

Forecasting Future Trends of Under Five Mortality for Brazil Using Artificial Neural Networks

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Abstract - This study uses annual time series data on under five mortality rate for Brazil from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecasting evaluation statistics indicate that the applied model is stable in forecasting under five mortality rate. The ANN (12, 12, 1) model projections suggest that U5MR will hover around 14 deaths per 1000 live births over the out of sample period. Therefore, we encourage the authorities in Brazil to attend to the factors that strongly contribute to under five mortality especially in marginalized groups or disadvantaged communities in the rural and urban areas.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Global population health is a political priority in recent times as the entire world is accelerating progress towards achieving sustainable development by 2030 (UN, 2016; UN, 2015). The three dimensions of sustainable development are social, economic and environmental. Ensuring good health and promotion of well-being for all at all ages is the focus of the 3rd sustainable development goal. SDG 3 target 3.2 aims at the significant reduction of newborn and under five deaths to as low as 12 deaths per 1000 live births and 25 deaths per 1000 live births respectively by 2030 (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018). Brazil's neonatal mortality rate declined from 37 deaths per 1000 live births in 1990 to 18 deaths per 1000 live births in 2017 (Hug *et al.* 2019; DATASUS, 2020). The country's infant mortality rate declined from 47 per 1000 live births in 1990 to 12 per 1000 live births in 2017 (Reis *et al.* 2021). The aim of this paper is to model and forecast future trends of under-five mortality rate for Brazil using the artificial neural network model. Forecast results are expected to detect abnormal trends of U5MR and assist in crafting appropriate child health intervention strategies to keep under five mortality under control.

II. LITERATURE REVIEW

Iriondo *et al.* (2020) developed and validated different mortality predictive models, using Spanish data, to be applicable to centers with similar morbidity and mortality. Infants born alive, admitted in NICU, and registered in the SEN1500 database, were included. Multivariable regression models were used for the different time periods. The study concluded that using dynamic models to predict individual mortality can improve outcome estimations. Development of models in the prenatal period, first 24 hours, and during hospital admission, cover key stages of mortality prediction in preterm infants. A cross-sectional study carried out by Edem *et al.* (2020) examined the health practices, care-seeking behavior, and referral of sick out-born neonates to a district and regional hospital in the Upper West Region of Ghana. The study findings revealed that socio-cultural factors strongly influence health seeking behavior and the health outcome of neonates in this setting. Soleman *et al.* (2020) conducted a cross-sectional study 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. Bhatia *et al.* (2019) analyzed the patterns and trends in the mortality rates of infants and children under the age of 5 in India (1992–2016) and quantified the variation in performance between different geographical states through three rounds of nationally representative household surveys. Three rounds of cross-sectional survey data. The study is conducted at the national level: India and its selected good-performing states, namely Haryana, Kerala, Maharashtra, Punjab and Tamil Nadu, and selected poor-performing states, namely Bihar, Chhattisgarh, Madhya Pradesh and Uttar Pradesh. The study revealed that attempts to reduce infant and child mortality rates in India are heading in the right direction although there is huge variation in performance between states.

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 Brazil.

Data Issues

This study is based on annual under five mortality rate in Brazil 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	Z
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	0.065344
MSE	20.120537
MAE	1.662510

Residual Analysis for the Applied Model

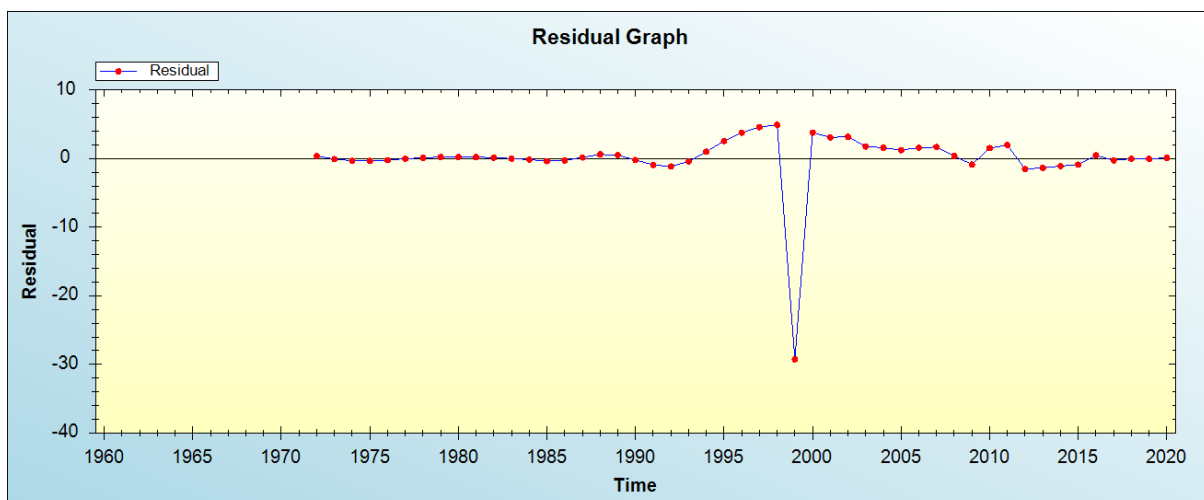


Figure 1: Residual analysis

In-sample Forecast for Z

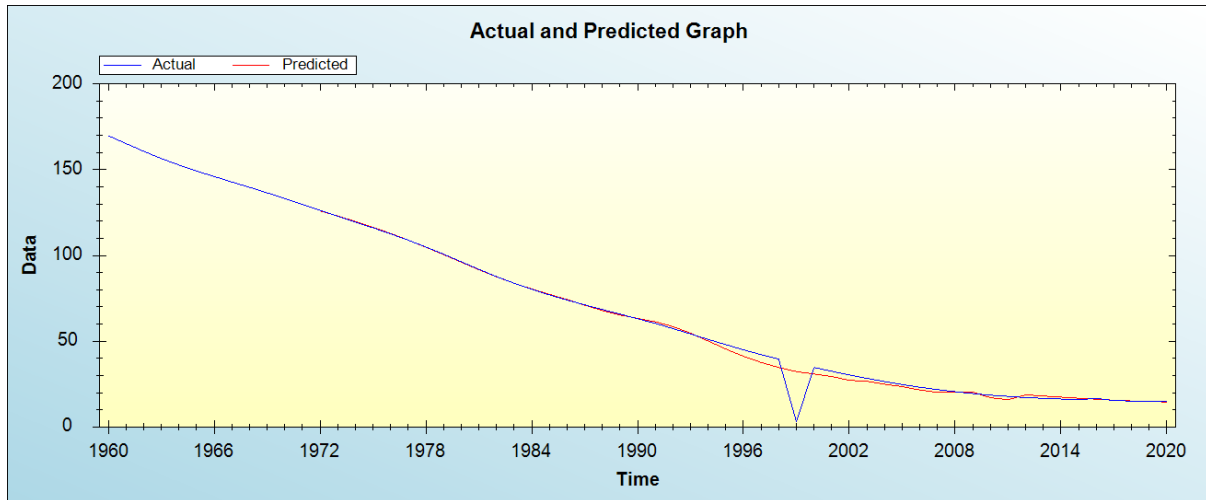


Figure 2: In-sample forecast for the Z series

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

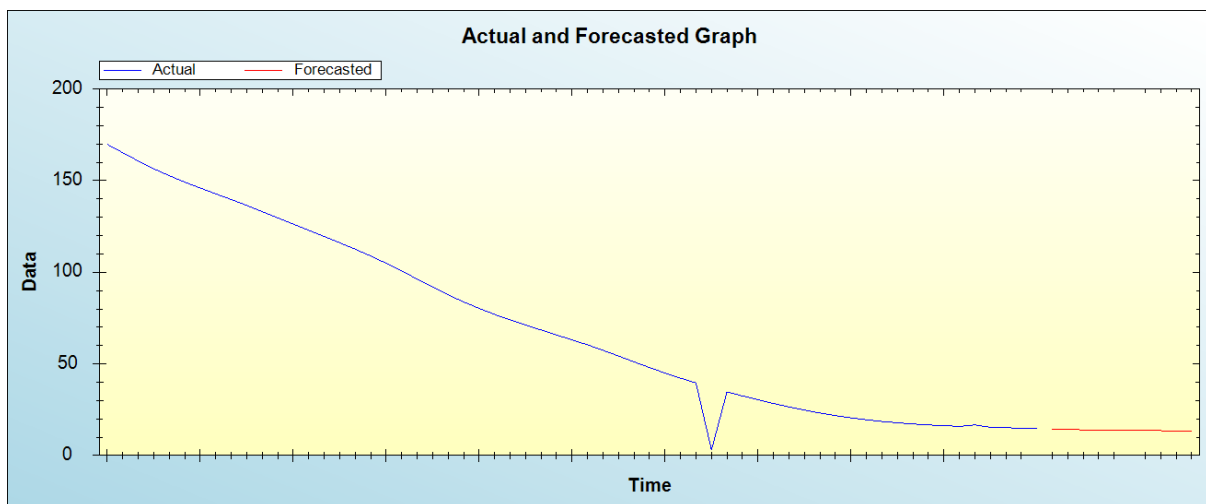


Figure 3: Out-of-sample forecast for Z: actual and forecasted graph

Out-of-Sample Forecast for Z: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	14.3822
2022	14.2065
2023	14.0827
2024	13.9558
2025	13.8211
2026	13.6943
2027	13.6776
2028	13.6056
2029	13.4324
2030	13.3715

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 will hover around 14 deaths per 1000 live births over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Sustainable development goals (SDGs) have been in existence since September 2015 and many countries have made commendable SDG progress. However this progress is uneven with some countries lagging behind due to various country specific challenges that include lack of financial and human resources, political conflict and civil wars. In this study we applied the ANN model to forecast future trends of under-five mortality rate and the findings revealed that U5MR will hover around 14 deaths per 1000 live births over the out of sample period. Therefore, we encourage the authorities in Brazil to focus on addressing challenges being encountered by disadvantaged under five children in rural and urban areas.

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/sustainabledevelopment/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.
- [7] Hug L., Alexander M., You D., and Alkema L (2019). For Child Mortality Estimation UI-aG. National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. *Lancet Glob Health*, 7, 6, 710–20.
- [8] DATASUS (2020). Information systems on live births and mortality. Brazilian Ministry of Health, 2020.

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