Forecasting Total Fertility Rate (TFR) in Ethiopia

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Abstract - **In this research article, the ANN approach was applied to analyze TFR in Ethiopia. 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 Ethiopia. The results of the study indicate that annual total fertility rates in Ethiopia are likely to remain around 4.3 births per woman throughout the out-of-sample period. Therefore, the Ethiopian government is encouraged to (1) focus on creating more demand for family planning services and tackle system challenges which hinder access to sexual and reproductive health (SRH) services (2) promote women empowerment through funding women empowerment programs.**

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

I. INTRODUCTION

Many adolescent girls and young women in Sub Saharan Africa are involved in early sexual activity and have unwanted pregnancies (Mulye et al, 2009; WHO, 2008; Negash et al, 2006). This age group has a high risk of having STIs such as HPV, HIV, gonorrhea and syphilis (Malleshappa et al, 2011; WHO, 2005). Ethiopia is a signatory to the 1994 International conference on Population and development which took place in Cairo, Egypt whose main objective was to address sexual and reproductive health rights for both sexes and ensure universal access to health including sexual and reproductive health. The conference was meant to address gender imbalances or inequalities which are existing in the society with particular emphasis on recognizing the sexual and reproductive rights of adolescent girls and women. Respecting the rights of women is a priority at global level as this forms the basis of socioeconomic development. Girls and women should be accorded equal access to education, health and employment opportunities in order to improve the living standards of women and children. Ensuring access to family planning services is a huge step towards achieving the sustainable developments goals (SDGs) by 2030.Family planning services should be composed of health information, education, counseling, screening of STIs, quality antenatal and post natal care, appropriate contraceptive methods, and upholding of human rights especially for adolescent girls and women.

Ethiopia has witnessed a downward trend in fertility rates from 7.2 births per woman in 1955 to 4.3 births per woman in 2020 (Worldometer, 2020). There are limited studies in the region that have investigated fertility trends or did fertility forecasting. In this paper we shall mention a few available research papers which have been published. Tilahun et al (2021) assessed factors associated with the utilization of adolescent and youth sexual and reproductive health services in this western Ethiopia. A community-based cross-sectional quantitative method mixed with the qualitative inquiry was conducted among 771 adolescents and youth aged 15 to 24 years from February 1 to 28, 2020. The study findings indicated that sexual and reproductive health service utilization among adolescents and youth was found to be low. Guided by an explorative qualitative study, Dessalegn et al (2020) analyzed gender context in the Afar region of Ethiopia and proposed a set of strategies or actions to improve adolescent and youth health. Sixteen key informants and eight focus group discussions were conducted among adult women and men of young adolescents and youth. The study revealed that younger and older women are the most disadvantaged groups of the society. Coast et al (2019) explored early adolescent understandings and experiences of sexual and reproductive health (SRH) in Ethiopia and Rwanda, drawing on a multisite qualitative research study with 10- to 12-year-old and 14- to 15-year-old male and female adolescents and a range of adult participants. The authors concluded that there was need for program designers and implementers to address the role of underlying social norms in a more strategic and context-specific way to help young people navigate their sexual and reproductive lives.

The purpose of this study is to forecast TFR in Ethiopia using an artificial intelligence technique. The results of the study are envisioned to highlight the likely trends of fertility in the out of sample period. This is expected to facilitate policy making, planning, resource mobilization and allocation to the 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 Ethiopia.

Data Issues

This study is based on annual total fertility rate (births per woman)in Ethiopia 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	E
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	0.084166
MSE	0.019677
MAE	0.110270

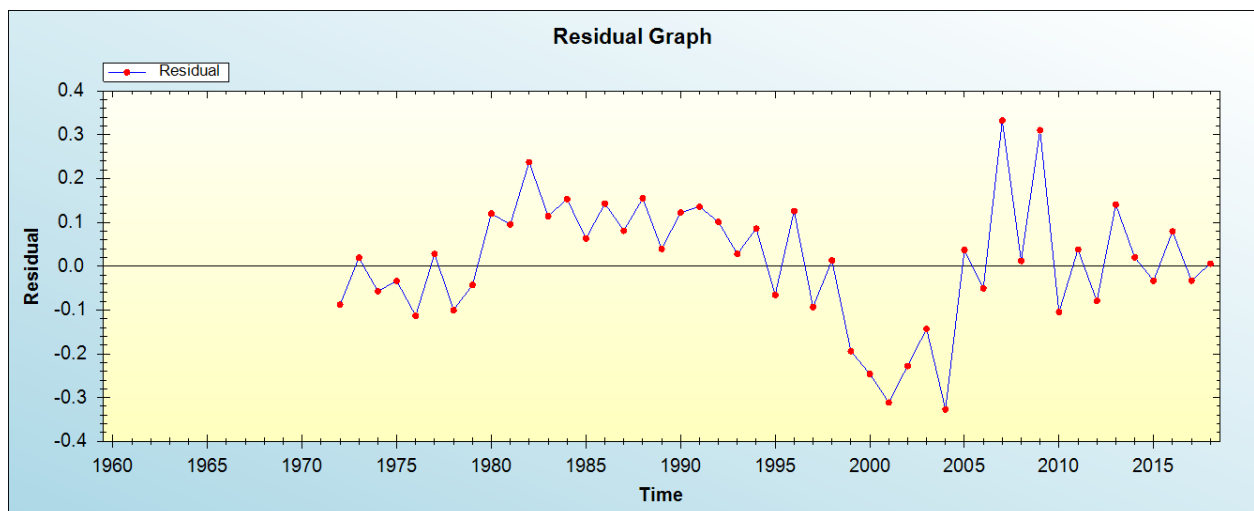*Residual Analysis for the Applied Model*

Figure 1: Residual analysis
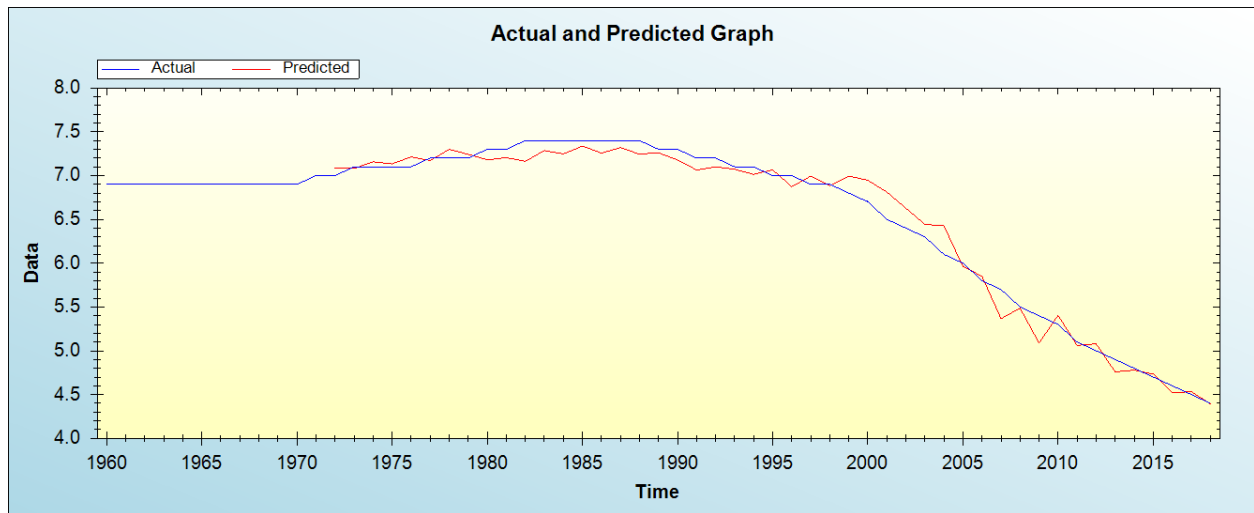

In-sample Forecast for E

Figure 2: In-sample forecast for the E series

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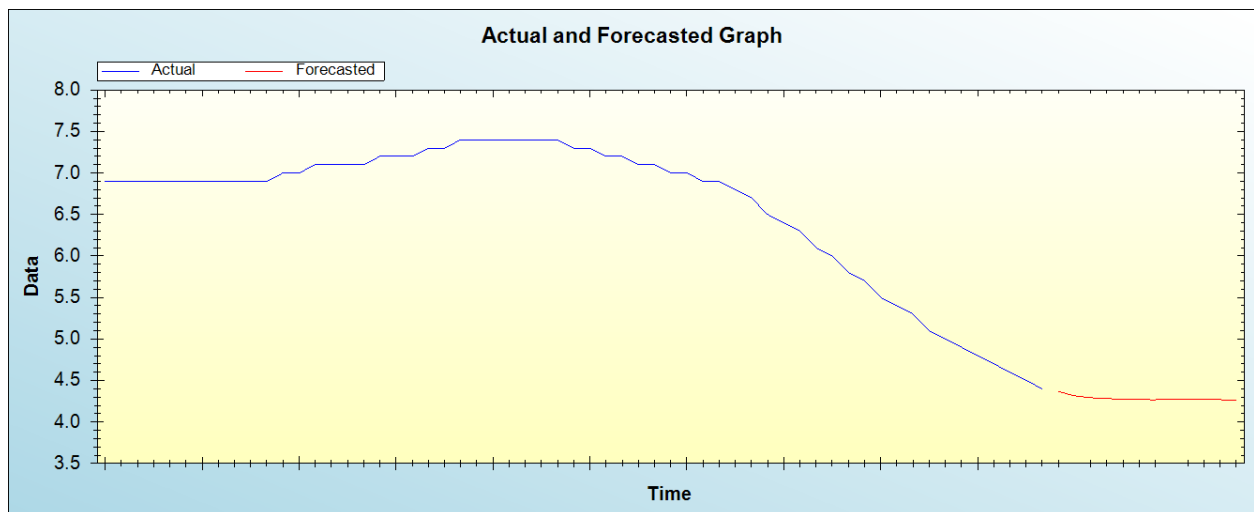

Figure 3: Out-of-sample forecast for E: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	4.3672
2020	4.3156
2021	4.2920
2022	4.2843
2023	4.2696
2024	4.2701
2025	4.2679
2026	4.2698
2027	4.2695
2028	4.2684
2029	4.2687
2030	4.2648

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 Ethiopia are likely to remain around 4.3 births per woman throughout the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

Total fertility rates have declined over the years in Ethiopia, however teenage pregnancies remain a challenge for public health specialist. In this paper we proposed a machine learning technique to predict TFR in Ethiopia. The ANN (12, 12, 1) model projections suggest that annual total fertility rates in Ethiopia are likely to remain around 4.3 births per woman throughout the out-of-sample period. Therefore, the Ethiopian government is encouraged to focus on creating more demand for family planning services and tackle system challenges which hinder access to sexual and reproductive health (SRH) services. We also recommend to the government to channel more resources towards women empowerment programs.

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