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Forecasting Future Trends of Under Five Mortality Rate for Chile Using Double Exponential Smoothing Model

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Chile from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria of the applied model is stable in forecasting U5MR. Holt's linear exponential smoothing model was applied in this paper. The optimal values of smoothing constants α and β are 0.9 and 0.1 respectively based on minimum MSE. The model projections revealed that annual U5MR will continue to drop throughout the out of sample period. Therefore, the government of Chile is encouraged to craft strategies that will ensure under five mortality remains below 25 deaths per 1000 live births.**

Keywords: Exponential smoothing, Forecasting, U5MR.

I. INTRODUCTION

The welfare of women and children is a top priority for both developing and developed countries and this was clearly spelt out in the agenda 2030 for sustainable development (UN, 2016; UN, 2015). The International conference on Population and development (ICPD) which was held in the Egyptian Capital, Cairo in 1994 adopted the programme of action which recognized sexual and reproductive health (SRH) as a fundamental right (UNFPA, 2008). This commitment was affirmed during the 2019 Nairobi Summit (UNFPA & ICD 25, 2019). It was further cemented by the agenda 2030 for sustainable development (SDG 2015-2030) particularly SDG 3 (Barclay *et al.* 2016). SRH and rights includes information on SRH and rights, including sexual and reproductive health of adolescents, abortion and gender-based violence (Starrs *et al*. 2018).The third sustainable development goal also includes the targets of reducing maternal, neonatal and under five mortality. All UN member states are encouraged to make frantic efforts to substantially reduce global maternal mortality ratio to less than 70 deaths per 100 000 live births, neonatal mortality to as low as 12 deaths per 1000 live births and under five mortality to levels as low as 25 deaths per 1000 live births (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). In addition, SDG3 focuses on addressing communicable, non-communicable and neglected tropical diseases. Ending epidemic diseases such as TB, HIV and Malaria will significantly contribute to the reduction of mortality among all age groups. Globally 45% of new HIV infections occur in Sub-Saharan Africa and 53% of people living with HIV are from this region (UNAIDS, 2018). HIV/AIDS is the leading cause of mortality among adolescents aged 10-19 years (UNICEF, 2018). Adolescent girls and young women are at high risk of HIV infections due to gender based violence, inequalities and physiological factors (UNSAIDS, 2018).

The aim of this paper is to model and forecast future trends of under-five mortality rate in Chile using the Holt's linear exponential smoothing method. The study findings are expected to inform child health policies, planning and allocation of resources with the aim of ending all preventable under five deaths in the country.

II. LITERATURE REVIEW

Baroni *et al.* (2021) outlined an integrated dataset containing monthly data in a historical series from 1996 to 2017 with information on all births, neonatal deaths, and NMR (total, early and late components) enriched with information related to the municipality. It is a dataset of historical data with information on the number of births, the number of neonatal deaths, the neonatal mortality rate (including early and late), and geographic information for each month (between January 1996 and December 2017) and Brazilian municipality. A retrospective review study was conducted by Falciglia *et al*. (2020) to investigate mortality in periviable neonates ≤23 weeks gestational age and calculate its impact on overall neonatal mortality rate over a 12-year period (1998–2009). It was found that neonatal mortality rate from periviability was 96.2% and constituted half of the overall rate in the period (1998–2009). There was not significant reduction of periviable mortality between 2010 and 2015.Nath*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 Statistic. 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). Another Brazillian study was conducted by Souza et al. (2019) to investigate the determinants of neonatal mortality in Foz do Iguassu in Brazil. The authors analyzedall neonatal deaths that occurred in Foz do Iguassu from 2012 to 2016. Birth and mortality data were extracted from two national governmental databases (SINASC and SIM). It was found that high rate of neonatal death in Foz do Iguassu is strongly associated with newborn characteristics and not

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associated with maternal socio-demographic characteristics. Saravanou *et al.* (2016) studied the infant mortality prediction using features extracted from birth certificates. Training of classification models to decide whether an infant will survive or not was carried out. The authors focused on exploring and understanding the importance of features in subsets of the population and compared models trained for individual races to general models. The study concluded that the applied methodology outperformed standard classification methods used by epidemiology researchers.

III. METHODOLOGY

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

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

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

E_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 Chile 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	E
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)	3.349817
Sum Square Error (SSE)	4064.759431

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Mean Square Error (MSE)	66.635401
Mean Percentage Error (MPE)	4.395629
Mean Absolute Percentage Error (MAPE)	7.659478

Residual Analysis for the Applied Model

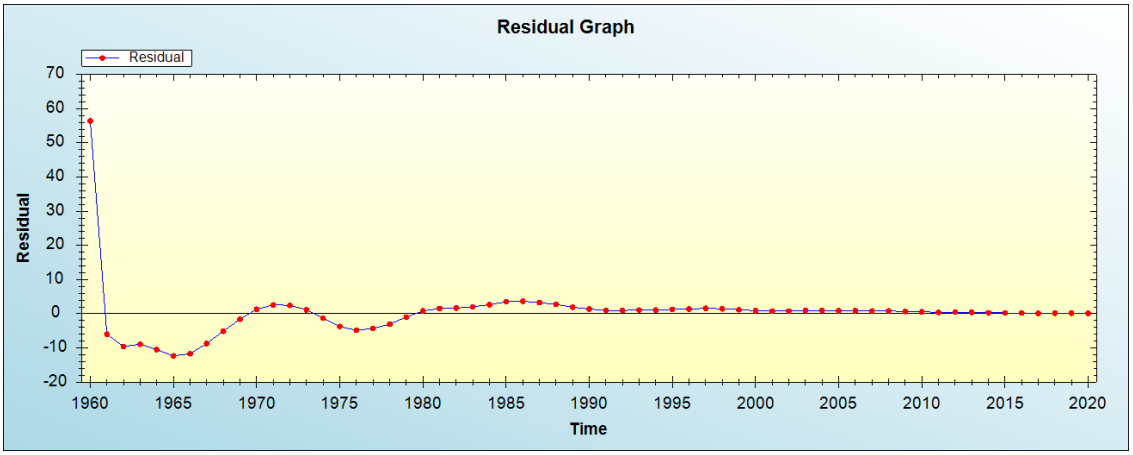

Figure 1: Residual analysis

In-sample Forecast for E

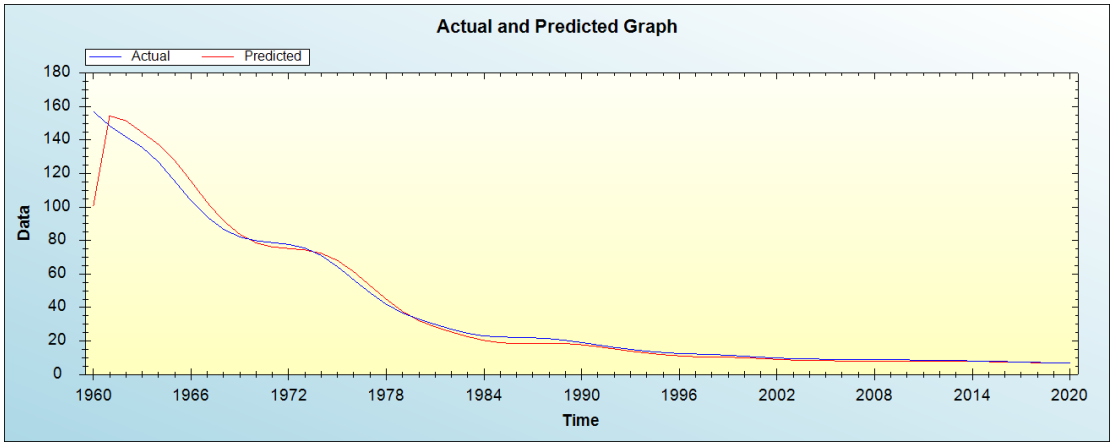

Figure 2: In-sample forecast for the E series

Actual and Smoothed Graph for E

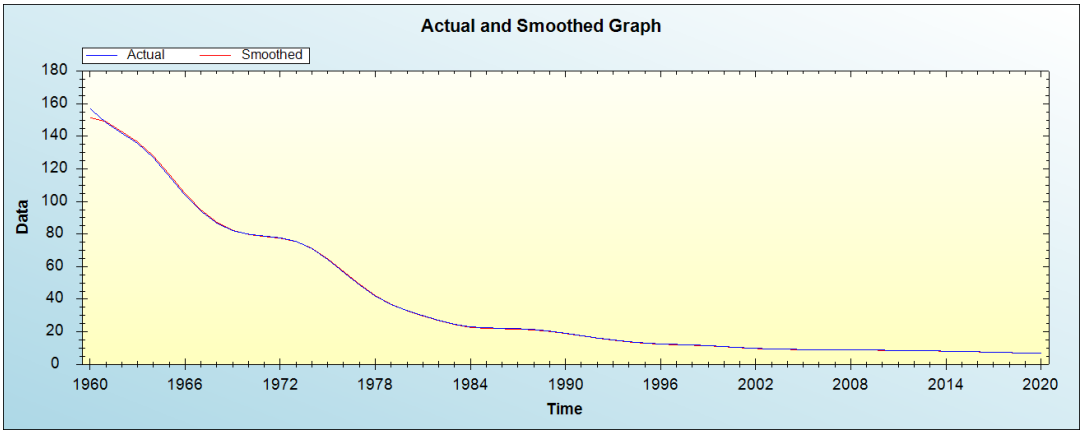

Figure 3: Actual and smoothed E series

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

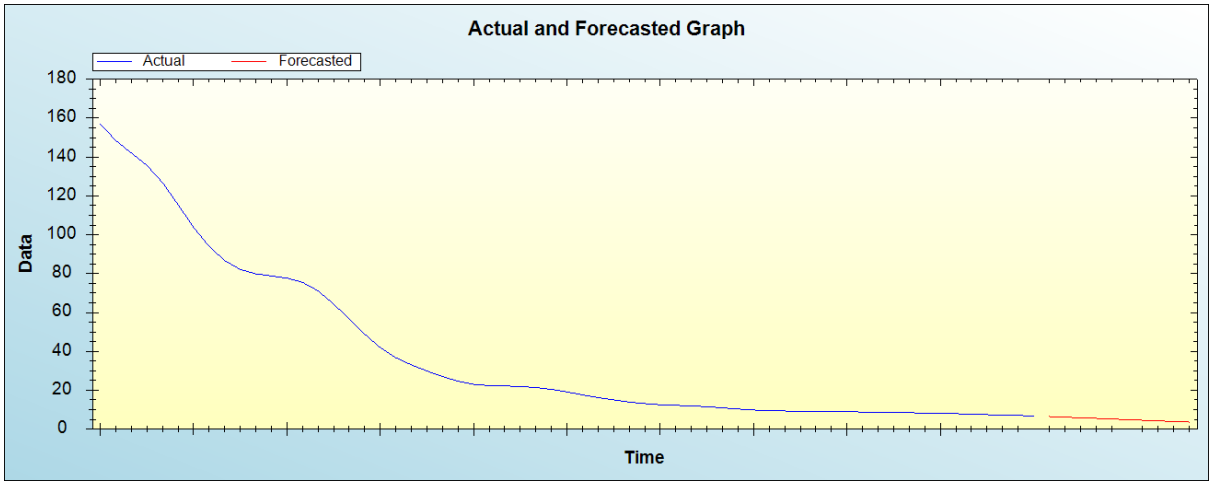

Figure 4: Out-of-sample forecast for E: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	6.4640
2022	6.1431
2023	5.8222
2024	5.5013
2025	5.1804
2026	4.8594
2027	4.5385
2028	4.2176
2029	3.8967
2030	3.5758

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 throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Time series forecasting techniques are essential early surveillance tools that guide policies, decisions and allocation of resources. Their use in tracking SDG progress will stimulate appropriate early responses to under five mortality in Chile. In this study we proposed the Holt's linear method to predict U5MR and the findings revealed that annual U5MR will continue to drop throughout the out of sample period. Therefore, we encourage the government in Chile to formulate appropriate policies that will keep under five mortality below 25 deaths per 1000 live births.

REFERENCES

[1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.
[2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
[3] UN (2020) sustainable development goals. https://www.un.org/sustainabl development/development-agenda
[4] UNICEF (2018). Every Child alive. New York: UNICEF
[5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
[6] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.

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[7] UNFPA & ICPD25 (2019). Fulfilling the ICPD Promise. Progress, Gaps and Working at Scale. Available from: https://www.unfpa.org/sites/default/files/ pub-pdf/CDP_report_23-online.pdf
[8] UNFPA (2008). Making Reproductive Rights and sexual and Reproductive Health a Reality for all. New York.
[9] Starrs AM., Ezeh AC., Barker G., Basu A., Bertrand J T & Blum R (2018). Accelerate progress—sexual and reproductive health and rights for all: report of the Guttmacher– Lancet Commission. Lancet, 391: 2642–2692.
[10] The Joint United Nations Programme on HIV/AIDS (UNSAIDS) (2018). Program HIV/ AIDS, pp1–376.
[11] UNICEF (2018). UNICEF's Global HIV Response: Addressing the global HIV epidemic among pregnant women, Mothers, Children and Adolescents.

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