

# Forecasting Total Fertility Rate (TFR) in Botswana

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**Abstract - In this research article, the ANN approach was applied to analyze TFR in Botswana. 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 Botswana. The results of the study indicate that annual total fertility rates in Botswana are likely to slightly rise over the out-of-sample period. Therefore, we encourage the government of Botswana to create more demand for family planning services and create youth friendly health facilities to enable easy access to sexual and reproductive health (SRH) services.**

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

## I. INTRODUCTION

Botswana is a Sub-Saharan country whose economy is doing well as a result of large diamond deposits which have generated income being used in education, health and infrastructure development (Smith, 2013; World Bank, 2010). The country is ranked 109 out of the 157 according to the human development index revealing the gender inequalities which are existing in the country (World Bank, 2011). There is high prevalence of illegal and unsafe abortions (Botswana & UNICEF, 2001). The country reported a fast decline in TFR from 7.1 births per woman in 1981 to 2.9 births per woman in 2011 (World Bank, 2011). Despite significant progress in reproductive health maternal mortality remains very high and needs urgent attention (Botswana, 1995). Teenagers are engaging in risky sexual behaviors which place them at risk of getting STIs, unwanted early pregnancies and HIV infection (Sun et al, 2018). A secondary data analysis of a cross-sectional survey conducted in Mombasa, Kenya by Wilson et al (2020) characterized sexual and reproductive health (SRH) indicators among adolescent girls and young women (AGYW) engaged in casual and transactional sexual relationships as well as sex work. The study found that high need for SRH services, particularly, access to contraception and safe abortion. Sun et al (2018) assessed gender differences among theory-based sexual and reproductive health protective and risk factors in a cross-sectional sample of 228 Botswana adolescents. The authors found that there was incongruence between preferred and actual sources of sexual information and several important gender differences in parent-adolescent relationships, psychosocial influences, and adolescent sexual behaviors. Tlale et al (2019) assessed the quality of administrative data from Expanded Immunization Program (EPI) and condom use, Depo-Provera uptake and domiciliary care attendance in Botswana. The retrospective study entailed a review of data retrieved from district health records and District Health Information System (DHIS). The findings highlighted a poorer data quality for SRH indicators compared to child health indicators. Based on a mixed-method design, Letshwenyo-Maruatona (2017) sought to determine whether men who participate in SRH services have specific preference for the gender of health workers for consultation on different types of services. The study results revealed that the gender of the provider is of minor importance compared with other characteristics such as competence and confidentiality.

The aim of this study is to predict total fertility rate in Botswana using an artificial intelligence algorithm. The findings of the study are expected to reveal likely future trends in TFR. This will guide policy, planning and allocation of resources for Health, education and 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 Botswana.

### Data Issues

This study is based on annual total fertility rate (births per woman) in Botswana 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	B
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	0.065422
MSE	0.018084
MAE	0.104473

#### Residual Analysis for the Applied Model

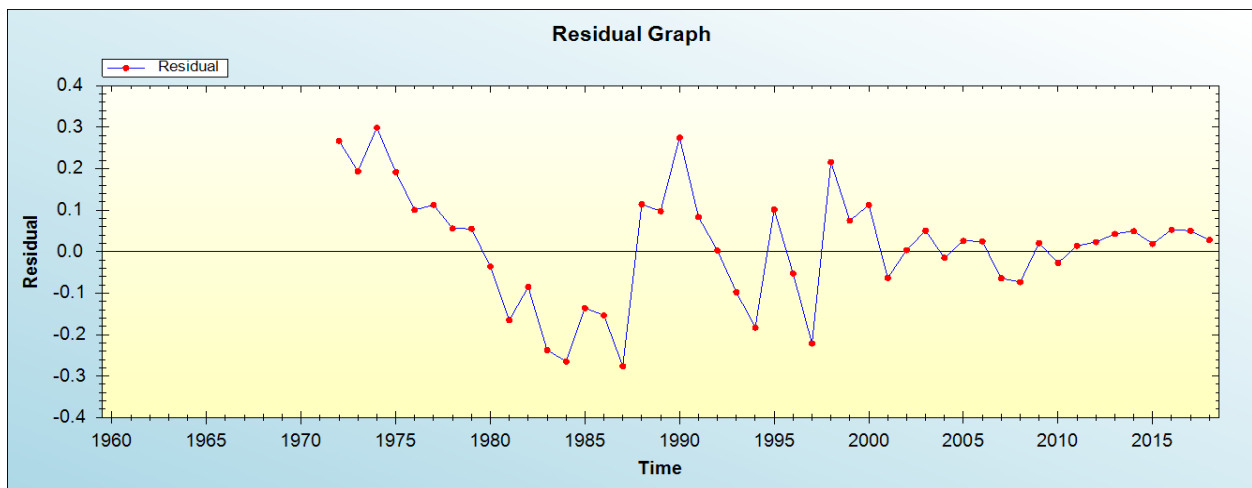


Figure 1: Residual analysis

#### In-sample Forecast for B

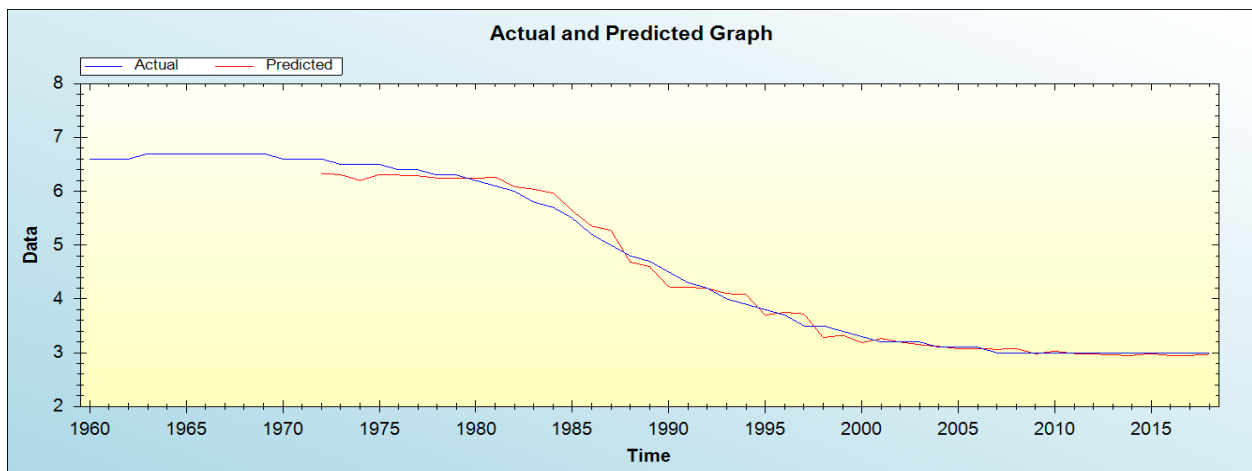


Figure 2: In-sample forecast for the B series

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

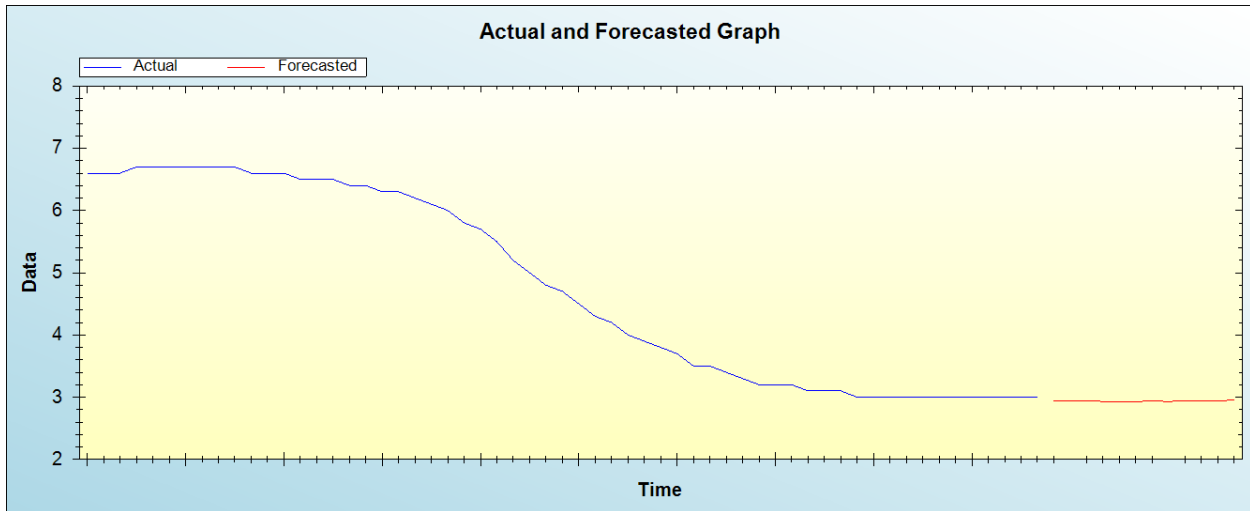


Figure 3: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	2.9360
2020	2.9403
2021	2.9377
2022	2.9338
2023	2.9302
2024	2.9309
2025	2.9385
2026	2.9321
2027	2.9375
2028	2.9395
2029	2.9415
2030	2.9542

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 Botswana are likely to slightly rise over the out-of-sample period.

**IV. CONCLUSION & RECOMMENDATIONS**

Teenage pregnancies and unsafe abortions are issues of concern in developing countries. Governments need to ensure that the rights of children and women are recognized so as to avoid adverse maternal and child health outcomes. In this paper we apply the artificial neural network to predict total fertility rates in Botswana. The results of the study indicated that annual total fertility rates in Botswana are likely to slightly rise over the out-of-sample period. Therefore the government of Botswana should create more demand for family planning services and create youth friendly health facilities to enable easy access to sexual and reproductive health (SRH) services.

**REFERENCES**

[1] Worldometer (2020). Guinea demographics. <https://www.worldometers.info>  
 [2] Stephanie S. Smith (2013). Reproductive Health and the Question of Abortion in Botswana: A Review, African Journal of Reproductive Health December, 17(4):26  
 [3] The World Bank (2010). Fertility decline in Botswana 1980–2006: A case study, 2010. Available [worldbank.org/](http://www.worldbank.org/) from <http://siteresources>.

- [4] The World Bank (2011). Reproductive health at a glance: Botswana. 2011. Available from <http://www.wds.worldbank.org/>
- [5] Govt. Botswana and the National Preparatory Committee for the Regional and World Conferences on Women (1995). Policy on Women in Development. Gaborone: Government Printer, 1995:1-40.
- [6] Christina J. Sun., Esther S. Seloilwe., Mabel Magowe., Kefalotse S., Dithole., Kim S., Mille Janet S., & St. Lawrence

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