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Analysing Future Trends of Adolescent Fertility for Sri Lanka Using Holt's Linear Method

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***Abstract* - This study uses annual time series data of adolescent fertility rate for Sri Lanka from 1960 to 2020 to predict future trends of adolescent fertility rate over the period 2021 to 2030. The study utilizes Holt's linear exponential smoothing model. The 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 adolescent fertility rate will continue to decrease throughout the out of sample period. Therefore, we encourage authorities in Sri Lanka to relentlessly support girl child education and empowerment programs for young adults to improve their labor participation.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

High adolescent fertility rate in low and middle income countries is regarded as a huge public health problem due to the expected increase in the population size resulting in increased demand and competition for local resources (UN, 2020). The 3rd sustainable development goal seeks to address this problem through universal health coverage, however countries with successful public health systems have also failed to reduce adolescent pregnancy rates (WHO, 2020; Chandra-Mouli *et al.*2015). Literature has revealed that social, economic and cultural factors have been identified as causes of high rates of adolescent pregnancies (Kassa *et al.* 2018; Yakubu *et al.* 2018). The negative consequences of teen pregnancy are well documented in literature and these include hypertensive disorders, anemia and mental stress (Patton *et al.* 2016; Azevedo*et al.* 2015). In addition, low birth weight, prematurity and poor nutrition will affect the baby (Nguyen *et al.* 2019; de Onis & Branca, 2016). The problem of child marriage continues to hamper global efforts to end sexual abuse of adolescent girls and women. Enforcement of laws is very key in the fight against gender based violence including forced child marriage. Harmonization of customary laws and national laws should be done in order to eliminate harmful cultural practices. Sri Lanka is a signatory to international laws and policies that protect sexual and reproductive health rights of women. The country has made significant progress towards the reduction of adolescent fertility as evidenced by the gradual decline in adolescent fertility over the past decades according to World Bank figures. However, there is need to review current policies in order to end teenage pregnancies in the country. This paper applies exponential smoothing to forecast future trends of adolescent fertility in Sri Lanka and findings are expected to depict the future burden of adolescent births. This will stimulate review of current laws and policies, and allocation of resources towards the protection of women's rights and ending child marriage.

II. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Sri Lanka. 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.

Holt's linear method is specified as follows:

Model equation

$Q_t = \mu_t + \rho_t \mathbf{t} + \varepsilon_t$

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Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

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

Q_t is the adolescent fertility rate at time t

ε_t is the time varying **error term**

μ_t is the time varying mean (**level**) term

ρ_t is the time varying **slope term**

t is the trend component of the time series

L_t is the exponentially smoothed value of adolescent fertility rate 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

b_t is the trend estimate at time t

b_{t-1} is the trend estimate at time period t-1

Data Issues

This study is based on annual adolescent fertility rate in Sri Lanka 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.

III. FINDINGS OF THE STUDY

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	Q
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	

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Mean Absolute Error (MAE)	1.701806
Sum Square Error (SSE)	959.216798
Mean Square Error (MSE)	15.724866
Mean Percentage Error (MPE)	0.710660
Mean Absolute Percentage Error (MAPE)	3.129748

Residual Analysis for the Applied Model

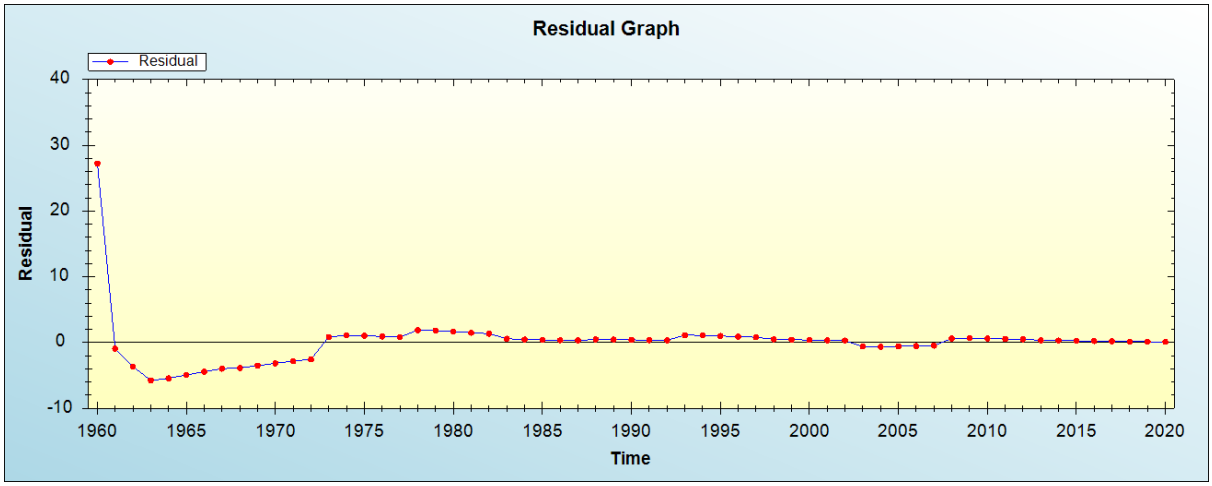

Figure 1: Residual analysis

In-sample Forecast for Q

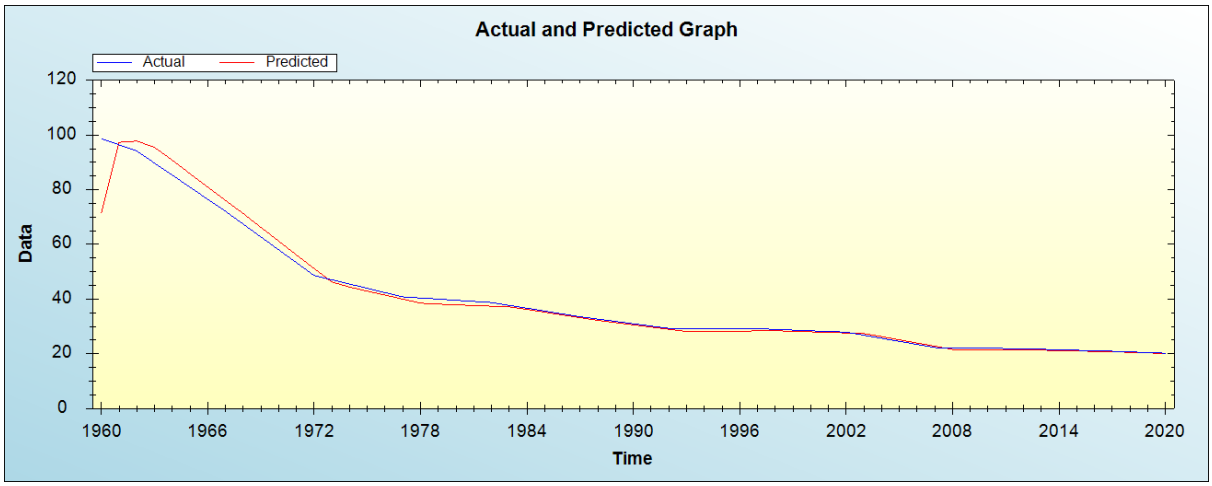

Figure 2: In-sample forecast for the Q series

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Actual and Smoothed graph for Q series

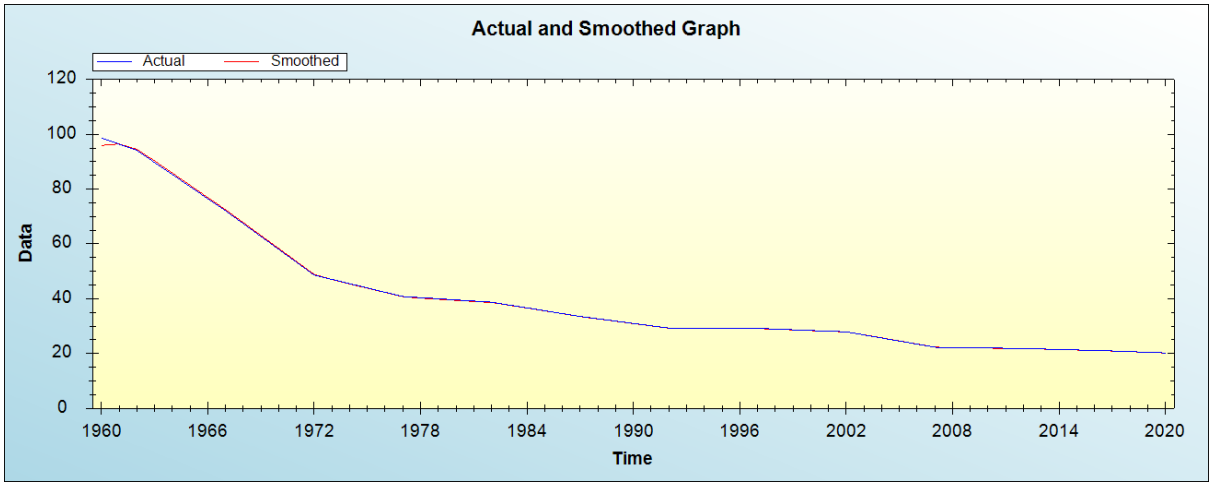

Figure 3: Actual and smoothed graph for Q series

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

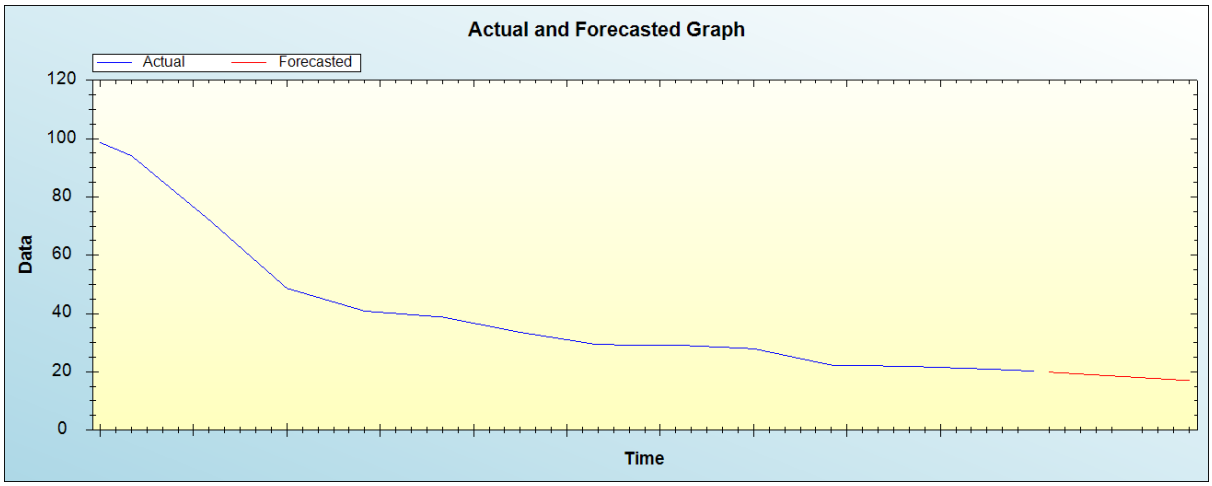

Figure 4: Out-of-sample forecast for Q: actual and forecasted graph

Out-of-Sample Forecast for Q: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	19.8834
2022	19.5588
2023	19.2342
2024	18.9096
2025	18.5849
2026	18.2603
2027	17.9357
2028	17.6111
2029	17.2865
2030	16.9618

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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 adolescent fertility rate will continue to decrease throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adolescents face numerous challenges which predispose them to risky sexual behaviors. Engaging in unprotected early sexual activity increases their risk of experiencing adverse SRH outcomes such sexually transmitted infections, unsafe abortions and unintended pregnancies. Preventing teenage pregnancy should be a priority for any government intervention as this will help to avert adverse pregnancy outcomes. This paper applies Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Sri Lanka. Our study findings suggest that adolescent fertility in Sri Lanka will continue to decrease throughout the out of sample period. Therefore, we encourage the Sri Lankan government to relentlessly support girl child education and empowerment programs for young adults to improve their labor participation.

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