

Forecasting Under Five Mortality Rate for Venezuela Using Double Exponential Smoothing (HOLT)

¹Dr. Smartson. P. NYONI, ²Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Venezuela from 1960 to 2020 to predict future trends of Venezuela over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied the Holt's linear method is stable in forecasting under five mortality rate. Optimal values of smoothing parameters α and β are 0.5 and 0.1 respectively based on minimum MSE. The double exponential smoothing model projections revealed that annual U5MR will increase throughout the out of sample period. Therefore, we encourage health authorities in Venezuela to address all the various issues that affect the quality of the maternal and child health program at all levels of healthcare.

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

Ensuring health lives and promotion of well-being for all at all stages of life is the main objective of the third sustainable development goal (UN, 2016; UN, 2015). It was highlighted by all UN member states in 2015 that it was high time for all countries to adopt an aggressive approach towards addressing the current global challenges such as poverty, hunger, educational & health needs, and climate change. Global population health is highly interlinked with other sustainable development goals hence achievement of SDG3 depends on the progress made on achieving these health related SDGs. SDG3 has a list of targets of which target 3.1 and 3.2 focus on maternal, neonatal and child health. Target 3.1 aims to achieve a substantial decline in maternal mortality to less than 70 deaths per 100 000 live births by 2030 and target 3.2 aims to reduce neonatal and under five mortality to as low as 12 deaths per 1000 live births and 25 deaths per 1000 live births respectively by 2030 (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018; Gulmezoglu *et al.* 2016). Monitoring and tracking progress towards achieving the set targets by 2030 is among the key pillars of the Agenda 2030 for sustainable development, hence in this study we apply double exponential smoothing (Holt) to model and forecast future trends of under-five mortality rate in Venezuela. The findings of this research are anticipated to reveal likely future trends of U5MR so as to inform maternal and child (MNCH) policies, planning and allocation of resources to the maternal and child health program.

II. LITERATURE REVIEW

Reis *et al.* (2021) evaluated the fetal and infant mortality rates due to congenital anomalies (CA) in Maranhão from 2001 to 2016 in Brazil. Data were obtained from the SINASC, and SIM databases. The study utilized simple linear regression, Poisson distribution, and ANOVA (Bonferroni's post hoc test) and analyzed the public data (2001–2016) of 1934858 births and determined the fetal, neonatal, perinatal, and post-neonatal mortality rates associated with CA by mesoregions. The results revealed that mortality rates due to CA in Maranhão increased over the period 2001–2016 possibly as a result of improved maternal-infant health conditions eliminating other causes of death. Das & Chakraborty (2021) investigated the influence of both individual and community level factors on neonatal death in Bangladesh. The study employed data from Bangladesh Demographic and Health Survey 2014. Bivariate analysis was used to examine the differentials in neonatal mortality by selected background variables of both levels. Multilevel logistic model confirmed that there exists clustering impact on neonatal death. An interrupted time series analysis was done by MacDonald *et al.* (2021) to determine if the new maternity unit brought about improvements in maternal and neonatal outcomes using data collected between July 2016 and October 2019 including 20 months before the opening of the maternity unit and 20 months after. Authors examined maternal neonatal outcomes such as physiological (vaginal) births, caesarean birth, postpartum hemorrhage (PPH), maternal deaths, stillbirths and undesirable outcomes (eclampsia, PPH, perineal laceration, postpartum infection, maternal death or stillbirth). The study concluded that the new maternity unit led to an upward trend in caesarean births yet an overall reduction in all undesirable maternal and neonatal outcomes. Raymondville *et al.* (2020) conducted a convergent, mixed methods study to assess barriers and facilitators to facility based childbirth at Hôpital Universitaire de Mirebalais (HUM) in Mirebalais, Haiti. A secondary analyses of a prospective cohort of pregnant women seeking antenatal care at HUM was performed and quantitatively assessed predictors of not having a facility-based childbirth at HUM. The study also prospectively enrolled 30 pregnant women and interviewed them about their experiences delivering at home or at

HUM. It was found that living further from the hospital, poverty and household hunger were associated with not having a facility-based childbirth. Primigravid women were more likely to have a facility-based childbirth.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

C_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 Venezuela 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	C
Included Observations	61 (After Adjusting Endpoints)
Smoothing constants	
Alpha (α) for data	0.500
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	2.015916
Sum Square Error (SSE)	936.418230
Mean Square Error (MSE)	15.351119
Mean Percentage Error (MPE)	1.534601

Mean Absolute Percentage Error (MAPE)	6.386920
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Residual Analysis for the Applied Model

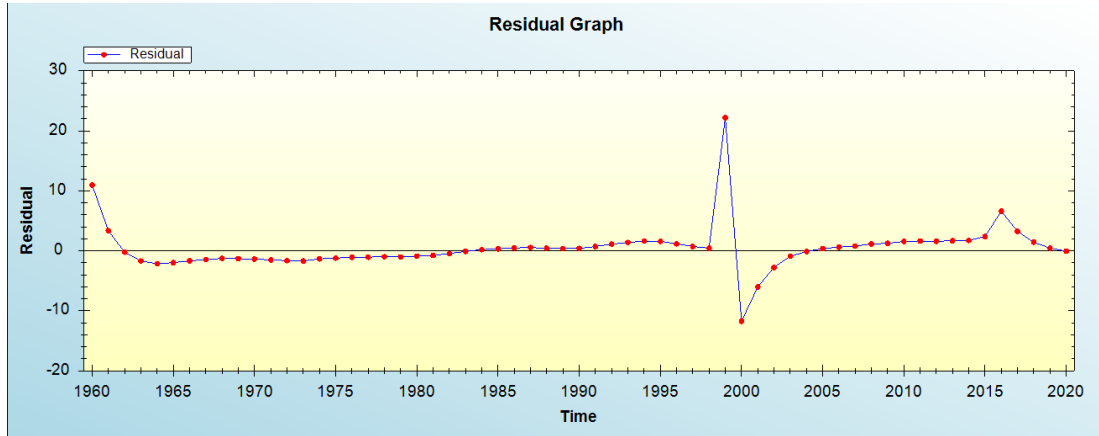


Figure 1: Residual analysis

In-sample Forecast for C

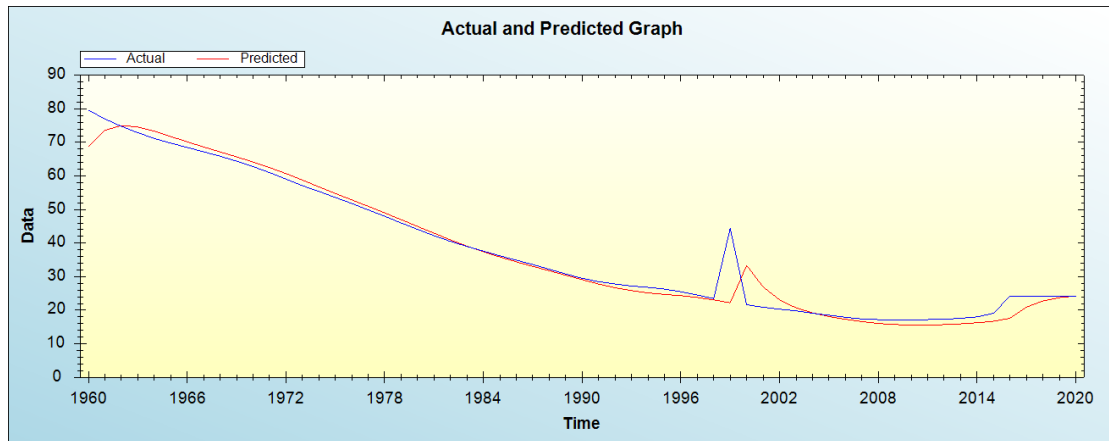


Figure 2: In-sample forecast for the C series

Actual and smoothed graph for C

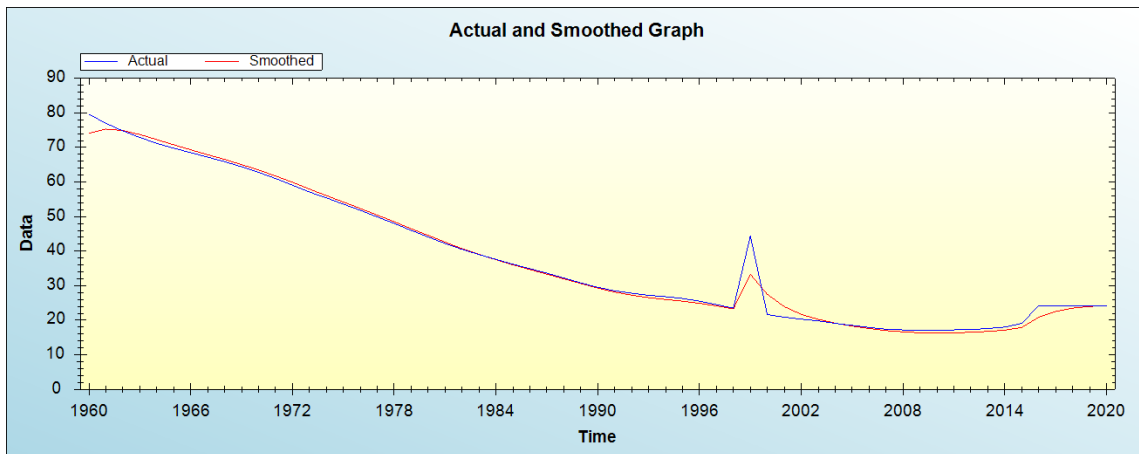


Figure 3. Actual and smoothed graph for C

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

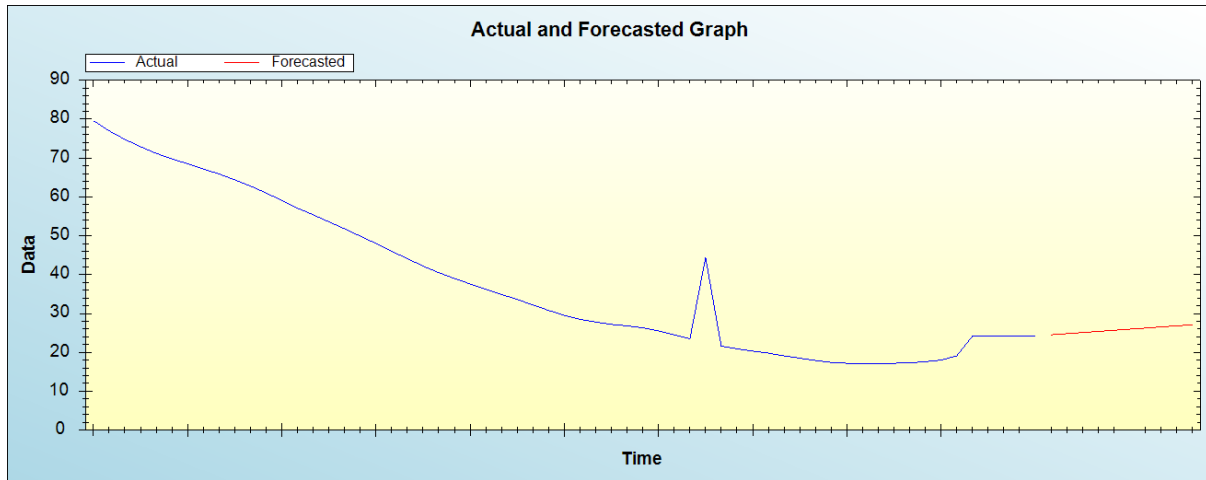


Figure 4: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	24.5177
2022	24.8038
2023	25.0899
2024	25.3760
2025	25.6621
2026	25.9482
2027	26.2343
2028	26.5204
2029	26.8065
2030	27.0926

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 increase throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

By the end of 2030, all UN member countries will have to reflect on their past performance to evaluate efforts that were directed towards achieving all the 169 targets attached to the 17 objectives of the 2030 agenda for sustainable development. Many countries currently are committing resources to ensure smooth implementation of SDGs. The 3rd sustainable development goal forms the core of sustainable development therefore governments must ensure that this objective becomes top political priority. Tracking of SDG progress cannot be overemphasized as this guides policies, decisions and allocation resources. This study applied the double exponential smoothing (Holt) model to project future trends of under-five mortality rate for Venezuela and forecast results revealed that annual U5MR will increase throughout the out of sample period. Hence, health authorities in Venezuela are encouraged to address the various challenges that affect the quality of maternal and child healthcare program at all levels of healthcare.

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