

Forecasting Total Fertility Rate (TFR) In Turkey Using the Multilayer Perceptron Neural Network

¹Dr. Smartson. P. NYONI, ²Tatenda. A. CHIHOHO, ³Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Health Economist, Zimbabwe

³SAGIT Innovation Center, Harare, Zimbabwe

Abstract - In this research paper, the ANN approach was applied to analyze TFR in Turkey. 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 Turkey. The results of the study indicate that annual total fertility rates in Turkey are likely to be around 2.3 births per woman throughout the out-of-sample period. Therefore, the Turkish government is encouraged to continue on this commendable path by continuously addressing challenges being faced by adolescent girls and young women.

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

I. INTRODUCTION

Turkey is a country with a population estimate of 73million and growth rate of 1% per annum (Turner, 2012). Approximately 60% of the population is urban and its economy is mainly driven by services and manufactured goods (International futures, 2012). Total fertility rate in Turkey dropped from 6.7 births per woman in 1955 to 2.1 births per woman in 2020 (Worldometer, 2020). The life expectancy at birth for both sexes is 78.5 years. The country has witnessed a decline in infant and under five mortality rates. IMR dropped from 217.18 infant deaths per 1000 live births in 1950 to 7.27 infant deaths per 1000 live births in 2020. Under five mortality rate declined from 292.05 deaths per 1000 live births in 1950 to 10.89 deaths per 1000 live births in 2020 (Worldometer, 2020) reflecting significant progress made by the government to reduce adverse maternal and child health outcomes. There are few authors in the region who have studied fertility issues. Pourreza et al (2021) did a systematic review between the years 2000 and 2016. The different databases like Cochrane, PubMed, Scopus, and Science Direct and the Google Scholar search engine were used. At first, 270 articles and then 18 articles were selected and meticulously read for the final analysis. The results indicated a declining trend in the TFR in the Middle East and North Africa, as in other parts of the world. Regarding the causes of this declining trend, several factors were identified and categorized into five main factors of health care-related, cultural, economic, social, and political. Ghaem et al (2019) investigated the trend of changes in Age-Specific Fertility Rate (ASFR), Total Fertility Rate (TFR), and Cohort Fertility Rate (CFR) in rural areas of Fars province, southern Iran during 1988-2012. This cross-sectional study was conducted based on analysis of fluctuations in fertility. The study concluded that fertility followed a negative slope during 1992-2012, indicating their descending trend during these years. The investigation of Socio-Economic Determinants on Fertility Rate at Aggregate Level in Turkey was carried out by Karakaya (2016). The study utilized the OLS method. The results of the hypothesis test revealed the inverse relation of total fertility rate with literacy, female workforce in non-agricultural sectors and proportion of urban population.

The aim of this study is to project TFR in Turkey using an artificial neural network approach. The findings of this piece of work is envisioned to reveal likely future trends of fertility in the country and stimulate an appropriate response to the future health, educational and employment needs of the Turkish 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 Turkey.

Data Issues

This study is based on annual total fertility rate (births per woman) in Turkey 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	T
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	0.235228
MSE	0.069697
MAE	0.205798

Residual Analysis for the Applied Model

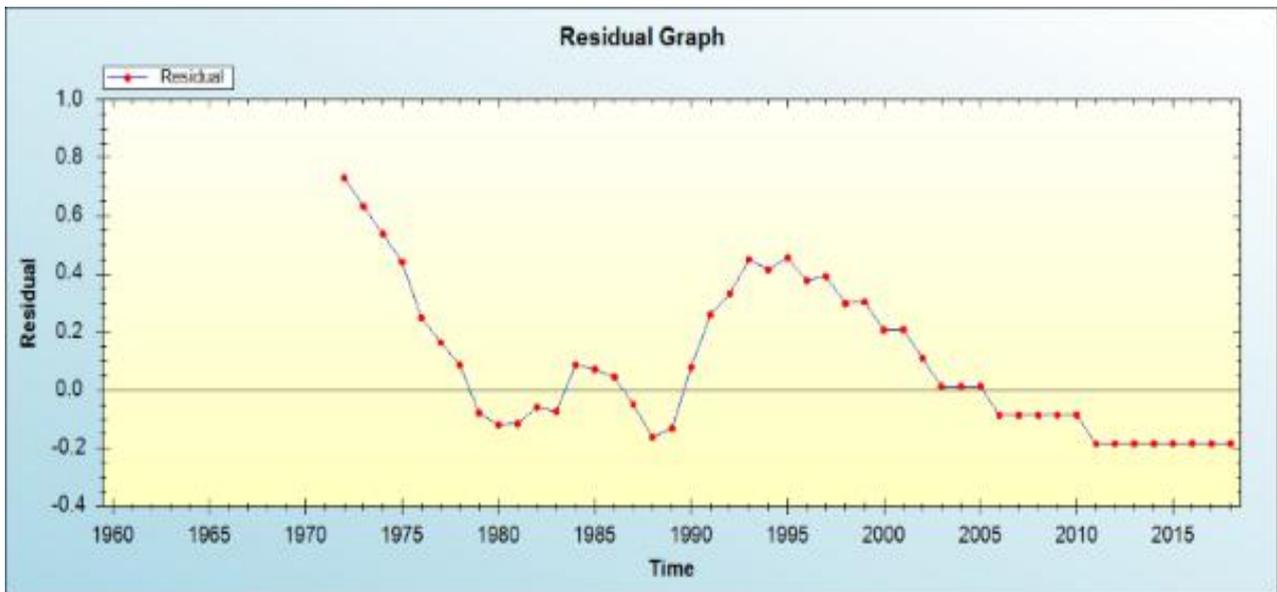


Figure 1: Residual analysis

In-sample Forecast for T

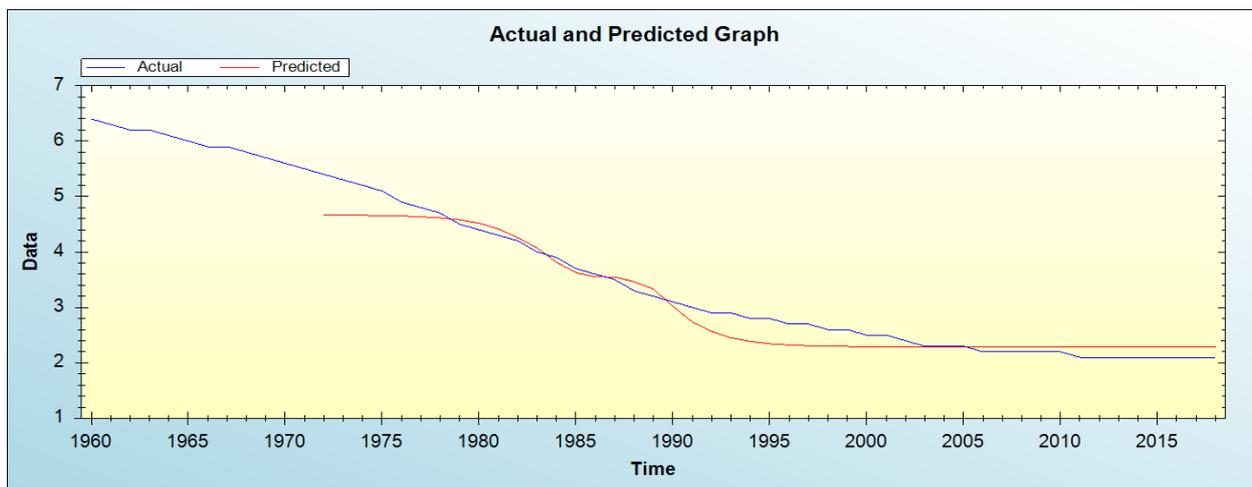


Figure 2: In-sample forecast for the T series

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

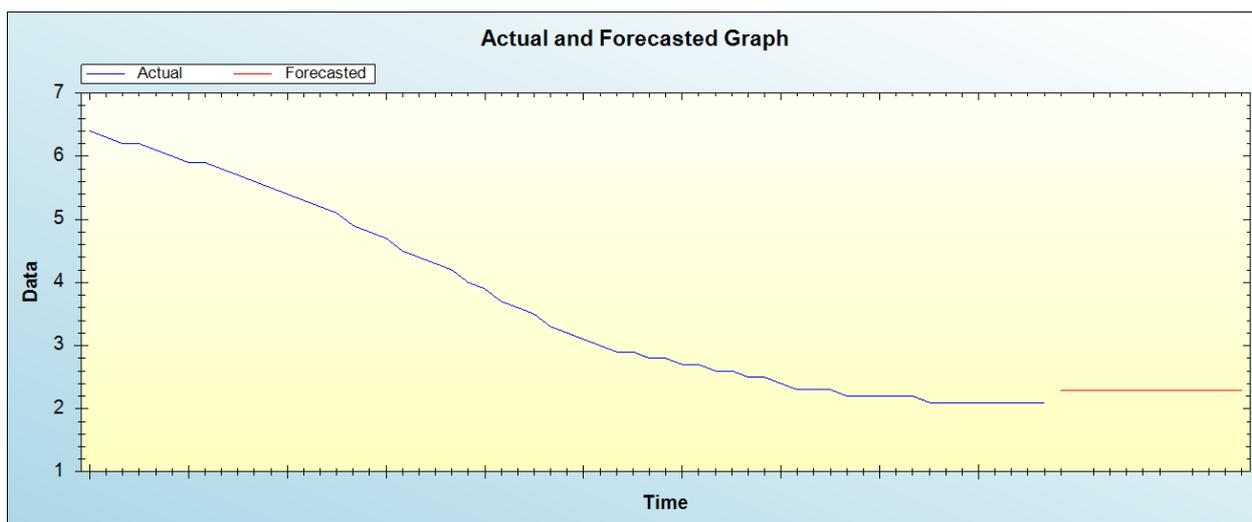


Figure 3: Out-of-sample forecast for T: actual and forecasted graph

Out-of-Sample Forecast for T: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted TFR values
2019	2.2838
2020	2.2838
2021	2.2839
2022	2.2839
2023	2.2838
2024	2.2839
2025	2.2839
2026	2.2840
2027	2.2840
2028	2.2841
2029	2.2841
2030	2.2841

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 Turkey are likely to be around 2.3 births per woman throughout the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Turkey has made significant progress in improving the health status of its population as this is reflected by its low infant and child mortality rates. In this paper we proposed an artificial neural network approach to project TFR in Turkey. The ANN model projections revealed that annual total fertility rates in Turkey are likely to be around 2.3 births per woman throughout the out-of-sample period. Therefore, the Turkish government is encouraged to continue on this commendable path by continuously addressing challenges being faced by adolescent girls and young women.

REFERENCES

- [1] Sara Turner, International Futures- Fall 2012, Dr. Barry Hughes (2012), Turkey in 2050 Creating Sustainable Economic Growth and an Inclusive Society, pp 1-29
- [2] Worldometer (2020). Turkey demographics. <https://www.worldometers.info>

Citation of this Article:

Dr. Smartson. P. NYONI, Tatenda. A. CHIHOHO, Thabani NYONI, "Forecasting Total Fertility Rate (TFR) In Turkey Using the Multilayer Perceptron Neural Network" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 8, pp 331-334, August 2021. Article DOI <https://doi.org/10.47001/IRJIET/2021.508072>
