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# Predicting Future Trends of Under Five Mortality Rate for Barbados Using Double Exponential Smoothing

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Barbados from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast performance measures indicate that the applied Holt's linear exponential smoothing model is stable in forecasting U5MR in Barbados. Optimal values of smoothing constants α and β are0.9 and0.1 respectively based on minimum MSE. The exponential smoothing model projections revealed that annual U5MR will continue to drop throughout the out of sample period. Therefore, we encourage the government of Barbados to continue channeling adequate resources to maternal and child health program activities in order to end all preventable under five deaths.**

***Keywords:*** Exponential smoothing, Forecasting, U5MR.

## I. INTRODUCTION

The 3rd sustainable development goal (SDG3) is a very important thematic area found in the agenda 2030 for sustainable development (UN, 2016; UN, 2015). It is enriched with several targets that seek to end all preventable deaths due to various causes in different regions of the world. It is meant to ensure good health and promotion of well-being for all at all ages.The objective is to derive effective strategies to prevent and control communicable and non-communicable diseases. Countries should address epidemic diseases such as TB, HIV and Malaria (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018). Barbados is a Caribbean country whose main focus is on equitable, efficient and accessible health care system within the context of its national development (Barbados, 2008). The prevalence of overweight, obesity and chronic non-communicable diseases is going up for the general population (Barbados, 2008). Newborn and under five mortality have significantly declined to levels below the set SDG targets by 2030 (World Bank, 2019; Barbados, 2012). This study proposes the Holt's linear exponential smoothing model to project future trends of under-five mortality rate in Barbados. The results are expected to inform policy, decision making and allocation of resources towards maternal and child health programs. This early surveillance tool will help to detect abnormal trends U5MR and stimulate timeous implementation of child health intervention strategies to end all preventable under five deaths.

## II. LITERATURE REVIEW

Nath *et al.* (2020) examined the effect of extreme prematurity and early neonatal deaths on infant mortality rates in England. Authors used aggregate data on all live births, stillbirths and linked infant deaths in England in 2006–2016 from the Office for National Statistic. Infant mortality decreased from 4.78 deaths/1000 live births in 2006 to 3.54/1000 in 2014 (annual decrease of 0.15/1000) and increased to 3.67/1000 in 2016 (annual increase of 0.07/1000). This rise was driven by increases in deaths at 0–6 days of life. A cross-sectional study was conducted by Biracyaza & Habimana (2019) developed a model of infant mortality and its associated risk factors in Rwanda from 2011 to 2015.The study used 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.A descriptive study was carried out by McNamara *et al.* (2018) to reveal intrapartum fetal deaths and unexpected neonatal deaths in Ireland from 2011 to 2014. Anonymised data pertaining to all intrapartum fetal deaths and unexpected neonatal deaths for the study time period was obtained from the national perinatal epidemiology centre. The findings of the study indicated that the corrected intrapartum fetal death rate was 0.16 per 1000 births and the overall unexpected neonatal death rate was 0.17 per 1000 live births. 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 $\chi 2$ test and SPSS 19.0 software. An autoregressive integrated moving average (ARIMA) model was fitted to forecast U5MRs between 2016 and 2020 using the EViews 8.0 software. The study revealed 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.

 

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## III. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of under-five mortality rate in Barbados. 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.

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

*Smoothing equation*

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

*Trend estimation equation*

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

*Forecasting equation*

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

$C_t$ is the actual value of time series at time t

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

$\alpha$ is the exponential smoothing constant for the data

$\beta$ 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 Barbados 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

Residual Analysis for the Applied Model

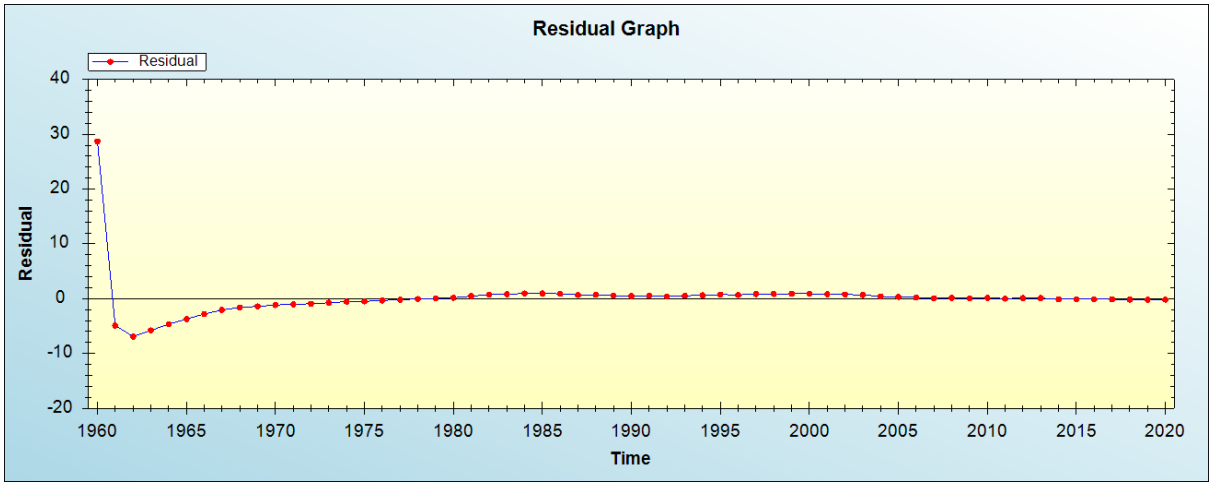


Figure 1: Residual analysis

 

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In-sample Forecast for C

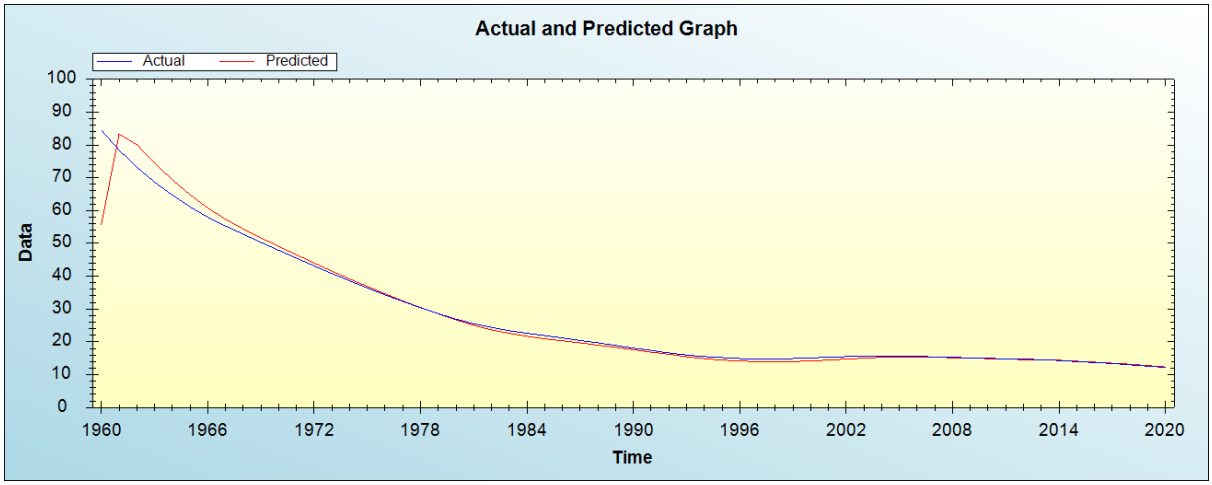


Figure 2: In-sample forecast for the C series

Actual and smoothed graph for C

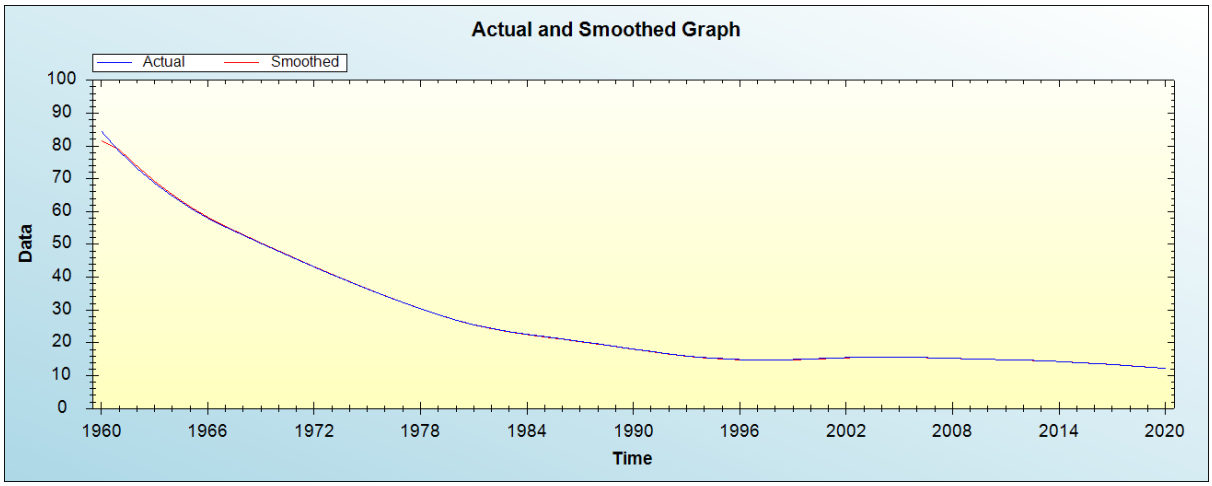


Figure 3: Actual and smoothed graph for C

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

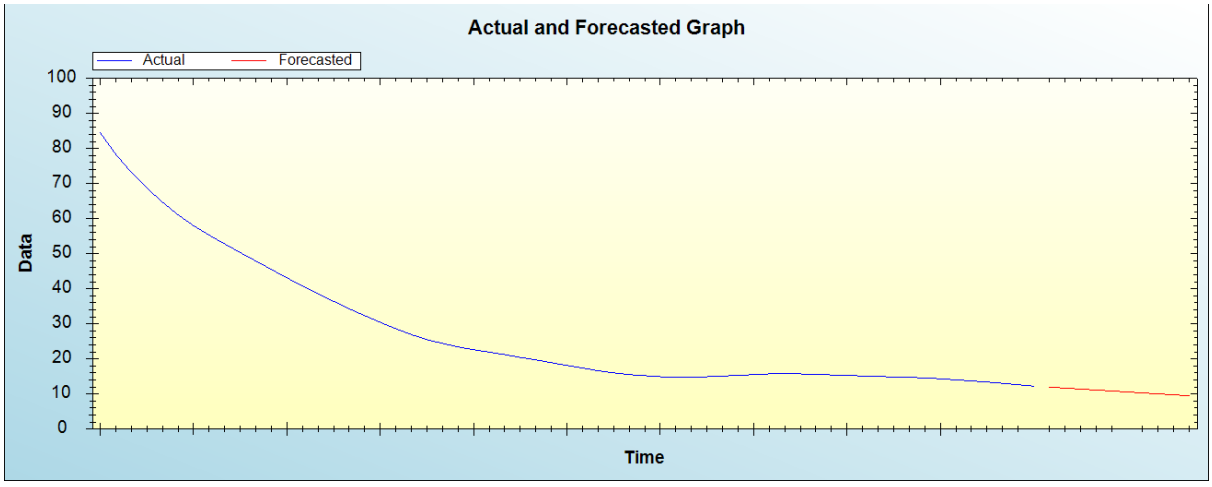


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

 

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Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| | |
|---|---|
| 2021 | 11.9404 |
| 2022 | 11.6652 |
| 2023 | 11.3899 |
| 2024 | 11.1147 |
| 2025 | 10.8395 |
| 2026 | 10.5643 |
| 2027 | 10.2891 |
| 2028 | 10.0138 |
| 2029 | 9.7386 |
| 2030 | 9.4634 |

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 throughout the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

Remarkable SDG progress has been reported by the government of Barbados as evidenced by the significant decline of under-five mortality in the country. Tracking of SDG progress through application of time series forecasting models will help detect any likely abnormal future trends of under-five mortality and stimulate early public health responses. In this study the Holt's linear method was applied to predict future trends of U5MR in Barbados and the findings showed that annual U5MR will continue to drop throughout the out of sample period. Therefore, we encourage health authorities in Barbados to continue channeling adequate resources to maternal and child health programs in the country to keep under five mortality below 25 deaths per 1000 live births.

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