

Projection of Total Fertility Rate (TFR) in Romania

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Abstract - In this research paper, the ANN approach was applied to analyze TFR in Romania. The employed annual data covers the period 1960-2019 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 Romania. The results of the study indicate that annual total fertility rates in Romania are likely to hover around 1 birth per woman over the out-of-sample period. Therefore, the government is encouraged to promote child bearing by providing incentives to couples.

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

I. INTRODUCTION

The 1994 international conference on population and development which was held in Cairo, Egypt made a landmark commitment to improve the quality of life for many people all over the world by recognizing their sexual and reproductive health rights (UN, 2020). The programme action called for all countries to provide universal access to health including sexual and reproductive health services to which are safe and reliable (UN, 1995). The 2030 agenda for sustainable development goals includes a target for family planning and fertility reduction under goal 3 (UN, 2020). Family planning involves counselling, education, contraception, obstetric and post abortal care, and STI screening and treatment. It is unfortunate that in some of the developing countries many women and adolescent girls continue to suffer from gender based violence and sexual abuse. Some of the cultural practices deprive women and adolescent girls of their right to determine age of marriage, desired number of children and birth spacing (UN, 2020). Total fertility rate globally has fallen drastically from 3.2 births per woman in 1990 to 2.5 births per woman in 2019. In Sub-Saharan Africa total fertility has dropped from 6.3 births per woman in 1990 to 4.6 births per woman in 2019 (UN, 2020). The aim of this paper is to project TFR in Romania using a machine learning approach. The results are expected to reveal the likely fertility trends in the out of sample period. This will assist in policy making and trigger an appropriate response to the future health, education and employment needs of the people in Romania.

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 Romania.

Data Issues

This study is based on annual total fertility rate (births per woman) in Romania 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	0.188911
MSE	0.099132
MAE	0.241896

Residual Analysis for the Applied Model

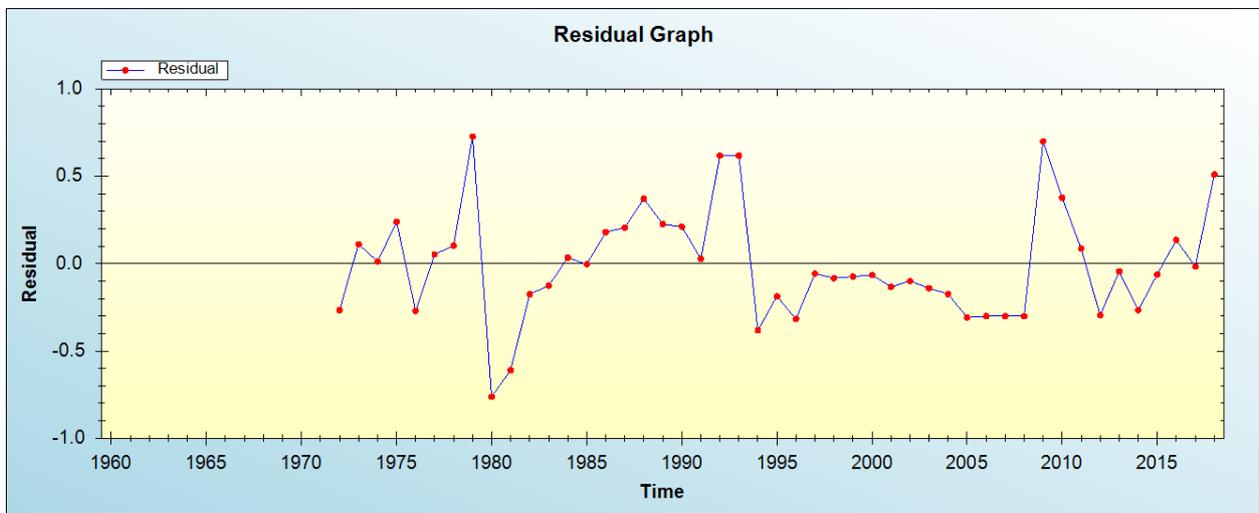


Figure 1: Residual analysis

In-sample Forecast for A

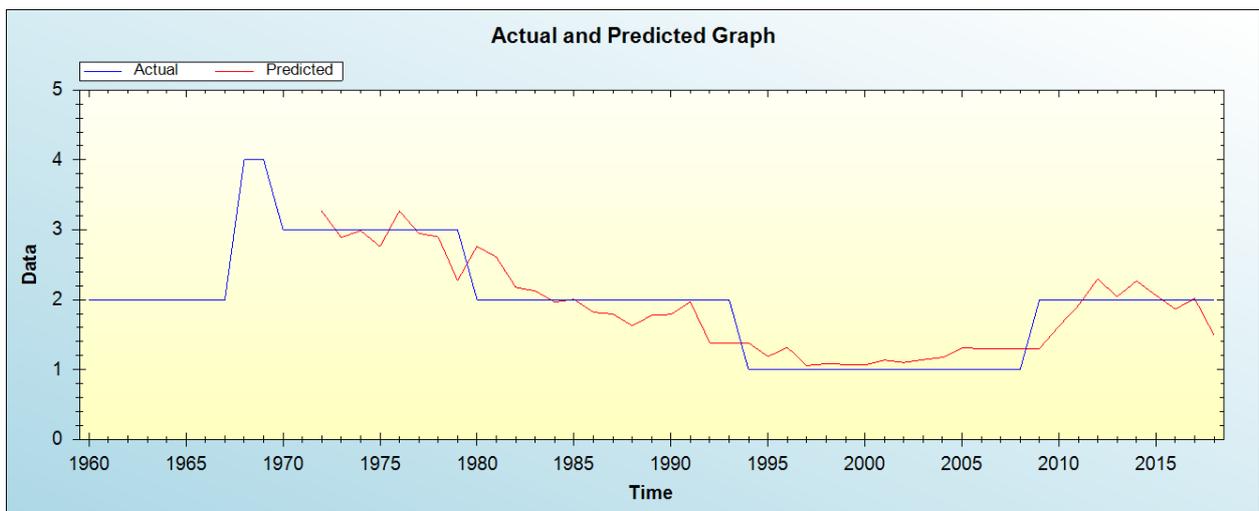


Figure 2: In-sample forecast for the A series

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

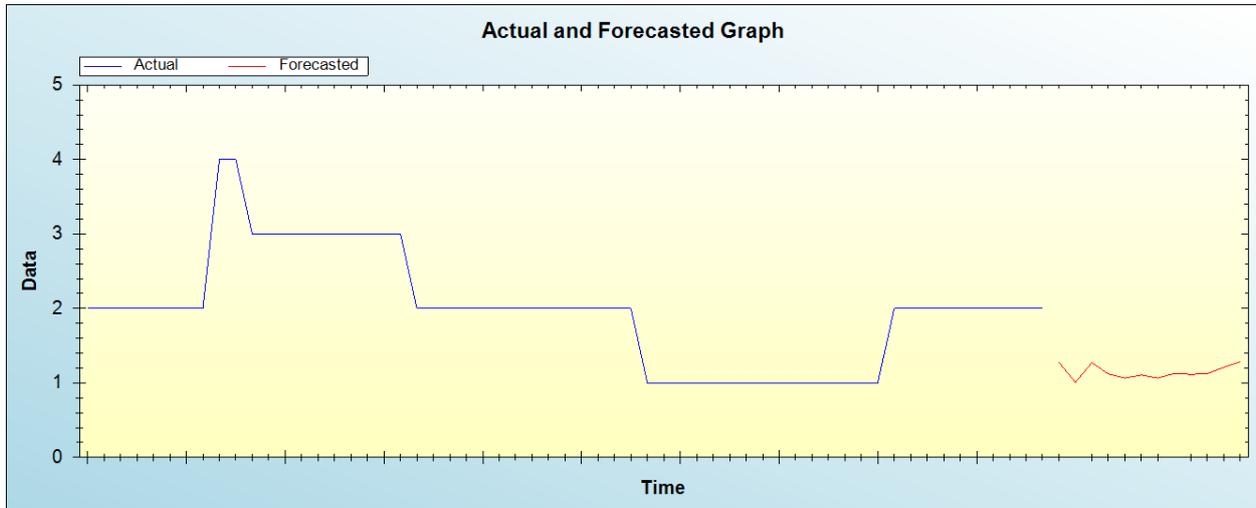


Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	1.2785
2020	1.0085
2021	1.2739
2022	1.1197
2023	1.0665
2024	1.1069
2025	1.0660
2026	1.1284
2027	1.1153
2028	1.1236
2029	1.2097
2030	1.2849

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

IV. CONCLUSION & RECOMMENDATIONS

Total fertility rate in Romania has declined over the years to below replacement level. The country’s 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 Romania. The model projections revealed that annual total fertility rates in Romania are likely to be around 1 birth per woman over the out-of-sample period. Therefore, the government is encouraged to promote child bearing by providing incentives to couples.

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