Projection of Total Fertility Rate (TFR) in Colombia

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Abstract - **In this research article, the ANN approach was applied to analyze TFR in Colombia. 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 Colombia. The results of the study indicate that annual total fertility rates in Colombia are likely to be around 2.2 births per woman in most of the out-of-sample period. Therefore, the government should continue addressing adolescent and young adult challenges in accessing Sexual Reproductive Health (SRH) services and continue funding women empowerment programs.**

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

I. INTRODUCTION

The total fertility rate is an important fertility indicator in population projections, historical and international comparisons (Castanheira & Kohler, 2015). It is the average number of children born to a woman throughout her life if she passes through her child bearing age (15-49years) and experiences the exact current age specific fertility rates (Demena, 2005). TFR is the recognized standard measure of fertility of a population and determines its growth and composition (Batyra et al, 2021). The aim of this study is to project total fertility rate in Colombia using a machine learning technique. The findings of this paper will highlight the likely fertility trends in the out of sample period. This is important for policy making and will trigger an early response to the future health, education and employment needs of the country's 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 Colombia.

Data Issues

This study is based on annual total fertility rate (births per woman)in Colombia 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

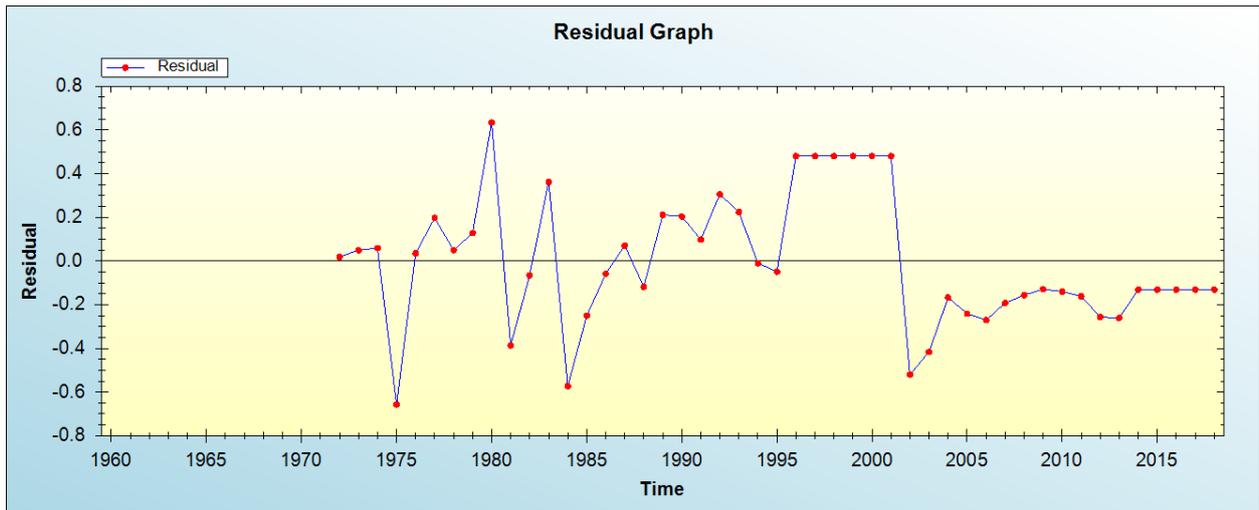| Momentum	0.05
Criteria:	
Error	0.107223
MSE	0.088709
MAE	0.2396555

Residual Analysis for the Applied Model

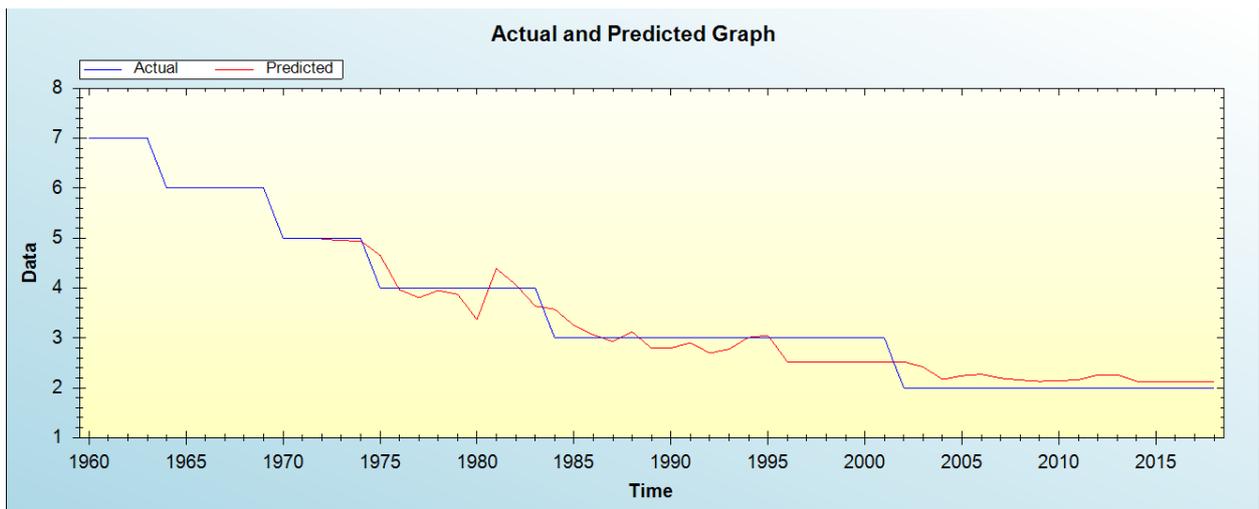Figure 1: Residual analysis

In-sample Forecast for A

Figure 2: In-sample forecast for the A series

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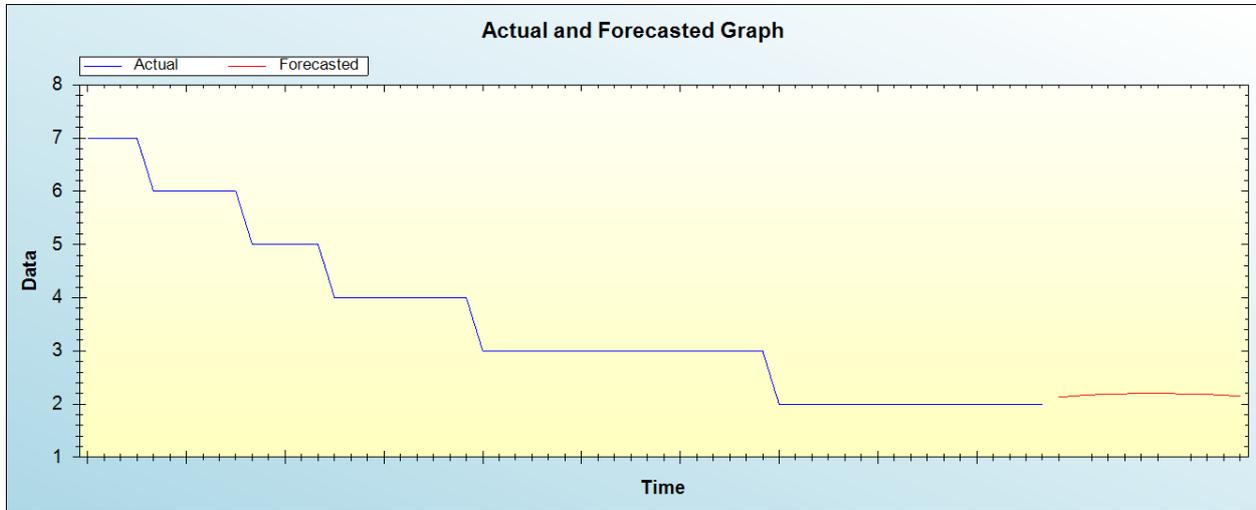

Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	2.1309
2020	2.1534
2021	2.1754
2022	2.1815
2023	2.1920
2024	2.2065
2025	2.1984
2026	2.1962
2027	2.1872
2028	2.1836
2029	2.1644
2030	2.1517

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 Colombia are likely to hover around 2 births per woman over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Total fertility rates below replacement level may soon be of major concern in Colombia as this has serious implications on future labor force and health care expenditure. In this study we predicted TFR for Colombia using a machine learning approach. The results of the study indicate that annual total fertility rates in the country are likely to be around 2.2 births per woman throughout the out-of-sample period. Therefore, the government should continue addressing adolescent and young adult challenges in accessing Sexual Reproductive Health (SRH) services and continue funding women empowerment programs.

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