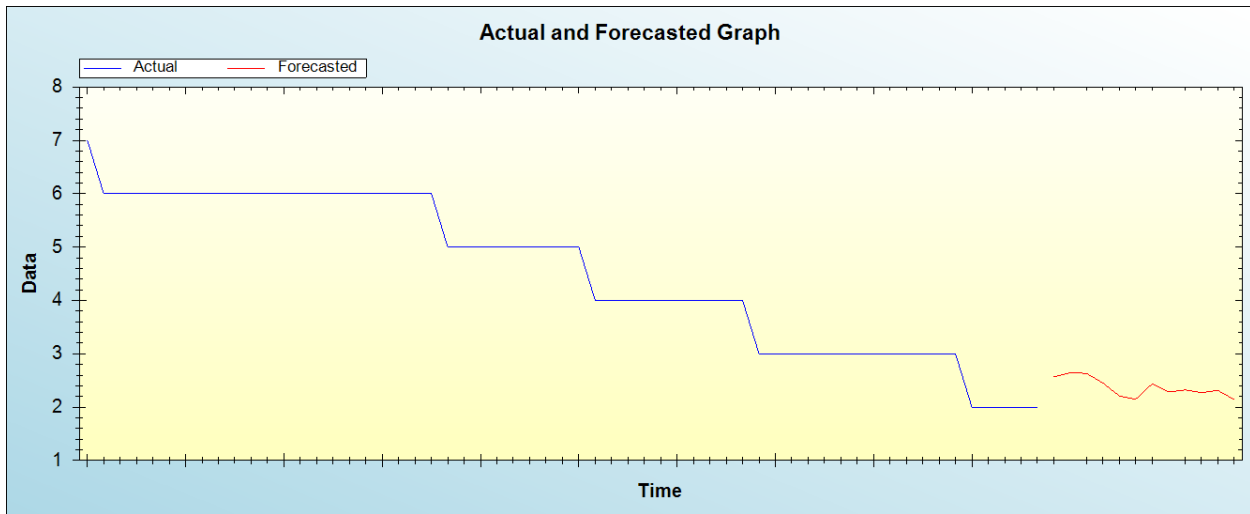


Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	2.5665
2020	2.6472
2021	2.6319
2022	2.4525
2023	2.2087
2024	2.1480
2025	2.4353
2026	2.2829
2027	2.3218
2028	2.2714
2029	2.3137
2030	2.1446

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 Belize are likely to slightly decline and hover around 2 births per woman over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Total fertility rate in Belize may decline over the years to below replacement level. The country’s generally low infant and child mortality rates reflect improvements in the health status of the population. In this study we proposed an artificial intelligence approach to project TFR in Belize. The model projections revealed that annual total fertility rates in the country are likely to be around 2 births per woman over the out-of-sample period. Therefore, the government is encouraged to continue with its current population control policy.

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