

Forecasting Total Fertility Rate (TFR) in Libya

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Abstract - In this piece of work, the ANN approach was applied to analyze TFR in Libya. 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 Libya. The results of the study indicate that annual total fertility rates in Libya are likely to hover around 2.4 births per woman throughout the out-of-sample period. Therefore, the Libyan government is encouraged to continue improving access to family planning services to minimize adverse maternal and child health outcomes, and promotion of women empowerment and rights.

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

I. INTRODUCTION

Libya is characterized by civil conflict which has led to the death and displacement of thousands of people (OCHA, 2020). The country is a major transit and destination point for international migration (IOM, 2020). It is of international concern that migrants, refugees and asylum seekers have no access to judicial processes and effective monitoring systems are not available meaning that there is no protection against violations and abuse (UNSMIL, 2018; HRW, 2019; GDP, 2018). This means that SRH rights are not being upheld in regions of political and civil conflict. The risk of getting unwanted pregnancies, unsafe abortions and STIs is increased. As a result of poor infrastructure Libya is at risk of having high maternal, infant and under five mortality. Libya's total fertility rate has been declining over the years from 8.1 births per woman in 1975 to 2.3 births per woman in 2020. The country recorded an infant mortality rate of 9.0 infant deaths per 1000 live births in 2020 (Worldometer, 2020). Kuehne et al (2021) described morbidities and water, hygiene, and sanitation (WHS) conditions in detention in Tripoli, Libya. The retrospective study analyzed data collected between July 2018 and December 2019, as part of routine monitoring within an Médecins Sans Frontières (MSF) project providing healthcare and WHS support for migrants, refugees and asylum seekers in some of the official detention centers (DC) in Tripoli. The study findings revealed that Living conditions failed to meet minimum requirements. Health problems diagnosed at MSF consultations reflect the living conditions and consist largely of diseases related to overcrowding, lack of water and ventilation, and poor diet. Based on qualitative study, Egeh et al (2019) investigated Somali Islamic religious leaders' views on birth spacing. Qualitative individual interviews were conducted with 17 Somali Islamic religious leaders aged 28–59 years and analyzed through content analysis. The study results indicated that according to the religious Islamic leaders, selected practice recommendations for contraceptive use is permitted in relation to birth spacing to promote the health of the mother and child. Based on cross-sectional survey, Kågesten et al (2017) described the characteristics of VYA (very young adolescents) aged 10-14 years in two humanitarian settings, focusing on transitions into puberty and access to SRH information. Their findings revealed that Parents/guardians were the most common source of SRH information in both sites, however VYA indicated that they would like more information from friends, siblings, teachers and health workers. Gure et al (2015) did a qualitative study to explore women's reproductive health knowledge and experiences. In 2014, the study conducted four focus group discussions with 21 married and unmarried women of reproductive age living in Mogadishu, Somalia. The findings of the study highlighted that misinformation, restrictive policies, mistrust of clinicians, and prohibitively expensive services shape women's experiences and health-seeking behaviours.

The aim of this study is forecast total fertility rate in Libya using a machine learning technique. The findings of this study are expected to reveal the likely future trends of fertility in the country to facilitate planning and resource mobilization 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 Libya.

Data Issues

This study is based on annual total fertility rate (births per woman) in Libya 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	L
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	0.063050
MSE	0.042709
MAE	0.163200

Residual Analysis for the Applied Model

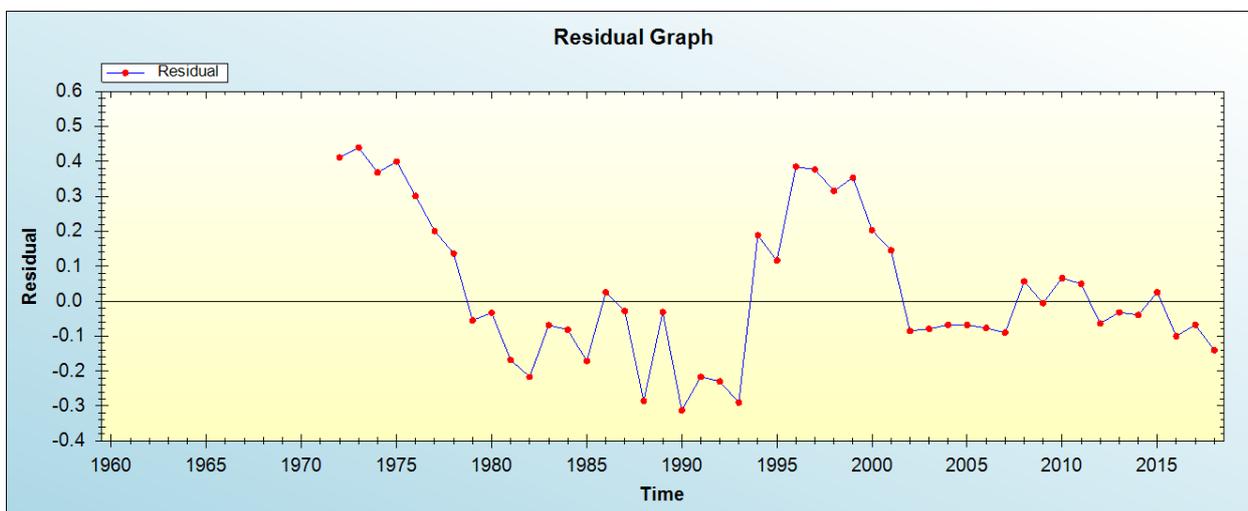


Figure 1: Residual analysis

In-sample Forecast for L

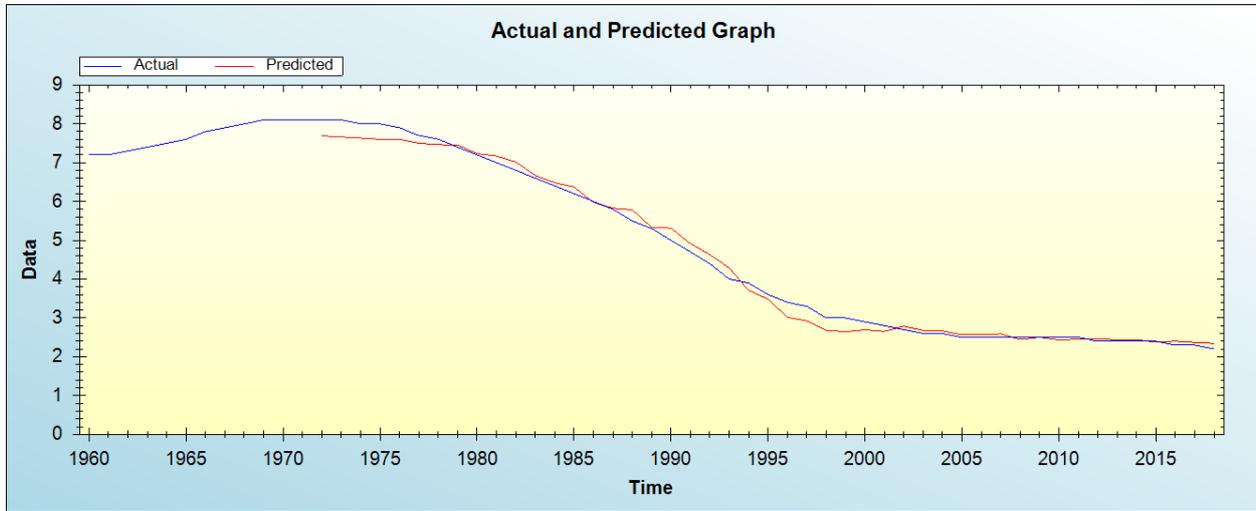


Figure 2: In-sample forecast for the L series

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

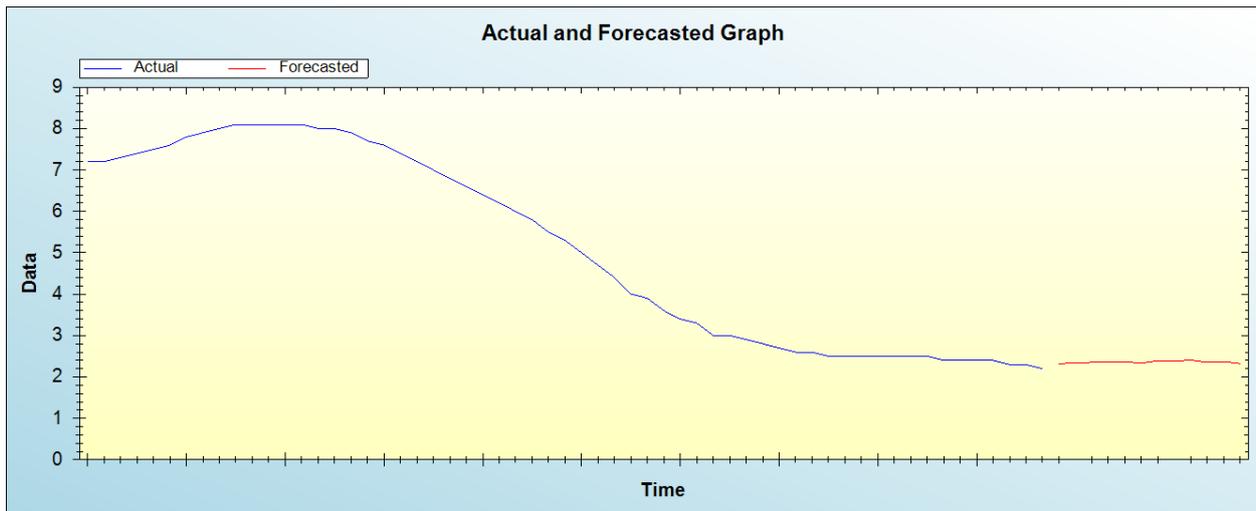


Figure 3: Out-of-sample forecast for L: actual and forecasted graph

Out-of-Sample Forecast for L: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	2.3258
2020	2.3359
2021	2.3538
2022	2.3554
2023	2.3692
2024	2.3331
2025	2.3908
2026	2.3742
2027	2.4108
2028	2.3507
2029	2.3725
2030	2.3238

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 Libya are likely to hover around 2.4 births per woman throughout the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

The civil conflict in Libya has led to destruction of health infrastructure and internal displacement of thousands of Libyans. Total fertility rate has been declining over the years alongside infant and child mortality rates. In this study we proposed a machine learning technique to predict TFR in Libya. The ANN model projections revealed that annual total fertility rates in Libya are likely to hover around 2.4 births per woman throughout the out-of-sample period. Therefore, the Libyan government is encouraged to continue improving access to family planning services to minimize adverse maternal and child health outcomes, and promotion of women empowerment and rights.

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