

Tracking the Future Path of Under Five Mortality Rate for Canada Using Double Exponential Smoothing Model

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Canada from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that Holt's linear model is stable in forecasting U5MR in Canada. The optimal smoothing parameters α and β are 0.9 and 0.1 respectively based on minimum MSE. The findings of the study showed that annual U5MR will continue to decline over the out of sample period. Therefore we implore health authorities in Canada to design strategies that will help keep under five mortality below 25 deaths per 1000 live births.

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

September 2015 marked the beginning of the era of sustainable development goals. The 17 thematic areas covered by the outcome document defined a clear roadmap to end all forms of suffering affecting people across the globe. High on the list of global challenges were global health challenges, hunger, poverty, climate change, peace, security, human rights, education, inequalities and economic problems (UN, 2016; UN, 2015). The 3rd sustainable development goal (SDG3) has a clear focus of addressing all the major health challenges such as maternal and child health problems, preventing and treating substance abuse to improve mental health, preventing and treating epidemic diseases like TB, HIV and Malaria, and ending preventable deaths as a result of road traffic accidents and harmful chemical substances (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). Maternal health, child health and epidemic diseases remain a global issue of concern. The rates of unintended pregnancies and new HIV infections among adolescent girls and young women are becoming a global concern (Aventin *et al.* 2021). Globally approximately 170 000 adolescents aged 10-19 years were newly infected with HIV in 2019 raising alarm in many developing countries where there is a dual epidemic of HIV and TB (UNICEF, 2020). It is worrisome to note that 19 % of adolescent girls become pregnant by the time they reach 19 years of age (UNICEF, 2016) and 50% of inpatient deaths among females aged 15 years and above are as a result of complications following unsafe abortions (Mosaase & Tiebere 1996). The aim of this paper is to model and forecast future trends of under-five mortality rate in Canada using the Holt's linear exponential smoothing technique. We expect the findings of this paper to guide child health policies, planning and allocation of resources to MNCH program in order to end all preventable under five deaths in the country.

II. LITERATURE REVIEW

Zeitlin *et al.* (2020) investigated the patterns of stillbirth and neonatal mortality rates in Europe between 2004 and 2010. Data about live births, stillbirths and neonatal deaths by gestational age (GA) were collected using a common protocol by the Euro-Peristat project in 2004 and 2010. The study indicated that stillbirths and neonatal deaths declined at all gestational ages in countries with both high and low levels of mortality in 2004. 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. Dwomoh *et al.* (2019) investigated the factors contributing to the decline in child mortality throughout the MDG period. This study used Demographic and Health Surveys (DHS) from 2003, 2008 and 2014 and data from World Bank Development Indicators (2000–2018). They employed modified Poisson with robust SE and multivariate decomposition approach to assess risk factors of child mortality using DHS data from 2003, 2008 and 2014. Penalized regression was used to assess the effect of 25 country-level contextual factors on child survival. The study found that multiple births and shorter birth spacing are associated with increased risk of infant and under-five deaths over the last decade. Increased in FLFP, and the proportion of children sleeping under bed-net are associated with reduced risk of both infants and under-five deaths. 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 χ^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 E Views 8.0 software. The study concluded 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.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

Y_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 Canada 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	Y
Included Observations	61 (After Adjusting Endpoints)
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.455354
Sum Square Error (SSE)	74.294579
Mean Square Error (MSE)	1.217944

Mean Percentage Error (MPE)	1.338501
Mean Absolute Percentage Error (MAPE)	2.982211

Residual Analysis for the Applied Model

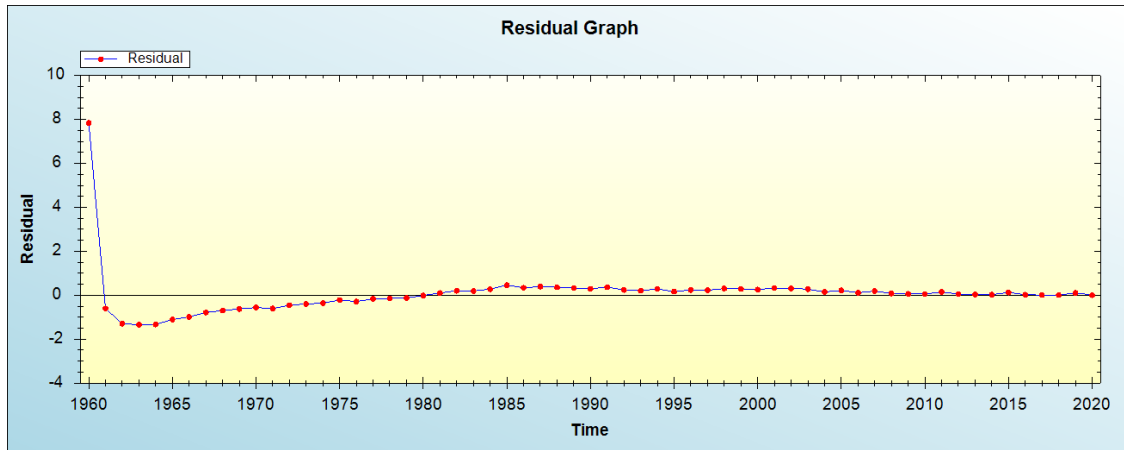


Figure 1: Residual analysis

In-sample Forecast for Y

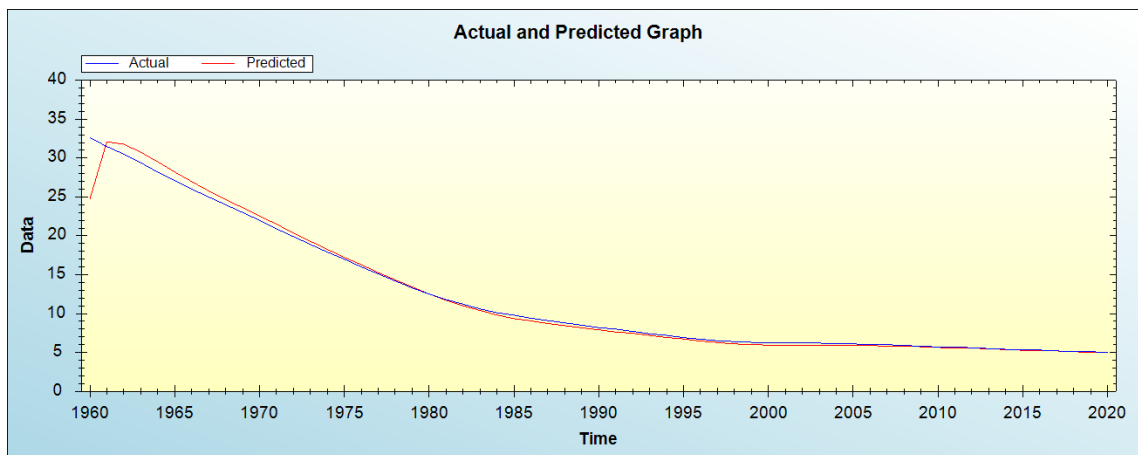


Figure 2: In-sample forecast for the Y series

Actual and Smoothed graph for Y series

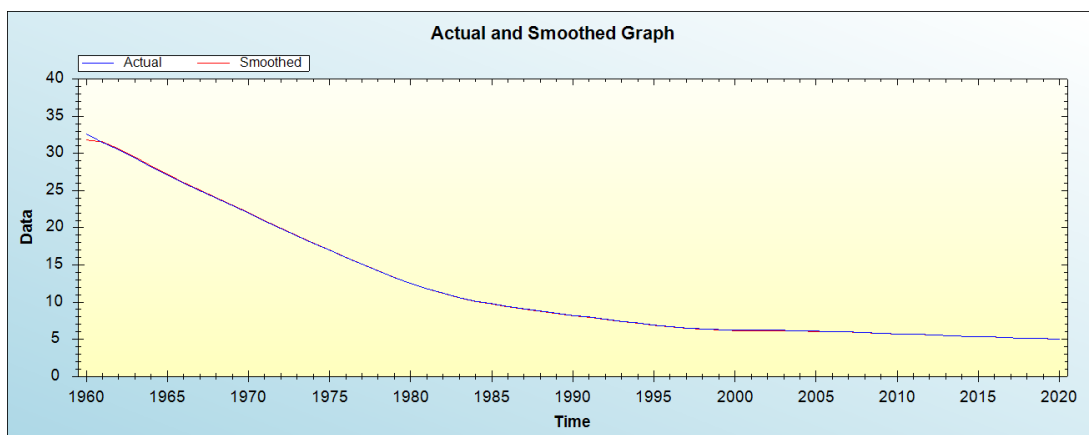


Figure 3: Actual and smoothed graph for Y series

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

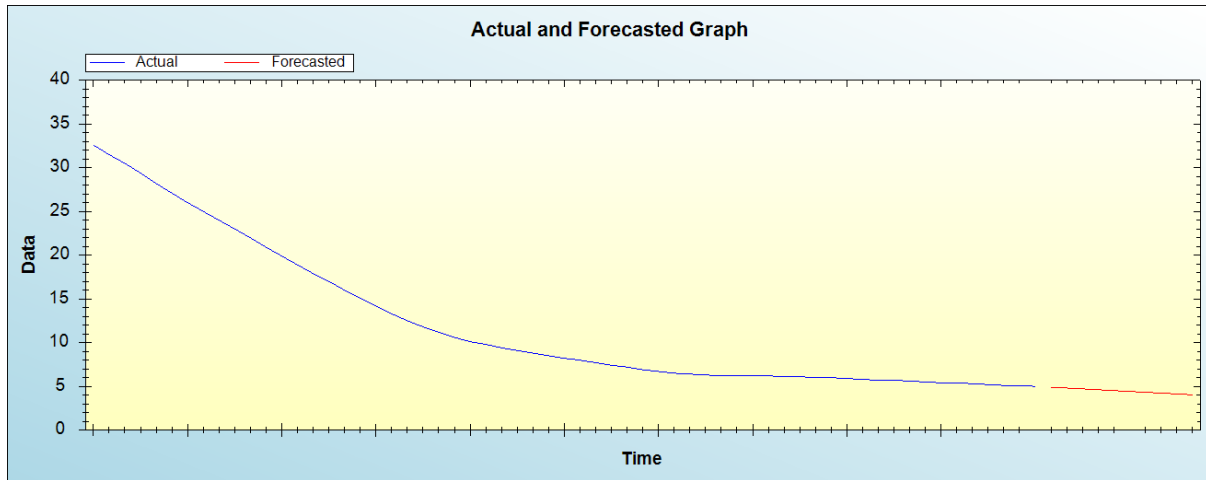


Figure 4: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	4.9033
2022	4.8072
2023	4.7112
2024	4.6152
2025	4.5192
2026	4.4232
2027	4.3272
2028	4.2312
2029	4.1352
2030	4.0392

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

By end of 2030, all UN member countries are expected to have achieved all the set SDG targets including reduction of under-five mortality to levels as low as 25 deaths per 1000 live births. Tracking future SDG progress using time series forecasting techniques will help inform policy, decision making and allocation of resources. In this study we propose the double exponential smoothing model to forecast future trends of under-five mortality rate for Canada. The model projections revealed that annual U5MR will continue to decline over the out of sample period. Hence, we encourage health authorities in Canada to design policies that will keep under five mortality rate below 25 deaths per 1000 live births.

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] Áine Aventin., Stephan Rabie., Sarah Skeen., Mark Tomlinson., Moroosi Makhetha., Zanele Siqabatiso., Maria Lohan., Mike Clarke., Lynne Lohfeld., Allen Thurston & Jackie Stewart (2021) Adaptation of a gender-transformative sexual and reproductive health intervention for adolescent boys in South Africa and Lesotho using intervention mapping, *Global Health Action*, 14:1, 1927329, DOI: 10.1080/16549716.2021.1927329
- [8] UNICEF (2020). Adolescent HIV prevention 2020. Available from: <https://data.unicef.org/topic/hivaids/adolescentsyoung-people>
- [9] UNICEF (2016). STATE OF THE WORLD'S CHILDREN 2016: a fair chance for every child. ISBN: 9789280648386. UNICEF, Available at: <https://www.unicef.org/reports/state-worlds-children-2016>
- [10] Mosaase M L., & Tlebere P (1996). Unsafe abortion and post abortion family planning in Africa: the case of Lesotho. *Afr J Fertility Sexuality Reproductive Health*, 1:26–28.

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