Projecting Future Trends of Under Five Mortality Rate for Bulgaria Using Holt's Linear Method

[1]Dr. Smartson. P. NYONI, [2]Thabani NYONI

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Bulgaria from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation statistics indicate that the applied Holt's linear model is stable in forecasting future trends of under-five mortality rate in Bulgaria. Optimal values for smoothing constants α and β are 0.8 and 0.1 respectively based on minimum MSE. The double exponential smoothing model projections showed that annual U5MR will continue to decline over the out of sample period. Therefore authorities in Bulgaria are encouraged to draft child health policies that will keep under five mortality under control.

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

By the end of 2030, all UN member states are expected to have achieved all the set SDG targets despite the various challenges that exist in different parts of the world (UN, 2016; UN, 2015). The 3rd sustainable development goal has a long list of targets that must be met before the end of 2030. Among the list of targets maternal and child health, sexual and reproductive health issues and epidemic diseases are contributing significantly to morbidity and mortality among women and children, hence the need to urgently address all these issues. Adolescent girls and young women's sexual and reproductive health issues are increasingly becoming a global health challenge because of the high absolute numbers of unintended pregnancies, STIs, unsafe abortions, and obstetric complications (Woog *et al.* 2015).About 13 million young women aged 15-19 years give birth each year accounting for 11% of the global births and 95% of childbirths occur in developing countries (UN, 2013). Pregnancy and delivery related complications are the second leading causes of death among adolescents aged 15-19 years worldwide (WHO, 2014). By end of 2030 all individual UN member states should have managed to substantially reduce maternal, newborn and under five mortality (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). The purpose of this research article is predict future trends of under-five mortality rate for Bulgaria using Holt's linear exponential smoothing model. The study results are envisioned to guide child health policy, planning and resource allocation with the aim of ending all preventable under five deaths in the country.

II. LITERATURE REVIEW

Baroni *et al.* (2021) outlined an integrated dataset containing monthly data in a historical series from 1996 to 2017 with information on all births, neonatal deaths, and NMR (total, early and late components) enriched with information related to the municipality. It is adataset of historical data with information on the number of births, the number of neonatal deaths, the neonatal mortality rate (including early and late), and geographic information for each month (between January 1996 and December 2017) and Brazilian municipality. Biracyaza & Habimana (2019) developed a model of infant mortality and its associated risk factors in Rwanda from 2011 to 2015.A cross-sectional survey was conducted using data from 2014/2015 Rwanda Demographic and Health Survey. Target population was women aged 15-49 years from sampled households. All 492 of the clusters selected were surveyed for 2014/2015 RDHS. The study concluded that factors associated with IM were grouped into community, ecological, socio-economic and proximate factors and identified that each group consists of multifactor that influence the infant mortality rate. Mishra *et al.* (2019) applied the ARIMA model to forecast infant mortality rates (2017 – 2025). The forecast of the sample period (1971 – 2016) showed accuracy by the selected ARIMA (2, 1, 1) model. The post-sample forecast with ARIMA (2, 1, 1) model showed a decreasing trend of infant mortality (2017 – 2025). The forecast infant mortality rate for 2025 in India is 15/1000 live births. Caluza (2018) utilized data mining technique using decision tree called J48 algorithm in classifying child mortality rate, life expectancy at birth, annual population growth, and the gross domestic product. Results revealed that annual population growth is highly correlated in predicting child mortality and generate three distinct rules. The generated model had high acceptability with 97.4% ROC curve result of the three classes in predicting child mortality under five years old.

III. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of under-five mortality rate in Bulgaria. In exponential smoothing forecasts are generated from the smoothed original series with the most recent historical values having more influence than those in the more distant past as more recent values are allocated more weights than those in the distant past. This study uses the Holt's linear method (Double exponential smoothing) because it is an appropriate technique for modeling linear data.

$Q_t = \mu_t + b_t t + \varepsilon_t$

Smoothing equation

$L_t = \alpha Q_t + (1-\alpha)(L_{t-1} + b_{t-1})$

Trend estimation equation

$T_t = \beta(L_t - L_{t-1}) + (1-\beta)b_{t-1}$

Forecasting equation

$f_{t+h} = L_t + h b_t$

Q_t is the actual value of time series at time t

L_t is the exponentially smoothed value of time series at time t

α is the exponential smoothing constant for the data

β is the smoothing constant for trend

f_{t+h} is the h step ahead forecast

T_t is the trend estimate

Data Issues

This study is based on annual under five mortality rate in Bulgaria 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

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	Q
Included Observations	61 (After Adjusting Endpoints)
Smoothing constants	
Alpha (α) for data	0.800
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.896373
Sum Square Error (SSE)	346.796460
Mean Square Error (MSE)	5.685188
Mean Percentage Error (MPE)	0.168233
Mean Absolute Percentage Error (MAPE)	3.023594

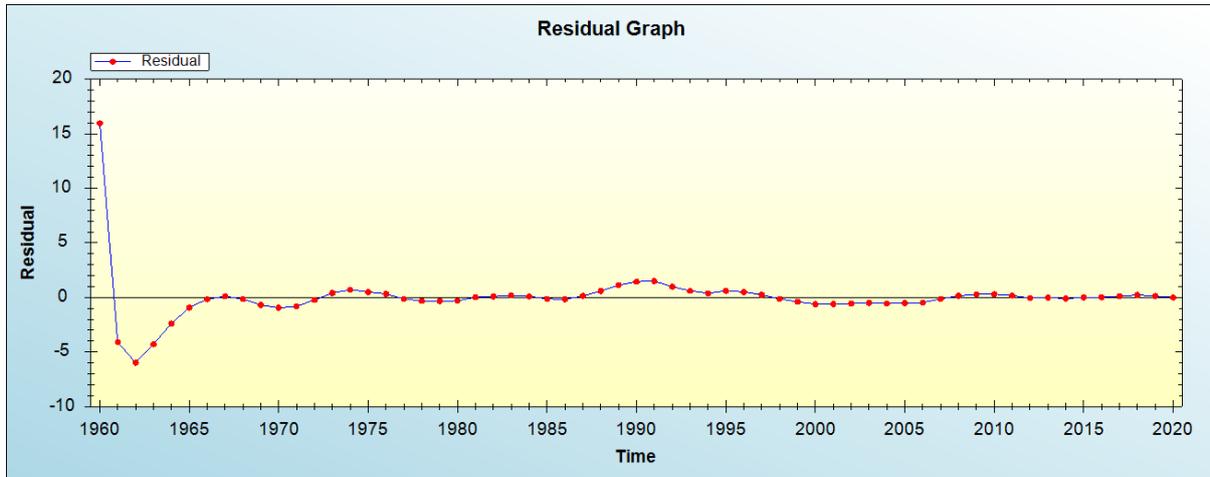Residual Analysis for the Applied Model

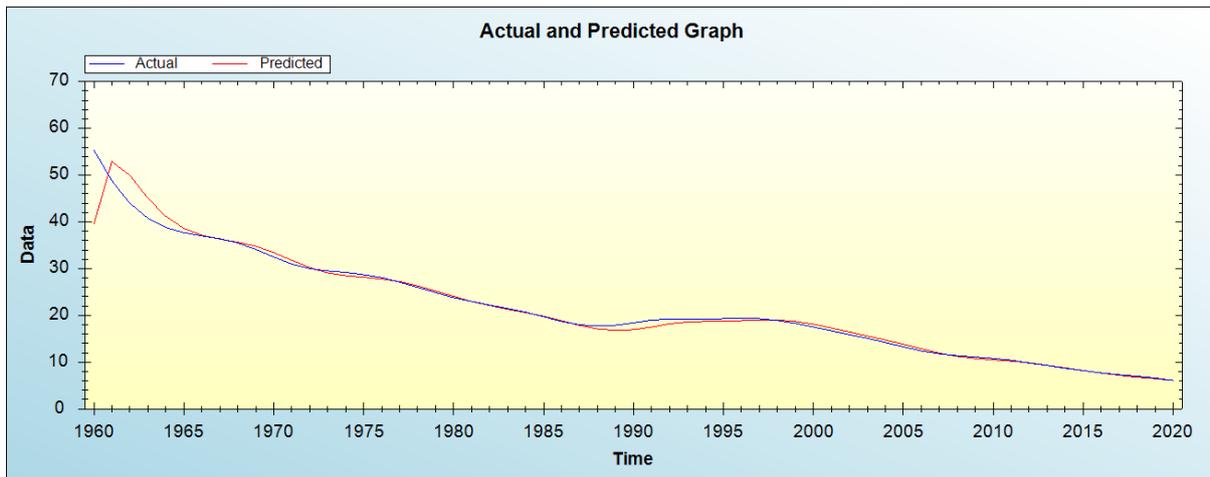Figure 1: Residual analysis

In-sample Forecast for Q

Figure 2: In-sample forecast for the Q series
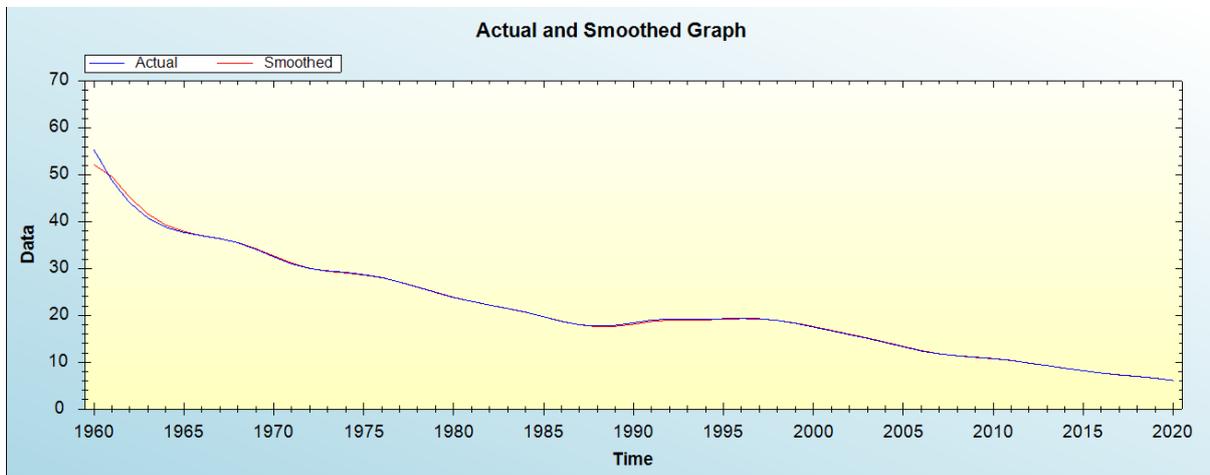
Actual and smoothed graph for Q

Figure 3: Actual and smoothed graph for Q

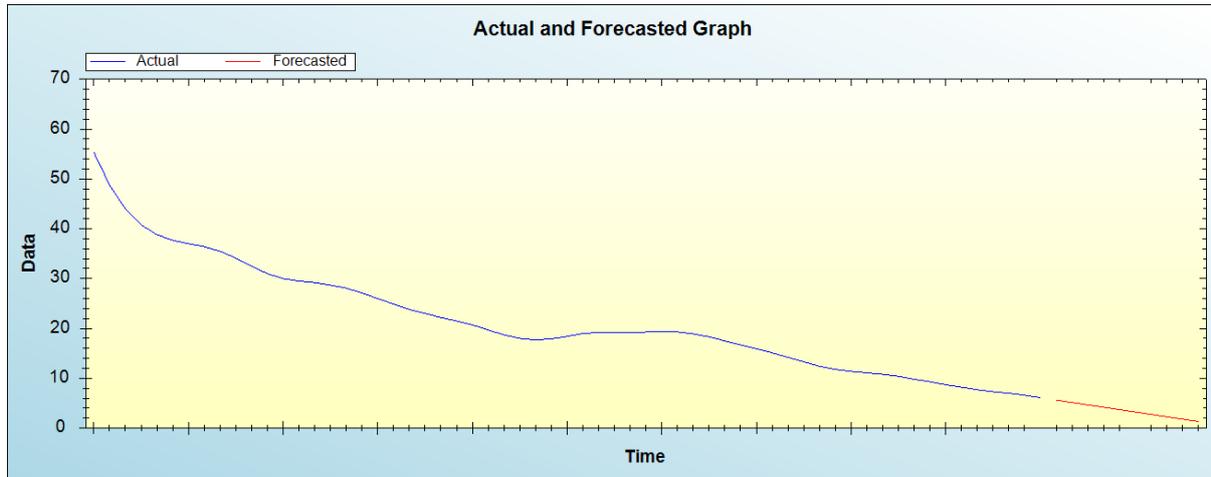Out-of-Sample Forecast for Q: Actual and Forecasted Graph

Figure 4: Out-of-sample forecast for Q: actual and forecasted graph

Out-of-Sample Forecast for Q: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	5.6221
2022	5.1450
2023	4.6679
2024	4.1908
2025	3.7137
2026	3.2367
2027	2.7596
2028	2.2825
2029	1.8054
2030	1.3284

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

Exponential smoothing is widely applied in time series forecasting problems hence in this study we applied the Holt's linear model to predict future trends of under-five mortality in Bulgaria. The findings indicate that annual U5MR will continue to decline over the out of sample period. Therefore, we encourage health authorities in Bulgaria to prioritize maternal and child health care programs in order to keep under five mortality under control.

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/sustainabl development/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] Vanessa Woog., Susheela Singh, Alyssa Browne and Jesse Philbin (2015). Adolescent Women's Need for and Use of Sexual and Reproductive Health Services in Developing Countries, pp 1-63

[8] UN (2013). Population Division, United Nations (UN) Department of Economic and Social Affairs, World Population Prospects: The 2012 Revision, New York.

[9] WHO (2014). Health for the World's Adolescents, Geneva.

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