

Time Series Forecasting of Total Fertility Rate (TFR) in Angola

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Abstract - High period fertility and birth rates characterize Angola. In this research article, the ANN approach was applied to analyze TFR in Angola. 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 Angola. The results of the study indicate that annual total fertility rates in Angola are likely to decline slightly over the out-of-sample period. Therefore, the Angolan government is encouraged to (1) create more demand for family planning services so as to prevent undesirable sexual and reproductive health (SRH) outcomes among adolescent girls and young women, and (2) promote female education and women's rights to curb child marriages and violation of women's rights.

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

I. INTRODUCTION

Child bearing is considered an important event in the life cycle of a woman during her reproductive years (Yaya & Ghose, 2018). Therefore it is very critical for governments to channel more resources towards women's health so as to get the best outcomes. Unwanted pregnancies should be addressed in order to reduce high fertility levels which characterize resource limited settings or developing countries. Many adolescents and youths lack comprehensive knowledge on SRH services. At global level, a large percentage of women are unaware of the advantages of family planning and get pregnant without proper or recommended preparations. Unwanted pregnancies increase the risk of unsafe abortions and obstetric complications (Horvath et al, 2017; Dastgiri et al, 2017; Melese et al, 2017; Bishwajit et al, 2017). In Angola the modern contraceptive prevalence rate is 12.8% with significant variations across regions (Nieto-Andrade et al, 2017).

Fertility rates in Angola have been decreasing over the past decades from 7.5 births per woman in 1975 to 5.6 births per woman in 2020 (Worldometer, 2020). The country recorded a decline in infant mortality rate from 192.8 infant deaths per 1000 live births in 1950 to 53.41 infant deaths per 1000 live births in 2020 (Worldometer, 2020). There are limited previous studies in the region that have investigated fertility trends. Ajayi et al (2021) did a scoping review to examine how the body of research on ASRH in SSA has evolved over the past decade, and its present profile, in terms of trends in volume, geographic and substantive focus, and Africa-led inquiry. A three-step search strategy to identify English and French peer-reviewed publications and relevant grey literature on ASRH in SSA published between January 2010 and December 2019 was done. The findings indicated that research on ASRH is limited in focus and is unevenly distributed across SSA countries and the identified gaps can guide future research and funding to advance ASRH policies and programmes. 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. Almeida et al (2019) investigated the effects of an Educational Intervention on Angolan Adolescents' Knowledge of Human Reproduction by employing a Quasi-Experimental Study. The study findings revealed that students from Huambo province have a significant lack of knowledge on human biology and sexuality. Yaya & Ghose (2018) explored the prevalence of unmet need for contraception and unintended pregnancy as well as their relationship among married women in Angola. The authors utilized cross-sectional data from Angola Demographic and Health Survey (DHS) conducted in 2015-16. Participants were 7,808 married women aged 15-49 years. Unwanted pregnancy was measured in terms of the mistimed and unintended conception for the last-born child. Unmet need for contraception included those who reported unmet need for spacing and limiting. Data were analyzed using bivariate and multivariable techniques. The results indicated that the combined prevalence of mistimed and unwanted pregnancy was 38.3% (95% CI = 35.9-40.7), and that of unmet need for contraception for spacing and limiting was 51.7% (49.9-53.5).

The aim of this study is to project TFR in Angola using a machine learning algorithm. The results of the study are expected to provide an insight of the likely fertility trends in the out of sample period. This will facilitate planning and allocation of resources towards 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 Angola.

Data Issues

This study is based on annual total fertility rate (births per woman) in Angola 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	A
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	0.077922
MSE	0.007496
MAE	0.073348

Residual Analysis for the Applied Model

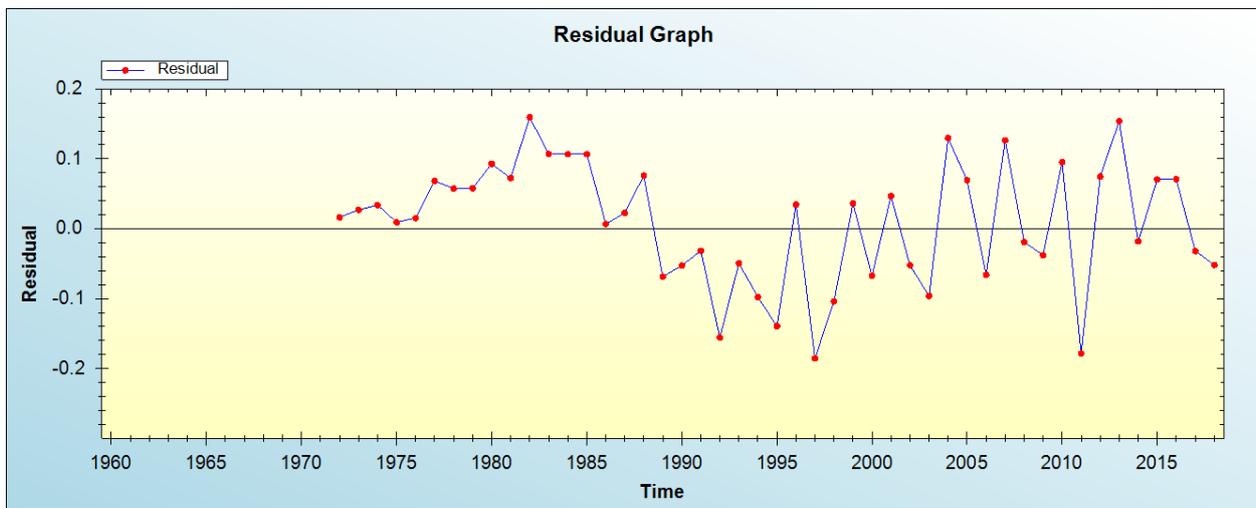


Figure 1: Residual analysis

In-sample Forecast for A

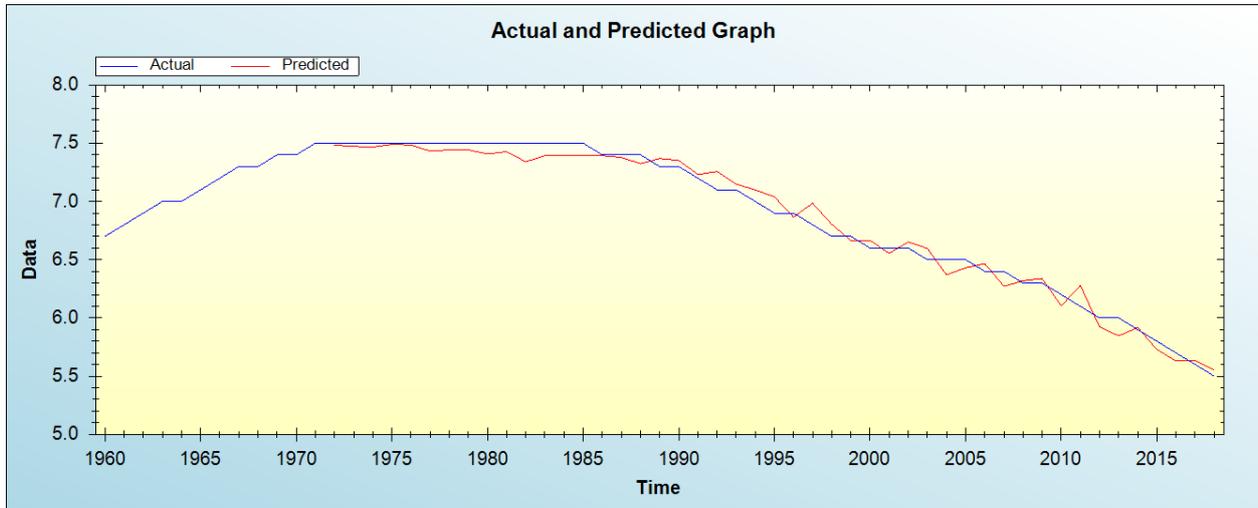


Figure 2: In-sample forecast for the A series

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

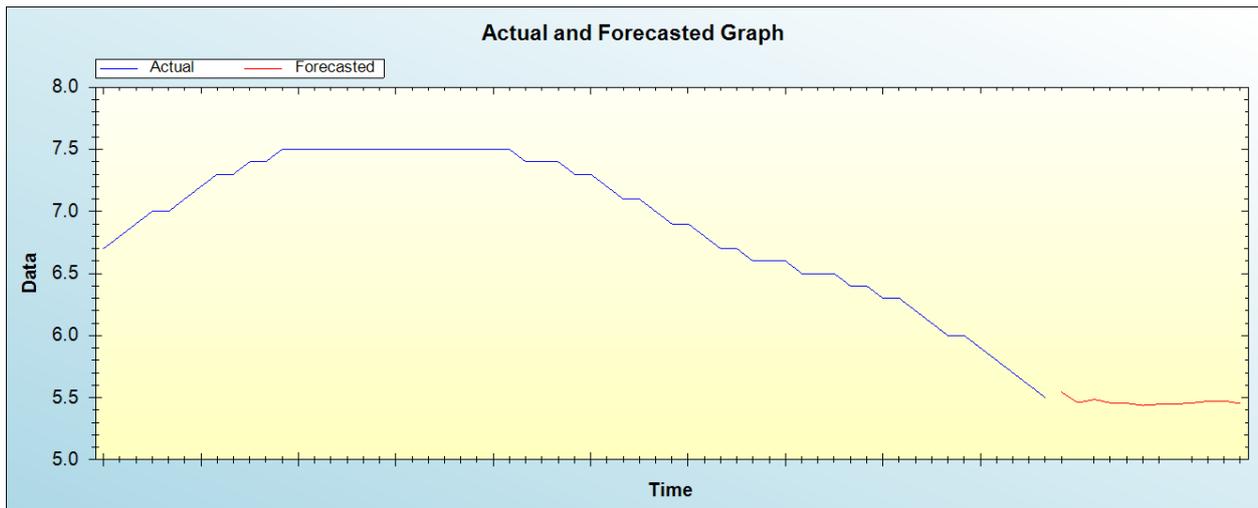


Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	5.5443
2020	5.4598
2021	5.4857
2022	5.4579
2023	5.4545
2024	5.4360
2025	5.4460
2026	5.4490
2027	5.4557
2028	5.4709
2029	5.4735
2030	5.4522

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

IV. CONCLUSION & RECOMMENDATIONS

High teenage pregnancies in sub-Saharan Africa are the major drivers of high fertility rates therefore intervention strategies should aim to address challenges and concerns of adolescent girls and young women which include forced child marriages, sexual abuse of girls and women and lack of formal education. Forecasting fertility rates is crucial to have an insight of the likely fertility trends in the future and facilitate early resource mobilization. In this study we employed a machine learning approach to predict TFR in Angola. The findings showed that annual total fertility rates in Angola are likely to decline slightly over the out-of-sample period. We therefore implore the Angolan government to create more demand for family planning services amongst other measures so as to prevent unwanted pregnancies among adolescent girls and young women.

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