

Projecting Under Five Mortality Rate for Turkey Using a Machine Learning Approach

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Turkey from 1960 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 revealed that annual U5MR will continue to decline over the out of sample period. Therefore, we encourage the Turkish government to address all the factors that significantly affect the successful implementation of the maternal and child health program.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Sustainable development goals (SDGs) are not supposed to be implemented in isolation from local, national and regional plans, and budgets. Their inclusion is key to facilitate the successful implementation of the global action plan that is the 2030 Agenda for sustainable development (UN, 2020; UNICEF, 2019; UNICEF, 2018; UNICEF, 2016; UN, 2015). By 2030 all UN member states should have managed to end poverty, hunger, gender inequalities and other deprivations. It is crucial to involve all stakeholders as we move forward addressing various complex issues that affect human beings across the globe. Understanding the different political, social, cultural and economic dynamics in various regions of the world is necessary so that appropriate and country specific strategies are put in place in order to solve the pertinent issues affecting specific populations (UN, 2020; WHO, 2019; UNICEF, 2019). It is also important to highlight that involvement of political leaders and government departments or structures will allow a fast and smooth execution of this global action plan. Knowledge exchange and skills transfer forms a strong foundation in building capacity which is required for the implementation of the SDGs. Review of progress and follow up cannot be overemphasized as this is the mandate of all UN member states together with global partners. A review of existing accurate data will reliably inform policy making, planning and allocation of resources to different programs with the goal of achieving the set SDG targets. The use of time series data in the review of progress is one of the important surveillance tools that help in the early detection of abnormal trends of events such as diseases and other health related events (Zhao *et al.* 2020; Panch *et al.* 2018). The purpose of this research is to project under five mortality rate for Turkey using the multilayer perceptron neural network and the findings are envisioned to detect abnormal trends of U5MR early with the aim of informing policy and allocation of resources to the maternal and child health program in order to keep child mortality under control.

II. LITERATURE REVIEW

A cross-sectional study by Tanou *et al.* (2021) assessed the effect of geographical accessibility to health facilities on antenatal care and delivery services utilization in Benin, with an emphasis on geographical zones. The study employed multivariate logistic regression for analysis and the findings indicated that the distance to the closest health center had adverse effects on the likelihood of a woman receiving appropriate maternal healthcare. The estimates showed that one km increase in straight line distance to the closest health center reduces the odds of the woman receiving at least one antenatal care by 0.042, delivering in facility by 0.092, and delivering her baby with assistance of skilled birth attendants by 0.118. Weiland *et al.* (2021), in Portugal, examined the effects of the 2006 National Program of Maternal and Neonatal Health policy on spatial inequalities in access to care and consequently avoidable infant mortality. A thematic analysis of qualitative data including interviews and surveys and a quantitative spatial analysis using Geographic Information Systems was applied. Spatial inequalities were found which may lead to avoidable infant mortality. Inequalities exist in freedom of choice and autonomy in care, within a medicalized system. Nyoni & Nyoni, 2020 utilized the ARIMA model to model and forecast infant mortality in Zimbabwe. The ARIMA (1, 2, 5) was the best model and the forecast results indicated that the number of infant deaths per year, over the out-of-sample period, will follow a downward trend. Another study by Bandeira *et al.* (2016) described Portugal's achievements in the maternal and child health program. The study highlighted that the joint venture of pediatricians and obstetricians with adequate top-down government commissions for maternal and child health for the decision making by health administrators and a well-defined schedule of preventive and managerial measures in the community and in hospitals, registry of special diseases and training of medical personnel are the most likely explanations for this success.

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 Turkey.

Data Issues

This study is based on annual under five mortality rate in Turkey 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	
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	0.000486
MSE	0.350779
MAE	0.507160

Residual Analysis for the Applied Model

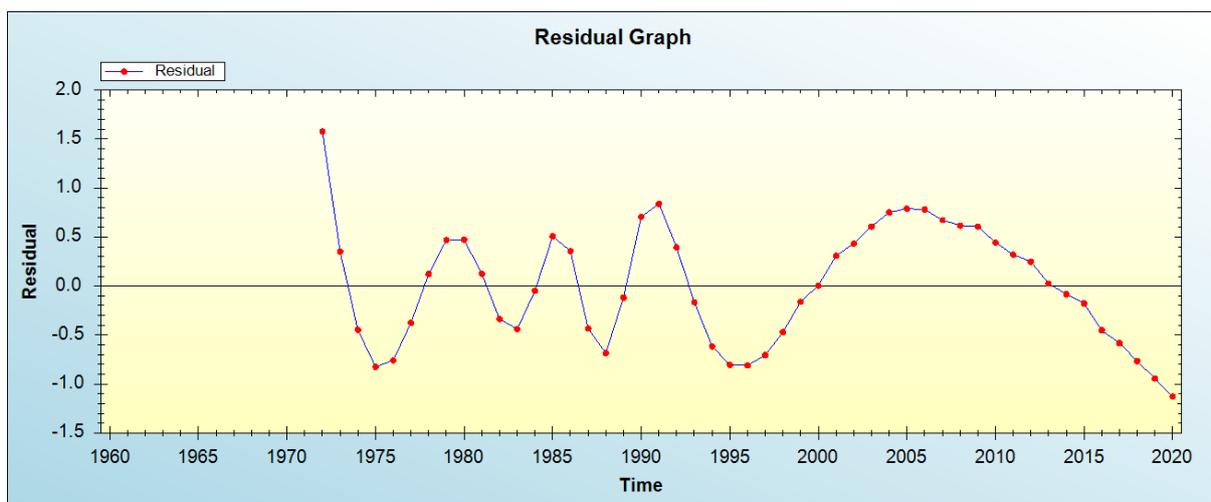


Figure 1: Residual analysis

In-sample Forecast for C

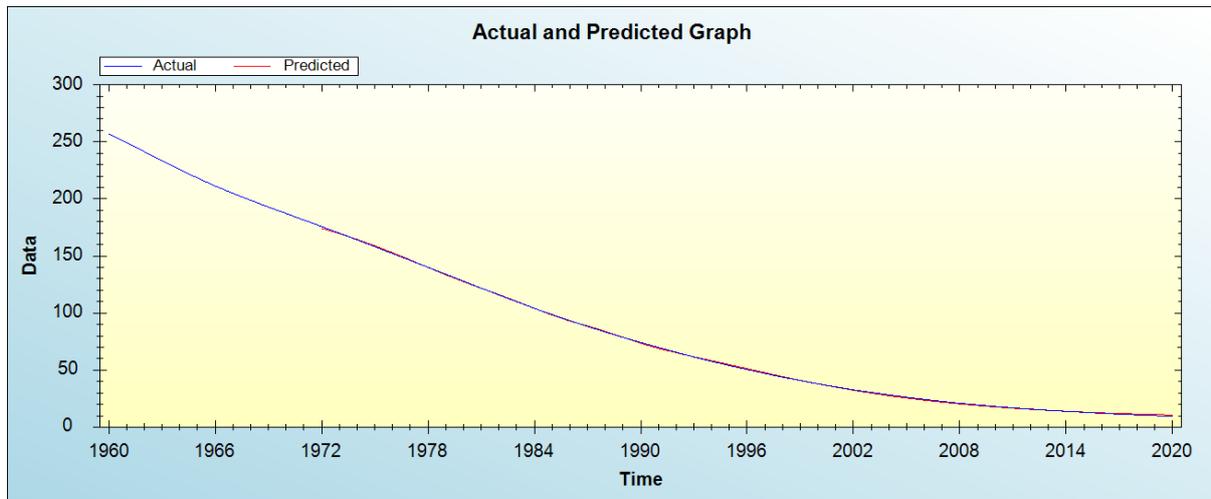


Figure 2: In-sample forecast for the C series

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

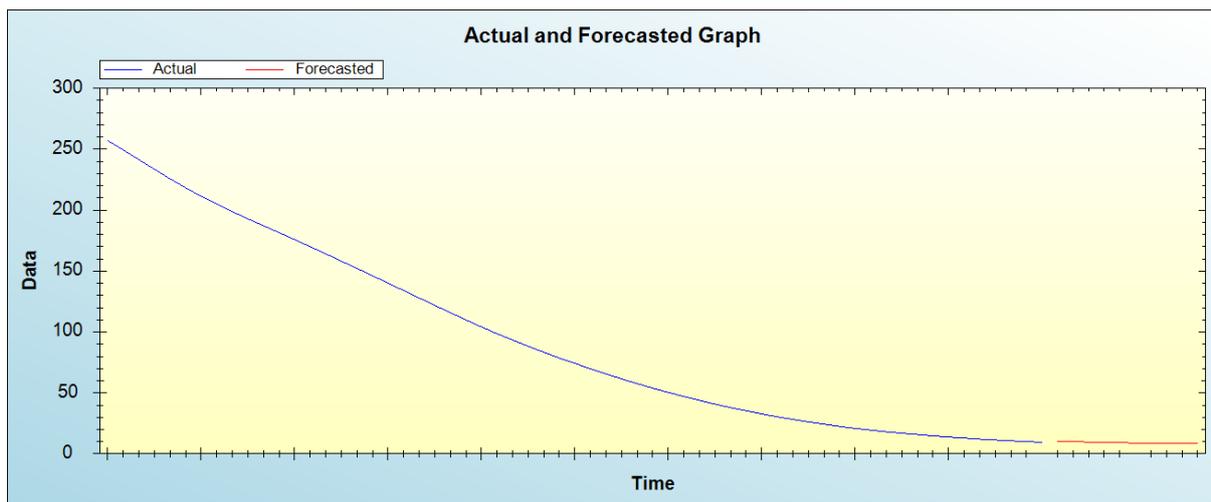


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	10.2964
2022	9.8994
2023	9.7632
2024	9.3890
2025	9.2037
2026	8.9291
2027	8.8526
2028	8.7206
2029	8.5577
2030	8.4317

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 decline over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The Turkish government has made significant progress towards substantial reduction of under-five mortality. Over the past decades the country reported a downward trend of under-five and neonatal mortality rates. This reflects the commitment of the Turkish government in solving issues affecting under five children and improving child survival. This study applied the ANN model to project future trends of under-five mortality rate and forecast results revealed that annual U5MR will continue to decline over the out of sample period. Therefore, the Turkish government must address all the issues that affect the successful implementation of the maternal and child health program.

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