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Univariate Time Series Analysis of Total Fertility Rate (TFR) in Mauritania

[1]Dr. Smartson. P. NYONI, [2]Tatenda. A. CHIHOHO, [3]Thabani NYONI

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Health Economist, Zimbabwe
[3]SAGIT Innovation Center, Harare, Zimbabwe

***Abstract*- In this research article, the ANN approach was applied to analyze TFR in Mauritania. 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 Mauritania. The results of the study indicate that annual total fertility rates in Mauritania are likely to slightly decline over the out-of-sample period. Therefore, the government of Mauritania must focus on improving accessibility of sexual and reproductive health (SRH) services to adolescents and young adults, and channel more resources towards women empowerment programs.**

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

I. INTRODUCTION

Reproductive health is very important in order to achieve sustainable development goals by 2030. The 1994 programme action of the International conference on population and development recognized human rights especially the sexual and reproductive health rights. The sexual and reproductive rights of every individual or couple must be respected. The signatories to the conference recognized the need to uphold the SRH rights of women and adolescent girls who are suffering from gender-based or intimate violence and sexual abuse in many countries across the globe. Adolescent girls and young women have the right to information on family planning services (Darroch JE & Singh, 2013). Developing countries continue to report high maternal and infant mortality (Horvath S & Schreiber, 2017; Dastgiri et al, 2017; Melese et al, 2017; Bishwajit et al, 2017). Adolescent girls and young women are at high risk of having STIs, early unwanted pregnancies, unsafe abortions and obstetric complications (Chandra-Mouhi et al, 2015). Many adolescents lack comprehensive information on SRH and thus end up having unprotected sexual intercourse leading to unintended pregnancies and STIs (Yakubu et al, 2018).Over the past decades Mauritania has recorded a downward trend in fertility rates from 6.8 births per woman in 1970 to 4.6 births per woman in 2020 (Wordometer, 2020). The country has witnessed a downward trend in infant and under five mortality rates. In 2020 the country reported an IMR of 48.2 infant deaths per 1000 live births and under five mortality rate of 71.2 deaths per 1000 live births (Worldometer, 2020).
There are few studies on fertility and related issues in the region. Shayo and Kalomo (2019) estimated the prevalence and examined the correlates of sexual intercourse among in-school adolescents of SSA. Secondary analysis of the Global School-based Student Health Surveys (GSHS) datasets pooled from five SSA countries Benin, Mozambique, Namibia, Seychelles, and Tanzania. Their analysis included a sample of 15,318 in-school adolescents. The primary independent variables were ever had sexual intercourse and sex with multiple partners, while the dependent variables were smoking cigarettes, alcohol use, use of marijuana and amphetamine, and parental connectedness. The study found out that Adolescents sexual intercourse and more especially sex with multiple partners was prevalent and strongly correlated with substance use. Amroussia et al (2017) examined the self-perceptions and childbirth experiences of single mothers at the public healthcare facilities in Tunisia. The study concluded that ensuring women's right to dignified, respectful healthcare during childbirth requires tackling the underlying causes of social inequalities leading to women's marginalization and discrimination.

The aim of this study is to project fertility rate in Mauritania using an artificial neural network approach. The findings of this piece of work are envisioned to highlight the likely fertility trends in the out of sample period. This will trigger a timely response to the health, educational and employment needs of the Mauritanian 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 Mauritania.

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Data Issues

This study is based on annual total fertility rate (births per woman)in Mauritania 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	M
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	0.064464
MSE	0.006208
MAE	0.061928

Residual Analysis for the Applied Model

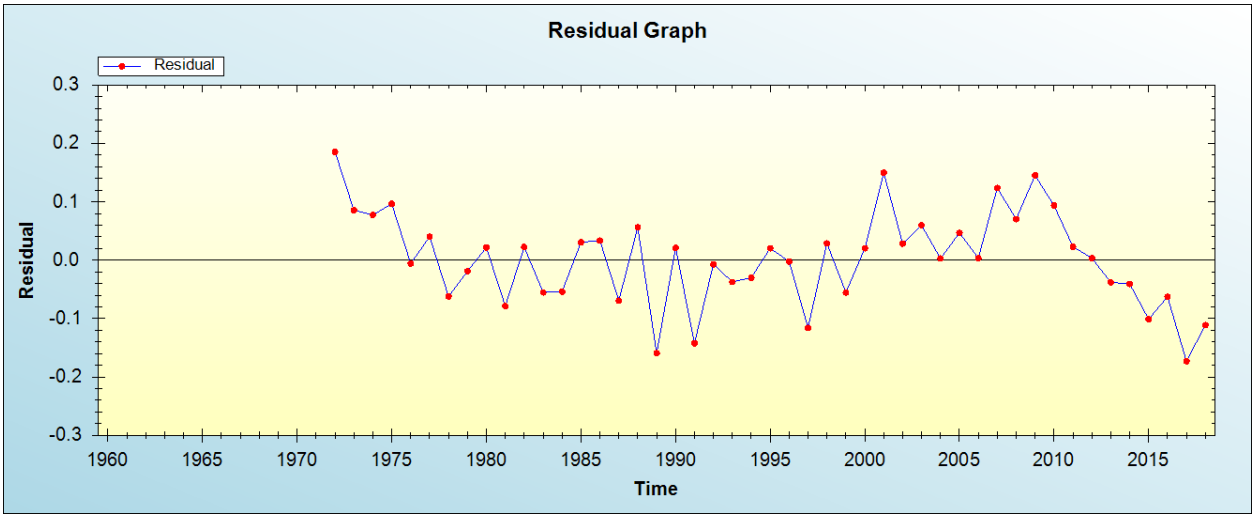

Figure 1: Residual analysis

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In-sample Forecast for M

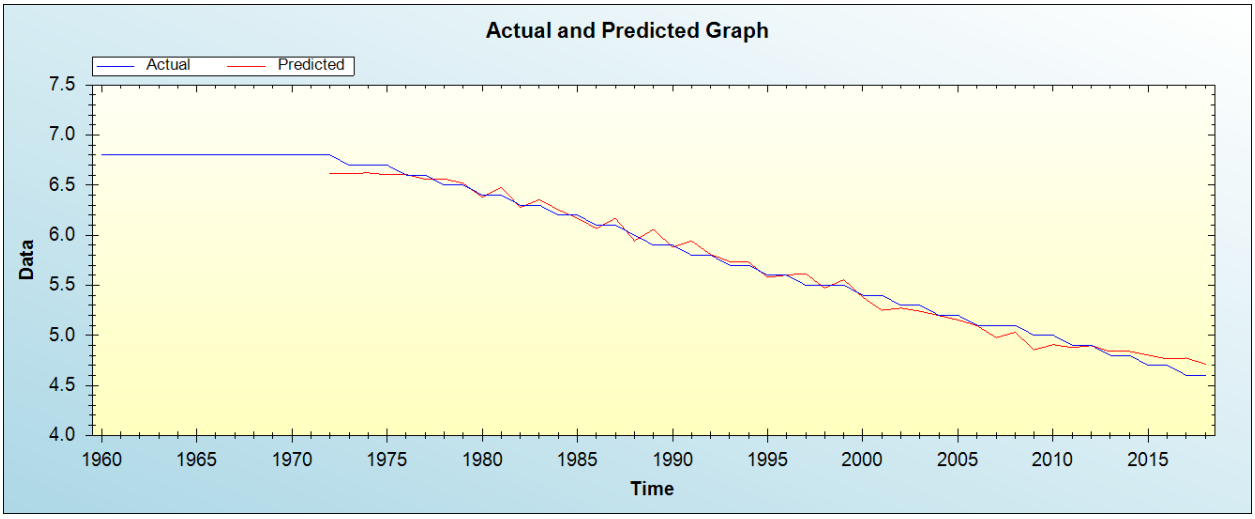

Figure 2: In-sample forecast for the M series

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

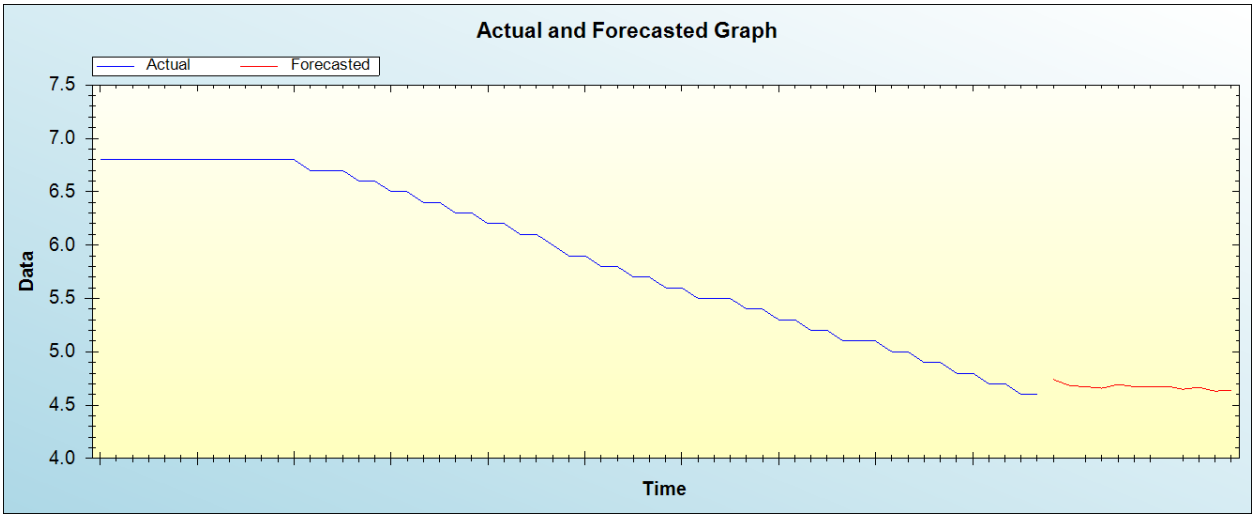

Figure 3: Out-of-sample forecast for M: actual and forecasted graph

Out-of-Sample Forecast for M: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	4.7399
2020	4.6826
2021	4.6723
2022	4.6586
2023	4.6938
2024	4.6725
2025	4.6731
2026	4.6769
2027	4.6493
2028	4.6666
2029	4.6308
2030	4.6410

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

IV. CONCLUSION & RECOMMENDATIONS

Teenage pregnancies continue to be an SRH problem in Mauritania with many adolescents lacking comprehensive knowledge on SRH services. The country has recorded a decline in total fertility rates over the years. In this paper we proposed an artificial neural network approach to forecast TFR in Mauritania. The findings of the study revealed that annual total fertility rates in Mauritania are likely to slightly decline over the out-of-sample period. Therefore the government is encouraged to focus on improving accessibility of sexual and reproductive health (SRH) services to adolescents and young adults, and channel more resources towards women empowerment programs.

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