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# Tracking Future Trends of Under Five Mortality for Romania Using Artificial Neural Networks

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Romania from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and model evaluation statistics indicate that the applied ANN (12, 12, 1) model is stable in forecasting U5MR. ANN model projections revealed that annual U5MR will hover around 6 deaths per 1000 live births over the out of sample period. Therefore, we encourage the government of Romania to design strategies that will maintain under five mortality below 25 deaths per 1000 live births.**

***Keywords:*** ANN, Forecasting, U5MR.

## I. INTRODUCTION

All 193 UN member states have a keen interest in knowing the likely future progress towards achieving sustainable development goals (SDGs) as this is relevant in policy formulation, decision making and resource mobilization. According to the Agenda 2030 for sustainable development outcome document, developing and developed countries are anticipating to meet all the 17 objectives and 169 set targets by 2030 (UN, 2016; UN, 2015).All governments have a responsibility of developing monitoring and evaluation (M & E) plans that will assist in identifying gaps and strengths as we move towards 2030. Data collection tools must be available at all levels of government and timeous reporting is important in tracking SDG progress. There should be smooth coordination of activities from subnational, national, regional and international levels within each sector (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). Ensuring good health and promotion of well-being for all at all stages of life is the focus of the 3rd sustainable development goal (SDG3). High on the list of targets under the 3rd SDG is ending all preventable maternal, newborn and under five deaths (UN, 2020). Although developed countries are leading in terms of progress towards achieving the set SDG targets, it is still critical for the leaders and stakeholders to come up with policies that will maintain this commendable trajectory. In line with Agenda 2030, this research focuses on forecasting U5MR for Romania using artificial neural networks. We expect the findings of this study to detect any likely abnormal trends of under-five mortality rate so as to trigger an early response to the problem.

## II. LITERATURE REVIEW

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. Harpur *et al.* (2021) investigated trends in infant mortality rates (IMR) and stillbirth rates by socio-economic position (SEP) in Scotland, between 2000 and 2018, inclusive. Data for live births, infant deaths, and stillbirths between 2000 and 2018 were obtained from National Records of Scotland. Annual IMR and stillbirth rates were calculated and visualized for all of Scotland and when stratified by SEP. Negative binomial regression models were used to estimate the association between SEP and infant mortality and stillbirth events, and to assess for break points in trends over time. The study revealed that IMR fell from 5.7 to 3.2 deaths per 1000 live births between 2000 and 2018, with no change in trend identified. Stillbirth rates were relatively static between 2000 and 2008 but experienced accelerated reduction from 2009 onwards. When stratified by SEP, inequalities in IMR and stillbirth rates persisted throughout the study and were greatest amongst the sub-group of post-neonates.Another study by Simeoni *et al.* (2019) analyzed the infant (IMR) and neonatal (NMR) mortality rates of Italian and foreign children and evaluated if there is a disparity among geographical macro-areas. Data from 2006 to 2015 were collected by the Italian Statistics Bureau (ISTAT) and extracted from two different national databases, which considered i) underlying cause of death and ii) birth registry. The main analyses were made comparing Italian versus foreigners as a single category as well as by country origin and contrasting Northern residents versus Southern ones. Comparisons between groups were done using relative risks. The study findings indicated that Inequalities in neonatal and infant mortality are evident between Italians and immigrants and among geographical macro-areas.A descriptive study in Portugal was done by Guimarães (2015) who outlined the contribution of Portuguese reform of perinatal healthcare in the reduction of perinatal mortality. The author highlighted that the organization in primary, secondary and tertiary healthcare resulted in the improvement of perinatal care centered on both mother and child needs.

 

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## 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 Romania.

### Data Issues

This study is based on annual under five mortality rate in Romania 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 | R |
|---|---|
| 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 | 0.001640 |
| MSE | 0.124087 |
| MAE | 0.247513 |

Residual Analysis for the Applied Model

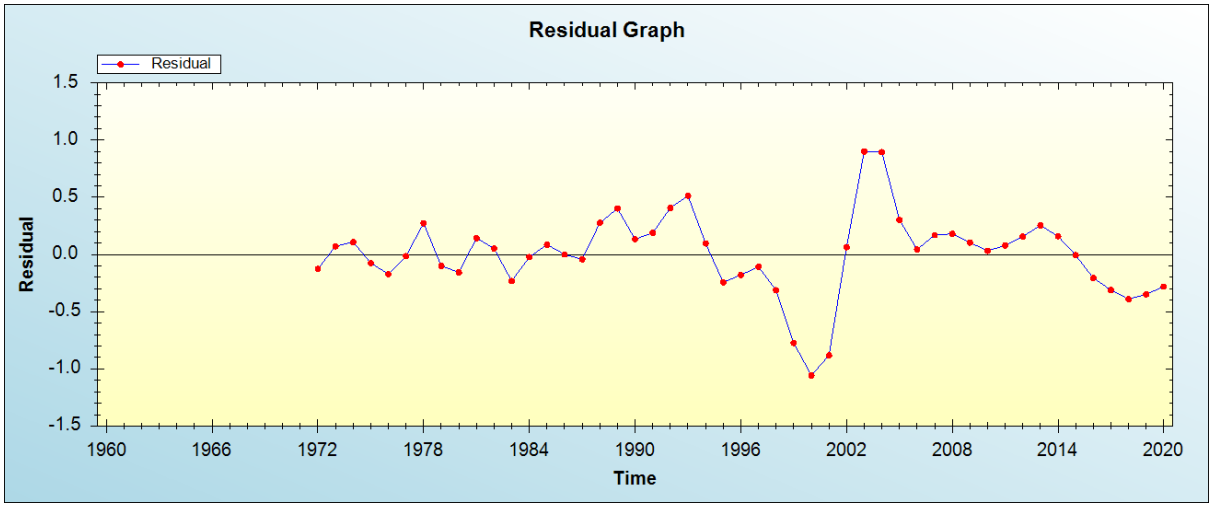


Figure 1: Residual analysis

 

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In-sample Forecast for R

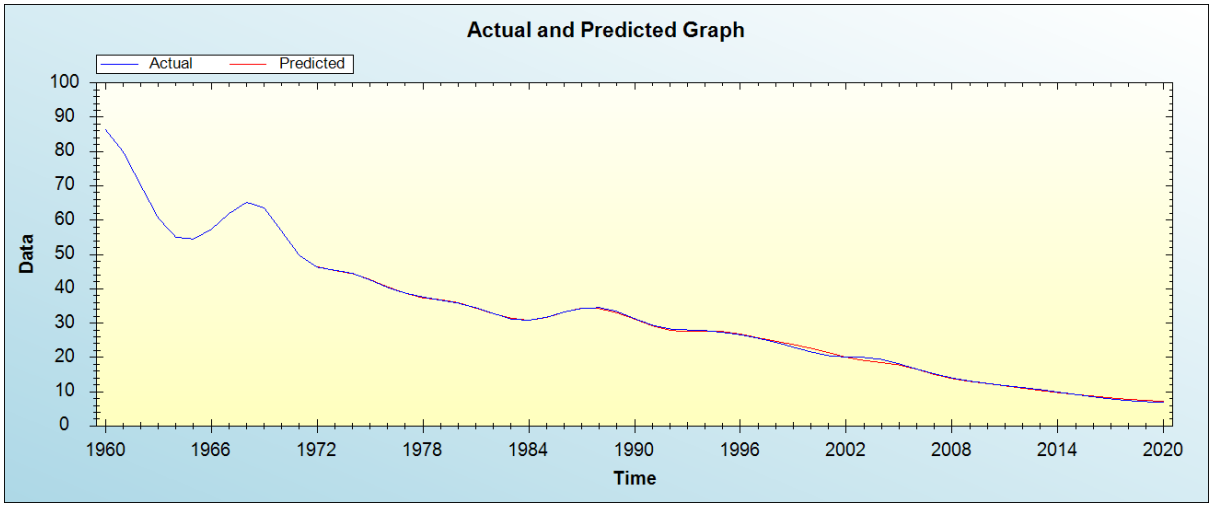


Figure 2: In-sample forecast for the R series

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

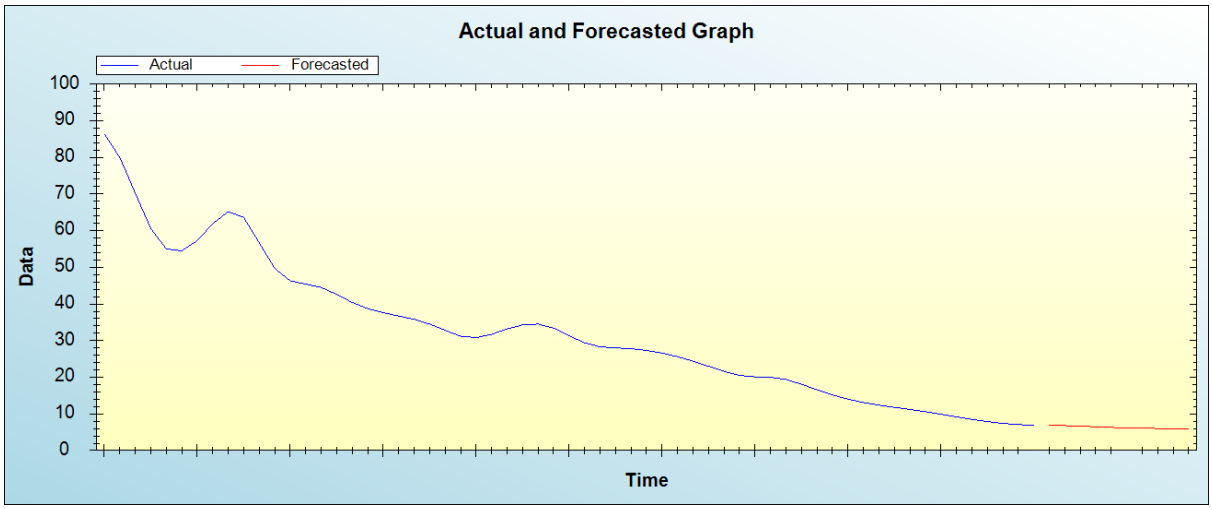


Figure 3: Out-of-sample forecast for R: actual and forecasted graph

Out-of-Sample Forecast for R: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| | |
|---|---|
| 2021 | 6.9681 |
| 2022 | 6.8098 |
| 2023 | 6.6461 |
| 2024 | 6.4804 |
| 2025 | 6.3121 |
| 2026 | 6.1886 |
| 2027 | 6.1006 |
| 2028 | 6.0246 |
| 2029 | 5.9709 |
| 2030 | 5.9114 |

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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 6 deaths per 1000 live births over the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

The government of Romania has made significant progress in solving all the issues highlighted by the 3rd sustainable development goal. Over the past decades, the country has reported a downward trend ofunder-five and neonatal mortality rates. This study applied the ANN model to predict under five mortality rate and forecast results indicate thatannual U5MR will hover around 6 deaths per 1000 live births over the out of sample period. Therefore, we encourage the government of Romania to design new strategies that will maintain under five mortality rate below 25 deaths per 1000 live births.

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