

# Forecasting Total Fertility Rate in the Central African (CAF) Republic

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**Abstract** - In this research article, the ANN approach was applied to analyze TFR in CAF Republic. 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 CAF Republic. The results of the study indicate that annual total fertility rates in Central Africa Republic are likely to decline over the out-of-sample period. Therefore, the authorities in the CAF Republic should address pertinent challenges being faced by adolescents and young adults in accessing family planning services and fund empowerment programs for women.

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

## I. INTRODUCTION

Child marriage is a violation of fundamental human rights that has a negative impact on the girls' sexual, mental, and physical well-being (UNICEF, 2015; UNFP, 2012a). Approximately 45% of women aged 20-24 are married before they reach the legal age of majority (UNICEF, 2014b). It has been noted that child marriage and pregnancy are the major risk factors of maternal and child mortality in low and middle income countries (Wadlar, 2012). Despite the visibility of family planning programs in developing countries, many adolescent girls and women face many obstacles in accessing family planning services (STAG, 2017; Alkema et al, 2013). About 214 million women in developing countries in need of contraception do not use any contraceptive method (Guttmacher Institute, 2017).

The global fertility rates have declined over the years due to use of modern methods of contraception, health education, and increased level academic education. The CAF Republic has experienced a fertility transition over the period 1975 to 2020 with TFR declining from 6.8 births per woman in 1975 to 2.8 births per woman in 2020. In 2020, the country recorded an IMR of 29 infant deaths per 1000 live births and under five mortality rate of 43.8 deaths per 1000 live births (Worldometer, 2020). This indicates significant progress made over the years in order to improve maternal and child health outcomes. There are limited studies in the country that have examined and forecasted fertility rates. Barrow (2020) utilized a community-based descriptive cross-sectional study to determine the women's proportion of contraceptive uptake and knowledge of FP methods for 643 women of reproductive age (15-49 years) from the selected clusters in rural Gambia through a multistage sampling technique. A pretested structured interview questionnaire was used to collect data. The study showed a moderately low contraceptive uptake. Mac-Seing et al (2019) assessed the relationships between equity-focused legislation and policy and the utilization of SRH services by vulnerable populations in sub-Saharan Africa. We 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 revealed 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. Muanda et al (2018) examined adolescents' and young people's insights on their cultural norms, practices and attitudes towards SRH services. Fourteen focus group discussions were conducted with a total of 224 adolescents and young people aged 15-24 years in urban and rural areas of the DRC. The topics discussed and age groups of participants differed somewhat in the urban and rural areas. Data were analyzed to identify themes in the participants' discussion of their attitudes towards SRH. The study revealed that there is pressing need for information and services for young people in both urban and rural areas. Cavallaro et al (2017) examined FP trends over time among WRAU and subgroups, and trends in knowledge of FP and intention to use among women with unmet need for FP in Senegal. Study results showed that percent demand satisfied is lower among rural poor women and adolescents than WRAU (Women of reproductive age in union), although higher among unmarried women. Marked recent increases have been observed in all subgroups, however fewer than 50% of women in need of FP use modern contraception in Senegal. Knowledge of FP has risen steadily among women with unmet need; however, intention to use FP has remained stable at around 40% since 2005 for all groups except unmarried women (75% of whom intend to use).

The aim of this paper is to project TFR in CAF Republic using a machine learning algorithm. The findings of this paper are expected to reveal the likely future trends of fertility in the out of sample period. This will facilitate planning and the nation’s response to the future health, education and employment requirements.

## 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 Central Africa Republic.

### Data Issues

This study is based on annual total fertility rate (births per woman)in Central Africa Republic 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	0.141687
MSE	0.010471
MAE	0.078683

### Residual Analysis for the Applied Model

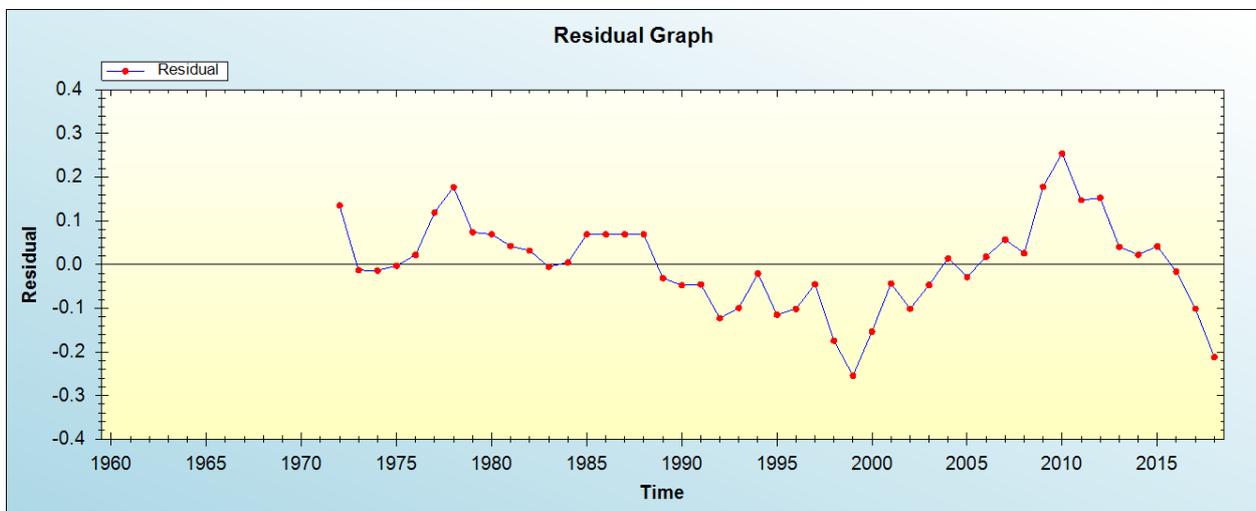


Figure 1: Residual analysis

*In-sample Forecast for C*

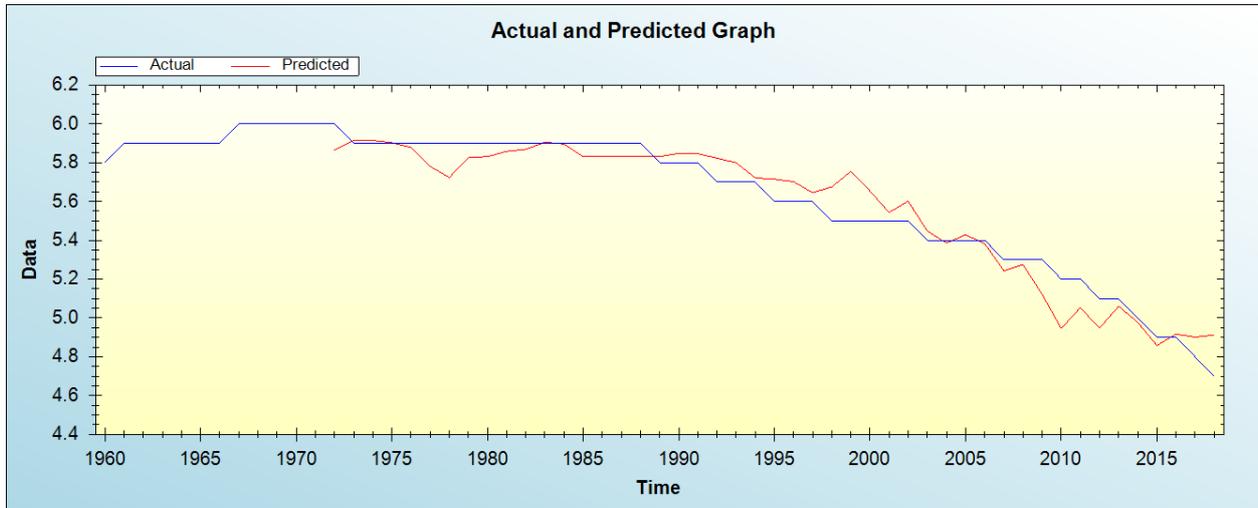


Figure 2: In-sample forecast for the C series

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

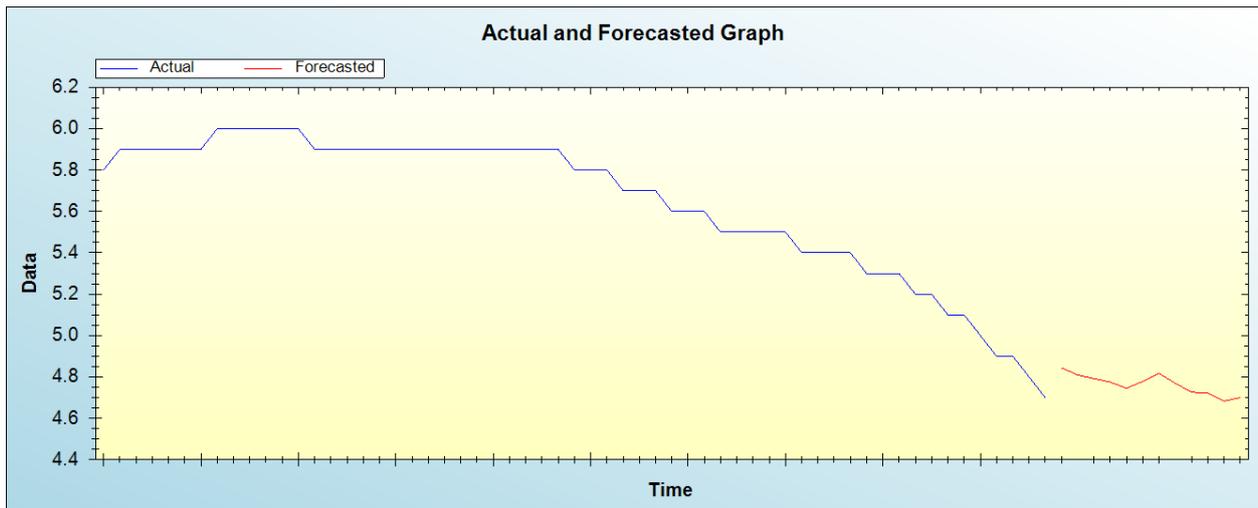


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

*Out-of-Sample Forecast for C: Forecasts only*

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	4.8434
2020	4.8092
2021	4.7920
2022	4.7750
2023	4.7446
2024	4.7789
2025	4.8177
2026	4.7696
2027	4.7263
2028	4.7236
2029	4.6833
2030	4.7000

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 Central Africa Republic are likely to decline over the out-of-sample period.

#### IV. CONCLUSION & RECOMMENDATIONS

Child marriages in developing nations are still occurring and are a violation of children's rights. Lack of comprehensive SRH knowledge among adolescents and young women needs to be addressed in order to prevent adverse maternal and child health outcomes. In this paper we apply a machine learning technique to predict total fertility rates in CAF Republic. The results of the study showed that annual total fertility rates in Central Africa Republic are likely to decline over the out-of-sample period. Therefore, the authorities in CAF Republic should address pertinent challenges being faced by adolescents and young adults in accessing family planning services and fund empowerment programs for women.

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