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Forecasting Total Fertility Rate (TFR) in Egypt

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***Abstract* - The International conference on Population and Development took place in the Egyptian Capital, Cairo in 1994 and triggered the recognition of sexual and reproductive health rights as fundamental human rights. Violation of sexual and reproductive health rights especially those of adolescent girls and women is common around the world. Sociocultural, demographic and spatial factors are the major determinants of fertility. In this research paper, the ANN approach was applied to analyze TFR in Egypt. 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 Egypt. The results of the study indicate that annual total fertility rates in Egypt are generally likely to rise slightly over the out-of-sample period. Therefore, the Egyptian government is encouraged to improve accessibility of sexual and reproductive health (SRH) services especially among adolescents and young adults to prevent unintended pregnancies and other adverse SRH outcomes.**

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

I. INTRODUCTION

Sexual and reproductive health rights are now considered a key component of human rights (ICPD, 1994). All the signatories to the International conference on Population and Development which was held in Cairo, Egypt in 1994 agreed to respect the rights of individuals and couples particularly the sexual and reproductive rights of adolescent girls and women. Every individual has the right to decide responsible the number, spacing and the times of children. People have the right to get access to standard SRH services (WHO, 2015; Freedman, 1993). It is important to uphold the SRH rights of women because it improves female participation in economic activities, reduces the number of unwanted pregnancies and related complications, improves maternal and child health outcomes (Sharma et al, 2004).

Egypt has witnessed a downward trend in fertility rates over the years from 6.8 births per woman in 1955 to 3.3 births per woman in 2020 (Worldometer, 2020). The country reported a decline in infant mortality rate from 248.64 infant deaths per 1000 live births in 1950 to 13.17 infant deaths per 1000 live births in 2020 (Worldometer, 2020). According to the EDHS 2014, contraceptive prevalence rate among women in the 15-19 years age group is 21% compared to 73% among married women aged 35-39. The widely used contraceptive methods are IUD, the pill and injectable. There are limited studies in the region that have examined or predicted fertility rates. Zaki (2020) provided a descriptive profile of the patterns of reliance on sources of family planning services during the early 2000s. The study revealed that among the more important findings is the consistency women display in the choice of provider among women reporting multiple segments of use Pearce (2019) explored adolescent access to reproductive health services through the experiences of adolescent girls and healthcare providers in Namibia. It was a qualitative case study. The data was collected through interviews with adolescent girls and key-informants who are experienced healthcare providers. The findings revealed that the girls have access to SRHS. However, they lack a comprehensive understanding of their sexual and reproductive health rights (SRHR). Coast et al (2019) examined 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 is 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 aim of this study is to project the TFR for Egypt using an artificial intelligence technique. The results of the study are expected to reveal likely fertility trends in the out of sample period. This will guide policy 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

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activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual total fertility rates in Egypt.

Data Issues

This study is based on annual total fertility rate (births per woman)in Egypt 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	0.079329
MSE	0.026590
MAE	0.138541

Residual Analysis for the Applied Model

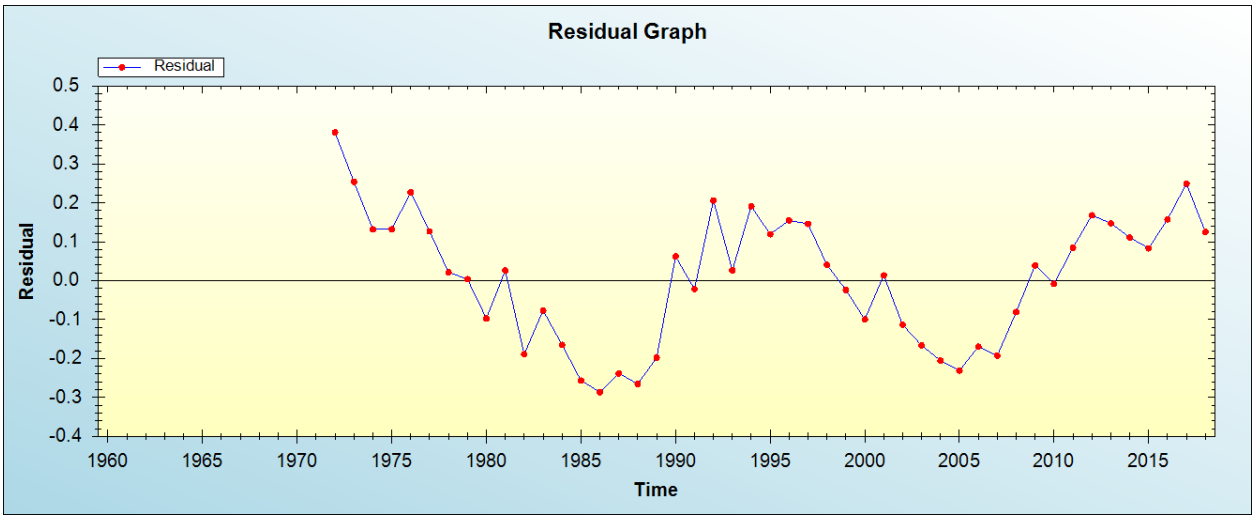

Figure 1: Residual analysis

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In-sample Forecast for E

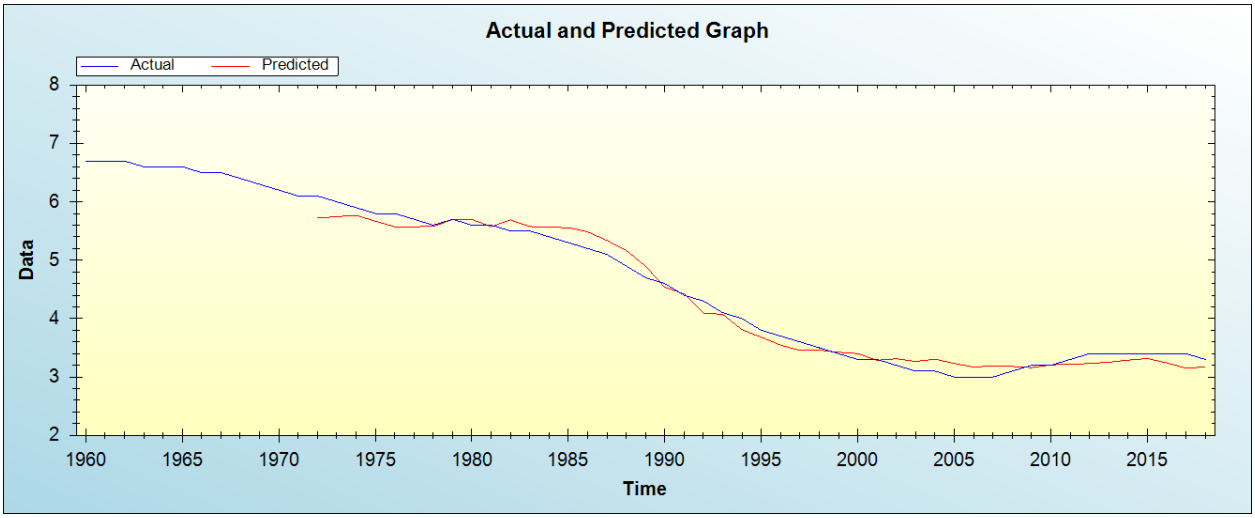

Figure 2: In-sample forecast for the E series

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

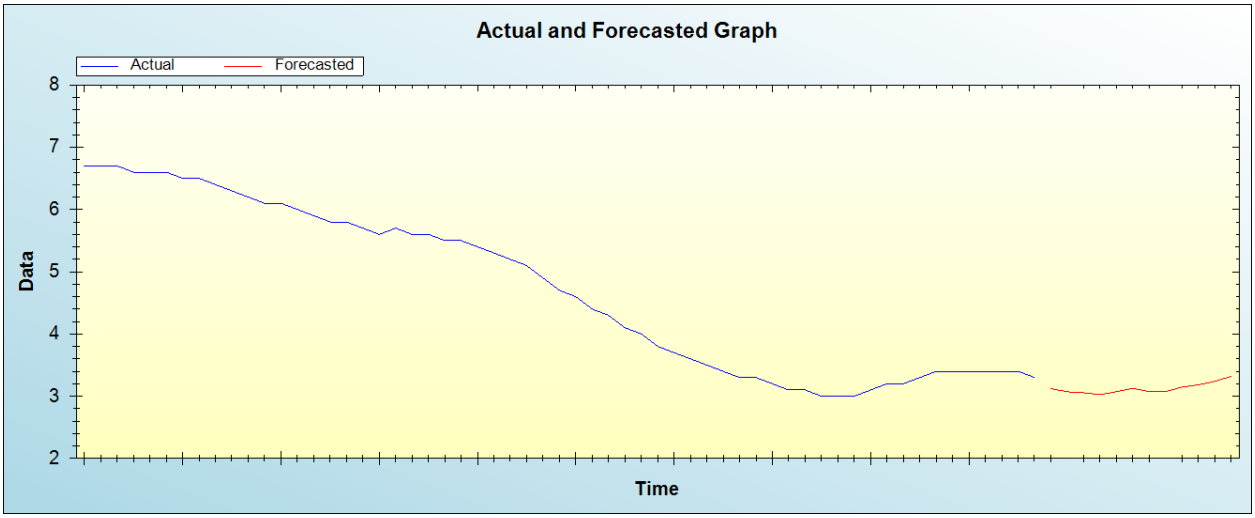

Figure 3: Out-of-sample forecast for E: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	3.1242
2020	3.0720
2021	3.0548
2022	3.0256
2023	3.0729
2024	3.1280
2025	3.0741
2026	3.0733
2027	3.1472
2028	3.1826
2029	3.2379
2030	3.3197

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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 Egypt aregenerally likely to rise slightly over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

The use of time series forecasting techniques is essential in revealing the likely future age structure of a population which has a huge bearing on the size of the labor force, demand for services such as health, education and housing. In this paper we employed a machine learning approach to forecast total fertility rate in Egypt. The ANN model projections revealed that annual total fertility rates in Egypt are generally likely to rise slightly over the out-of-sample period. Therefore, the Egyptian government is encouraged to improve accessibility of sexual and reproductive health (SRH) services especially among adolescents and youths to prevent unintended pregnancies and other adverse SRH outcomes.

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