Prediction of Under Five Mortality Rate For Libya Using Double Exponential Smoothing

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for Libya from 1960 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 under five mortality rate. Holt's linear method was applied to forecast U5MR in Libya. Optimal values of smoothing constants α and β are 0.9and 0.1 respectively based on minimum MSE. The results of the study indicated that annual U5MR will decline throughout the out of sample period. Therefore, we encourage the Libyan authorities to continue supporting the maternal and child health program to ensure availability of medical supplies and medical staff at every healthcare facility across the country.**

Keywords: Exponential smoothing, Forecasting, U5MR

I. INTRODUCTION

The current situation calls for all UN member countries to engage on an aggressive mode in the implementation of sustainable development goals (UN, 2020; UN, 2016; UN, 2015). Although significant progress has been made it is still important to continuously improve on the various SDG indicators in order to achieve the set SDG targets by 2030 (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). Maternal and child health indicators have been on a downward trajectory over the years reflecting political leadership commitment in different countries (World Bank, 2019). Global partners are continuously providing financial and technical support to MNCH programs all over the world. Despite all the efforts many developing countries are seemingly not going to realize the success they desire by 2030. Therefore, this study aims to project future trends of under-five mortality rate for Libya using the Holt's linear exponential smoothing method. This will reflect the likely future trends ofU5MR thereby informing policy, planning and allocation of resources.

II. LITERATURE REVIEW

A Kenyan study by Olack *et al.* (2021) investigated the causes of neonatal LBW and preterm mortality in Migori County, among participants of the PTBI-K (Preterm Birth Initiative-Kenya) study.Verbal and social autopsy (VASA) interviews were conducted with caregivers of deceased LBW and preterm neonates delivered within selected 17 health facilities in Migori County, Kenya. The probable cause of death was assigned using the WHO International Classification of Diseases (ICD-10). The study findings revealed that significant predictors of neonatal mortality were birth asphyxia (45.5%), neonatal sepsis (26.1%), respiratory distress syndrome (12.5%) and hypothermia (11.0%). Sougou & Diouf (2020) conducted a secondary analysis of the 2017 DHS for Senegal to analyze the factors associated with neonatal deaths in Senegal in 2017. The study results indicated that significant predictors of neonatal mortality were newborns with a low birth weight < 2500 g, newborns who are considered "very small" by their mother at birth and birth by caesarean section. Ewere & Eke (2020) examined the impact of maternal / child care characteristics on neonatal mortality in Nigeria using the logistic regression model. The study concluded that stake holders in the public health sector must improve the quality of existing health care facilities and access to quality services in order to substantially reduce neonatal mortality in the country.). Brault *et al*. (2018) examined factors contributing to the reductions in under-five mortality in Postwar Liberia by conducting a case study mixed methods approach drawing on data from quantitative indicators, national documents and qualitative interviews were used to describe factors that enabled Liberia to rebuild their maternal, neonatal and child health (MNCH) programmes and reduce under-five mortality following the country's civil war. The findings revealed that three main factors contributed to the reduction in under-five mortality: national prioritization of MNCH after the civil war; implementation of integrated packages of services that expanded access to key interventions and promoted inter-sectoral collaborations; and use of outreach campaigns, community health workers and trained traditional midwives to expand access to care and improve referrals.

A cross sectional study was conducted in Nigeria by Ezeh *et al*. (2015) to investigate factors associated with post-neonatal, infant, child and under-5 mortality in Nigeria.A multistage, stratified, cluster random sampling method was used to gather information on 63 844 singleton live-born infants of the most recent birth of a mother within a 5-year period before each survey was examined using cox regression models. The findings revealed that no formal education, poor households and living in rural areas increased the risk of post neonatal, infant, child and under-5 mortality among Nigerian children.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

A_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 Libya 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	A
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)	5.229759
Sum Square Error (SSE)	12550.178691
Mean Square Error (MSE)	205.740634
Mean Percentage Error (MPE)	2.653816
Mean Absolute Percentage Error (MAPE)	5.708491

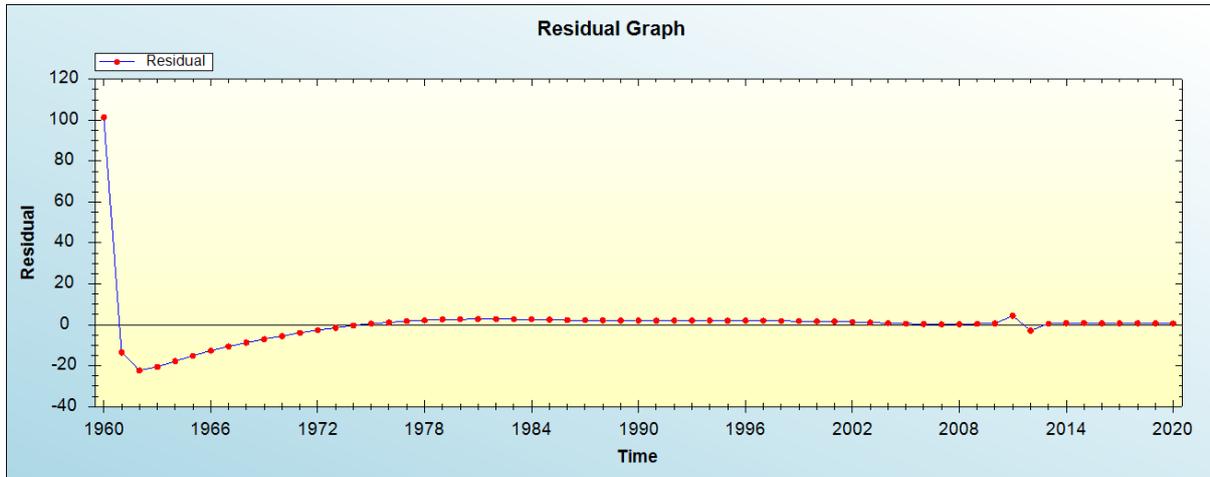Residual Analysis for the Applied Model

Figure 1: Residual analysis
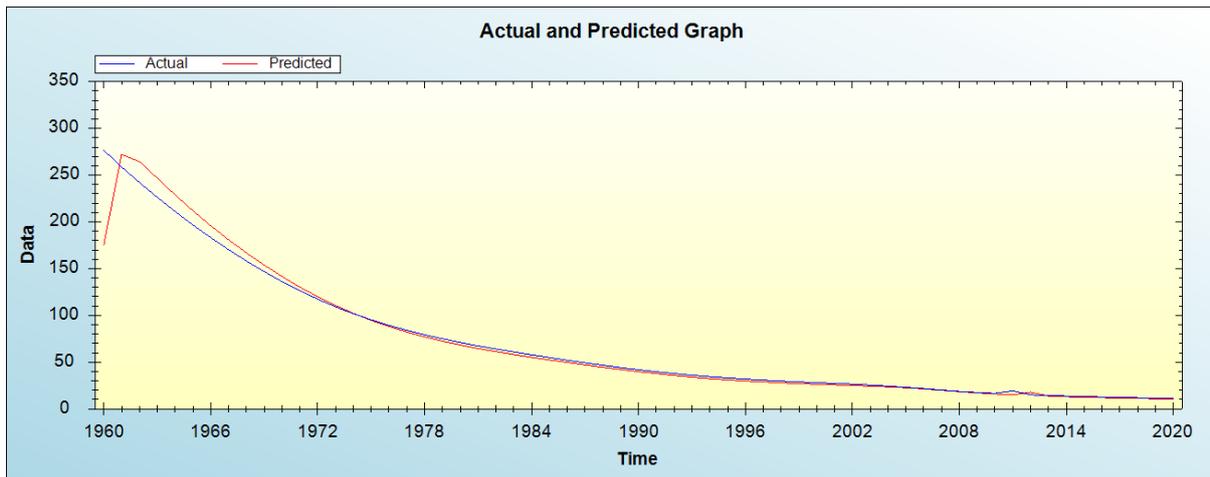
In-sample Forecast for A

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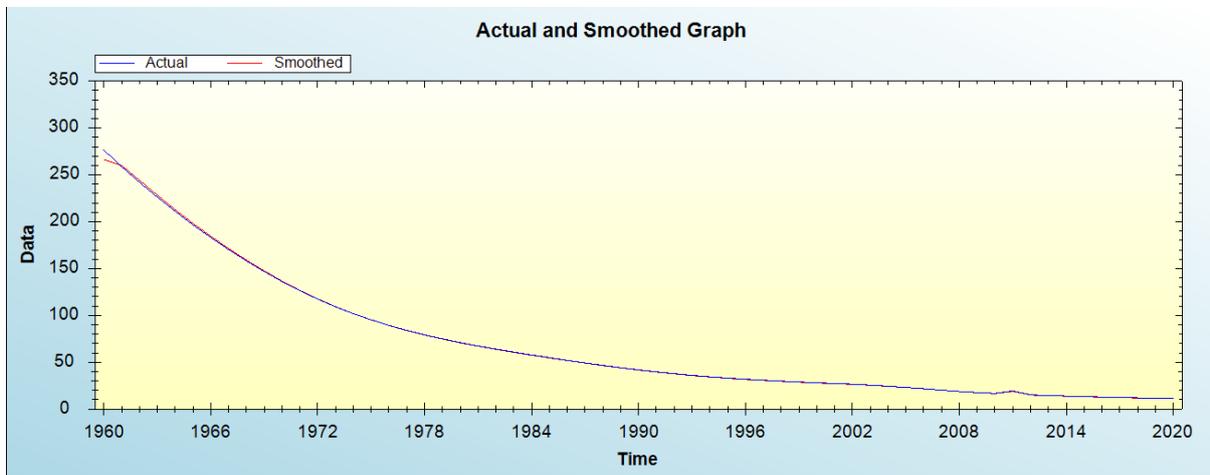
Actual and smoothed graph for A

Figure 3: Actual and smoothed graph for A

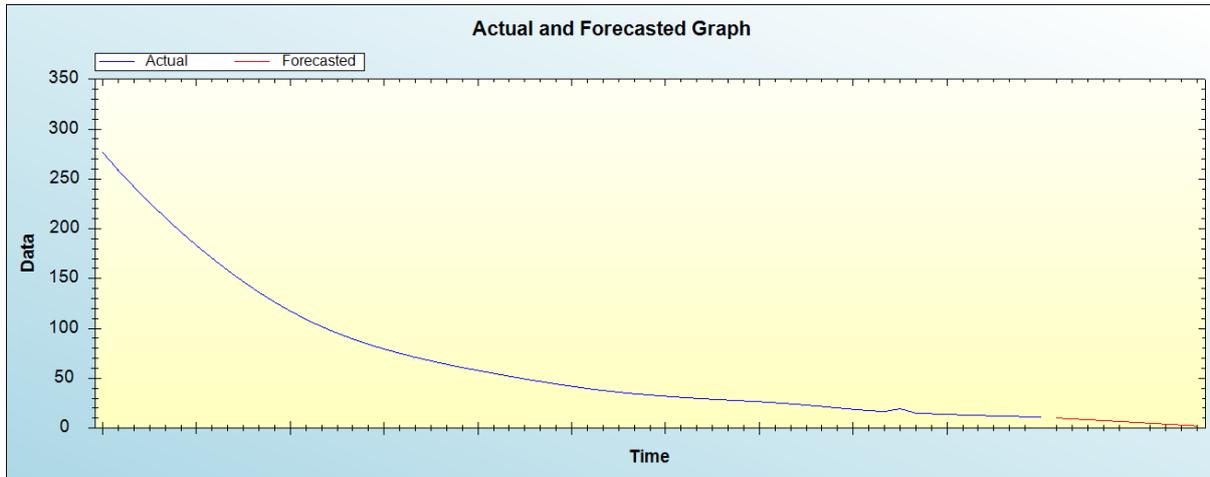Out-of-Sample Forecast for A: Actual and Forecasted Graph

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

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	10.1575
2022	9.2753
2023	8.3932
2024	7.5110
2025	6.6289
2026	5.7467
2027	4.8645
2028	3.9824
2029	3.1002
2030	2.2181

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 throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The application of time series forecasting approaches is very important in public health programming as it informs policies, decisions and allocation of resources. In this study we applied the double exponential smoothing model to predict future trends of under-five mortality in Libya. The forecast results showed that annual U5MR will decline throughout the out of sample period. Therefore, we implore Libyan authorities to continue supporting the maternal and child (MNCH) program to ensure availability of medical supplies and medical staff at every healthcare facility at all levels of healthcare.

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