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Projection of Total Fertility Rate (TFR) in Iran

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***Abstract* - In this research article, the ANN approach was applied to analyze TFR in Iran. 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 Iran. The results of the study indicate that annual total fertility rates in Iran are likely to be around 1.9 births per woman over the out-of-sample period. Therefore, the Iranian government is encouraged to continuously address challenges being faced by adolescents and young adults in accessing sexual and reproductive health (SRH) services.**

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

I. INTRODUCTION

Population changes are influenced by fertility, mortality and migration. In the absence of migration, reproduction compensates for deaths and if fertility exceeds mortality population growth becomes positive (Ghaem et al, 2019). The Islamic Republic of Iran has witnessed a decline in fertility rates from 6.9 births per woman in 19950 to 1.9 births per woman in 2005 and then rose to 2.2 births per woman in 2020 (Worldometer, 2020). In 2020, the country recorded an IMR of 10.5 infant deaths per 1000 live births and under five mortality rate of 12.3 deaths per 1000 live births (Worldometer, 2020). The decline in TFR for Iran will result in population ageing, reduced workforce and compromised health level (Famokh et al, 2014). There are limited empirical studies that have investigated or analyzed fertility trends in the region. 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. Based on a cross sectional study, 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. The study concluded that fertility followed a negative slope during 1992-2012, indicating their descending trend during these years. Azmoude et al (2018) investigated the relationship of fertility rate with demographic, socioeconomic, and religious factors among childbearing women in a city in Easter Iran. The study revealed that fertility rate was significantly associated with couple's age, age at marriage, and educational level among the women of reproductive age in Torbat Heydariyeh.

The aim of this study is to project total fertility rate in Iran using a machine learning approach. The findings of this piece of work will provide an insight of the likely future fertility trends in Iran. This will help in making policies and facilitate resource mobilization for the future health, education and employment needs of the Iranian 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 Iran.

Data Issues

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

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III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	N
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	0.169872
MSE	0.079490
MAE	0.214951

Residual Analysis for the Applied Model

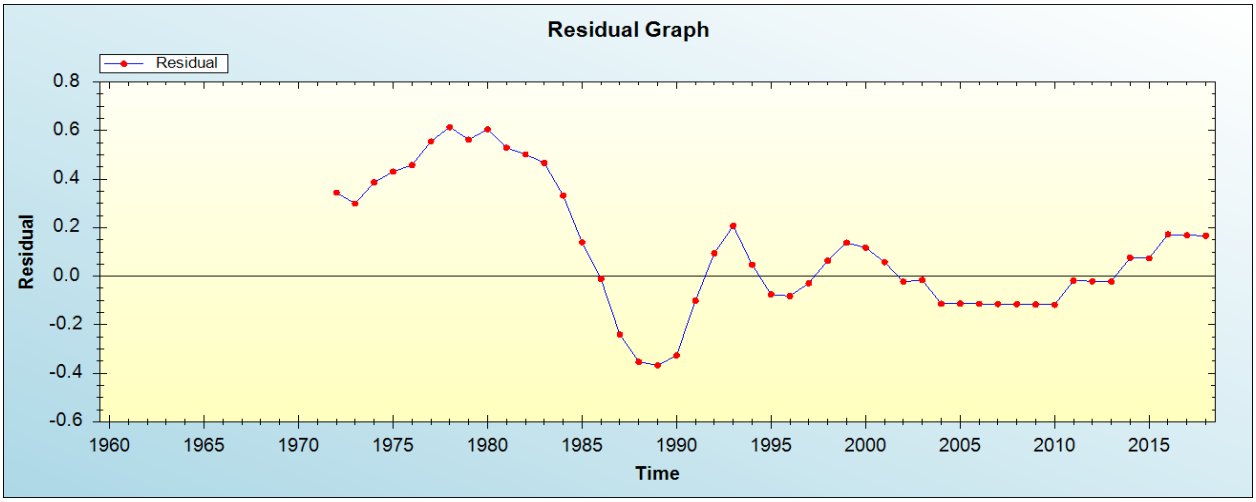

Figure 1: Residual analysis

In-sample Forecast for N

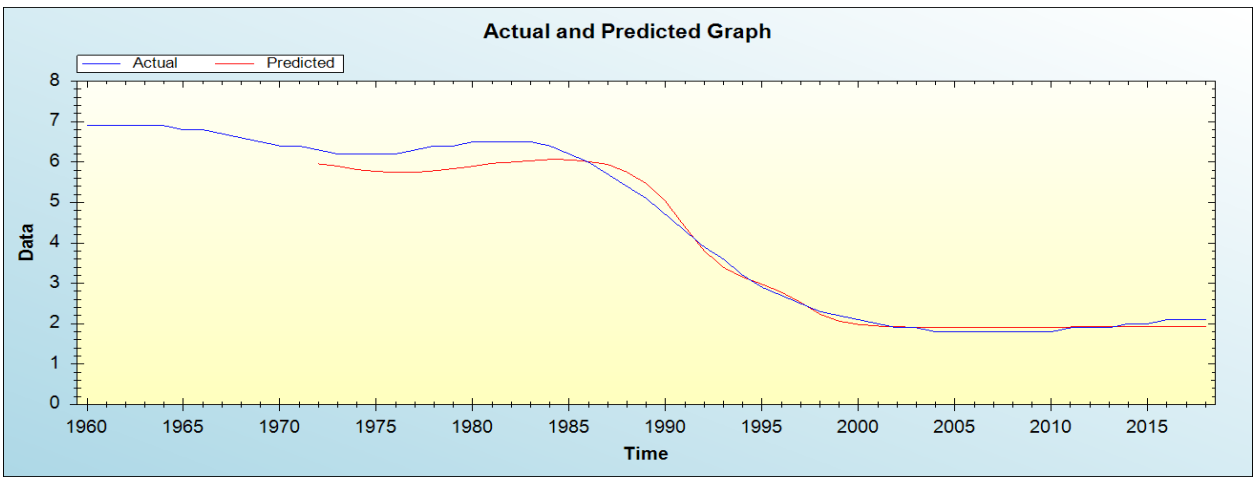

Figure 2: In-sample forecast for the N series

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

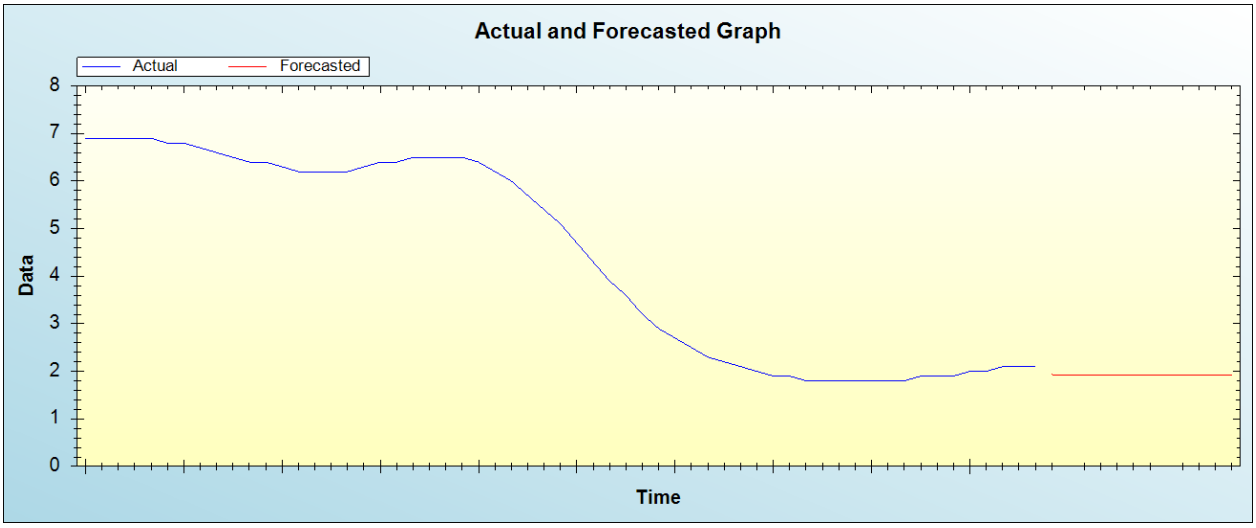

Figure 3: Out-of-sample forecast for N: actual and forecasted graph

Out-of-Sample Forecast for N: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted TFR values
2019	1.9336
2020	1.9313
2021	1.9313
2022	1.9292
2023	1.9287
2024	1.9271
2025	1.9258
2026	1.9240
2027	1.9244
2028	1.9231
2029	1.9232
2030	1.9241

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 Iran are likely to be around 1.9 births per woman over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Iran has experienced a decline in TFR (to below replacement level in 2005), infant and child mortality rates over the past decades. In this study we applied a machine learning algorithm to predict TFR in Iran. The ANN (12, 12, 1) model projected that annual total fertility rates in Iran are likely to be around 1.9 births per woman over the out-of-sample period. Therefore the Iranian government should continuously address challenges being faced by adolescents and young adults in accessing sexual and reproductive health (SRH) services.

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