Tracking Nigeria's Future Progress towards Achieving Substantial Reduction of under Five Mortality Using a Machine Learning Technique

[1]Dr. Smartson. P. NYONI, [2]Thabani NYONI

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for Nigeria from 1964 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied ANN (12, 12, 1) model is stable in forecasting under five mortality rate. ANN model projections indicate that U5MR will remain very high throughout the out of sample period. Therefore, we encourage the Nigerian government to allocate more resources to the maternal and child health (MNCH) program to ensure availability of medical supplies and medical staff at all levels of healthcare.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

By the end of 2030, all UN member countries should have achieved all the set sustainable development goal targets. As of now there is need to intensify efforts to ensure that all the SDG related plans are quickly implemented. The major global issues of concern are poverty eradication, ensuring access to quality affordable education and healthcare, ending wars, addressing inequalities and ending human rights abuses across the globe (UN, 2016; UN, 2015). Global health problems remain at the core of sustainable development goals and there is need to accelerate efforts to attend to all the major contributing factors of mortality. Ending preventable maternal, newborn and under five deaths is the mandate of SDG3. SDG3 target 3.2 seeks to achieve neonatal and under five mortality rates which are as low as 12 neonatal deaths per 1000 live births and 25 under five deaths per 1000 live births by 2030 (UN, 2020; WHO, 2019, UNICEF, 2019; UNICEF, 2018). This study applies the artificial neural network approach to predict future trends of under-five mortality rate for Nigeria. The findings will trigger an early response to the problem of under-five mortality so as to end all avoidable under five deaths.

II. LITERATURE REVIEW

Ewere & Eke (2020) examined the impact of maternal / child care characteristics on neonatal mortality in Nigeria using the logistic regression model. The study concluded that stake holders in the public health sector must improve the quality of existing health care facilities and access to quality services in order to substantially reduce neonatal mortality in the country.Gage & Bauhoff (2020) assessed the impact of PBF on early neonatal health outcomes and associated health care utilization and quality in Burundi, Lesotho, Senegal, Zambia and Zimbabwe. Authors utilized data from Demographic and Health Surveys and Multiple Indicator Cluster Surveys and applied difference-in-differences analysis to estimate the effect of PBF projects supported by the World Bank on early neonatal mortality and low birth weight and concluded that PBF had no impact on early neonatal health outcomes in the five African countries studied and had limited and variable effects on the utilization and quality of neonatal health care.Masaba & Phetoe (2020) described the trends of neonatal mortality within the two sub-Saharan countries. The study concluded that in 2018, the neonatal mortality rate for Kenya was 19.6 deaths per 1000 live births. The neonatal mortality rate had fallen gradually from 35.4 deaths per 1000 live births in 1975. On the other hand, South Africa had its neonatal mortality rate fall from 27.9 deaths per 1000 live births in 1975 to 10.7 deaths per 1000 live births in 2018.A cross sectional study was conducted in Nigeria by Ezeh *et al.* (2015) to investigate factors associated with post-neonatal, infant, child and under-5 mortality in Nigeria.A multistage, stratified, cluster random sampling method was used to gather information on 63 844 singleton live-born infants of the most recent birth of a mother within a 5-year period before each survey was examined using cox regression models. The findings revealed that no formal education, poor households and living in rural areas increased the risk of post neonatal, infant, child and under-5 mortality among Nigerian children.

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 for Nigeria.

Data Issues

This study is based on annual under five mortality rate in Nigeria for the period 1964 – 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	R
Observations	45 (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	0.001987
MSE	1.102068
MAE	0.830681

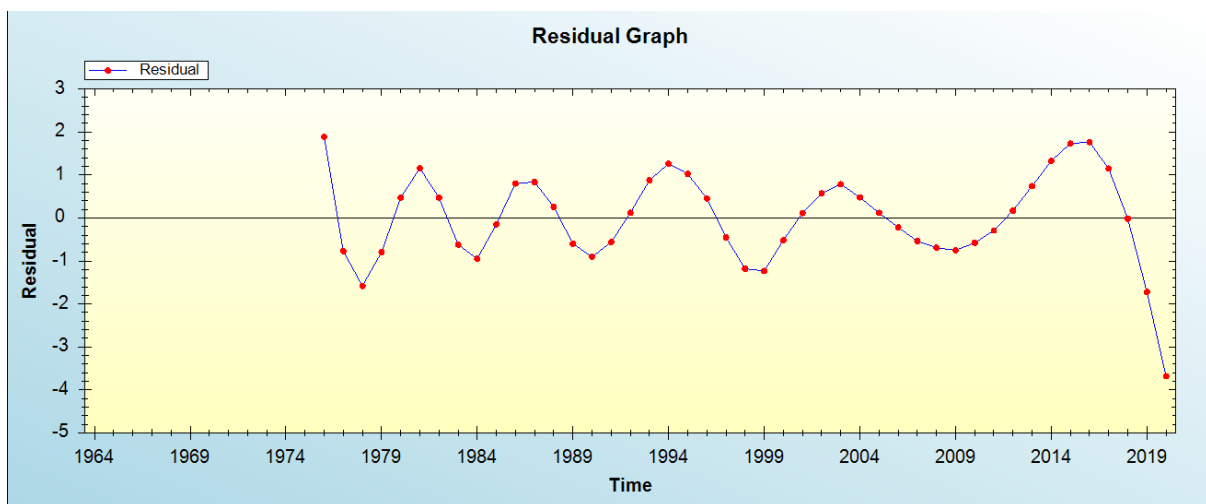Residual Analysis for the Applied Model

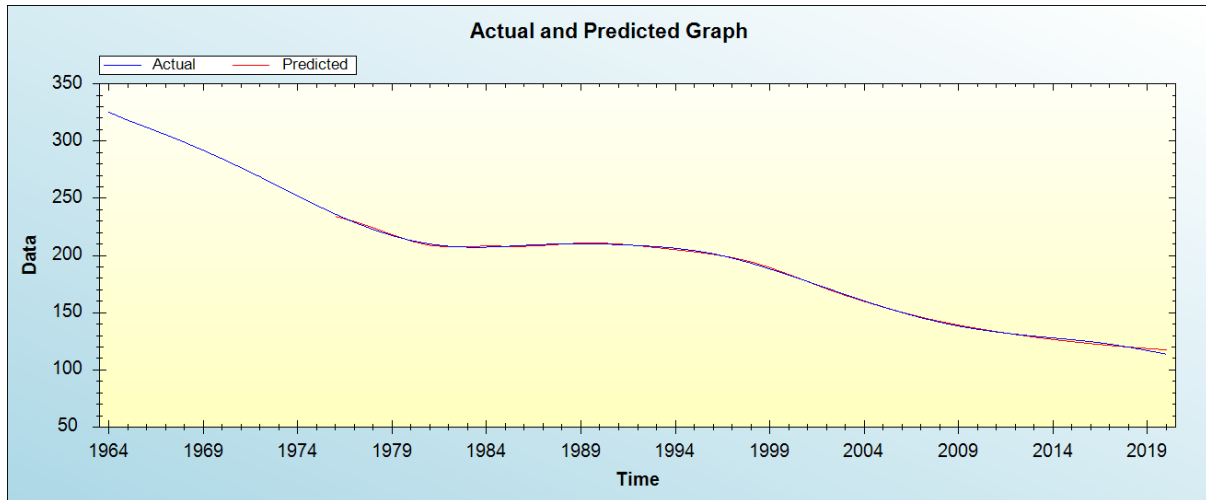Figure 1: Residual analysis

In-sample Forecast for R

Figure 2: In-sample forecast for the R series

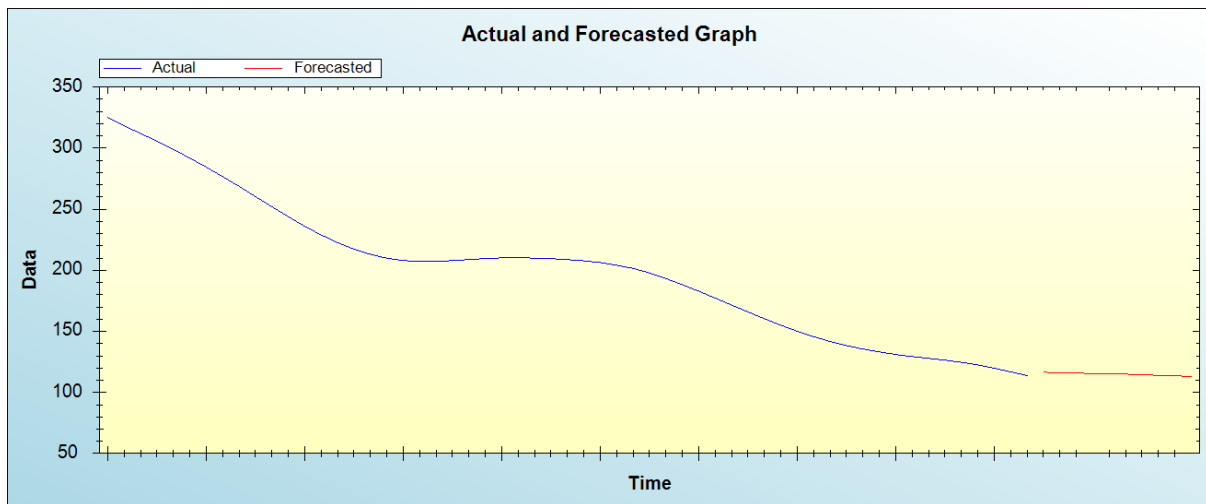Out-of-Sample Forecast for R: Actual and Forecasted Graph

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

Out-of-Sample Forecast for R: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	116.4831
2022	116.2477
2023	115.9122
2024	115.2993
2025	115.1981
2026	114.9799
2027	114.5836
2028	113.9737
2029	113.5821
2030	113.2064

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 remain very high throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The Nigerian government has made significant progress in the reduction of under-five mortality as the country reported a decline in under five and neonatal mortality rates over the past 2 decades. However, high absolute numbers of under five deaths is a cause for concern. The ANN model was applied in this study to predict under five mortality rate and the results of the study revealed that U5MR will remain very high throughout the out of sample period. Therefore, we encourage the Nigerian government to allocate more resources to the maternaland child health (MNCH) program to ensure availability of medical supplies and staff at all levels of healthcare.

REFERENCES

[1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.

[2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.

[3] UN (2020) sustainable development goals. https://www.un.org/sustainabl development/development-agenda

[4] UNICEF (2018). Every Child alive. New York: UNICEF

[5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.

[6] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.

****