Tracking Haiti'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 for Haiti from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residual and forecast evaluation criteria indicate that the applied Holt's linear model is stable in forecasting under five mortality rate in Haiti. Optimal values of smoothing constants α and β are 0.2 and 0.1 respectively based on minimum MSE. The double exponential smoothing model projections revealed that annual U5MR will decline but still remain high over the out of sample period. Therefore, we encourage the government of Haiti to focus on channeling more resources to the maternal and child health (MNCH) program to ensure availability of adequate medical supplies and staff especially in the rural areas. The government should address all the major factors that significantly contribute to under five mortality.**

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

Haiti is a low-middle income country with a high burden of maternal and neonatal mortality rates in the Americas (UNICEF, 2020; WHO, 2017; WHO, 2016). The country faces numerous health and economic challenges (Jacobs *et al*. 2016; Ramachandran *et al*. 2015). Above 50% of the Haitian population lives below the poverty datum line of below USD 2.41per day (World Bank, 2015). Lack of access to health services, poor road infrastructure and shortage of skilled medical staff are among the problems that contribute significantly to the adverse maternal and child health outcomes (Schuurmans *et al*. 2021). The introduction of sustainable development goals in September 2015 by all UN member states and Stakeholders was a serious commitment demonstrated by all states to fight modern time poverty, hunger, health challenges and other kinds of deprivations affecting different populations across the globe (UN, 2015). Global population health remains at the core of the Agenda 2030 for sustainable development and all countries are directing their resources and efforts towards sustainable development goals 3 which is clearly the top priority in recent times where mortalities from preventable diseases is among the trending stories in international media. SDG 3 focuses on ensuring healthy lives and promotion of well-being for all at all stages of life (WHO, 2019). This goal can be achieved by implementing strategies that address a wide range of issues like poverty and hunger eradication, universal education, peace and security, respect for international law and justice, universal health coverage and access to quality healthcare and stimulating economic growth through appropriate fiscal policies (UN, 2020; UNICEF, 2019; UN, 2016; UN, 2015). High maternal, newborn and under five deaths have always defined the health systems of many developing countries due to several issues which remain unattended as a result of lack of political will and lack of financial resources among other reasons. Tracking SDG 3 is essential for planning and resource allocation, hence this study is carried out in line with vision 2030, to forecast future trends of under-five mortality in Haiti using Holt's linear exponential smoothing model with the aim of informing policy and decision making so that appropriate measures are put in place to control under five mortality.

II. LITERATURE REVIEW

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 revealed that socio-cultural factors strongly influence health seeking behavior and the health outcome of neonates in this setting. Taha *et al.* (2020) investigated the prevalence of and factors associated with preterm birth and LBW among mothers of children under two years in Abu Dhabi, United Arab Emirates. Data were collected in clinical and non-clinical settings across various geographical areas in Abu Dhabi. The data were analyzed using both descriptive and inferential statistics. A total of 1610 mother–child pairs were included in the study. The study found that factors that were positively associated with preterm birth were Arab mothers, maternal education level below secondary, caesarean section, and LBW. LBW was associated with female children, caesarean section (CS), first child order, and preterm birth. Caluza (2018) utilized data mining technique using decision tree called J48 algorithm in classifying child mortality rate, life expectancy at birth, annual population growth, and the gross domestic product. The study findings revealed that annual population growth is highly correlated in predicting child mortality and generate three distinct rules. The generated model had high acceptability with 97.4% ROC curve result of the three classes in predicting child mortality under five years old. An ecological study by Kayode *et al*. (2017) investigated the variation in neonatal mortality

and identified underlying causes of variation in neonatal mortality in sub-Saharan Africa (SSA). The study utilized 2012 publicly available data from WHO, the US Agency for International Development and the World Bank. Variation in neonatal mortality across 49 SSA countries was examined using control chart and explanatory spatial data analysis. Associations between country-level characteristics and neonatal mortality were examined using linear regression analysis. The findings showed that there was a wide variation in neonatal mortality in SSA. A substantial part of this variation can be explained by differences in the quality of healthcare governance, prevalence of HIV and socioeconomic deprivation.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

H_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 Haiti 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	H
Included Observations	61 (After Adjusting Endpoints)
Smoothing constants	
Alpha (α) for data	0.200
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	7.230686

Sum Square Error (SSE)	19876.993832
Mean Square Error (MSE)	325.852358
Mean Percentage Error (MPE)	-0.148258
Mean Absolute Percentage Error (MAPE)	5.395305

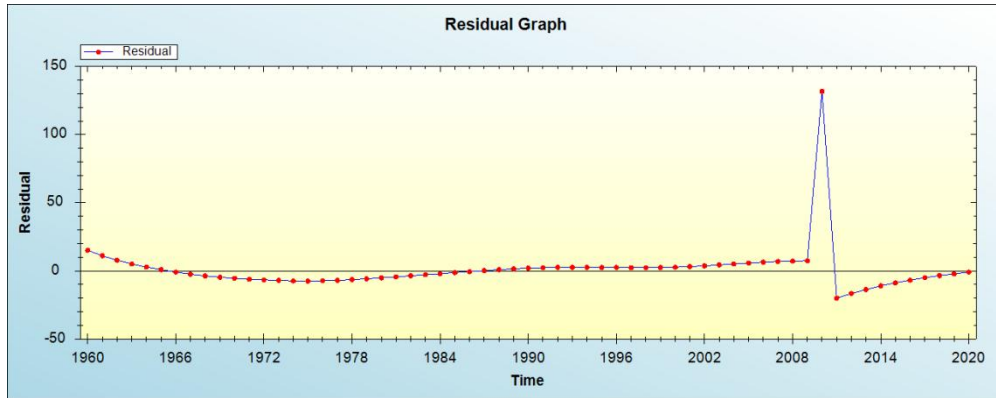Residual Analysis for the Applied Model

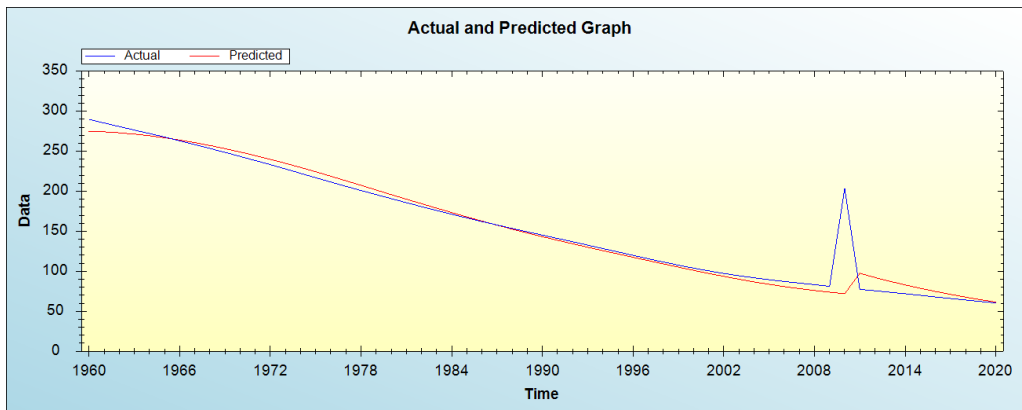Figure 1: Residual analysis

In-sample Forecast for H

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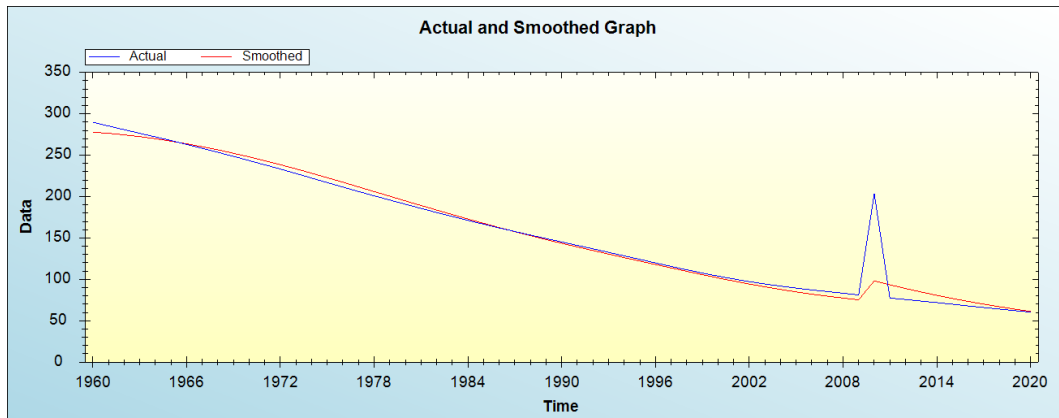
Actual and smoothed graph for H

Figure 3: Actual and smoothed graph for H

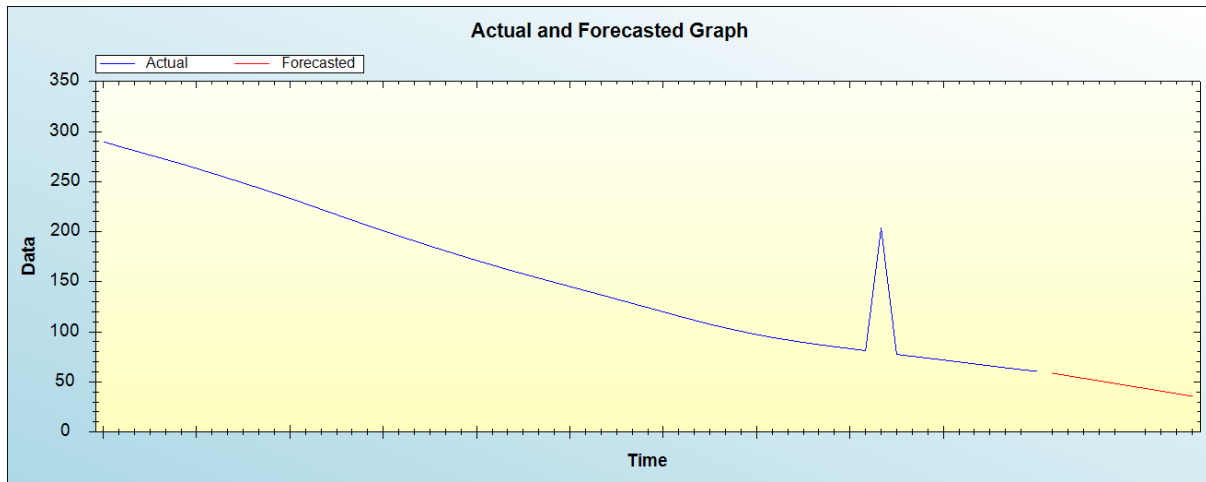Out-of-Sample Forecast for H: Actual and Forecasted Graph

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

Out-of-Sample Forecast for H: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	58.6989
2022	56.1434
2023	53.5879
2024	51.0324
2025	48.4769
2026	45.9214
2027	43.3659
2028	40.8104
2029	38.2550
2030	35.6995

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 over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Developing countries are struggling to control under five mortality. Several factors have been identified as predictors of mortality among under five children such as socio-demographic factors and health system related factors. Governments should attempt to solve this public health problem by addressing all these contributing factors. In this study we applied the Holt's linear method to predict under five mortality rate in Haiti and the model projections revealed that annual U5MR will decline but still remain high over the out of sample period. Therefore, we encourage the Haitian authorities to channel more resources to the maternal and child health (MNCH) program to ensure availability of medical staff and supplies especially in the rural areas.

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