Predicting Future Trends of Under Five Mortality Rate for New Zealand Using Artificial Neural Networks

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for New Zealand from 1960 to 2020to 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 revealed that annual U5MR will hover around 5 deaths per 1000 live births throughout the out of sample period. Therefore, authorities in New Zealand should continue supporting maternal and child health program activities to end all avoidable under five deaths in the country.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The global challenges existing in various regions of the world prompted all UN member states to craft the Agenda 2030 for sustainable development outcome document in an attempt to create a roadmap towards sustainable development. The global action plan aims to achieve the 3 dimensions of sustainable development which are social, economic and environmental (UN, 2016; UN, 2015). There is no doubt that every country is striving to ensure the successful implementation of the SDGs. It is important to highlight that every country should ensure full participation of all stakeholders so that every component of the global action plan is covered. It is unfortunate that certain regions of the world are currently facing serious challenges that will negatively impact on the SDG progress. Persistent wars, natural disasters and lack of resources are among the setbacks of sustainable development. Global health is at the core of the agenda 2030 because it is the backbone of economic development. Directing our efforts towards addressing all the major global health challenges remains a political priority. The focus of SDG 3 target 3.2 is to end all preventable newborn and under five deaths by 2030. By 2030, each country should achieve neonatal mortality which is as low as 12 deaths per 1000 births and under five mortality should have dropped to levels as low as 25 deaths per 1000 live births (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). The objective of this paper to forecast future trends of under-five mortality rate for New Zealand using artificial neural networks. The findings will inform policy, planning and allocation of resources to maternal and child program activities.

II. LITERATURE REVIEW

Bitew *et al.* (2020) determined the incidence density rate and predictors of neonatal mortality by utilizing electronic databases. The study findings revealed thatthe incidence density rate of neonatal mortality in Sub-Saharan Africa is significantly high. Multiple factors (neonatal and maternal) were found to be independent predictors.A prospective, population-based research study was conducted by Dhaded *et al*. (2020) to investigate neonatal deaths in rural Karnataka, India for the period 2014–2018.Study staff collected demographic and health care characteristics on eligible women enrolled with neonatal outcomes obtained at delivery and day 28. Cause of neonatal mortality at day 28 was assigned by algorithm using prospectively defend variables. Study found that infants who were preterm and low-birth weight remained at highest risk for 28-day neonatal mortality in India.The probit model was applied by a Lambon-Quayefio & Owoo (2018) to investigate the factors that affect neonatal deaths as well as examine the effect of the Ghana Health Insurance on neonatal deaths in Ghana using the most recent round of the Ghana Demographic and Health Survey. The study findings suggested significant regional differences in neonatal deaths and that the national health insurance may have the potential to substantially improve the health outcomes of neonates and have policy implications for increasing coverage to more mothers and their neonates, as well as coverage in critical neonatal services and drugs. Scalone *et al*. (2016) investigated the effects of individual bio-demographic and socioeconomic components on infant mortality. 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 for New Zealand.

Data Issues

This study is based on annual under five mortality rate in New Zealand 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	N
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	
MSE	
MAE	

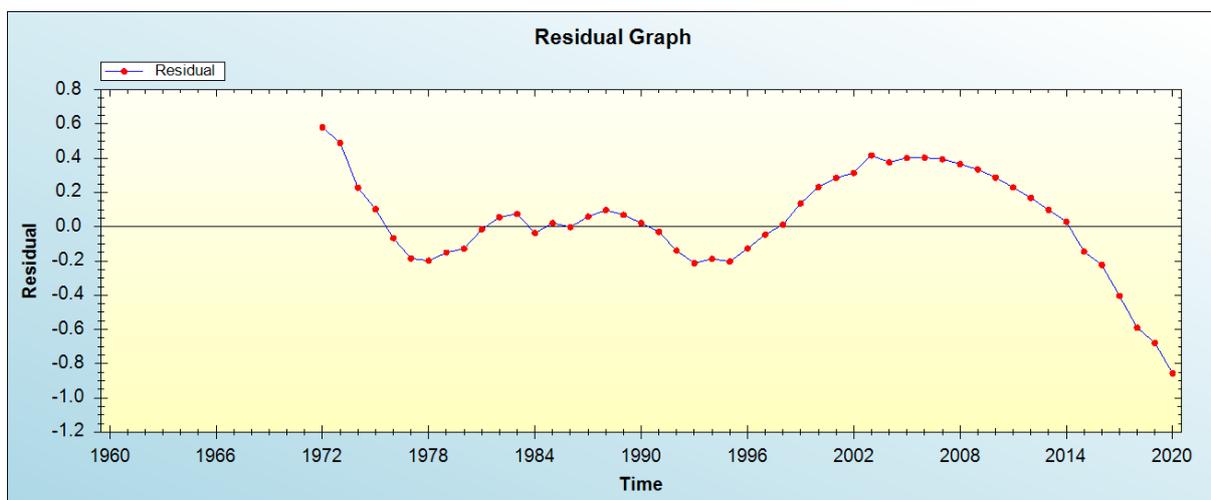Residual Analysis for the Applied Model

Figure 1: Residual analysis

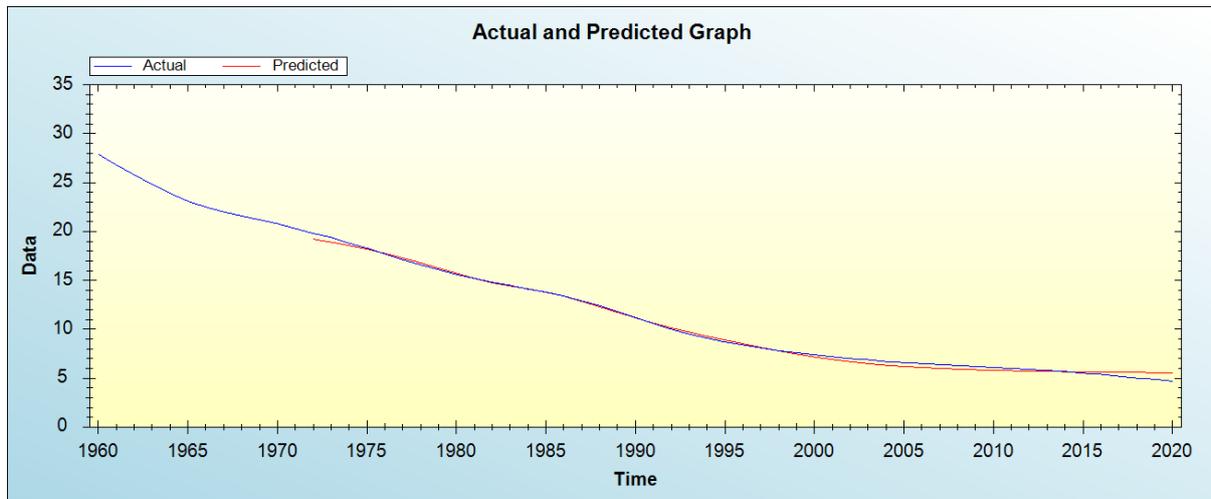In-sample Forecast for N

Figure 2: In-sample forecast for the N series

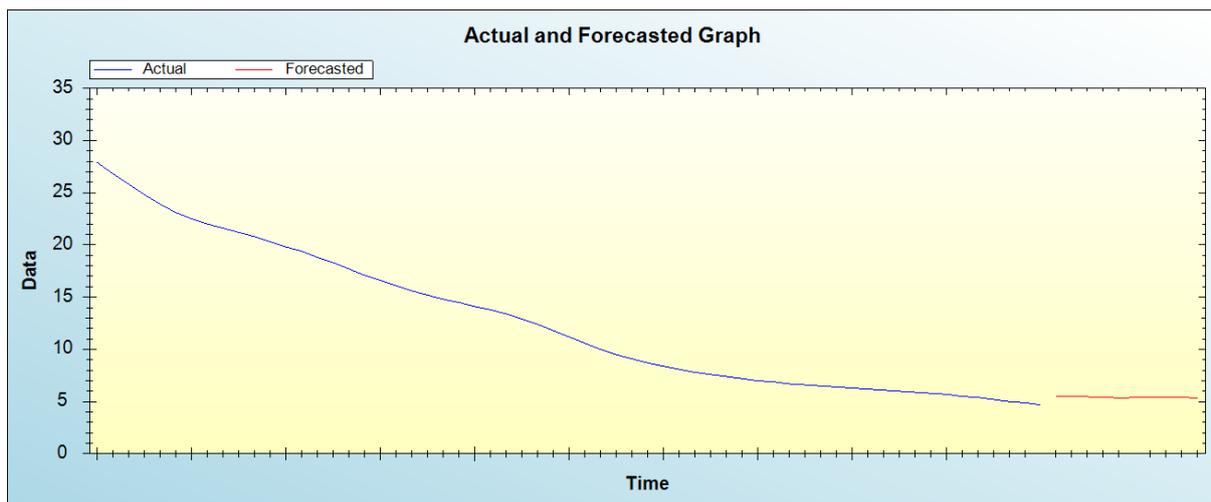Out-of-Sample Forecast for N: Actual and Forecasted Graph

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

Out-of-Sample Forecast for N: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	5.5418
2022	5.4994
2023	5.4600
2024	5.4115
2025	5.3539
2026	5.3826
2027	5.3982
2028	5.4077
2029	5.3926
2030	5.3545

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 5 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Ensuring good health and promotion of well-being should be part of the government's plans and budgets. The New Zealand government has made significant progress in the reduction of under five deaths as the country reported a decline in under five and neonatal mortality rates over the past decades. This was as a result of robust measures in implemented by government with the aim of improving child survival. This study applied the ANN model to project future trends of under-five mortality rate and the forecast results indicate thatannual U5MR will hover around 5 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the New Zealand government to continue supporting maternal and child health program activities in order to end all avoidable under five deaths in the country.

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