

Assessing the Feasibility of Achieving Substantial Reduction of Under Five Mortality in Cameroon Using Double Exponential Smoothing Model

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Cameroon 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 Holt's linear method is stable for forecasting under five mortality in Cameroon. Optimal values of smoothing parameters α and β are 0.9 and 0.4 respectively based on minimum MSE. The exponential smoothing model projections revealed that annual U5MR will decline but remain high over the out of sample period. Therefore, we encourage the government of Cameroon to channel more resources to child health programs in order to substantially reduce under five mortality to the desired level by 2030.

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

Surveillance in the implementation of sustainable development goals (SDGs) cannot be overemphasized as this involves systematic data collection, processing, analysis, interpretation, dissemination and use of the information so that effective strategies are timeously implemented to address the existing challenges (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). The national statistical offices in every country should play a key role in coordinating all statistical program activities and demonstrate good leadership so that all the data required to guide the implementation of the global action plan are captured at all levels. It is the responsibility of individual governments to mobilize adequate resources required for carrying out statistical programs. Furthermore, national statistical offices are expected to adopt new technologies that facilitate data collection, storage, processing and coordination with subnational, regional and international levels. Adequate and accurate data informs policies, planning and decision making so that appropriate resources are allocated in time. In line with the Cape Town Global action plan and the Agenda 2030 for sustainable development, this research is conducted to model and forecast future trends of under-five mortality in Cameroon using Holt's linear method. We expect the findings to guide the implementation of maternal and child health programs in the country with the goal of achieving the set SDG3 targets.

II. LITERATURE REVIEW

Gage & Bauhoff (2020) assessed the impact of PBF on early neonatal health outcomes and associated health care utilization and quality in Burundi, Lesotho, Senegal, Zambia and Zimbabwe. Authors utilized data from Demographic and Health Surveys and Multiple Indicator Cluster Surveys and applied difference-in-differences analysis to estimate the effect of PBF projects supported by the World Bank on early neonatal mortality and low birth weight and concluded that PBF had no impact on early neonatal health outcomes in the five African countries studied and had limited and variable effects on the utilization and quality of neonatal health care. Masaba & Phetoe (2020) described the trends of neonatal mortality within the two sub-Saharan countries. The study concluded that in 2018, the neonatal mortality rate for Kenya was 19.6 deaths per 1000 live births. The neonatal mortality rate had fallen gradually from 35.4 deaths per 1000 live births in 1975. On the other hand, South Africa had its neonatal mortality rate fall from 27.9 deaths per 1000 live births in 1975 to 10.7 deaths per 1000 live births in 2018. A cross-sectional study carried out by Edem *et al.* (2020) examined the health practices, care-seeking behavior, and referral of sick out-born neonates to a district and regional hospital in the Upper West Region of Ghana. The study findings suggested that socio-cultural factors strongly influence health seeking behavior and the health outcome of neonates in this setting. A similar cross-sectional study in Ghana was done by Annan & Asiedu (2018) who applied the logit model to assess the maternal, neonatal, and health system related factors that influence neonatal deaths in the Ashanti Region, Ghana. The authors concluded that there was a high number of neonatal deaths which were mainly caused by birth asphyxia, infections, congenital anomalies and respiratory distress syndrome. Owusu *et al.* (2018) also found out that mortality at the neonatal in-patient unit at the Komfo Anokye Teaching Hospital in Ghana is very high.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

W_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 Cameroon 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	W
Included Observations	61 (After Adjusting Endpoints)
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.400
Forecast performance measures	
Mean Absolute Error (MAE)	2.465738
Sum Square Error (SSE)	1519.399343
Mean Square Error (MSE)	24.908186
Mean Percentage Error (MPE)	0.057622
Mean Absolute Percentage Error (MAPE)	1.299696

Residual Analysis for the Applied Model

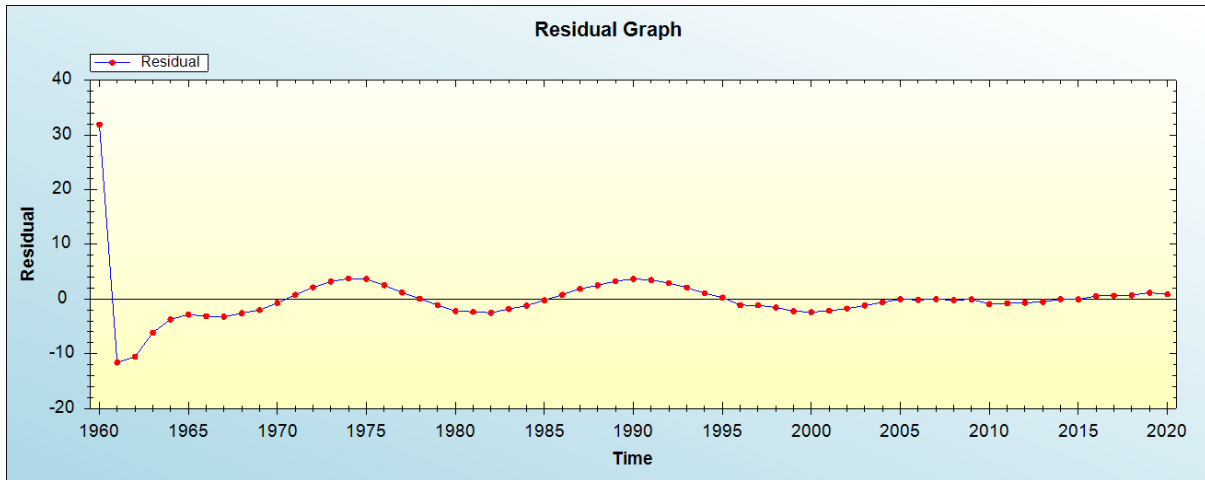


Figure 1: Residual analysis

In-sample Forecast for W

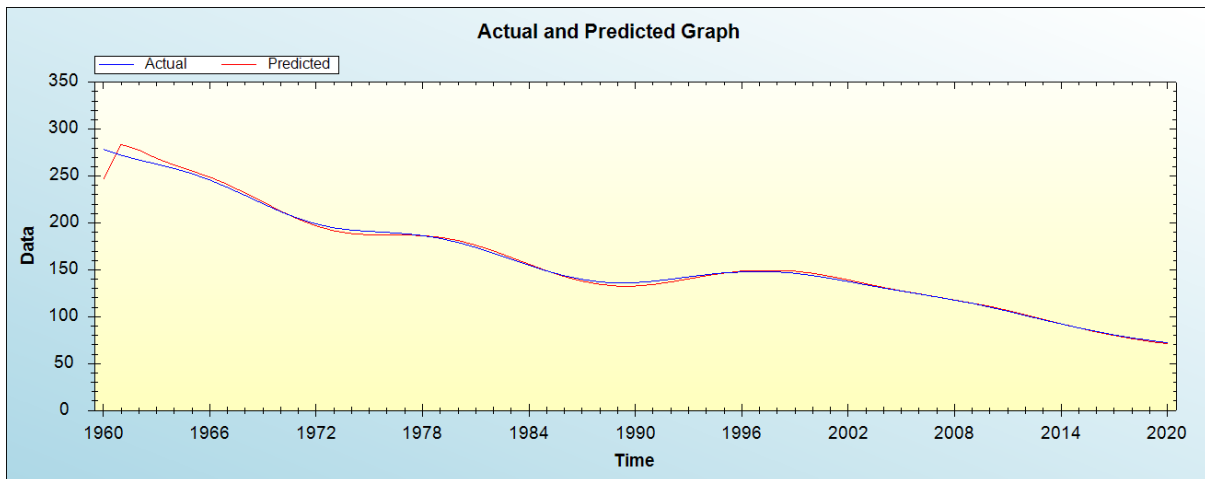


Figure 2: In-sample forecast for the W series

Actual and Smoothed W series

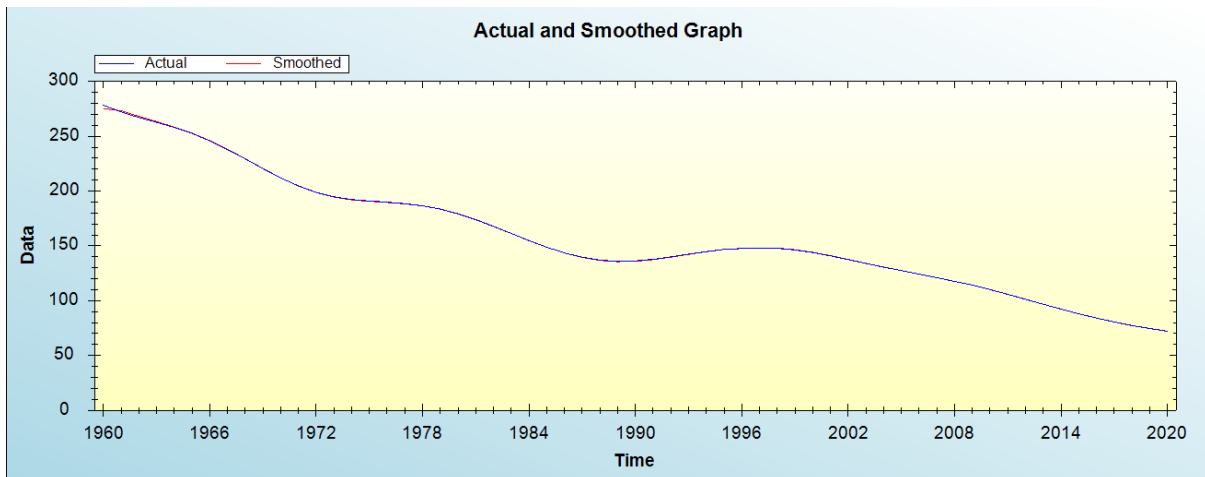


Figure 3: Actual and smoothed W series

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

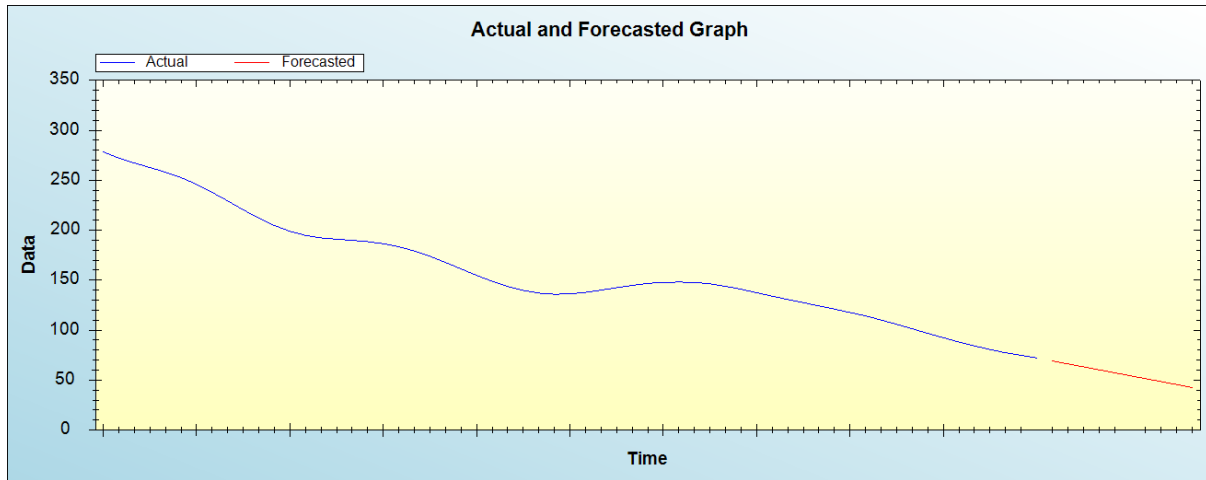


Figure 4: Out-of-sample forecast for W: actual and forecasted graph

Out-of-Sample Forecast for W: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	69.1599
2022	66.2085
2023	63.2570
2024	60.3056
2025	57.3541
2026	54.4026
2027	51.4512
2028	48.4997
2029	45.5483
2030	42.5968

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 but remain high over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Exponential smoothing models are widely applied time series forecasting models. In this study we applied the Holt’s linear method to forecast future trends of under-five mortality rate for Cameroon. The model projections indicate that annual U5MR will decline but remain high over the out of sample period. Therefore, we encourage the government of Cameroon to channel more resources to child health program activities in order to accelerate the implementation of SDG3 with the aim of substantially reducing under five deaths by 2030.

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