

Projection of Total Fertility Rate (TFR) in Australia

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 Australia. 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 Australia. The model projections revealed that annual total fertility rates in Australia are likely to be around 1.8 births per woman throughout the out-of-sample period. Therefore, the Australian government must promote child bearing by offering pro-fertility incentives and lowering the cost of raising children.

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

I. INTRODUCTION

Australia is committed to the international conference on population and development's goals of achieving universal access to sexual and reproductive health services. The country's family planning program is a key strategy to effectively reduce maternal and child mortality. The international conference on population and development emphasized the need to observe SRH rights of individuals or couples. Each couple or individual has a right to decide on the number of children, birth spacing, and timing of their children and have access to information. Family planning services are recognized as one of the strategies that have significantly contributed to reduction of global fertility rates. Fertility forecasts are an important aspect of population and labor forecasts, hence accurate prediction of fertility is key for government policy, planning and decision making to ensure adequate resource allocation to health sector, education and housing (Shang & Booth, 2020). According to Worldometer Australia's TFR decline from 3.4 births per woman in 1960 to 1.8 births per woman in 2020. The country recorded a low infant mortality rate of 2.7 infant deaths per 1000 live births and under five mortality rate of 3.2 deaths per 1000 live births in 2020. There are few researchers who have investigated or analyzed fertility trends in the country. Pourreza et al (2021) 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. Shang & Booth (2020) applied model averaging to fertility forecasting for the first time, using data for 17 countries and six models. Four model-averaging methods were compared: frequentist, Bayesian, model confidence set, and equal weights. Computation of individual-model and model-averaged point and interval forecasts at horizons of one to 20 years was done. The study concluded that model averaging holds considerable promise for the improvement of fertility forecasting in a systematic way using existing models and warrants further investigation. Evans & Gray (2018) used birth registration and Census data to explore the spatial variation of fertility in Australia and how it relates to compositional and contextual characteristics of places. Geographically weighted regression was used to analyze the spatial relationships and identify the geographical variability in the fertility experience of Australian women. The study found substantial variation with some areas having a total fertility rate well above or below the national average.

The aim of this study is to forecast total fertility rate in Australia using a machine learning approach. The findings of this paper are envisioned to highlight the likely fertility trends in the out of sample period. This will guide policy and facilitate resource mobilization for future health, education and employment needs of the Australian 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 Australia.

Data Issues

This study is based on annual total fertility rate (births per woman) in Australia 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	0.404830
MSE	0.016304
MAE	0.096913

Residual Analysis for the Applied Model

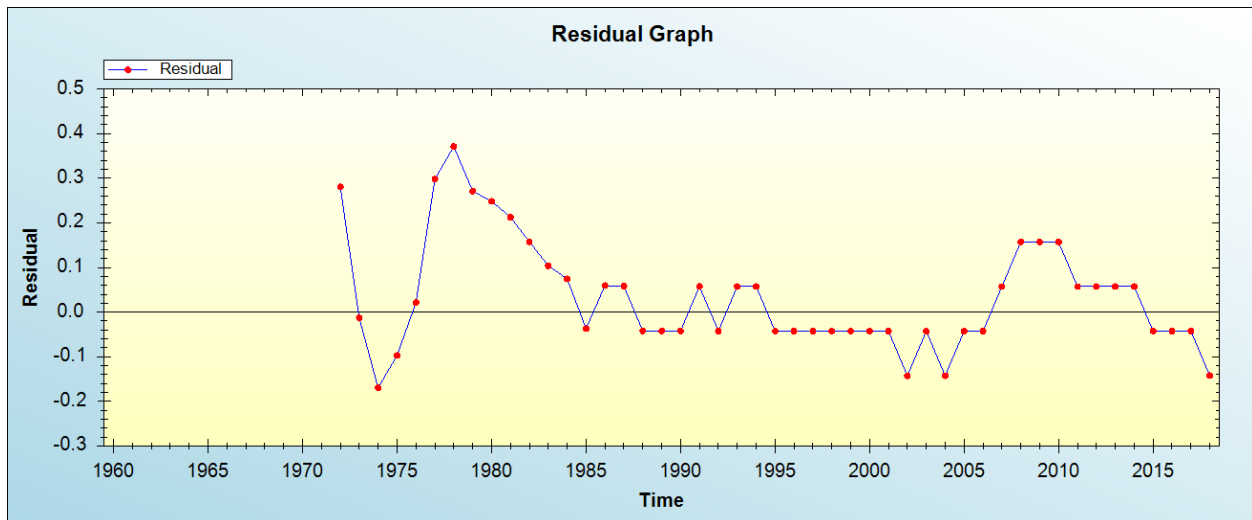


Figure 1: Residual analysis

In-sample Forecast for A

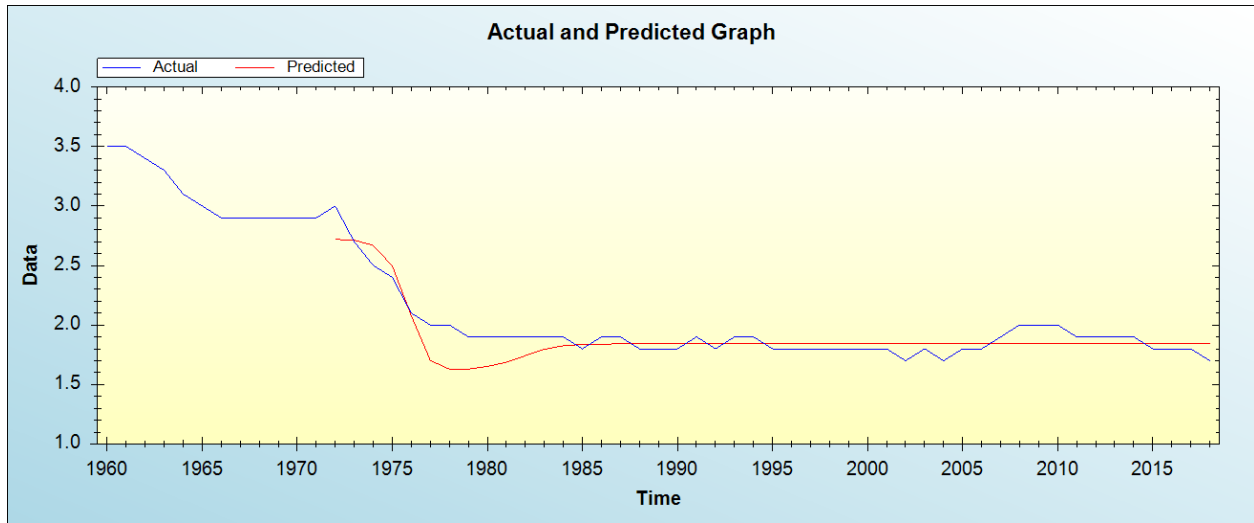


Figure 2: In-sample forecast for the A series

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

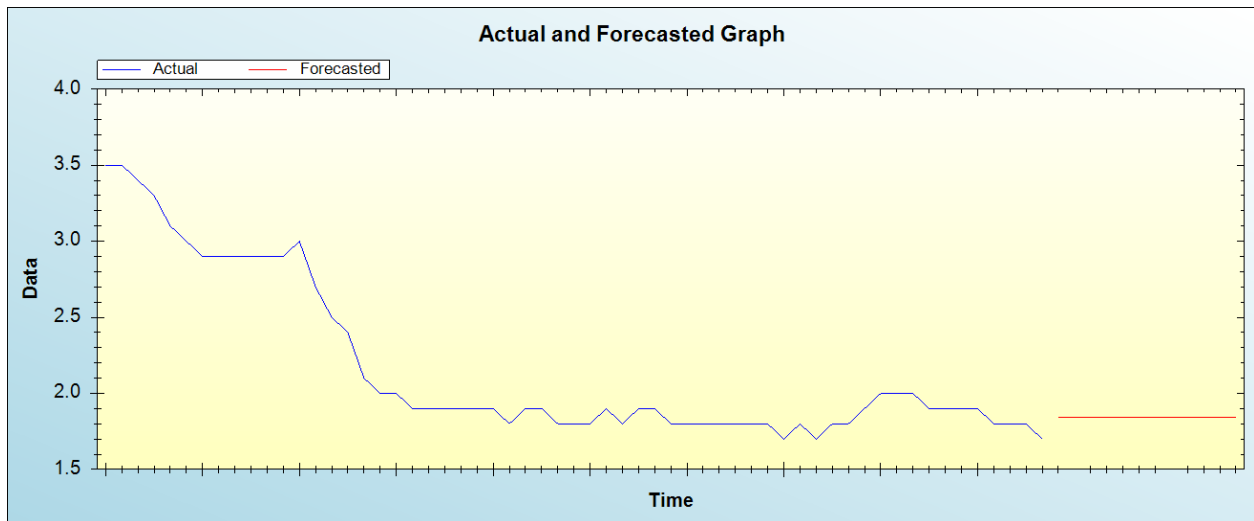


Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted TFR values
2019	1.8422
2020	1.8422
2021	1.8424
2022	1.8425
2023	1.8426
2024	1.8426
2025	1.8426
2026	1.8426
2027	1.8426
2028	1.8426
2029	1.8426
2030	1.8426

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 Australia are likely to be around 1.8 births per woman throughout the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Time series forecasting is gaining prominence in the field of demography and public health. Several methods are being utilized and these include statistical and machine learning techniques. Machine learning approaches have overtaken statistical methods due to their high predictive accuracy. In this study we applied the multilayer perceptron neural network to forecast TFR in Australia. The results of the study indicate that annual total fertility rates in Australia are likely to be around 1.8 births per woman throughout the out-of-sample period. Therefore the Australian government is encouraged to promote child bearing by offering pro-fertility incentives and lowering the cost of raising children.

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Citation of this Article:

Dr. Smartson. P. NYONI, Tatenda. A. CHIHOHO, Thabani NYONI, "Projection of Total Fertility Rate (TFR) in Australia" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 8, pp 248-251, August 2021. Article DOI <https://doi.org/10.47001/IRJIET/2021.508053>
