

Univariate Time Series Analysis of Total Fertility Rate (TFR) In Mauritius

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Abstract - In this research paper, the ANN approach was applied to analyze TFR in Mauritius. 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 Mauritius. The results of the study indicate that annual total fertility rates in Mauritius will remain below replacement level and generally likely to decline over the out-of-sample period. Therefore, authorities in Mauritius are encouraged to promote child bearing by providing pro-fertility incentives and lowering the cost of raising children.

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

I. INTRODUCTION

The International conference on Population and development (ICPD) which was held in the Egyptian Capital, Cairo in 1994 adopted the programme of action which recognized sexual and reproductive health (SRH) as a fundamental right (UNFPA, 2008). This commitment was rekindled during the 2019 Nairobi Summit (UNFPA & ICD 25, 2019). It was further cemented by the sustainable development goals (SDG 2015-2030) particularly SDG 3 (Barclay et al, 2016). SRH and rights encompasses information on SRH and rights, including sexual and reproductive health of adolescents, abortion and gender-based violence (Starrs et al, 2018). Globally 45% of new HIV infections occur in Sub-Saharan Africa and 53% of people living with HIV are from this region (UNAIDS, 2018). HIV/AIDS is the leading cause of mortality among adolescents aged 10-19 years (UNICEF, 2018). Adolescent girls and young women are at high risk of HIV infections due to gender based violence, inequalities and physiological factors (UNSAIDS, 2018).

Mauritius has witnessed a decline in fertility rate from 6.2 births per woman in 1965 to 1.4 births per woman in 2020. The country has an under five mortality rate of 11.48 deaths per 1000 live births and an infant mortality rate of 9.74 deaths per 1000 live births in 2020 (Wordometer, 2020). This reflects a significant improvement in reducing infant mortality and improving child survival. There are few published research articles which have focused on fertility and related issues. Mac-Seing et al (2019) conducted a systematic review of original primary research which examined the relationships between equity-focused legislation and policy and the utilization of SRH services by vulnerable populations in sub-Saharan Africa. Authors searched nine bibliographic databases for relevant articles published between 1994 and 2019. Thirty-two studies, conducted in 14 sub-Saharan African countries, met the inclusion criteria. They focused on maternal health service utilization, either through specific fee reduction/removal policies, or through healthcare reforms and insurance schemes to increase SRH service utilization. Findings across most of the studies showed that health-related legislation and policy promoted an increase in service utilization, over time, especially for antenatal care, skilled birth attendance and facility-based delivery. Shayo and Kalomo (2019), did a 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, performed descriptive statistics, and multivariate logistic regression stratified by gender using SPSS Complex Sample Statistics. A p-value of less than 0.05 was considered statistically significant at 95% confidence intervals. The authors concluded that Adolescents sexual intercourse and more especially sex with multiple partners was prevalent and strongly correlated with substance use.

The aim of this study is to forecast fertility rates in Mauritius using a machine learning technique. The results of the study are expected to reveal likely future trends of TFR in the country. This will facilitate planning and allocation of resources to health, education and employment sectors.

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 Mauritius.

Data Issues

This study is based on annual total fertility rate (births per woman) in Mauritius 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	0.097037
MSE	0.066961
MAE	0.222768

Residual Analysis for the Applied Model

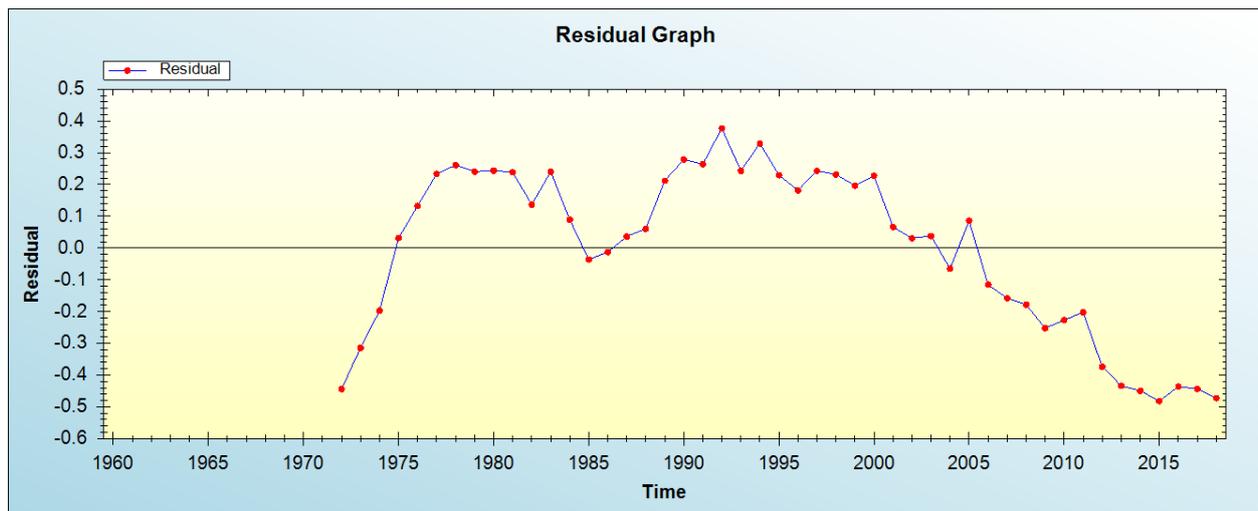


Figure 1: Residual analysis

In-sample Forecast for M

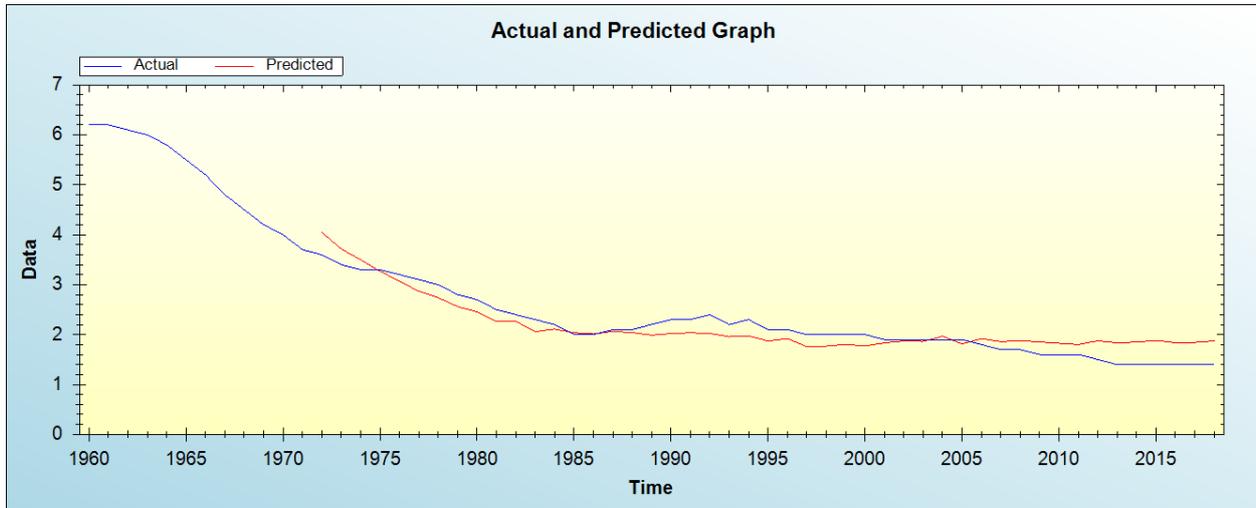


Figure 2: In-sample forecast for the M series

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

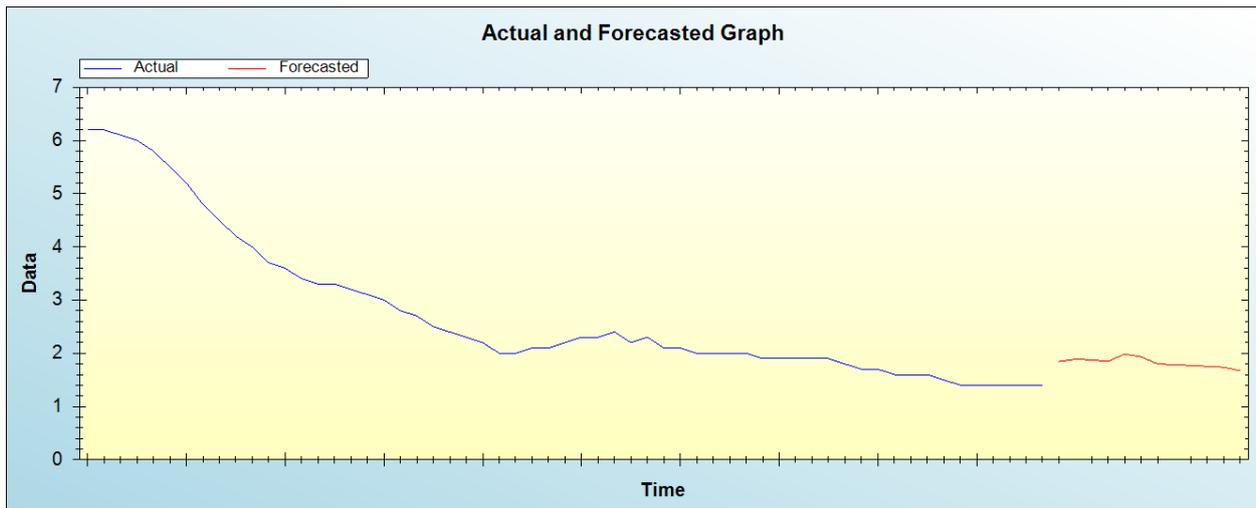


Figure 3: Out-of-sample forecast for M: actual and forecasted graph

Out-of-Sample Forecast for M: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	1.8458
2020	1.8897
2021	1.8757
2022	1.8515
2023	1.9861
2024	1.9302
2025	1.8003
2026	1.7890
2027	1.7702
2028	1.7557
2029	1.7372
2030	1.6734

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 Mauritius will remain below replacement level and generally likely to decline over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Mauritius has witnessed a decline in fertility rates over the past years to levels below replacement level in 2020. In this paper we propose to use a machine learning algorithm to predict TFR in Mauritius. The study results revealed that annual total fertility rates in Mauritius will remain below replacement level and generally likely to decline over the out-of-sample period. Therefore we encourage the authorities in Mauritius to promote child bearing by providing pro-fertility incentives and lowering the cost of raising children.

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