Tracking Central African Republic's Future Progress towards Achieving Substantial Reduction of under Five Mortality By 2030

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for the Central African Republic from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation statistics indicate that Holt's linear model is stable in forecasting U5MR in Central African Republic. Optimal values of smoothing constants α and β are 0.9 and 0.2 respectively based on minimum MSE. The exponential smoothing model projections indicate that annual U5MR will decline but still remain high throughout the out of sample period. Therefore, health authorities in the Central African Republic are encouraged to focus on addressing major drivers of under-five mortality in the country and allocate more resources to the maternal and child health program.**

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

The focus of the third sustainable development goal is to ensure good health and promotion of well-being for all at all ages (UN, 2016; UN, 2015). This SDG aims to tackle all the major health challenges affecting the human race. Sexual, reproductive, adolescent, child, mental health and family planning form the core of the 3rd sustainable development goal(UN, 2020; UNICEF, 2019; WHO,2019; UNICEF, 2018). All UN member states agreed to respect sexual and reproductive rights of women. Child marriage is regarded as violation of fundamental human rights that has a negative impact on the girls' sexual, mental, and physical well-being (UNICEF, 2015; UNFP, 2012a). Approximately 45% of women aged 20-24 are married before they reach the legal age of majority (UNICEF, 2014b). The CAF Republic has witnessed fertility transition over the period 1975 to 2020 with TFR dropping from 6.8 births per woman in 1975 to 2.8 births per woman in 2020. In 2020, the country recorded an IMR of 29 infant deaths per 1000 live births and under five mortality rate of 43.8 deaths per 1000 live births (Worldometer, 2020). By the end of 2030, CAF Republic is expected to achieve an under five mortality which is as low as 25 deaths per 1000 live births.

The objective of this paper is to project future trends of under-five mortality rate for CAF Republic using the Holt's linear exponential smoothing method with the aim of informing policy, planning and allocation of resources to end all preventable deaths among under five children by 2030.

II. LITERATURE REVIEW

Garcia *et al*. (2020) described changes over time in the use of childbirth care in Egypt, focusing on location and sector of provision (public versus private) and the content of immediate postpartum care. The authors used five Demographic and Health Surveys conducted in Egypt between 1995 and 2014 to explore national and regional trends in childbirth care. The study findings suggested that Egypt achieved large increases in the percentage of women delivering in facilities and with skilled birth attendants. However, most women and newborns did not receive essential elements of high quality immediate postpartum care.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. 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. 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. A forecasting study was carried by Nyoni & Nyoni, 2020. The study applied the Box-Jenkins ARIMA methodology to forecast neonatal deaths in Zimbabwe using annual time series data on neonatal deaths in Zimbabwe from 1966 to 2018.The ARIMA (8, 2, 0) was found to be the optimal model. The study findings revealed that the numbers of neonatal deaths per year would decline sharply over the next 25 years.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

Q_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 Central African Republic 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	Q
Included Observations	61 (After Adjusting Endpoints)
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.200
Forecast performance measures	
Mean Absolute Error (MAE)	1.979133
Sum Square Error (SSE)	1216.511216

Mean Square Error (MSE)	19.942807
Mean Percentage Error (MPE)	-0.105823
Mean Absolute Percentage Error (MAPE)	0.931499

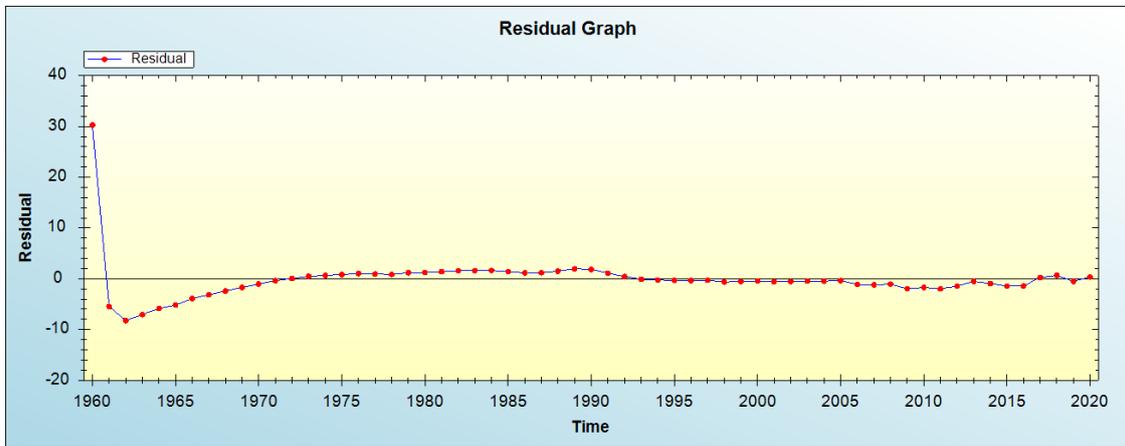Residual Analysis for the Applied Model

Figure 1: Residual analysis
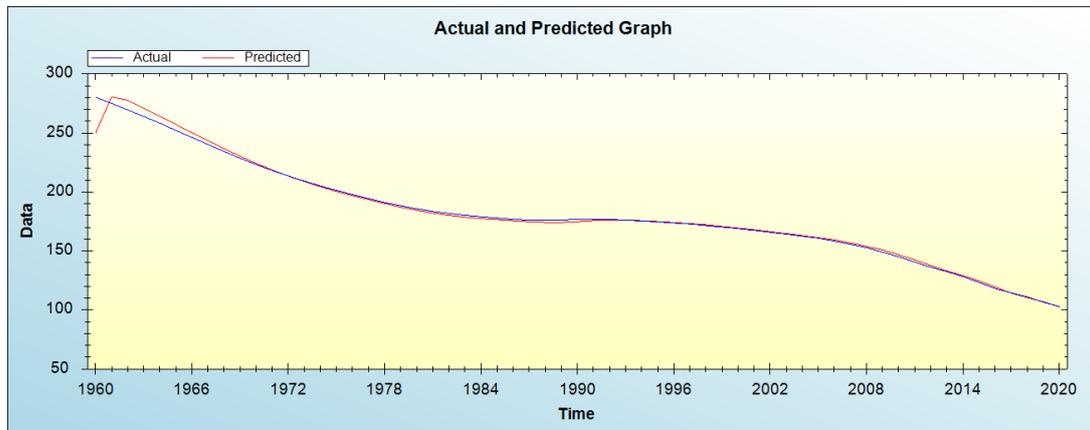
In-sample Forecast for Q

Figure 2: In-sample forecast for the Q series
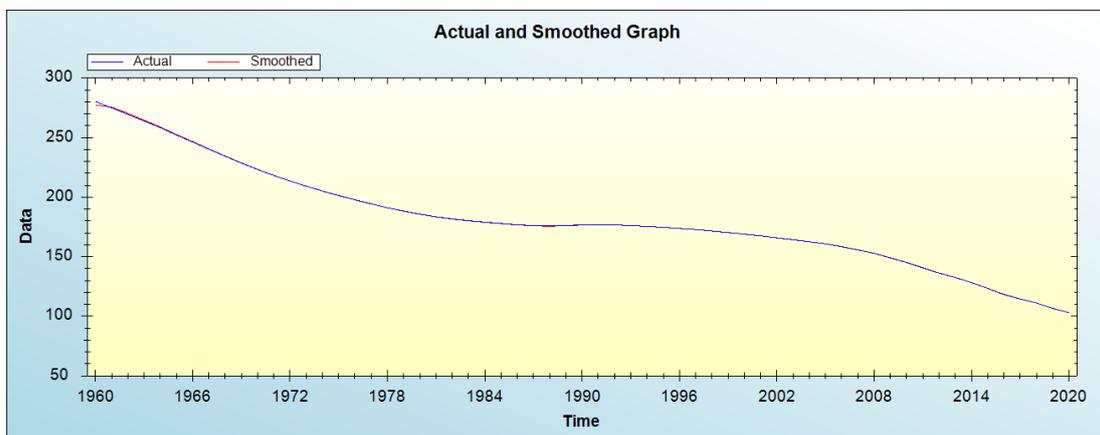
Actual and Smoothed Q series

Figure 3: Actual and smoothed Q series

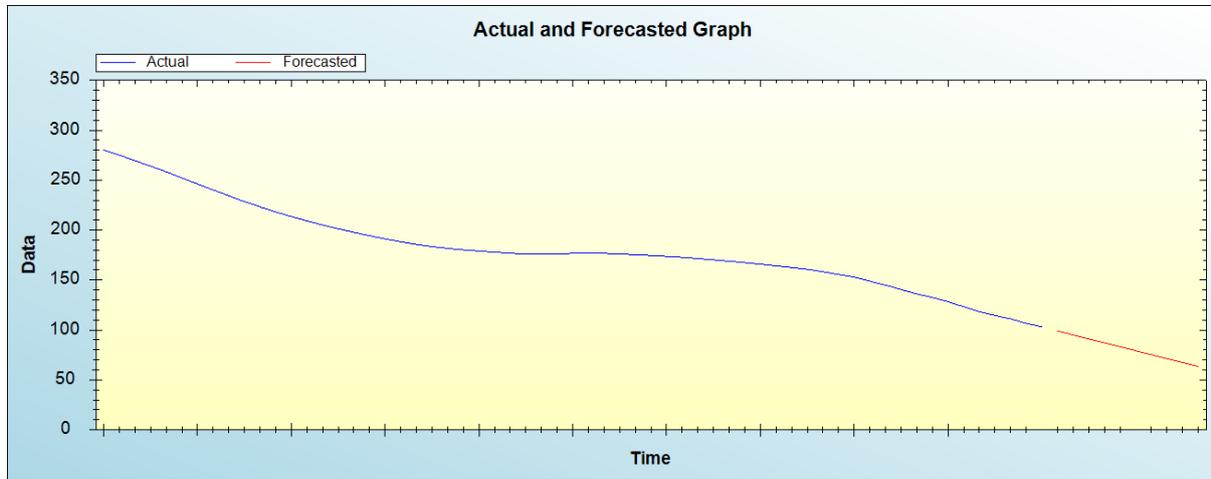Out-of-Sample Forecast for Q: Actual and Forecasted Graph

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

Out-of-Sample Forecast for Q: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	99.0147
2022	95.0657
2023	91.1166
2024	87.1676
2025	83.2186
2026	79.2696
2027	75.3206
2028	71.3716
2029	67.4226
2030	63.4736

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 still remain high throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Under-five mortality remains a public health problem across the globe. Sustainable development goal 3 (SDG-3) outlines a target for the reduction of under-five mortality to levels as low as 25 deaths per 1000 live births by 2030. Forecasting of U5MR will inform child health policies, decisions and allocation of resources. This study applies the Holt's linear model to forecast future trends of under-five mortality rate and the findings revealed that annual U5MR will decline but still remain high throughout the out of sample period. Therefore, we encourage health authorities in the country to focus on addressing the major drivers of mortality among children below five years and allocate more resources to the maternal and child health program.

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Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Tracking Central African Republic's Future Progress towards Achieving Substantial Reduction of under Five Mortality By 2030" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 153-157, July 2022. Article DOI https://doi.org/10.47001/IRJIET/2022.607031

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