

Assessing the Feasibility of Achieving Substantial Reduction of Adolescent Fertility for Mauritius Using Holt's Linear Method

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Abstract - This research paper uses annual time series data of adolescent fertility rate for Mauritius 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 will continue to decline throughout the out of sample period. Therefore, we encourage authorities in Mauritius to scale up educational campaigns among communities and enforce laws that protect sexual and reproductive health rights of women and girls.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Scaling up efforts to address the problem of adolescent pregnancy in Africa and other low and middle income countries is top priority in this era of sustainable development goals (Berhan & Andargachew, 2018). The negative impact of teenage pregnancy on health has been documented by many researchers around the globe (Althabeet *et al.* 2015; Ganchimeget *et al.* 2014; Weng *et al.* 2014; Malabareyet *et al.* 2012). High maternal and under five mortality rates are serious problems associated with adolescent pregnancy. Maternal deaths can be due to antepartum hemorrhage and severe pregnancy induced hypertension (Woog & Kagesten, 2017; Margret, 2015; Tebeuet *et al.* 2012). Severe prematurity, birth hypoxia and sepsis are among the leading causes of neonatal mortality (Finlay *et al.* 2017; Sayers *et al.* 2017). It has been established that there are a host of factors that drive teenage pregnancy in the African setting such as poverty, low educational level, having a family member who experienced teenage pregnancy, single parent households, child headed families, peer pressure and exposure to pornographic material in the media (Magnusson *et al.* 2019; Peltzer & Pengpid, 2019; Pettifor *et al.* 2009). It is important to highlight mortality as a result of adolescent pregnancy is largely preventable (Nkhoma *et al.* 2020; Hardenet *et al.* 2009). The decline in adolescent fertility in Sub-Saharan Africa can be attributed to improvements in education, increase in contraceptive prevalence, creating more employment opportunities and having an appropriate legal framework (Duflo *et al.* 2014; Tombros, 2005).

This paper applies Holt's double exponential smoothing technique to model and forecast future trends of adolescent fertility in Mauritius. The findings of this piece of work are envisioned to highlight the future burden of adolescent fertility in the out of sample period. This will trigger an appropriate national response to the challenge of teenage pregnancy especially by allocating adequate resources to teenage pregnancy prevention programs.

II. METHODOLOGY

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

$$Z_t = \mu_t + \rho_t t + \varepsilon_t$$

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

Forecasting equation

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

Z_t is the actual value of 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 slope of the trend at time t

b_{t-1} is the slope of the trend at time t-1

Data Issues

This study is based on annual adolescent fertility rate in Mauritius 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	Z
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	

Mean Absolute Error (MAE)	3.121041
Sum Square Error (SSE)	2582.501075
Mean Square Error (MSE)	42.336083
Mean Percentage Error (MPE)	0.268060
Mean Absolute Percentage Error (MAPE)	4.556158

Residual Analysis for the Applied Model

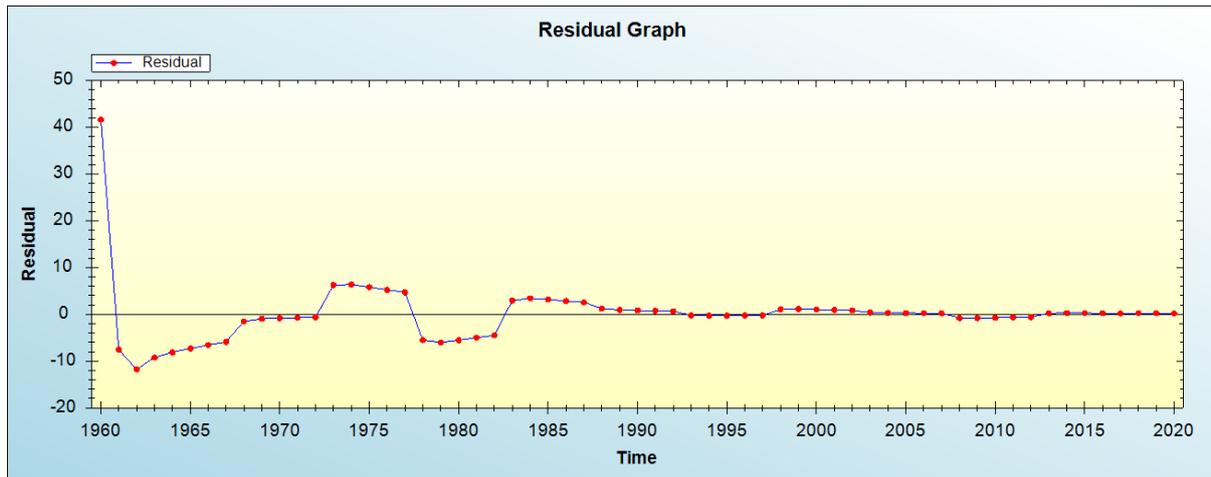


Figure 1: Residual analysis

In-sample Forecast for Z

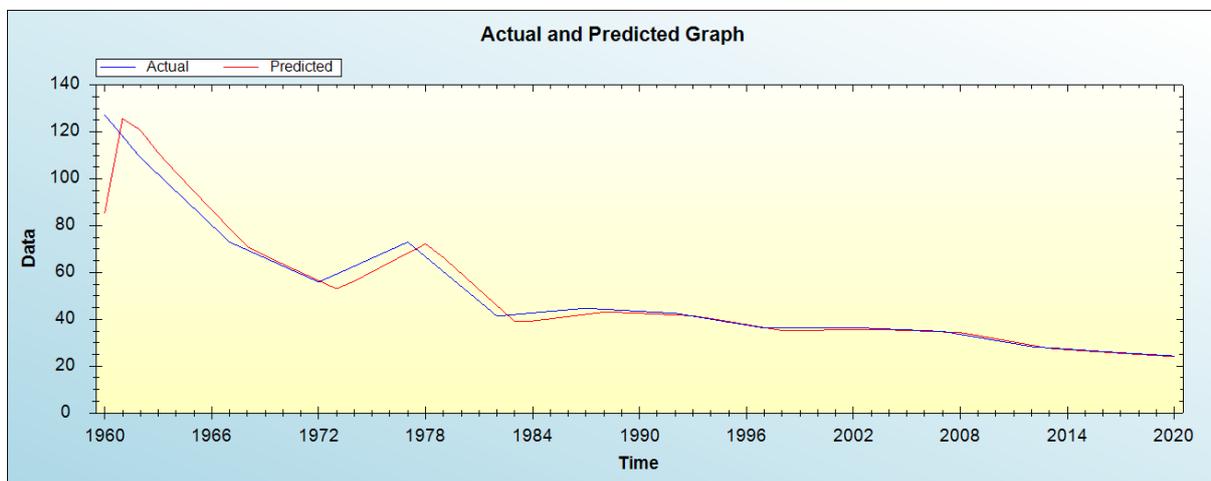


Figure 2: In-sample forecast for the Z series

Actual and Smoothed graph for Z series

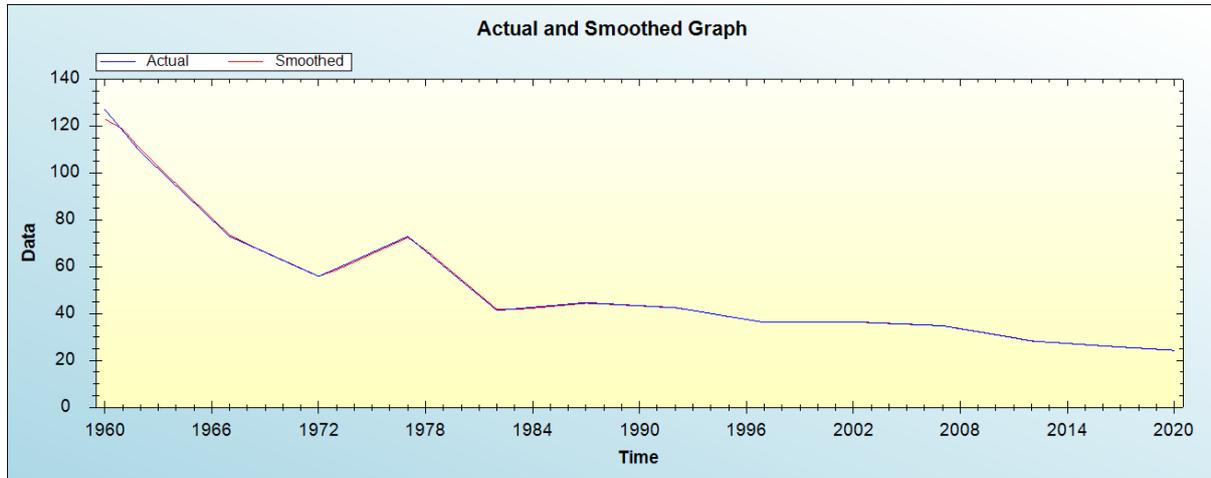


Figure 3: Actual and smoothed graph for Z series

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

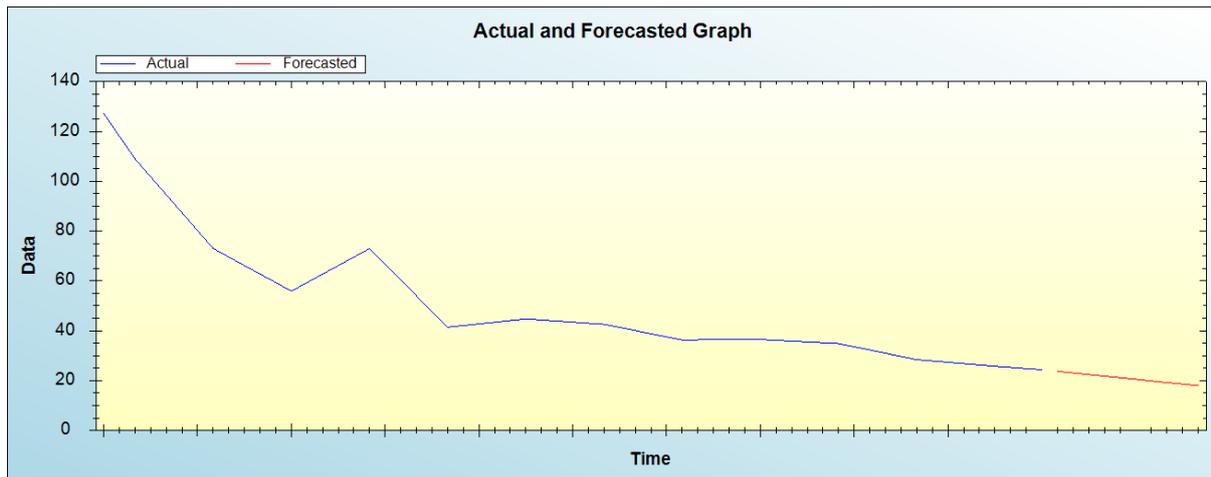


Figure 4: Out-of-sample forecast for Z: actual and forecasted graph

Out-of-Sample Forecast for Z: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Projected adolescent fertility rate
2021	23.7031
2022	23.0634
2023	22.4237
2024	21.7839
2025	21.1442
2026	20.5045
2027	19.8647
2028	19.2250
2029	18.5853
2030	17.9455

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 decline throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

High teenage pregnancy rates continue to threaten the lives of teenagers and their newborn babies. Adolescent fertility has been gradually declining in Mauritius during the period 1960 to 2020. The decline in adolescent fertility in Sub-Saharan Africa and other developing regions can be attributed to improvements in education, increase in contraceptive prevalence, creating more employment opportunities and having an appropriate legal framework. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Mauritius. We established that adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage the government to scale up educational campaigns among communities and enforce laws that protect sexual and reproductive health rights of women and girls.

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