International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 6, Issue 7, pp 205-209, July-2022
https://doi.org/10.47001/IRJIET/2022.607042

Predicting Future Trends of Under Five Mortality Rate for Djibouti Using Double Exponential Smoothing Model

[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 Djibouti from 1976 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied model is stable in forecasting U5MR in Djibouti. The double exponential (Holt's linear) smoothing model was applied to forecast U5MR. Optimal values of smoothing parameters α and β are 0.9 and 0.1 respectively based on minimum MSE. The results of study indicate that annual U5MR will decline over the out of sample period. Therefore, authorities in Djibouti are encouraged to allocate more resources to the maternal and child health (MNCH) program. There is need to address the various challenges encountered by pediatric patients at all levels of healthcare such as healthcare costs, accessibility and need for timeous healthcare interventions.**

Keywords: Exponential, Forecasting, U5MR.

I. INTRODUCTION

Exponential smoothing methods are statistical forecasting techniques that are suitable for modelling and forecasting discrete time series data (Ostertagová & Ostertag, 2011). A time series can display features such as trend, seasonality and levels therefore an appropriate exponential smoothing technique should be chosen. If a time series does not possess a trend and seasonality, simple exponential smoothing method is the forecast method of choice. In the presence of a trend without seasonality, double exponential smoothing (Holt's linear method) is the preferred method. Holt-Winters method is suitable for modelling a time series with both trend and seasonality (Montgomery *et al.* 1990; Aczel, 1989). Exponential smoothing models can be used as early surveillance tools to track progress towards achieving sustainable development goal targets by 2030. All UN member states are expected to reduce newborn and under five mortality to as low as 12 neonatal deaths per 1000 live births and 25 under five deaths per 1000 live births by 2030 (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). In this study we apply the Holt's linear exponential smoothing technique to forecast future trends of under-five mortality in Djibouti. The findings of this study are expected to inform child health policies, planning, decision making and allocation of resources to MNCH program activities in order to end all avoidable under five deaths.

II. LITERATURE REVIEW

Iriondo *et al.* (2020) developed and validated different mortality predictive models, using Spanish data, to be applicable to centers with similar morbidity and mortality. Infants born alive, admitted in NICU, and registered in the SEN1500 database, were included. Multivariable regression models were used for the different time periods. The study concluded that using dynamic models to predict individual mortality can improve outcome estimations. Development of models in the prenatal period, first 24 hours, and during hospital admission, cover key stages of mortality prediction in preterm infants. Islam *et al.* (2020) developed a predictive analytics framework to predict the death rates with high accuracy and to find the significant determinants that cause high child mortality. The framework used an automated method of information gain to rank the information-rich mortality variables for accurate predictions. Ethiopian Demographic Health Survey and Pakistan Demographic Health Survey data sets were used for the validation of the proposed framework. These real-world data sets were tested using machine learning classifiers, such as Naı¨ve Bayes, decision tree, rule induction, random forest, and multi-layer perceptron, for the prediction task. The study concluded that Naı¨ve Bayes classifier predicts the child mortality rate with the highest average accuracy of 96.4% and decision tree helps in identifying key classification rules covering the factors behind children deaths. Khan *et al.*(2019) modelled and forecasted infant mortality rates of Asian countries in the perspective of GDP. Secondary data of IMR and GDP (PPP) from 1980 to 2015 was analyzed and forecast was done from 2016 to 2025. AR (1) was found to be suitable for all the countries except Japan and Nepal for which ARIMA (1, 1, 1) model was appropriate based on FMSE and FRMSE. An Indian study by 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,

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 6, Issue 7, pp 205-209, July-2022

https://doi.org/10.47001/IRJIET/2022.607042

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.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

J_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 Djibouti for the period 1976 – 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	J
Included Observations	45 (After Adjusting Endpoints)
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	1.104728
Sum Square Error (SSE)	243.652501
Mean Square Error (MSE)	5.414500
Mean Percentage Error (MPE)	0.114560
Mean Absolute Percentage Error (MAPE)	0.827718

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 6, Issue 7, pp 205-209, July-2022
https://doi.org/10.47001/IRJIET/2022.607042

Residual Analysis for the Applied Model

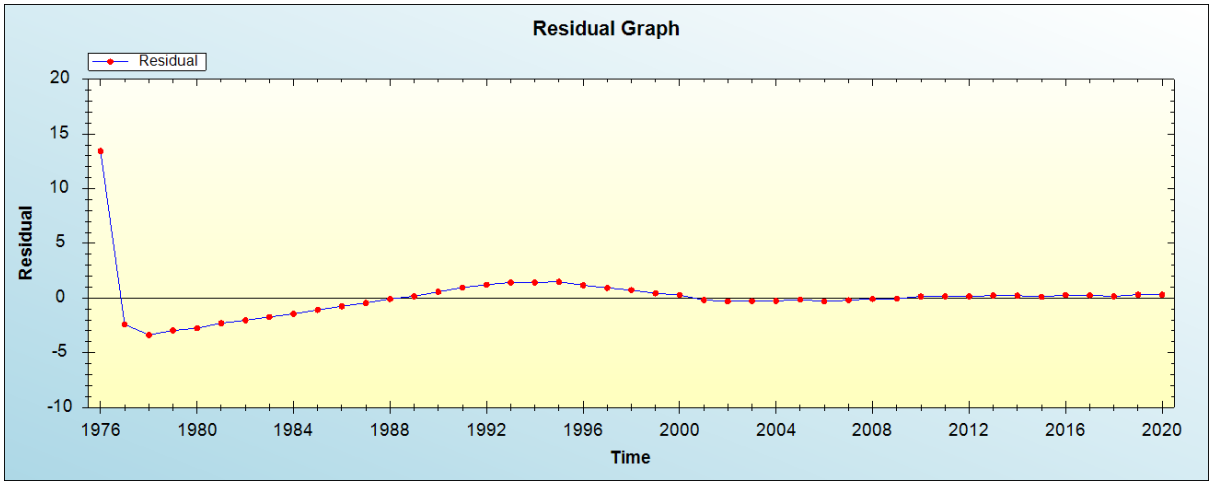

Figure 1: Residual analysis

In-sample Forecast for J

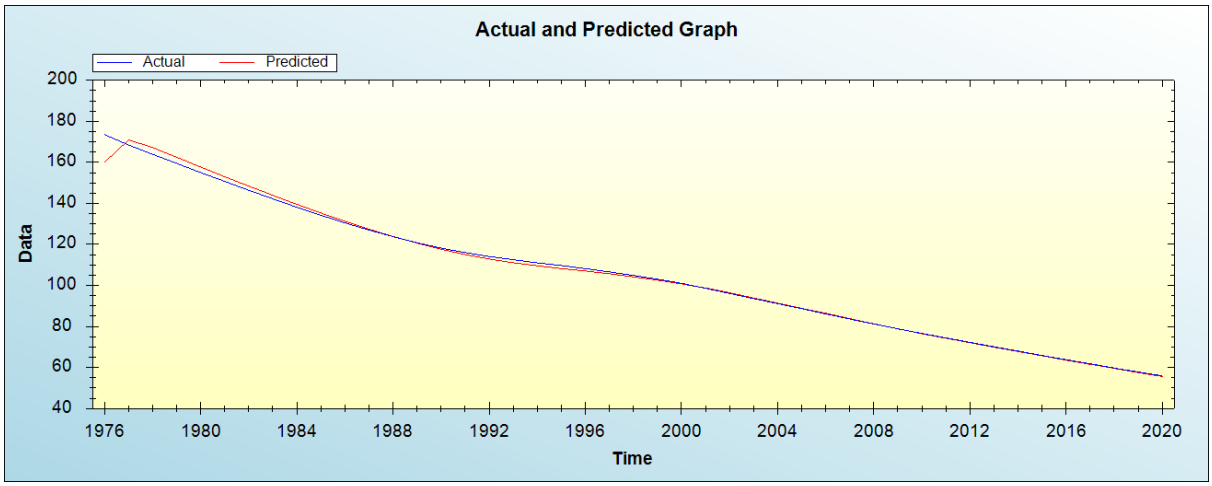

Figure 2: In-sample forecast for the J series

Actual and Smoothed graph for J series

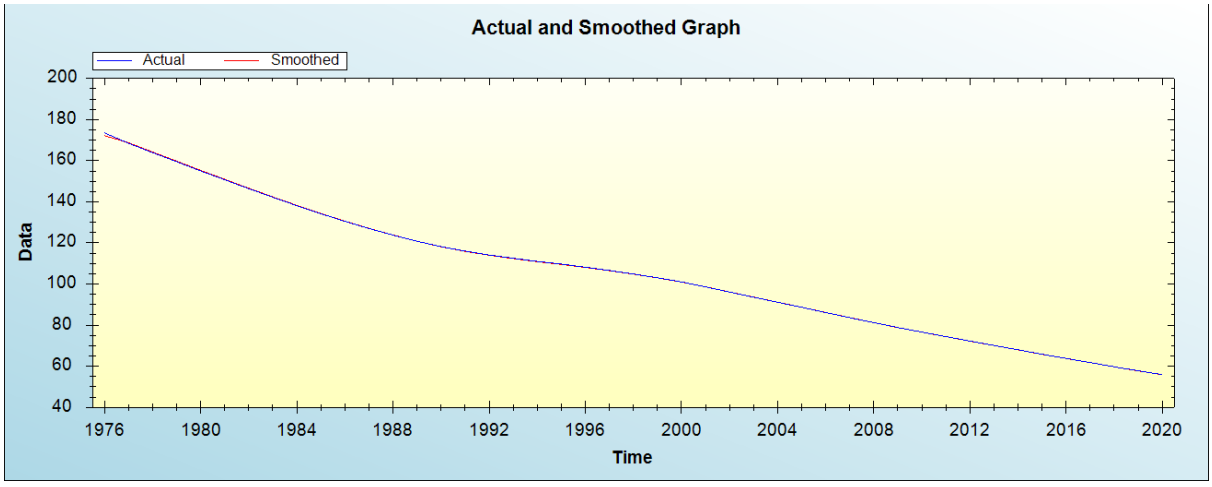

Figure 3: actual and smoothed J series

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 6, Issue 7, pp 205-209, July-2022

https://doi.org/10.47001/IRJIET/2022.607042

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

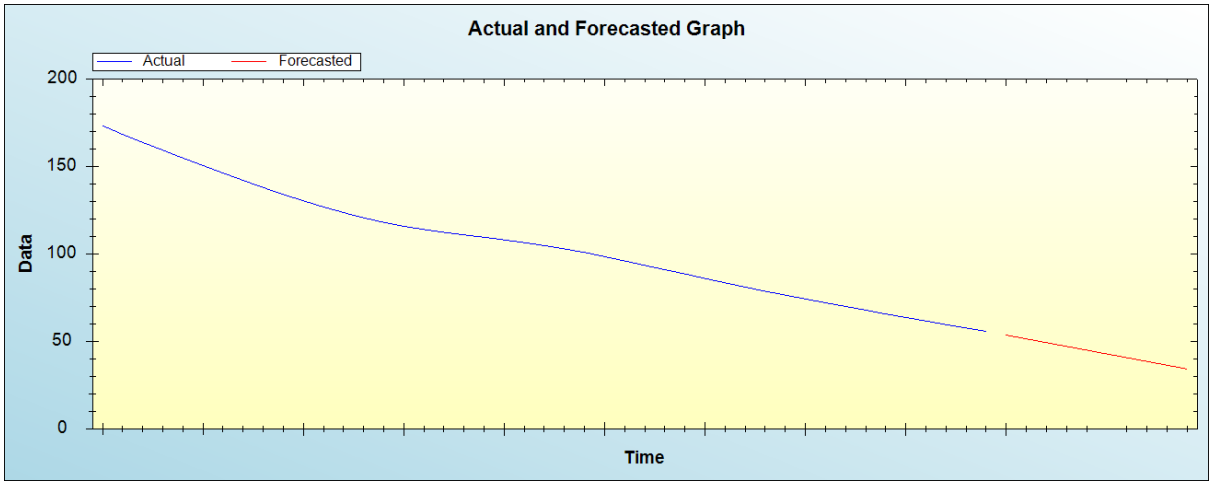

Figure 4: Out-of-sample forecast for J: actual and forecasted graph

Out-of-Sample Forecast for J: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	53.7195
2022	51.5699
2023	49.4203
2024	47.2707
2025	45.1211
2026	42.9715
2027	40.8220
2028	38.6724
2029	36.5228
2030	34.3732

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 decline over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Addressing various challenges affecting child survival is vital in order to achieve a meaningful reduction of under-five mortality. However it is crucial to utilize forecasting techniques so as to get informed policies, decisions and allocation of resources. This study applied Holt's linear exponential smoothing model to predict future trends of under-five mortality rate in Djibouti. The double exponential smoothing model projections indicate that annual U5MR will decline over the out of sample period. Therefore, we encourage authorities in Djibouti to address various challenges encountered by pediatric patients at all levels of healthcare such as healthcare costs, accessibility and need for timeous healthcare interventions.

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.

ISSN (online): 2581-3048
Volume 6, Issue 7, pp 205-209, July-2022
https://doi.org/10.47001/IRJIET/2022.607042

[7] Eva Ostertagová1and Oskar Ostertag (2011). Modelling of Mechanical and Mechatronic systems 2011, The 4th International conference, pp. 380-384.
[8] MONTGOMERY, D. C., JOHNSON, L. A., GARDINER, J. S., Forecasting and Time Series Analysis, McGraw-Hill, Inc., 1990, ISBN 0-07-042858-1
[9] ACZEL, A. D., Complete Business Statistics, Irwin, 1989, ISBN 0-256-05710-8.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Predicting Future Trends of Under Five Mortality Rate for Djibouti Using Double Exponential Smoothing Model" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 205-209, July 2022. Article DOI https://doi.org/10.47001/IRJIET/2022.607042

****

