Predicting Under Five Mortality Rate for China Using Artificial Neural Networks

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for China from 1969 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria of the applied model indicate that the ANN (12, 12, 1) is stable in forecasting under five mortality rate. The ANN model projections indicate that annual U5MR will continue to drop over the out of sample period. Therefore, we encourage the Chinese government to continue supporting maternal and child health programs by addressing various challenges faced by under five children in disadvantaged regions of the country.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Developing and developed countries gathered at the UN Headquarters in September 2015 in New York to draft a global strategy document to end all forms of poverty, unemployment, inequalities, health problems, economic challenges and other important issues affecting different regions of the world (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). This global action plan targets every nation leaving no one behind. First world countries have done very well in addressing all the three dimensions of sustainable development. China is one of the first world countries that have demonstrated commitment to solving the majority of problems affecting the Chinese population. It has the largest population size in the world with an estimated population size of approximately 1.39 billion in 2017 and has an annual population growth of about 6-7 million (Wang, 2019). The population size continues to increase annually despite its growing economy, increased social competition, improved gender equality and women's participation in labour force (Adsera, 2004; Boone & Kessler,1999; Becker *et al.* 1988). The country's life expectancy at birth increased from 43.4 to 76years from 1960 to 2015 (Li *et al.* 2018). This reflects significant progress made on the 3rd sustainable development goal. The nation's family planning policy is one the strictest in the world (Hesketh *et al.* 2005; Greenhalgh, 20003).Total fertility rate declined from 6.1 births per woman in 1955 to 1.7 births per woman in 2020.The country has also recorded a drop in infant and under five mortality rates. In 2020, infant mortality was 8.4 infant deaths per 1000 live births and under five mortality was 9.8 deaths per 1000 live births (Worldometer, 2020).

The objective of this paper is to forecast future trends of under-five mortality rate in China using the artificial neural network approach. We expect the study findings to guide policy, planning and allocation of resources to MNCH program activities in order to keep under five mortality 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 indicated that maternal education explains 15% of the infant mortality decline in Indonesia from 1980 to 2015. Liang *et al.* (2020) utilized a descriptive epidemiological method to analyze under five mortality in a city in Northwest China during the period 2012 to 2018. The study results revealed that there was down ward trend of neonatal, infant and under five mortality. A cross-sectional study by Weddhi *et al.* (2019) examined factors associated with neonatal mortality at the Referral Hospital in Nouakchott, Mauritania. The study was conducted between January 2013 and December 2013 and included neonatal patients hospitalized at the National Referral Hospital (NRH). Data were collected by reviewing the medical charts and through questionnaires administered to the parents. The authors concluded that neonatal mortality remains a significant burden in Mauritania. They identified different socioeconomic and clinical risk factors indicating the need for more intensified prenatal care and improved transport of high risk neonates, especially in the regions outside the capital. In China Cao *et al.* (2017) analyzed trends in mortality and causes of death among children aged under 5 years in Beijing, China between 1992 and 2015 and forecasted under-5 mortality rates (U5MRs) for the period 2016–2020. An entire population-based epidemiological study was conducted. Data collection was based on the Child Death Reporting Card of the Beijing Under-5 Mortality Rate Surveillance Network. Trends in mortality and leading causes of death were analyzed using the χ2 test and SPSS 19.0 software. An autoregressive integrated moving average (ARIMA) model was fitted to forecast U5MRs between 2016 and 2020 using the E Views 8.0 software. The study results showed that Beijing has made considerable

progress in reducing U5MRs from 1992 to 2015. However, U5MRs could show a slight upward trend from 2016 to 2020. Akinwande *et al.* (2016) Analyzed Infant and Child (Under-five) Mortality in Zaria using a regression Analysis Approach. The study was carried out using secondary data from Ahmadu Bello University Teaching Hospital, Zaria, on infant and child (under-five) mortality and delivery rates. Findings from the study showed that both infant and child mortality rates have a direct relationship with delivery rates. The correlation analysis result showed that there is a very strong and positive relationship between mortality and delivery rates. The study revealed that infant and child mortality rates will continue to decrease if there can be improvement in the factors under study. An Indonesian study by Suparmi *et al.* (2016) applied cox proportion hazard regression to analyze the contribution of low birth weight on neonatal mortality. The study findings revealed that children born with low birth weight and born from younger mothers had higher risk of neonatal mortality.

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 China.

Data Issues

This study is based on annual under five mortality rate in China for the period 1969 – 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	40 (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	0.000617
MSE	0.111308
MAE	0.254399

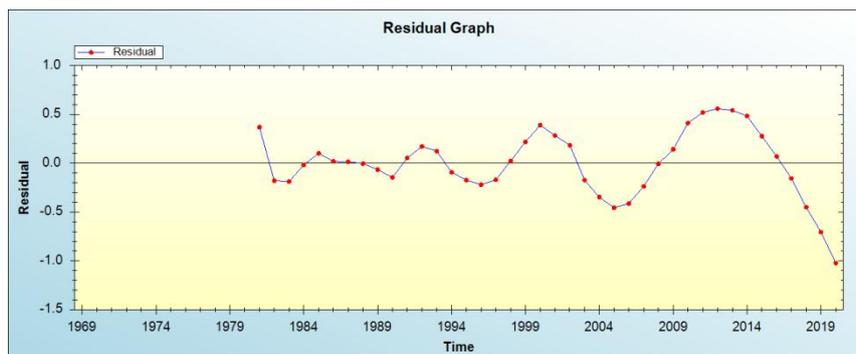Residual Analysis for the Applied Model

Figure 1: Residual analysis

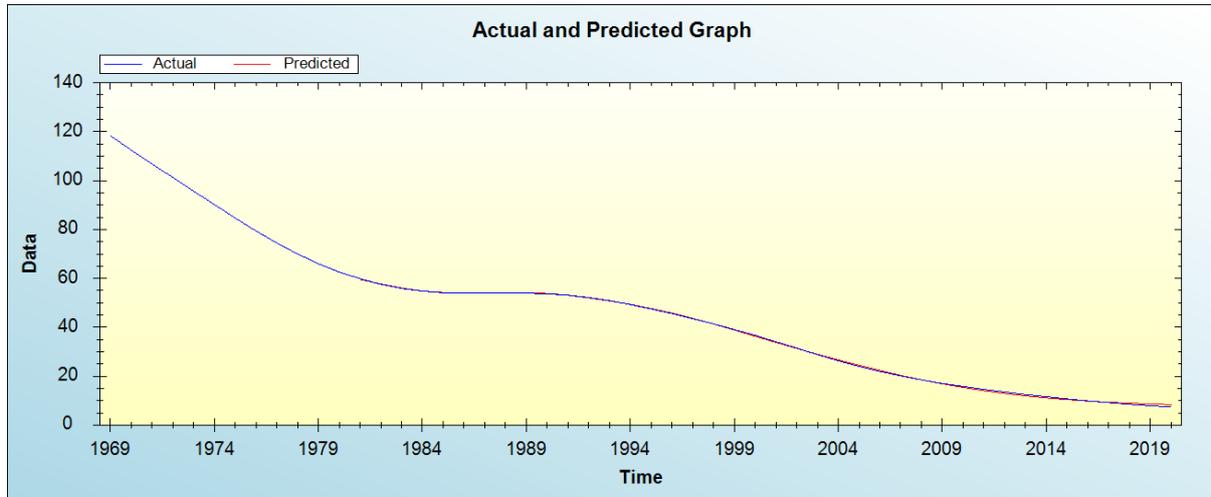In-sample Forecast for X

Figure 2: In-sample forecast for the X series

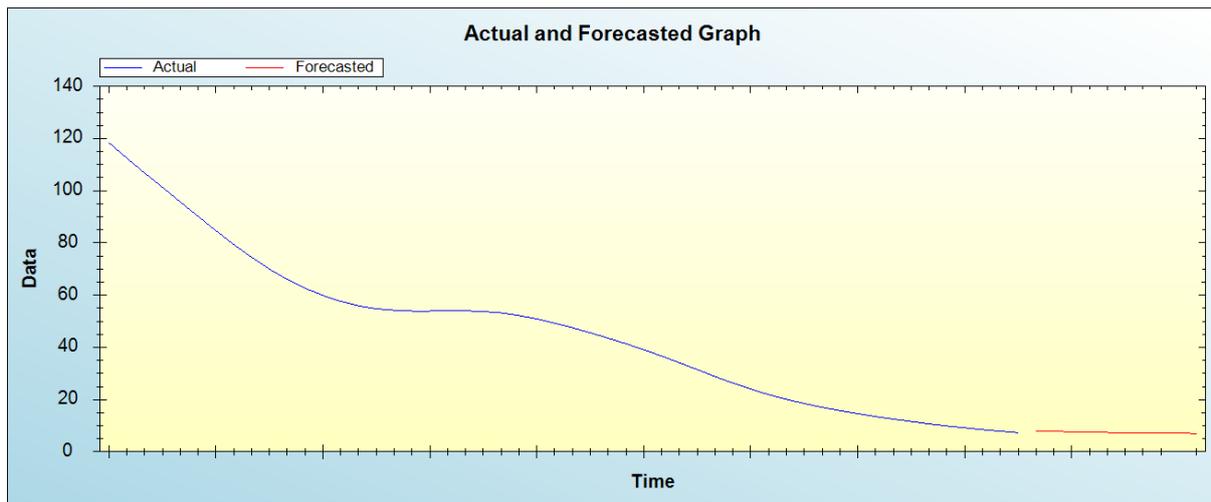Out-of-Sample Forecast for X: Actual and Forecasted Graph

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	8.0691
2022	7.8537
2023	7.6519
2024	7.5522
2025	7.4064
2026	7.3336
2027	7.2178
2028	7.1569
2029	7.0904
2030	7.0192

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 continue to drop over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Machine learning approaches are now widely used in public health. They have demonstrated a high level of accuracy in time series forecasting problems. In this study the ANN (12, 12, 1) model was utilized to predict future trends of under-five mortality rate in China. The results of the study indicate that annual U5MR will continue to drop over the out of sample period. Therefore, we encourage the Chinese authorities to continue supporting maternal and child health programs especially by addressing various challenges faced by disadvantaged under five children.

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