

Projecting Future Total Fertility Rates for Tajikistan Using Artificial Neural Networks

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Abstract - This study projected Tajikistan's total fertility rates from 2019 to 2030 by employing Artificial Neural Networks using Tajikistan data on TFRs from 1960 to 2018. The results of predicted TFRs remained constant at around 3.6 throughout the out of sample period.

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

I. INTRODUCTION

Population growth has been identified as a key factor in determining the level of economic growth of a country by some economists however other proponents postulates a negative relationship between economic growth and population growth beyond a specific population growth level. Whatever the case, the importance of predicting future population growth levels and trends for a country cannot be ignored as far as policy is concerned. If the future path of fertility rates is below replacement level it implies that a danger of under population is coming and if the fertility rates are too high it means overpopulation is coming. Therefore, for proper policies to be put into place there is need to precisely predict future total fertility rates. This then necessitates the importance of predicting future TFR for Tajikistan such that policy makers may implement sound policies for balanced economic and population growth (Gubhaju, B, Jongstra, E and Raikoti M, 2013). This entails proper policies either to boost population or reduce population depending on the predicted fertility levels. Tajikistan had a fertility rate of 6.3 in the 1970s, and has been falling ever since, reaching 5.04 in 1991 and 3.96 by 2002 (Clifford, 2009).

II. LITERATURE REVIEW

Below is some literature on total fertility rates:

Table 1: Literature on TFRs

Author/s (Year)	Study period	Method	Topic	Key results
Henry&Juraquova (2020)	1929 to 2017	Narrative review	Family planning in the Republic of Tajikistan: a narrative review from Soviet times to 2017	-an association between decision making and unmet needs for family planning was established -projection of fertility trends were done
Rowland (2005)	1989 to 2000	Narrative review Questionnaires	National and regional population trends in Tajikistan: results from recent census	-population increased rapidly due to high fertility -rural population grew rapidly but urban population fell
Clifford (2009)	2003	Multiple logistic regression model	Spousal separation, selectivity and contextual effects: exploring the relationship between international labour migration and fertility in Post-Soviet Tajikistan	-there is a short-term disruptive effect of spousal separation -there is significant positive covariance between migration and fertility -no evidence for unobserved selectivity at the couple level
Clifford et al (2010)	2000, 2003 and 2005	Piecewise-constant hazard model	Through civil war, food crisis and drought: trends in	-evidence of a fall in period fertility

			fertility and nuptiality in Post-Soviet Tajikistan	- strong evidence for a fall in nuptiality and fertility associated with the 1995 food crisis.
Tabyshalieva (2014)	Soviet to post-Soviet era	Narrative review	Women of Central Asia and the fertility cult	-development of Central Asia from viewing women as second class, inferior citizens to their emancipation as mothers with equal rights to men as evidenced by their participation in economic growth programmes and provision of education and health facilities for them
Spoorenberg (2015)	1955 to 2010	-cross sectional time series analysis -Bongaarts and Feeney tempo adjustment method	Explaining recent fertility increase in Central Asia	-recent fertility changes are real and are not as a result of data artifact -population composition effect, economic context and the shifting tempo effect caused an increase in period fertility rates.
Buckley (1998)	1990	Narrative review	Rural/urban differentials in demographic processes: the Central Asian states	-differentials in fertility and mortality rates in rural areas of Central Asian states indicate the need for future policy interventions and data collection to incorporate a specific focus for rural areas.
Berggren et al (1974)	1970	-questionnaires -quantitative analysis	Rural Haitian women: an analysis of fertility rates	-a TFR of 5.9 was found - modal number of live born children for women who completed their reproductive years in a stable union was 11 and those with more than one union was 3 children
De Broe & Hinde (2006)	1987, 1996, 1999 & 2002	-Ordinary Least Squares	Diversity in fertility patterns in Guatemala	-ethnic diversity and proportion of indigenous people are significant in explaining fertility
Gubhaju, Jongstra and Raikoti (2013)	1966, 1976, 1986, 1996, 2007	-own children method, Cho 1973. -Decomposition analysis technique	- Below replacement fertility of ethnic Indians in Fiji: a decomposition analysis of the components of changes in the total fertility rate	- educational attainment has a significant, negative impact on fertility -changes in marital structure have a negative impact on fertility in Fiji -marital fertility is positively related to TFR in Fiji

III. 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 Tajikistan.

Data Issues

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

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 2: ANN model summary

Variable	TFR
Included Observation	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	0.054944
MSE	0.010771
MAE	0.074159

Residual Analysis for the Applied Model

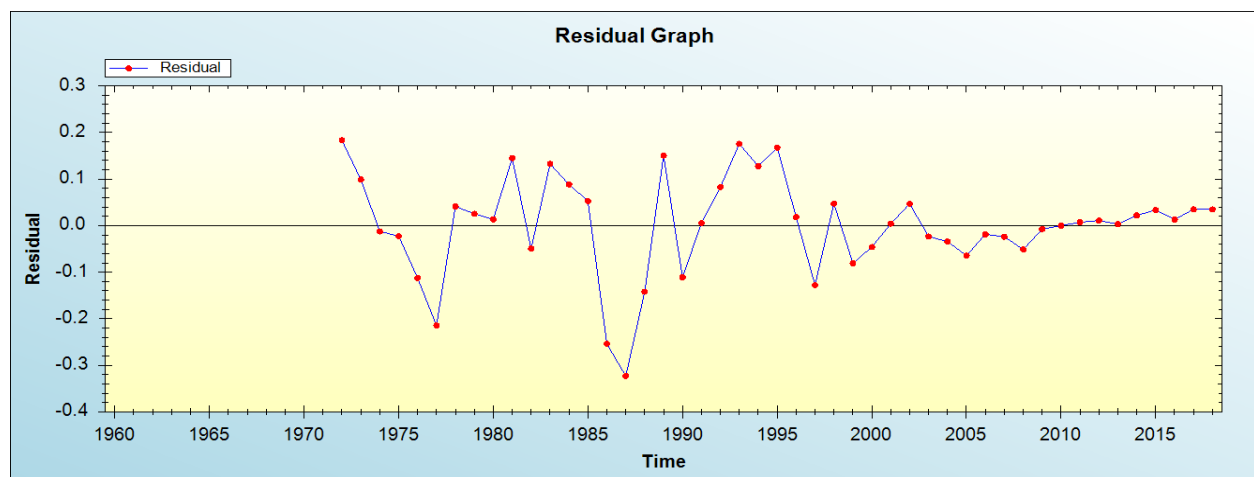


Figure 1: Residual analysis

In-sample Forecast for TFR

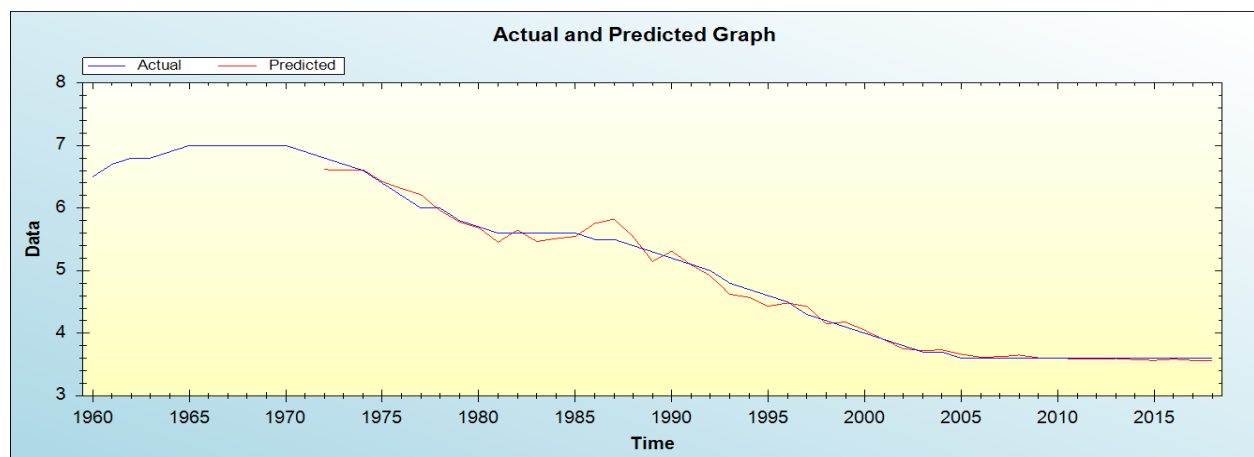


Figure 2: In-sample forecast for the TFR series

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

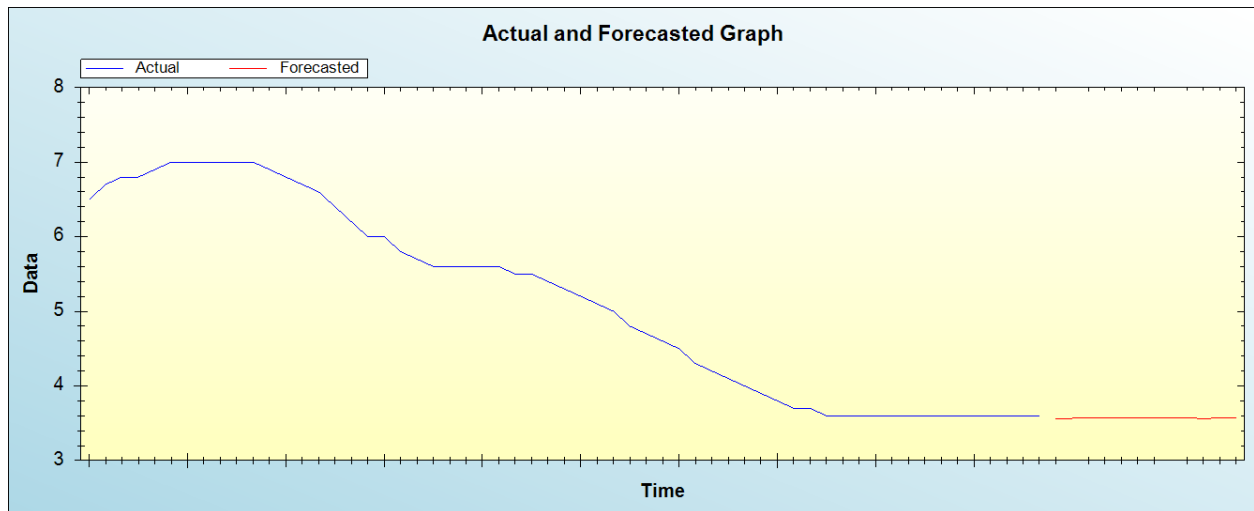


Figure 3: Out-of-sample forecast for TFR: actual and forecasted graph

Out-of-Sample Forecast for TFR: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasted
2019	3.5652
2020	3.5664
2021	3.5685
2022	3.5702
2023	3.5676
2024	3.5666
2025	3.5681
2026	3.5704
2027	3.5700
2028	3.5643
2029	3.5681
2030	3.5757

The main results of the study are shown in table 2. 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 Tajikistan are likely to remain constant at 3.6 over the out-of-sample period.

V. CONCLUSIONS AND RECOMMENDATIONS

With the predicted TFRs remaining constant at 3.6 throughout the out of sample period, there is a possibility of Tajikistan population to continue growing given a replacement level of 2.1. Tajikistan authorities therefore need to implement policies to curtail the possible future population growth.

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