

Forecasting Total Fertility Rate (TFR) in Carbo Verde

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Abstract - In this research article, the ANN approach was applied to analyze TFR in Carbo Verde. 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 Carbo Verde. The results of the study indicate that annual total fertility rates in Carbo Verde are likely to decline slightly over the out-of-sample period. Therefore, the government should create more youth friendly health facilities to improve access to sexual and reproductive health (SRH) services among adolescents and young adults.

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

I. INTRODUCTION

Developing countries are struggling to control the dual epidemic of HIV and TB and this is aggravated by poverty, hunger, civil conflict, and poor infrastructure. The emergence of the COVID-19 pandemic brought suffering to millions of people who have lost their sources of income due to repeated lockdowns triggered by the COVID-19 waves. Many adolescent girls and young women continue to have unwanted pregnancies, unsafe abortions and bad obstetric outcomes (WHO, 2014). The incidence of gender based violence and sexual abuse of adolescent girls and women are being reported during this COVID-19 pandemic (Mittal & Singh, 2020). About 17million adolescent girls give birth each year and most of them are in low and middle income countries (WHO, 2014; Ganchimeg et al, 2014). Religion and early marriages were found to be the major causes of high numbers of adolescent pregnancies as reported by Parson et al (2015).

Cabo Verde recorded a decline in fertility rates over the past decades from 7.0 births per woman in 1965 to 2.3 births per woman in 2020 (Worldometer, 2020). Infant mortality rate declined from 130.98 infant deaths per 1000 live births in 1950 to 14.21 infant deaths per 1000 live births in 2020 (Worldometer, 2020) reflecting significant improvements made in the reduction of infant mortality and improving child survival. There are limited studies that have focused on investigating fertility issues in the region particularly predicting fertility rates. Genus (2020) examined the determinants of trends wanted and unwanted fertility in SSA using fixed-effects regressions of country-level data. Data came from 103 DHS surveys in 25 countries in SSA with at least two DHS surveys between 1989 and 2019. The study revealed that Women's education and family planning programs are found to be the dominant determinants of fertility decline and their effects operate by reducing both wanted and unwanted fertility. Mercer et al (2019) estimated the levels and trends of FP indicators at a subnational scale in Nigeria utilizing all available data and accounting for survey design and uncertainty based on a cross-sectional study. The study revealed that the overall rates and trends of mCPR and unmet need have remained low in Nigeria. A secondary analysis of data from a study conducted to monitor the implementation of a UNFPA package of interventions directed to improve SRH in young people of Sierra Leone was done by Labat et al (2018). The study was a household quantitative survey with open ended questions used to illustrate and complete the analysis. The study indicated that there is a need to reach out to the 40% of young people who are sexually active and neither pregnant nor with pregnancy desire, and are not using condom or contraception.

The aim of this study is to forecast fertility rates in Carbo Verde using a machine learning algorithm. The results of the study are expected to reveal likely fertility trends in the out of sample period. This is expected to facilitate policy making and allocation of resources to health sector, education and for employment creation.

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 Carbo Verde.

Data Issues

This study is based on annual total fertility rate (births per woman) in Carbo Verde 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	C
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	0.047861
MSE	0.015618
MAE	0.105471

Residual Analysis for the Applied Model

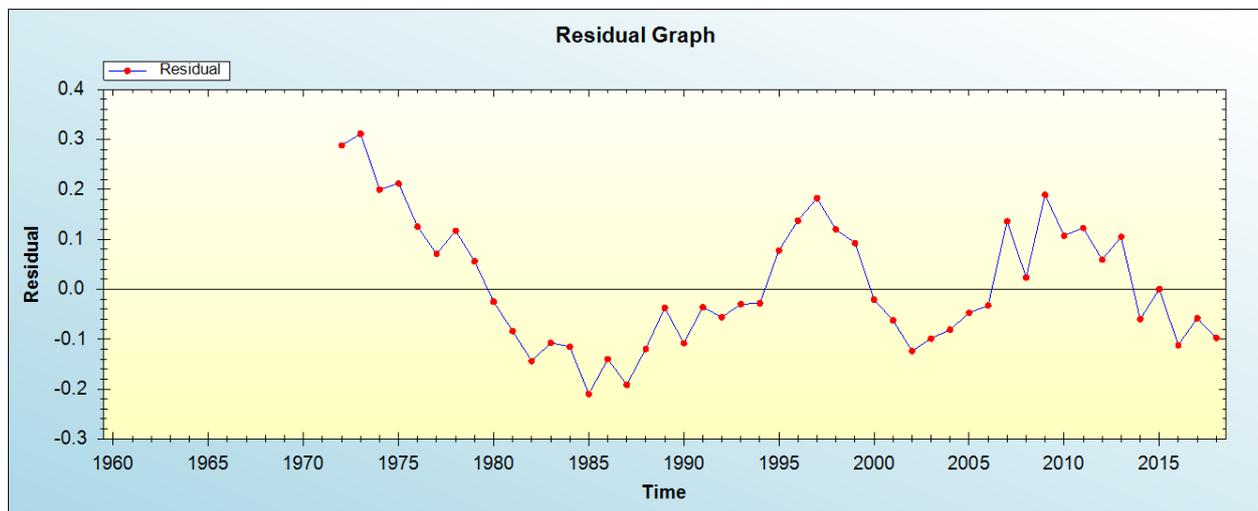


Figure 1: Residual analysis

In-sample Forecast for C

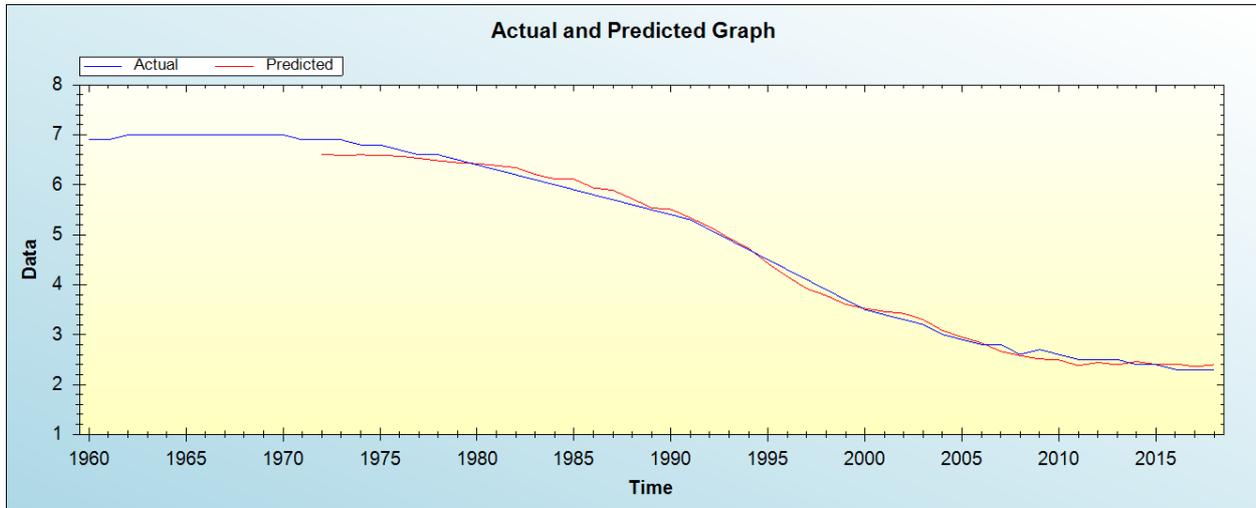


Figure 2: In-sample forecast for the C series

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

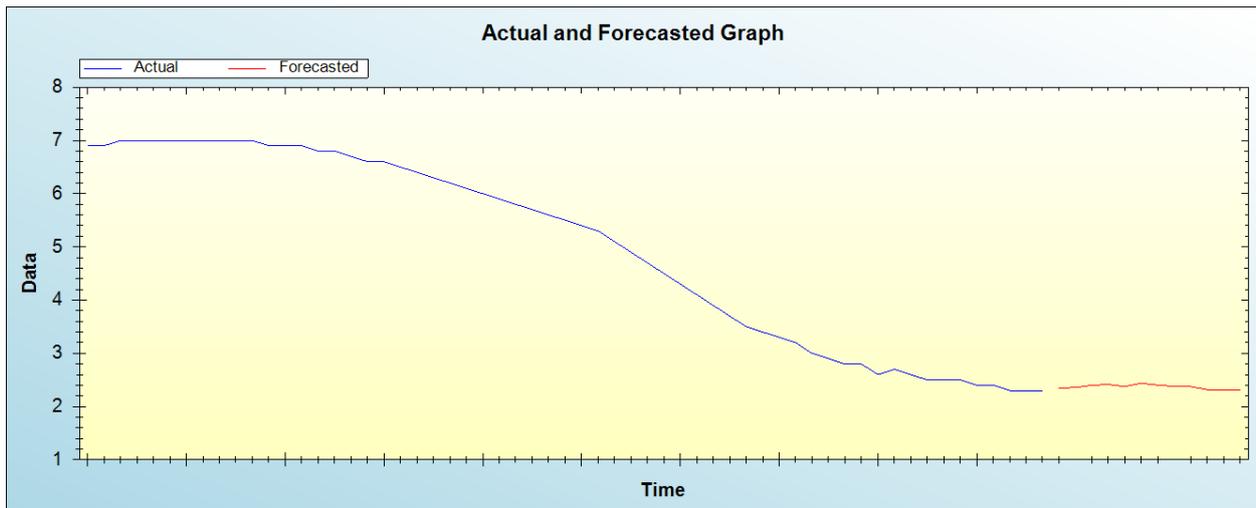


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	2.3500
2020	2.3565
2021	2.3985
2022	2.4145
2023	2.3749
2024	2.4351
2025	2.4025
2026	2.3770
2027	2.3719
2028	2.3172
2029	2.3129
2030	2.3012

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

IV. CONCLUSION & RECOMMENDATIONS

Fertility forecasting studies are rare in developing countries yet they are facing developmental challenges associated with high fertility rates. In this paper we employed an artificial intelligence technique to project total fertility rates in Cabo Verde. The model projections revealed that annual total fertility rates in Carbo Verde are likely to decline slightly over the out-of-sample period. Therefore the government is encouraged to create more youth friendly health facilities to improve access to sexual and reproductive (SRH) services among adolescents and young adults.

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