

# Predicting Future Total Fertility Rates for Haiti Using Artificial Neural Networks

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**Abstract-** This study intended to predict future total fertility rates (TFRs) for Haiti from 2019 to 2030 using Artificial Neural Networks. Data on Haiti’s TFRs from 1960 to 2018 which was obtained from the World Bank Online database was used. The future TFRs are predicted to fall throughout the out of sample period from 3.1 in 2019 to 2.9 in 2030.

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

## I. INTRODUCTION

Globally, fertility level is continuously falling, from 3.2 in 1990, to 2.5 in 2019 and is expected to reach 2.2 by 2050 (UN, Population Division, 2020). This global phenomenon coupled with expansion of life expectancy is the key force restructuring population dynamics around the world (Basten et al, 2013). This has social and economic impacts because it affects public policies, gender relations and labour markets. Haiti as well joined a bandwagon of countries experiencing falling fertility rates, from 6.3 in 1960 To 2.9 in 2018. Such developments have a direct bearing on resource allocation and therefore call for policy intervention. This study will therefore predict future fertility rates for Haiti up to the year 2030 so that such data may be used by the authorities to implement proper policies.

## II. LITERATURE REVIEW

Below is literature on studies on TFRs

Table 1: Literature on TFRs

Author/s (Year)	Study period	Method	Topic	Key results
Berggren, Murthy & Williams (1974)	1970	-questionnaires -quantitative analysis	Rural Haitian women: an analysis of fertility rates	-a TFR of 5.9 was found - modal number of liveborn 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 Sherbinin (1996)	1995	Narrative analysis	Human security and fertility: the case of Haiti	-Human insecurity (governance failure, poverty, degradation) in Haiti leads to higher fertility -inorder to achieve successful fertility reduction there is need to address economic and environmental security of Haitians.
Tucker (1996)	1990	Narrative analysis	Haiti: unions, fertility and the quest for survival	-most popular unions are legal marriage and setting up of a household in Haiti -more urban women use contraceptives than rural women
Allman (1982)	1971 to 1977	-world fertility survey approach	Fertility and family planning in Haiti	-more urban women use contraceptives than rural women

				-women with more education have lower fertility compared to those with lower education -direct relationship between age and fertility
Allman and May (1979)	1971 1973	-own children analysis -Brass model	Fertility, mortality, migration and family planning in Haiti	-malnutrition, longer breast-feeding period and use of contraceptives may reduce fertility -malnutrition and lack of quality healthcare services led to an increase in mortality
Rasheed and Tashtoush (2021)	2007 and 2012	Multiple regression analysis	The fertility and its relation with some demographic, economic and social variables in Jordan	-fertility levels are lower in urban areas than in rural areas -average age at first marriage, proportion of women in labour force, number of hospitals, doctors, nurses and midwives are statistically significant in affecting fertility
Nedoluzhko (2012)	Multiple Indicators Clusters survey of 2005 and 2006	-Poisson Regression -logistic regression model	Achieved fertility and fertility intentions among ethnic groups in Central Asia: Kyrgyzstan, Tajikistan and Uzbekistan compared	-number of children ever born and the intention to have another child appear to be negatively correlated with minority status.
Eickelman (1993)	1979, 1988	-qualitative analysis -questionnaires	Fertility and social change in Oman: women's perspectives	-natural factors such as decreasing resource base do not motivate individuals to make personal choices with regards to reduction of family size. -Omanis perceive children as signs of social strengths
Henry & Juraqulova (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
Gurbansoltan Eje clinical Medical Centre for Maternal and Child Health (2001)	2000	-one child method -quantitative analysis	Turkmenistan: demographic and health survey 2000	-TFR was 2.9 children -TRF for rural areas of 3.5 is higher by one than that for urban areas which is 2.5

### 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 Haiti.

#### Data Issues

This study is based on annual total fertility rate (births per woman) in Haiti 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	0.092537
MSE	0.030552
MAE	0.145851

##### Residual Analysis for the Applied Model

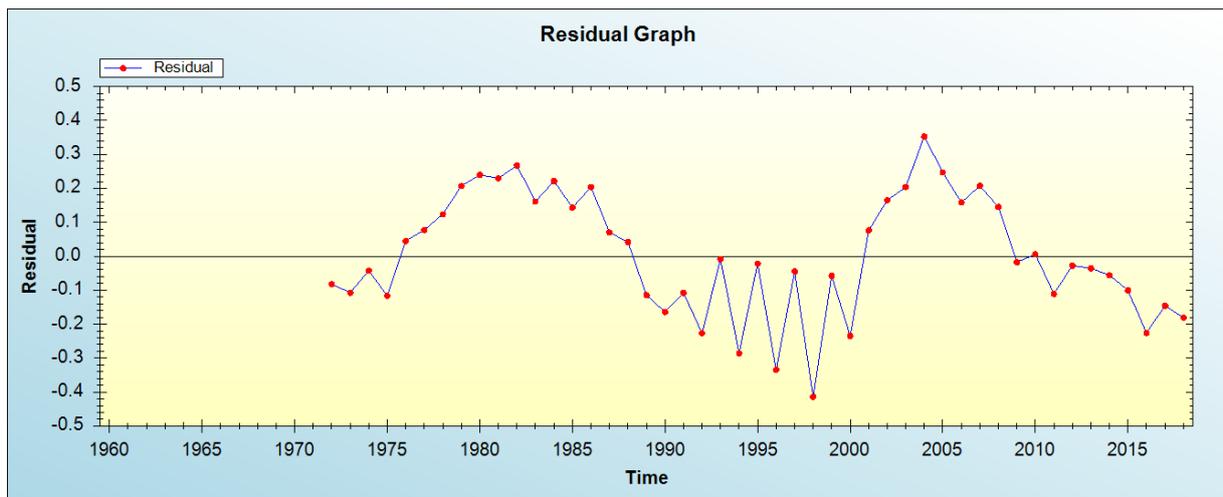


Figure 1: Residual analysis

##### In-sample Forecast for TFR

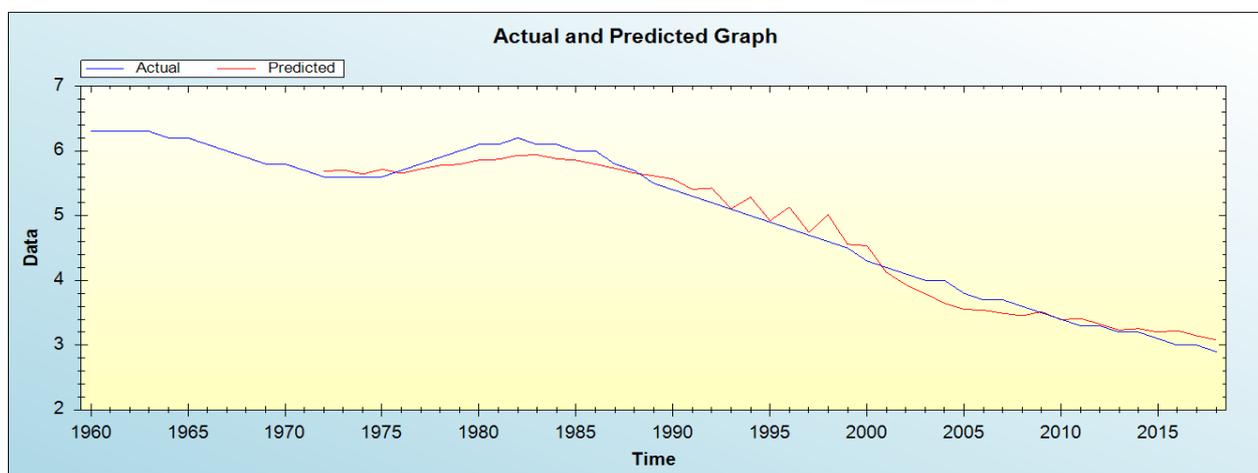


Figure 2: In-sample forecast for the TFR series

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

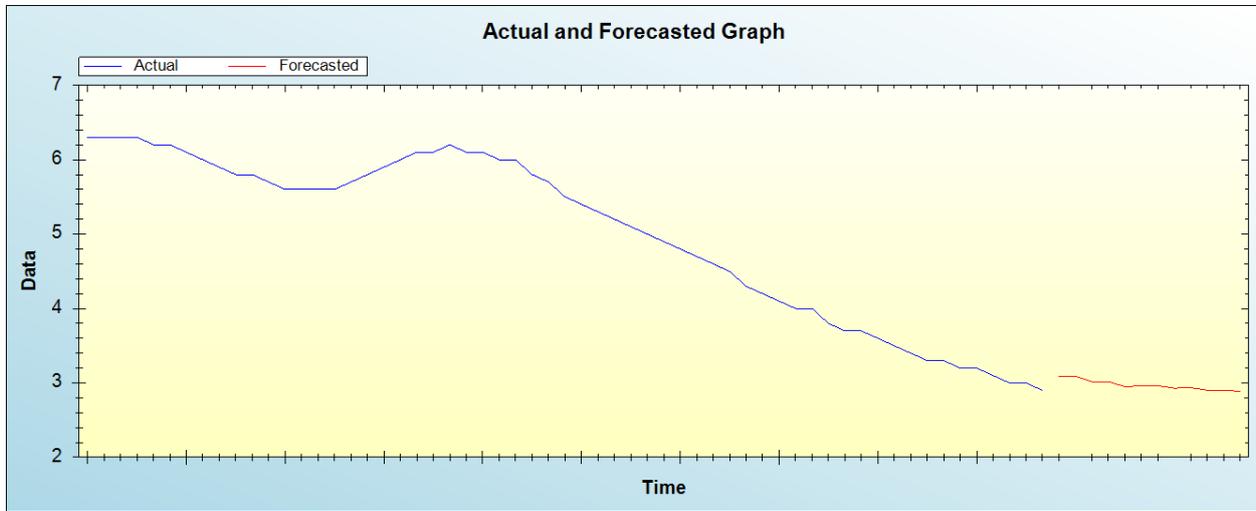


Figure 3: Out-of-sample forecast for TFR: actual and forecasted graph

Out-of-Sample Forecast for TFR: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasted
2019	3.0898
2020	3.0928
2021	3.0167
2022	3.0161
2023	2.9511
2024	2.9602
2025	2.9633
2026	2.9300
2027	2.9364
2028	2.9027
2029	2.9029
2030	2.8875

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

V. CONCLUSIONS AND RECOMMENDATION

The results predict a slight continuous fall of TFRs from 3.1 in 2019 to 2.9 by 2030. These rates are still greater than the fertility replacement rate of 2.1 implying that Haiti’s population is expected to continue growing throughout the out of sample period holding other factors constant. This then calls for policies aimed at reducing fertility rates or advanced technology to match future population growth with resources.

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