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Detection of Future Trends of Adolescent Fertility for Guinea Bissau Using Holt's Double Exponential Smoothing Technique

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***Abstract* - This research paper uses annual time series data of adolescent fertility rate for Guinea Bissau 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 and0.5 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility rate will continue to decline but still remain high over the out of sample period. Therefore, we implore authorities in Guinea Bissau to prioritize girl child education, allocate more resources to youth empowerment projects, scale up awareness campaigns among communities and enforce laws that protect the rights of women and girls.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adolescent pregnancy is a worldwide medical, economic and social problem that affects both developed and developing countries (Klein, 2005). Approximately twenty five percent of adolescent women are pregnant worldwide (Kassa *et al.* 2018;Kaphagawani & Kalipeni, 2017). The prevalence of adolescent pregnancy in Africa is 18.8 percent, of this, 19.3 percent occurred in Sub-Saharan Africa and 21.5 percent in eastern Africa (Kassa *et al.* 2018).The prevalence of adolescent pregnancy in eastern Africa ranges from 18 to 29 percent and around 50 percent of these pregnancies are unintended (Wado *et al.* 2019). Worldwide, approximately 3.9 million adolescents experience unsafe abortions, which contribute to the highest maternal mortality and morbidity (Darroch *et al.* 2016; Franklin &Corcoran, 2000).Literature has shown that pregnant teenagers are prone to adverse pregnancy outcomes such as hypertension, anemia, obstructed labour, preterm delivery and an tepartum hemorrhage (Sedgh *et al.* 2016; Larsson *et al.* 2002). According to count down to 2030, in 2012 adolescent fertility rate in Guinea Bissau was 106 births per 1000 females aged 15-19years. World Bank data indicates that adolescent fertility has been declining over the past 2 decades and reached levels as low as 100 births per 1000 females aged 15-19 years in 2020. This is tremendous progress, however these fertility levels are still unacceptable.

The objective of this study is to model and forecast future trends of adolescent fertility for Guinea Bissau using the double exponential smoothing technique. Findings of this study are expected to highlight future trends of adolescent fertility in the out of sample period. This will stimulate a national response to the problem of teenage pregnancy and child marriage.

II. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Guinea Bissau. 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 exponential smoothing is specified as follows:

Model equation

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

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Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

Forecasting equation

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

G_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 Bissau 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	G
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.500
Forecast performance measures	
Mean Absolute Error (MAE)	0.661491

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Sum Square Error (SSE)	108.072484
Mean Square Error (MSE)	1.771680
Mean Percentage Error (MPE)	-0.030077
Mean Absolute Percentage Error (MAPE)	0.581522s

Residual Analysis for the Applied Model

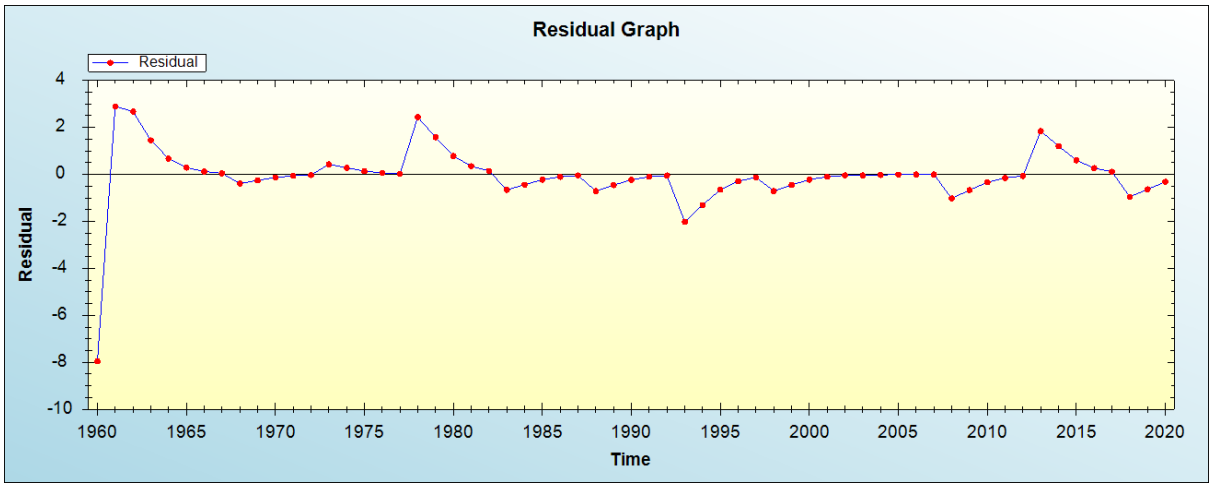

Figure 1: Residual analysis

In-sample Forecast for G

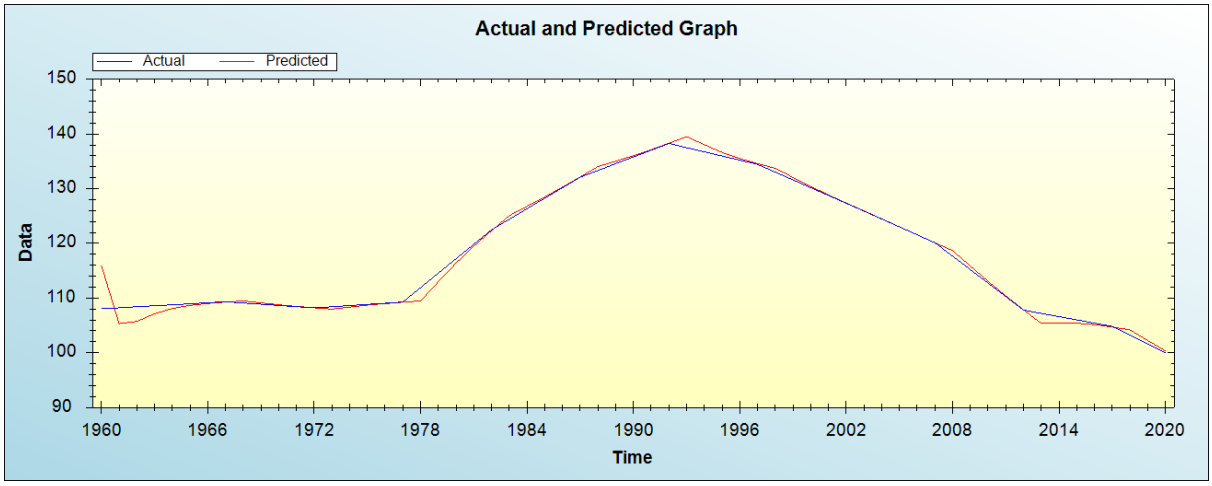

Figure 2: In-sample forecast for the G series

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Actual and Smoothed graph for G series

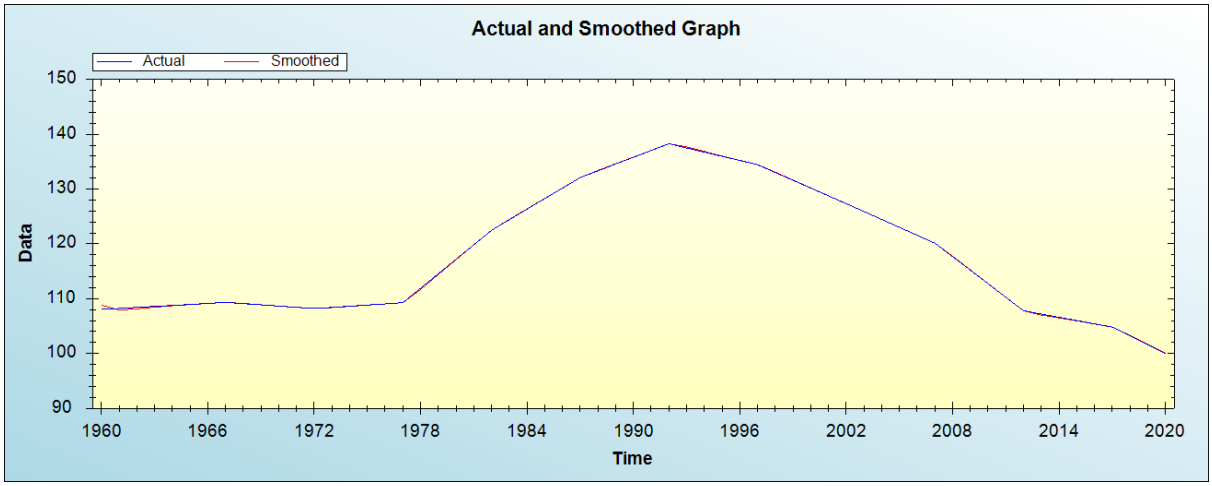

Figure 3: Actual and smoothed graph for G series

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

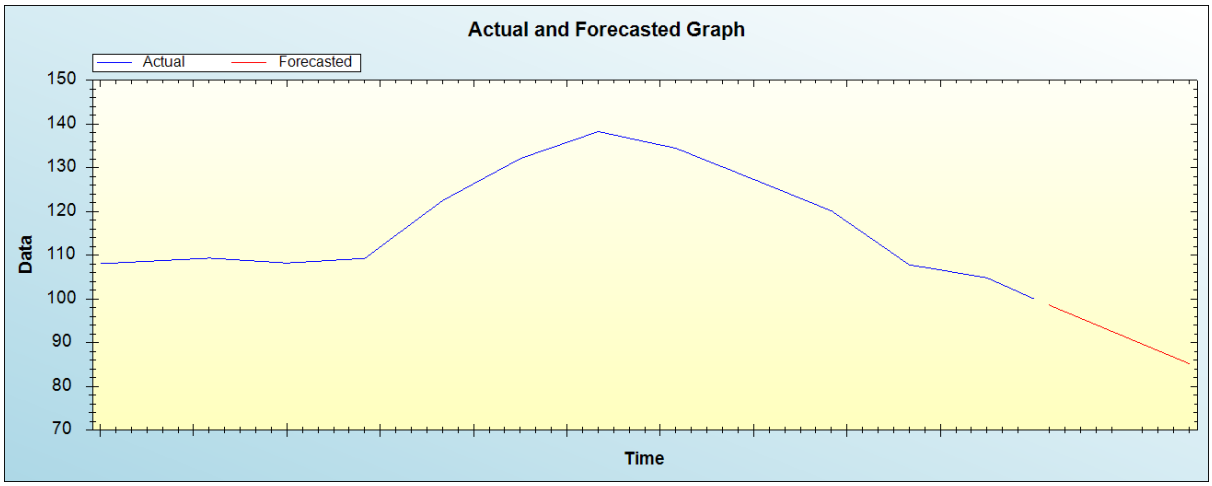

Figure 4: Out-of-sample forecast for G: actual and forecasted graph

Out-of-Sample Forecast for G: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Predicted adolescent fertility rate
2021	98.5736
2022	97.0860
2023	95.5984
2024	94.1109
2025	92.6233
2026	91.1357
2027	89.6482
2028	88.1606
2029	86.6730
2030	85.1855

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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 high throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Teenage pregnancy and child births is a huge public health issue in Guinea Bissau. The World Bank data indicates that adolescent fertility has been declining over the past 2 decades and reached levels around 100 births per 1000 females aged 15-19 years in 2020. This is tremendous progress, however these fertility levels are still unacceptable. Identified risk factors for teenage pregnancy include poverty, low educational level, peer pressure, poor parental guidance and substance abuse. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Guinea Bissau. Our findings revealed that adolescent fertility will continue to decline but remain high throughout the out of sample period. Therefore, we encourage the government to prioritize girl child education, allocate more resources to youth empowerment projects, scale up awareness campaigns among communities and enforce laws that protect the rights of women and girls.

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