

Projecting Future Trends of Under Five Mortality Rate For Kuwait Using Holt's Linear Method

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Kuwait 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 in Kuwait. Holt's linear exponential smoothing model was applied in this paper to project under five mortality rate. Optimal values of smoothing constants α and β are 0.9 and 0.1 respectively based on minimum MSE. The results of the study indicate that annual U5MR will continue to drop over the out of sample period. Hence, authorities in Kuwait should create local strategies that will effectively address the various issues that contribute significantly to mortality among under five children.

Keywords: Exponential smoothing, Forecasting, U5MR

I. INTRODUCTION

The unity and commitment demonstrated by all UN member countries in crafting the agenda 2030 for sustainable development was commendable. All the signatories to the outcome document agreed to end all suffering being experienced by different populations across the globe (UN, 2016; UN, 2015). It was recognized that the implementation of the global action plan requires a collaborative approach. Furthermore, political leadership involvement is very important in order to get the desired results in time. It was agreed that sustainable development goals must be incorporated into national plans and budgets. A lot of emphasis was put on the importance of strengthening statistical ecosystems in various countries and at all levels. Data capturing should be detailed as much as possible to inform policies, decisions and allocation of resources. Tracking of SDG progress should be ongoing and must target every component of the global action plan (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). This paper narrows its focus on SDG target 3.2 which aims at the substantial reduction of newborn and under five mortality to levels as low as 12 neonatal deaths per 1000 live births and 25 under five deaths per 1000 live births by 2030. This study applies the Holt's linear exponential smoothing method to model and forecast future trends of under-five mortality rate in Kuwait. We anticipate that the results of this study will trigger a quick response to the challenge of under five deaths in the country.

II. LITERATURE REVIEW

Li *et al.* (2021) examined the proportion of mothers with history of neonatal deaths using the most recent Demographic and Health Surveys from 56 low- and middle-income countries. Logistic regression models were used to assess the association between maternal history of neonatal death and subsequent neonatal mortality. The adjusted models controlled for socioeconomic, child, and pregnancy-related factors. Country-specific analyses were performed to assess heterogeneity in this association across countries. Study findings suggested that maternal history of neonatal death could be an effective early identifier of high-risk pregnancies in resource-poor countries. In another study by Khader *et al.* (2021) explored the healthcare professionals' perception about the usability of JSANDS. A descriptive qualitative approach, using focus group discussions, was adopted. A total of 5 focus groups including 23 focal points were conducted in five participating hospitals in Jordan. The study findings revealed that JSANDS was perceived positively by the current users. According to them, it provides a formative and comprehensive data on stillbirths and neonatal deaths and their causes. 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. 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 stakeholders 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. Nathet *et al.* (2020) examined the effect of extreme prematurity and early neonatal deaths on infant mortality rates in England. Authors used aggregate data on all live births, stillbirths and linked infant deaths in England in 2006–2016 from the Office for National Statistics. Infant mortality decreased from 4.78 deaths/1000 live births in 2006 to 3.54/1000 in 2014 (annual decrease of 0.15/1000) and increased to 3.67/1000 in 2016 (annual increase of 0.07/1000). This rise was driven by increases in deaths at 0–6 days of life.

III. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of under-five mortality rate in Kuwait. 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 Kuwait 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	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	2.576639
Sum Square Error (SSE)	3355.376174
Mean Square Error (MSE)	55.006167
Mean Percentage Error (MPE)	3.350928
Mean Absolute Percentage Error (MAPE)	5.687456

Residual Analysis for the Applied Model

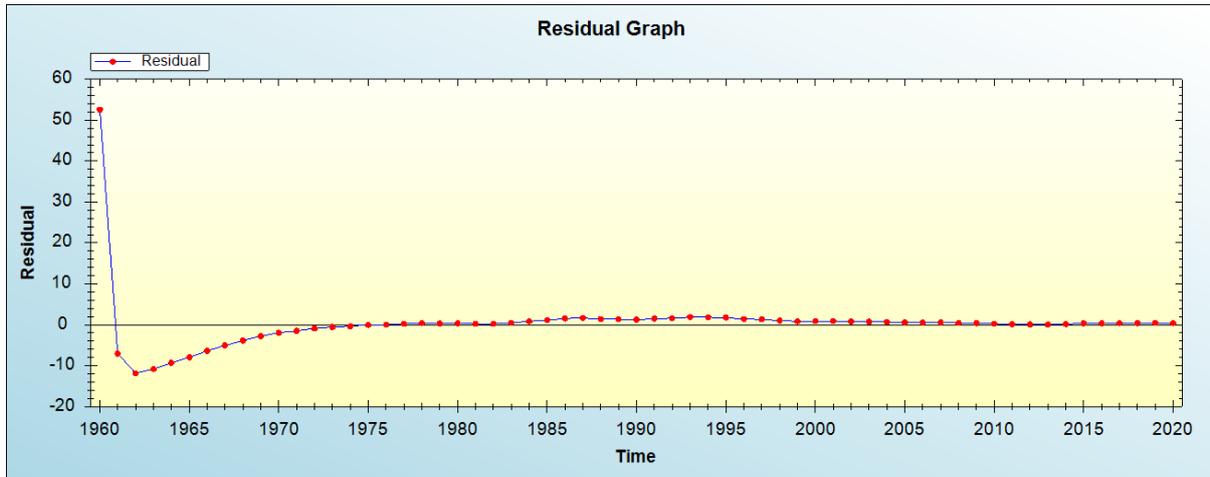


Figure 1: Residual analysis

In-sample Forecast for W

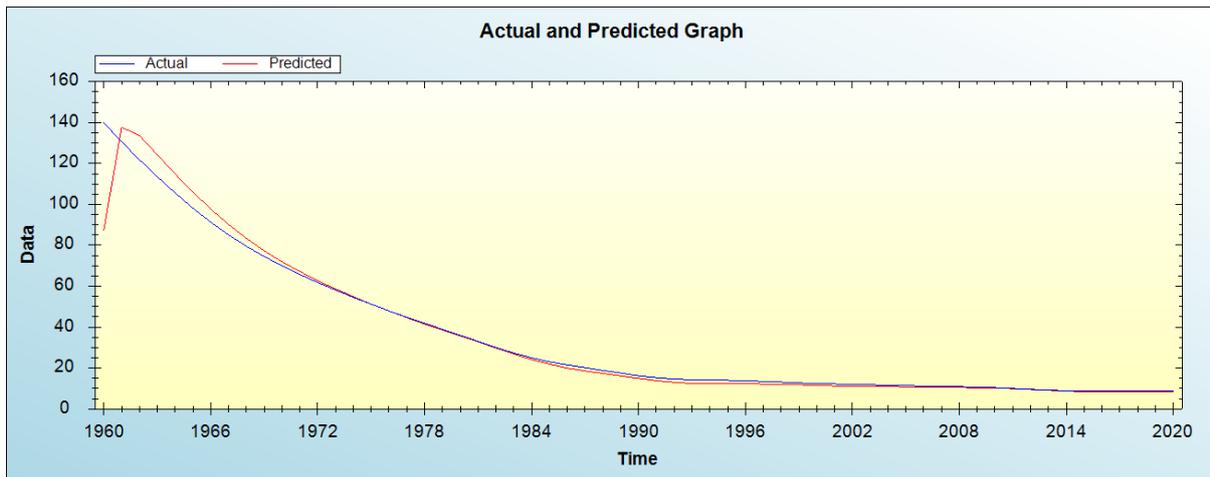


Figure 2: In-sample forecast for the W series

Actual and smoothed graph for W

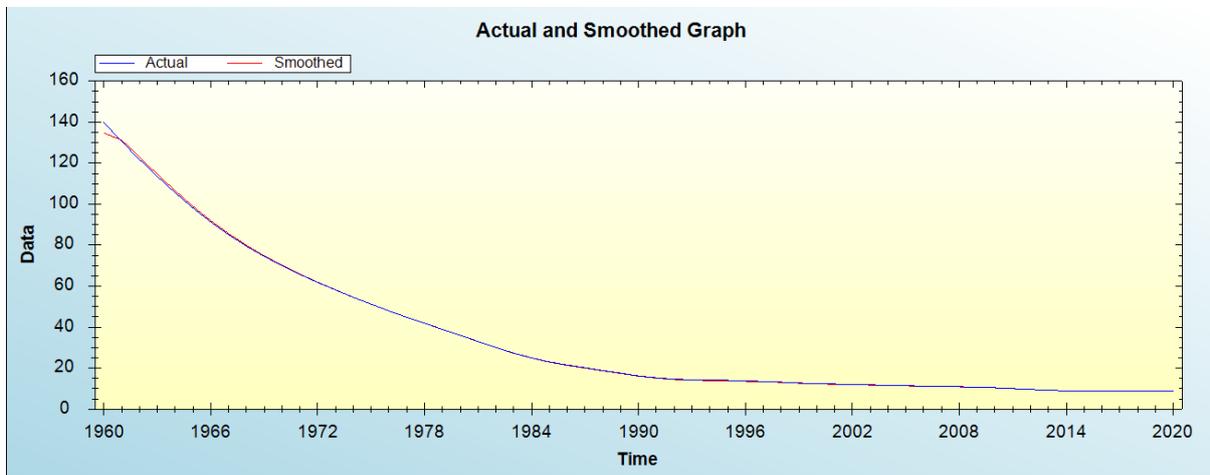


Figure 3 Actual and smoothed graph for W

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

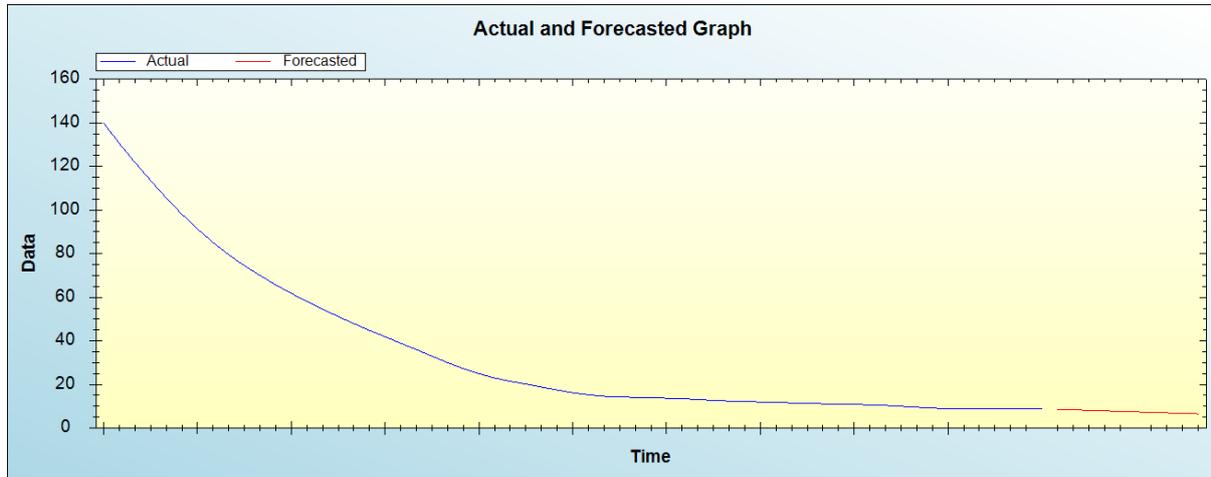


Figure 4: Out-of-sample forecast for W: actual and forecasted graph

Out-of-Sample Forecast for W: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	8.6271
2022	8.3955
2023	8.1639
2024	7.9323
2025	7.7007
2026	7.4692
2027	7.2376
2028	7.0060
2029	6.7744
2030	6.5428

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 drop over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The focus of SDG3 is to ensure good health for all at every stage of life. The government of Kuwait has made significant progress towards achieving all the set targets outlined under SDG3. The country has recorded a downward trend in under five mortality rate over the past decades. This study applied Holt’s linear method to project future trends of under-five mortality rate for Kuwait. The results of this paper showed that annual U5MR will continue to drop over the out of sample period. Hence, we implore health authorities in Kuwait to draft local strategies that will effectively address all the major health challenges that significantly contribute to mortality among under five children.

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