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Forecasting Adolescent Fertility Rate for Guinea Using Holt's Double Exponential Smoothing Technique

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***Abstract* - This research article uses annual time series data of adolescent fertility rate for Guinea 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 are0.9 and0.6 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will continue to decline but still remain very high throughout the out of sample period. Therefore, we encourage authorities in Guinea to scale educational campaigns among the communities, continuously promote girl child education, increase funding towards youth empowerment programs and set up adolescent friendly facilities that are well resourced to address adolescent health issues.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adverse pregnancy outcomes remain a global health challenge especially in developing countries. Bleeding during pregnancy, hypertensive disorders, obstructed labour, birth trauma, preterm delivery and severe prematurity are among the leading causes of maternal and perinatal mortality (WHO, 2014; UNFPA, 2013). Mortality rates tend to be higher among teenage pregnant mothers when compared to women in their twenties (Grønvik & Fossgard, 2018; Banke-Thomas *et al.* 2017). Previous studies revealed that infants born to teenage mothers also have an increased risk of experiencing adverse pregnancy outcomes (de Vienne *et al.* 2009). Developing regions are known to have higher teenage pregnancy rates and poor outcomes as a result of many factors such as poverty, lack of adequate resources, low educational level and low contraceptive prevalence rates and inaccessible SRH services in some cases (UNFPA, 2015; UNFPA, 2013;McMichael & Gifford, 2010). According to United Nations, establishing health interventions targeting adolescent sexual and reproductive health is envisioned to substantially reduce adolescent pregnancy and its complications (UN, 2020; UNICEF, 20I8; UN, 2016; UN, 2015). Furthermore, conducive legal and policy frameworks at national and regional levels are necessary to achieve gender equality and elimination of child marriage especially in developing countries (UN, 2015; UN, 1995). Evidence provided by the World Bank shows that adolescent fertility declined in Guinea from around 204 births per 1000 females aged 15-19 in 1960 to 120 births per 1000 females aged 15-19 in 2020. This shows that there has been significant progress in addressing teenage pregnancy, however the problem is still huge and therefore needs urgent attention.

The objective of this paper is to model and forecast future trends of adolescent fertility for Guinea using Holt's double exponential smoothing technique. The findings are expected to highlight the future burden of adolescent births in the out of sample period. This will guide policy, planning and allocation of resources to teenage pregnancy prevention programs with the aim of averting adverse SRH outcomes in the country.

II. METHODOLOGY

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

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

Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

$f_{t+h} = L_t + \mathrm{h} b_t$

X_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 trend estimate at time t

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

Data Issues

This study is based on annual adolescent fertility rate in Guinea 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	X
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.600

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Forecast performance measures	
Mean Absolute Error (MAE)	0.283289
Sum Square Error (SSE)	21.846194
Mean Square Error (MSE)	0.358134
Mean Percentage Error (MPE)	-0.015757
Mean Absolute Percentage Error (MAPE)	0.153287

Residual Analysis for the Applied Model

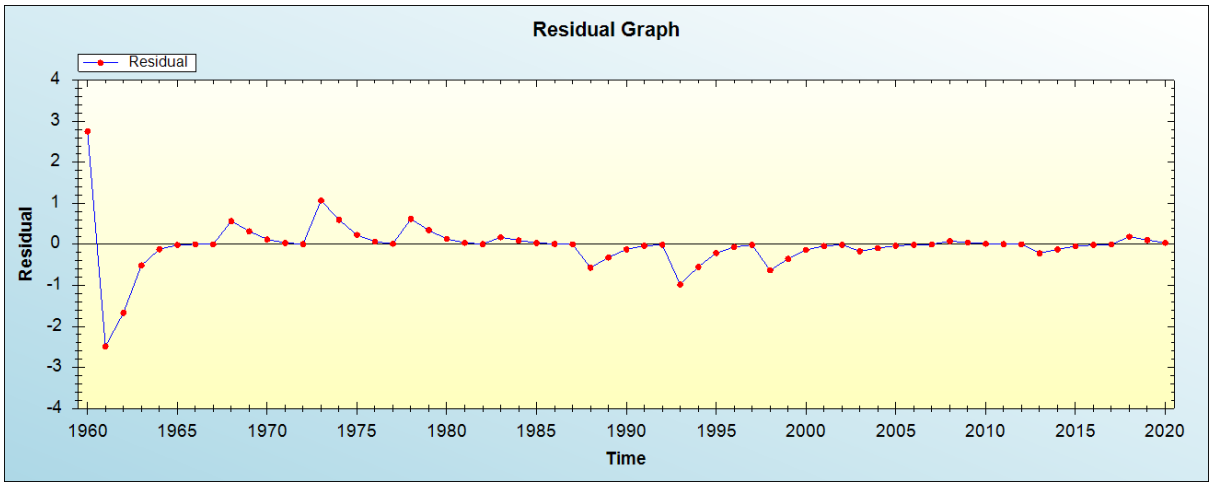

Figure 1: Residual analysis

In-sample Forecast for X

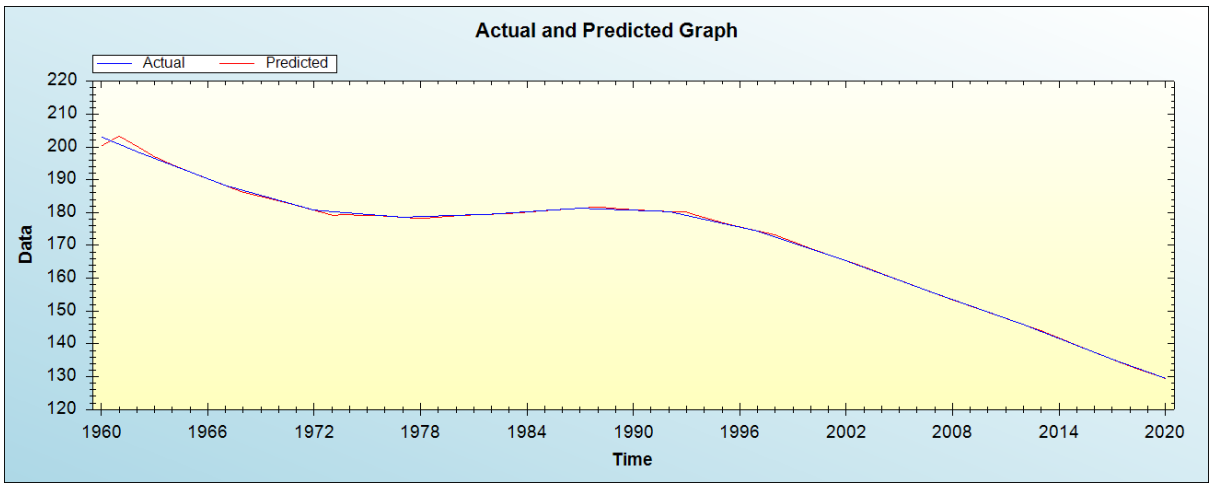

Figure 2: In-sample forecast for the X series

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Actual and Smoothed graph for X series

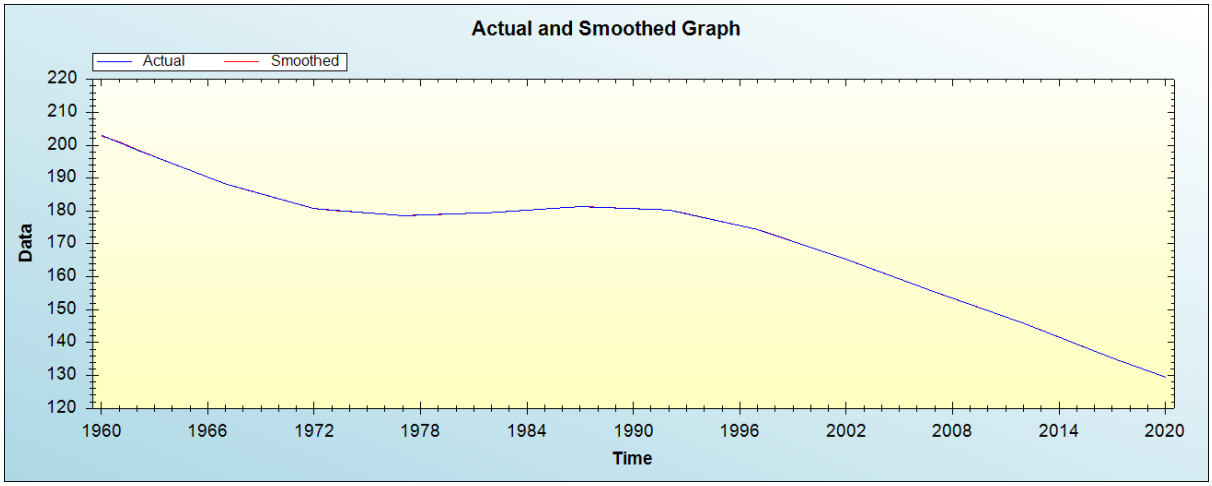

Figure 3: Actual and smoothed graph for X series

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

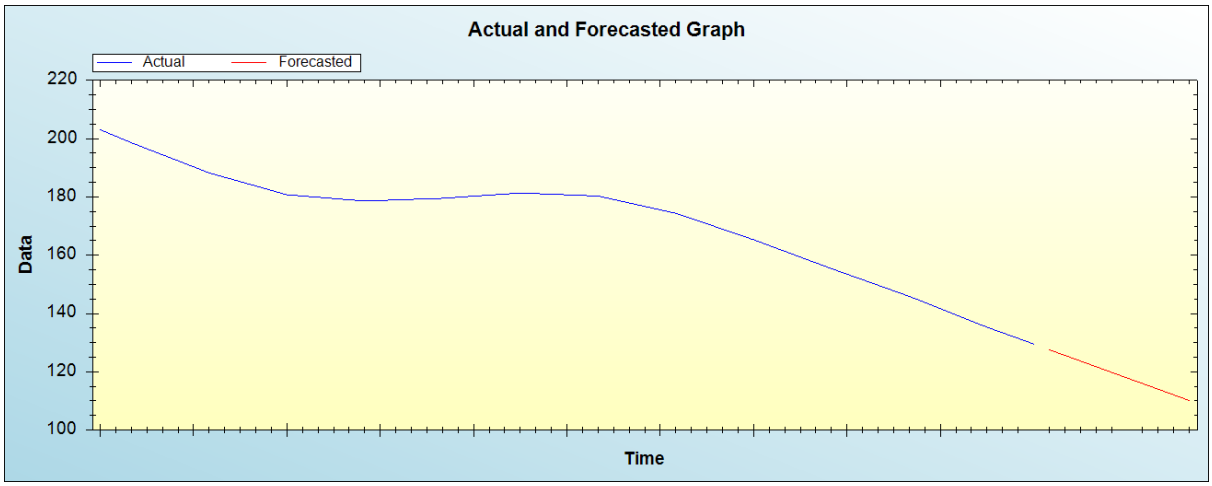

Figure 4: Out-of-sample forecast for X: actual and forecasted graph

Out-of-Sample Forecast for X: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	127.5661
2022	125.6291
2023	123.6922
2024	121.7553
2025	119.8184
2026	117.8814
2027	115.9445
2028	114.0076
2029	112.0707
2030	110.1337

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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 decline but still remain very high throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adverse pregnancy outcomes are common especially in developing countries. Bleeding during pregnancy, hypertensive disorders, obstructed labor, birth trauma, preterm delivery and severe prematurity are among the leading causes of maternal and perinatal mortality. Developing regions are known to have higher teenage pregnancy rates and poor outcomes as a result of many factors such as poverty, lack of adequate resources, low educational level and low contraceptive prevalence rates and inaccessible SRH services in some cases. This study applied Holt's double exponential smoothing technique to predict adolescent fertility for Guinea. We established that adolescent fertility will continue to decline but remain very remain high throughout the out of sample period. Therefore, we encourage the government to scale educational campaigns among the communities, continuously promote girl child education, increase funding towards youth empowerment programs and set up adolescent friendly facilities that are well resourced to address adolescent health issues.

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