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Estimating Future Trends of Under Five Mortality Rate for Austria Using Holt's Linear Exponential Smoothing Model

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Austria from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. The model evaluation criteria indicate that the applied Holt's linear model is stable in forecasting under five mortality rate in Austria. 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 decline over the out of sample period. Therefore, the Austrian government is encouraged to craft child health policies that will help maintain under five mortality below 25 deaths per 1000 live births.**

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

The 17 objectives found in the agenda 2030 for sustainable development clearly describe the path towards sustainable development with an ultimate agenda to address all the three dimensions of sustainable development which are social, economic and environmental (UN, 2016; UN, 2015). At the end of this era of sustainable development goals all UN member states should have accomplished all the 169 set targets. SDG3 remains at the core of the global action plan with many countries working tirelessly to end all preventable maternal, neonatal and under five deaths (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). Sexual and reproductive health is a component of SDG3 and a fundamental human right that was endorsed during the 1994 international conference on population and development (Barot, 2014). Significant progress has been made in ensuring universal access to SRH services. FP 2020 countries have channeled resources towards sustainable development goal 3(SDG3) in order to achieve its associated target by 2030 (FP 2020, 2017a). Family planning services have resulted in positive outcomes such as reduction in maternal deaths, infant mortality, unintended pregnancies, unsafe abortion, child poverty and malnutrition (UN, 2017b). In line with Agenda 2030, this research uses Holt's linear exponential smoothing technique to forecast future trends of under-five mortality rate in Austria and the findings are going to help in policy making, planning and allocation of resources to child health programmes in order to end all preventable under five deaths by 2030.

II. LITERATURE REVIEW

Masaba & Phetoe (2020) described the trends of neonatal mortality within two sub-Saharan countries and the researchers found out 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. 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. The findings of Damian *et al.*(2019) review paper revealed that estimates from both global metrics and institutional reporting, although widely divergent, indicate South Africa has not achieved MDG 4a and 5a goals but made a significant progress in reducing maternal and neonatal mortality. A cross-sectional survey by Biracyaza & Habimana (2019) developed a model of infant mortality and its associated risk factors in Rwanda from 2011 to 2015. The study utilized data from 2014/2015 Rwanda Demographic and Health Survey. The study concluded that factors associated with IM were grouped into community, ecological, socio-economic and proximate factors and identified that each group consists of multifactor that influence the infant mortality rate.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

Y_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 Austria 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	Y
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)	0.637607
Sum Square Error (SSE)	138.834395
Mean Square Error (MSE)	2.275974
Mean Percentage Error (MPE)	2.347968
Mean Absolute Percentage Error (MAPE)	4.199417

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Residual Analysis for the Applied Model

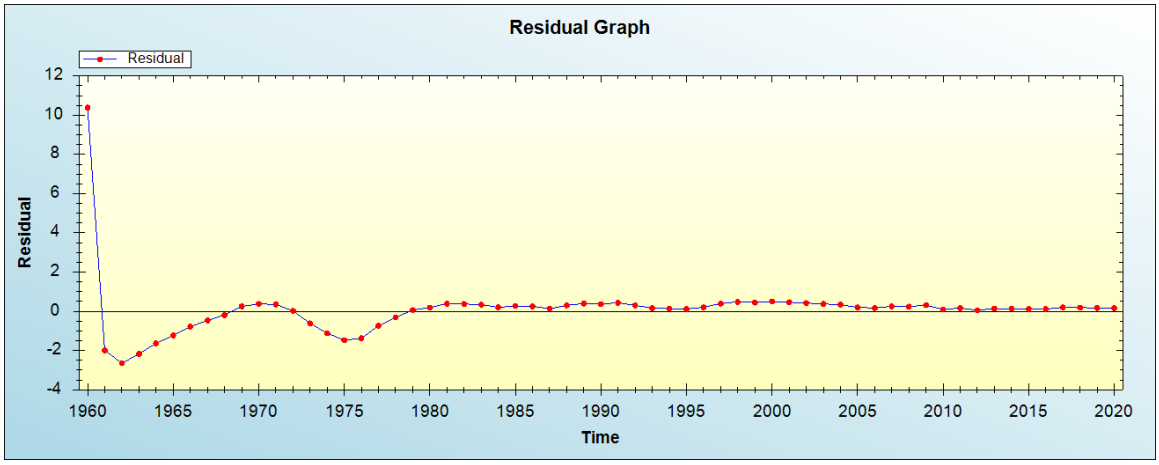

Figure 1: Residual analysis

In-sample Forecast for Y

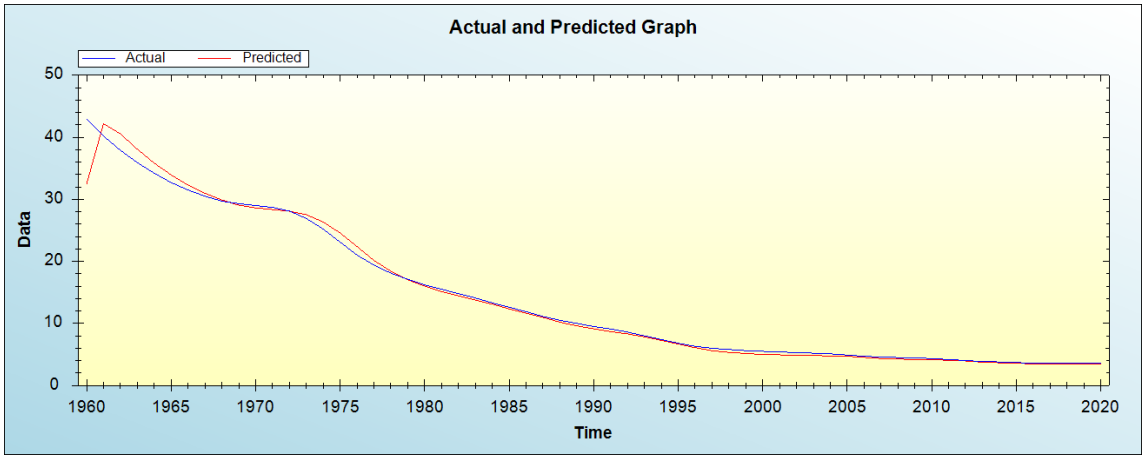

Figure 2: In-sample forecast for the Y series

Actual and smoothed graph for Y

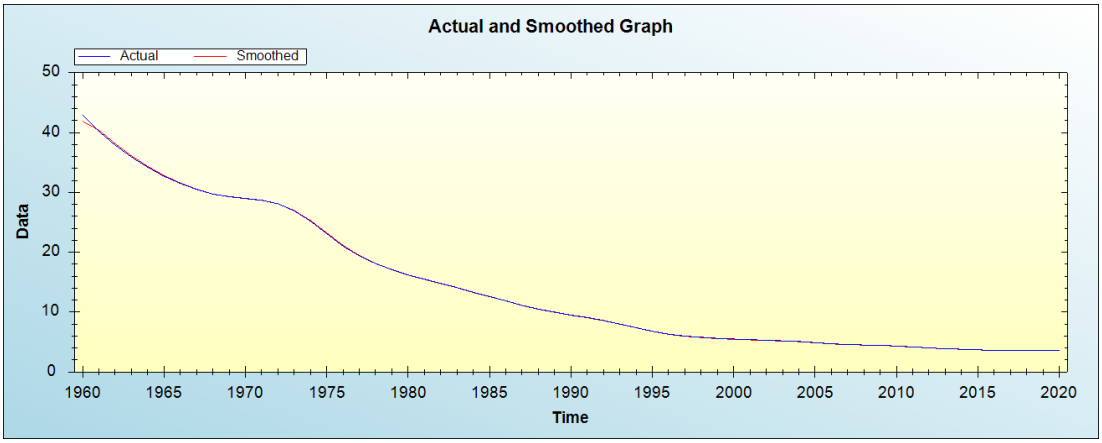

Figure 3: Actual and smoothed graph for Y

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

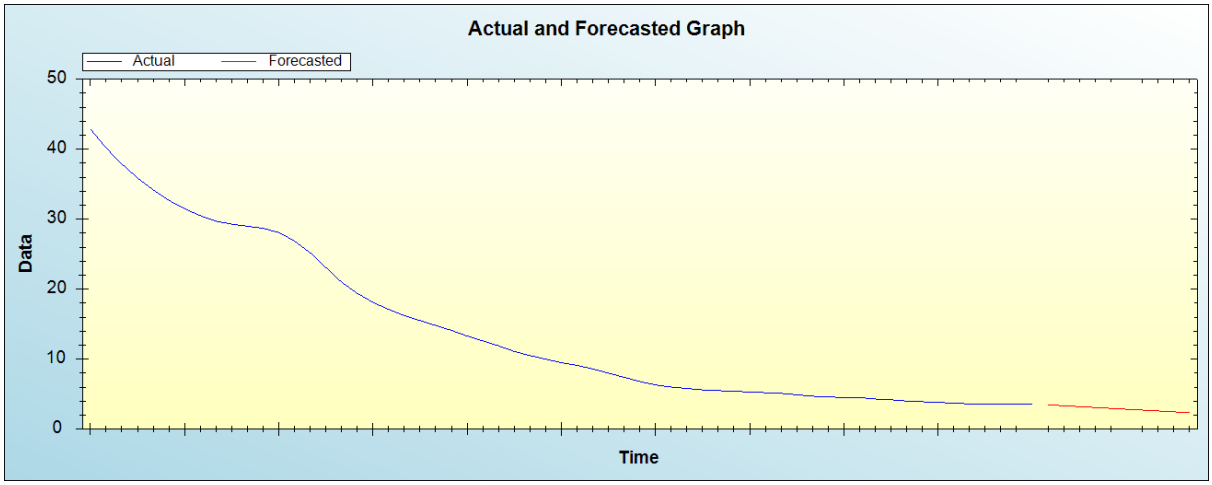

Figure 4: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	3.4606
2022	3.3367
2023	3.2128
2024	3.0890
2025	2.9651
2026	2.8412
2027	2.7173
2028	2.5934
2029	2.4696
2030	2.3457

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 decline over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Exponential smoothing models are widely applied time series forecasting techniques that are useful in the prediction of under-five mortality. This study applied Holt's linear model to predict future trends of under-five mortality rate in Austria. The findings of this piece of paper indicate that annual U5MR will continue to decline over the out of sample period. Therefore, Austrian authorities should craft local policies that will keep under-five mortality under control.

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