Artificial Neural Network Analysis of Under Five Mortality Rate for the United Arab Emirates

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for the United Arab Emirates (UAE) from 1960 to 2020 to predict future trends of U5MR over the out of sample period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied ANN (12, 12, 1) model is stable in forecasting U5MR. ANN model projections revealed that U5MR will hover around 8 deaths per 1000 live throughout the out of sample period. Therefore, we encourage authorities in the UAE to continue supporting maternal and child health program in order to keep under five mortality below 25 deaths per 1000 live births.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Tracking of progress towards achieving the set targets of sustainable development goals by 2030 is essential.At the UN General Assembly in New York in September 2015 all member states reiterated the importance of using statistical indicators to accurately collect data on various SDGs and report within the set timelines. Strengthening of statistical and data ecosystems is also crucial (UN, 2016; UN, 2015). The 17 set of sustainable development goals are associated with 169 set targets which address the 3 dimensions of sustainable development-social, environmental and economic (UN, 2020;WHO, 2019; UNICEF, 2019;UNICEF, 2018; UN, 2015). The 3rd Sustainable development goal was designed to tackle several health problems existing in different regions of the world. The overall aim is to ensure good health and promotion of well-being for all at all ages. This can be achieved through universal health coverage and access to quality affordable healthcare. Furthermore, the objective is to substantially reduce all preventable deaths due to various causes such as social, cultural, religious, economic and health system related factors. Under five mortality rate (indicator 3.2.1) and neonatal mortality rate (indicator 3.2.2) are used to monitor progress made towards achieving substantial reduction of under-five and neonatal mortality by 2030 (UN, 2020;WHO, 2019). The aim is to achieve a decrease of U5MR and NMR to as low as 25 deaths per 1000 live births and 12 deaths per 1000 live births respectively by 2030 (UNICEF, 2019). The objective of this paper is to predict U5MR for UAE using a machine learning technique and the findings are expected to guide child health policies in order to keep mortality among children below 5years of age under control.

II. LITERATURE REVIEW

Schellekens (2021) estimated the contribution of maternal education to infant mortality decline in Indonesia. A longitudinal, individual-level analysis of the determinants of trends in infant mortality in Indonesia was done by utilizing pooled data from all available phases of the Demographic and Health Survey (1980-2015).The study findings showed that maternal education explains 15% of the infant mortality decline in Indonesia from 1980 to 2015.A cross-sectional study conducted by Soleman et al. (2020) in Indonesia to describe trends and main causes of children mortality in Indonesia from 2000 to 2017. The data was taken from World Health Organization Maternal Child Epidemiology Estimation from 2000 to 2017. The study found that the trend of three parameters of child mortality declined within 17 years and the main causes of mortality were premature birth in neonates, ARI in post neonates and premature birth in under five children. Simeoni *et al.* (2019) analyzed the infant (IMR) and neonatal (NMR) mortality rates of Italian and foreign children and evaluated if there is a disparity among geographical macro-areas. Data from 2006 to 2015 were collected by the Italian Statistics Bureau (ISTAT) and extracted from two different national databases, which considered i) underlying cause of death and ii) birth registry. The main analyses were made comparing Italian versus foreigners as a single category as well as by country origin and contrasting Northern residents versus Southern ones. Comparisons between groups were done using relative risks. The study findings indicated that Inequalities in neonatal and infant mortality are evident between Italians and immigrants and among geographical macro-areas. The effects of individual bio-demographic and socioeconomic components on infant mortality were investigated by Scalone *et al.* (2016). The study utilized micro data from births, deaths and marriages civil registers of Granarolo, an Italian rural municipality close to Bologna, from 1900 to 1939 and then reconstructed some typical bio-demographic characteristics and the socioeconomic status of parents. Cox and Piecewise constant exponential models were used to estimate the effects of the selected predictors. The study indicated that still in the first four decades of the twentieth century rural daily wagers experienced a lower level in infant survivor, whereas the upper class registered significantly higher ones.

III. 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 under five mortality rate in the United Arab Emirates.

Data Issues

This study is based on annual under five mortality rate for the period 1960 – 2020. The out-of-sample forecast covers the period 2021 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	X
Observations	49 (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	0.000942
MSE	0.443812
MAE	0.567399

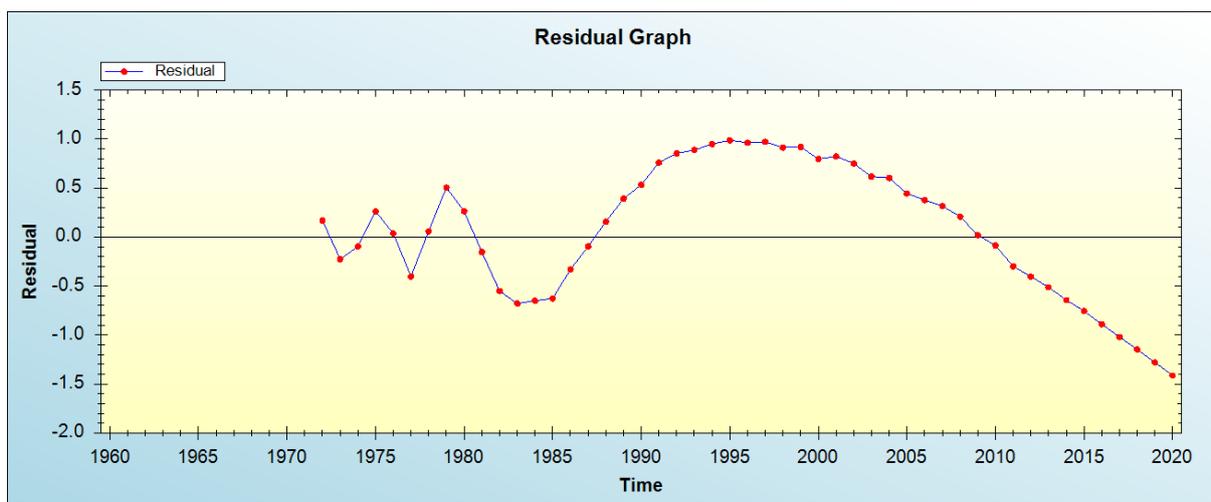Residual Analysis for the Applied Model

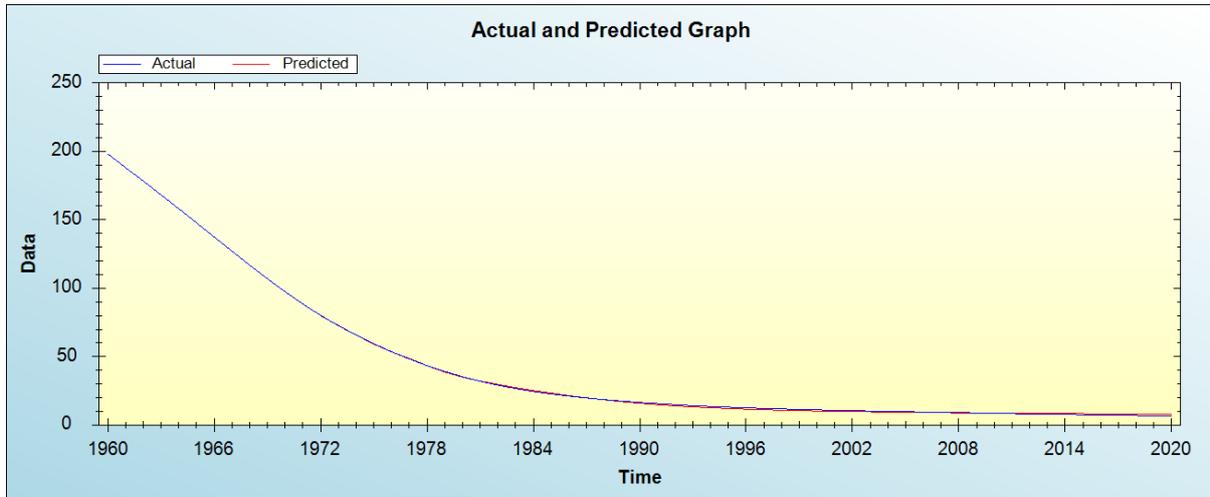Figure 1: Residual analysis

In-sample Forecast for X

Figure 2: In-sample forecast for the X series

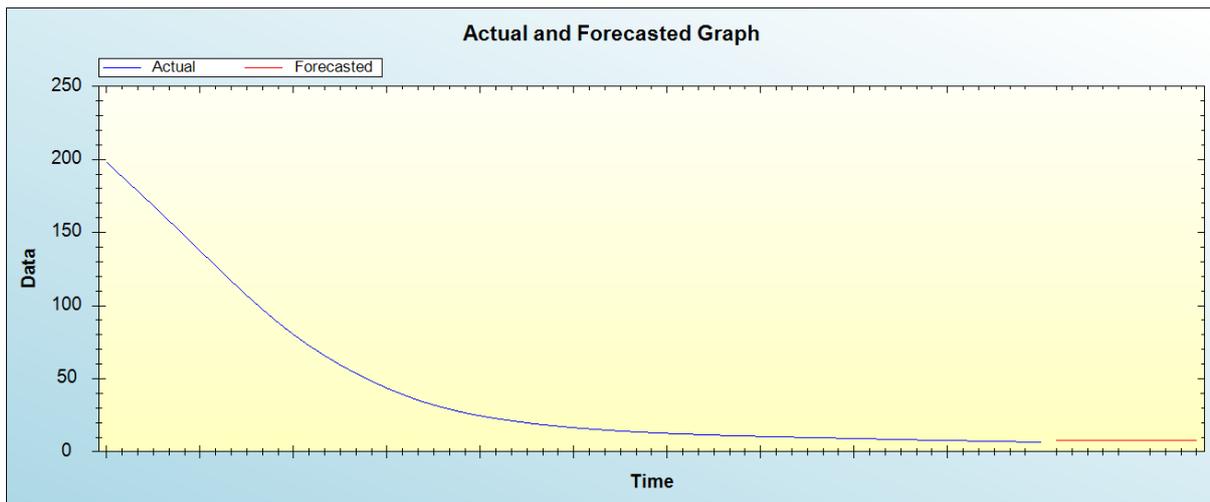Out-of-Sample Forecast for X: Actual and Forecasted Graph

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

Out-of-Sample Forecast for X: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	7.9365
2022	7.8874
2023	7.9929
2024	7.9102
2025	8.0298
2026	7.9020
2027	7.8851
2028	7.8984
2029	7.8470
2030	7.8380

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 U5MR will hover around 8.0 deaths per 1000 live births over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Time series forecasting techniques are important early surveillance tools that inform policies, decisions and allocation of resources. This study applied the ANN model to forecast the future path of under-five mortality rate in the UAE and projections suggested that U5MR will hover around 8 deaths per 1000 live births over the out of sample period. Therefore, authorities in the UAE must continue supporting the maternal and child health program in order to keep under five mortality under control.

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