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Detecting Abnormal Future Trends of Adolescent Fertility for Chad 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 Chad 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 and0.2 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility rate is anticipated to decline but remain very high throughout the out of sample period. Therefore, we encourage authorities in Chad to allocate more funding towards SRH programs with the aim of scaling up educational campaigns among communities, strictly enforcing laws to protect women's rights, promote girl child education, fund empowerment programs for youths and create adolescent friendly health facilities and improving access to quality and affordable SRH services.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Tackling the problem of teenage pregnancy is a huge challenge especially in developing countries. A third of adolescent girls in low and middle income countries get married before their 18th birthday, while 20% of these girls get married before 15 years of age (UNFPA, 2016). All 179 country representatives who attended the 1994 International Conference on Population and development identified child marriage as a hindrance to global health, development, and gender equality(UN, 1995). Sub-Saharan Africa, South Asia, Latin America and the Caribbean continuously report worrying trends of child marriage and teenage pregnancies (UNICEF, 2019). Girl child marriage has also been reported in previous studies in developed countries such as the United States of America (Koski *et al.* 2018). According to WHO, adolescents in Chad constitute 24.6% of the total population and in 2014, 75% of them were living in the rural areas. In 2020, 38.3% of adolescent girls aged 15-19 were already in union and 66.9 percent were married before 18 years of age. In the same vein, 35.9% of adolescents aged 15-19 had begun child bearing. The unmet need for modern contraception for those in union is 22.5% and 69.5% for those outside union. The number of new HIV infections among adolescent girls aged 15-19 in 2020 was 600.Several previous studies done in various settings revealed that adolescent pregnancy is caused by several factors which include early marriage or sexual intercourse, illiteracy or low level of education and poverty (Kassa *et al.* 2019; Wado *et al. 2019*; Kassa *et al.* 2018;Palamuleni, 2017; Neal et al. 2016; WHO, 2015;Gideon, 2013; Kearney &Levine, 2012). The aim of this paper is to project future trends of adolescent fertility in Chad using Holt's double exponential smoothing technique. The findings are expected to depict the future burden of adolescent births in the country and stimulate review of current policies in order to urgently address the problem of child marriages and sexual abuse of adolescent girls.

II. METHODOLOGY

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

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Model equation

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

Smoothing equation

$S_t = \alpha C_t + (1-\alpha)(S_{t-1} + b_{t-1})$

Trend estimation equation

$b_t = \beta (S_t - S_{t-1}) + (1-\beta) b_{t-1}$

Forecasting equation

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

C_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

S_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

Data Issues

This study is based on annual adolescent fertility rate in Chad 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	C
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.200
Forecast performance measures	

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Mean Absolute Error (MAE)	1.334994
Sum Square Error (SSE)	657.392616
Mean Square Error (MSE)	10.776928
Mean Percentage Error (MPE)	-0.122609
Mean Absolute Percentage Error (MAPE)	0.667506

Residual Analysis for the Applied Model

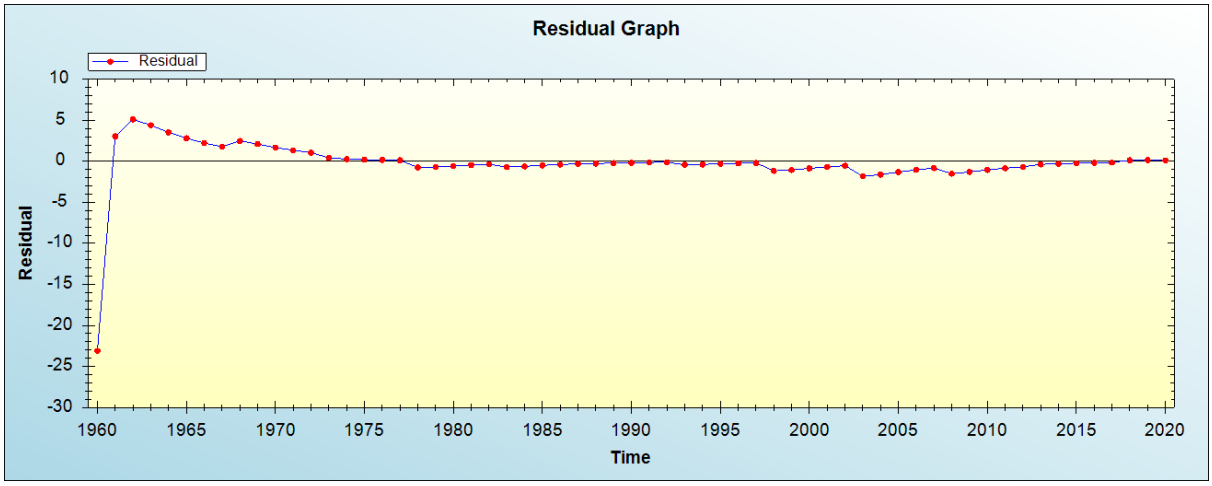

Figure 1: Residual analysis

In-sample Forecast for C

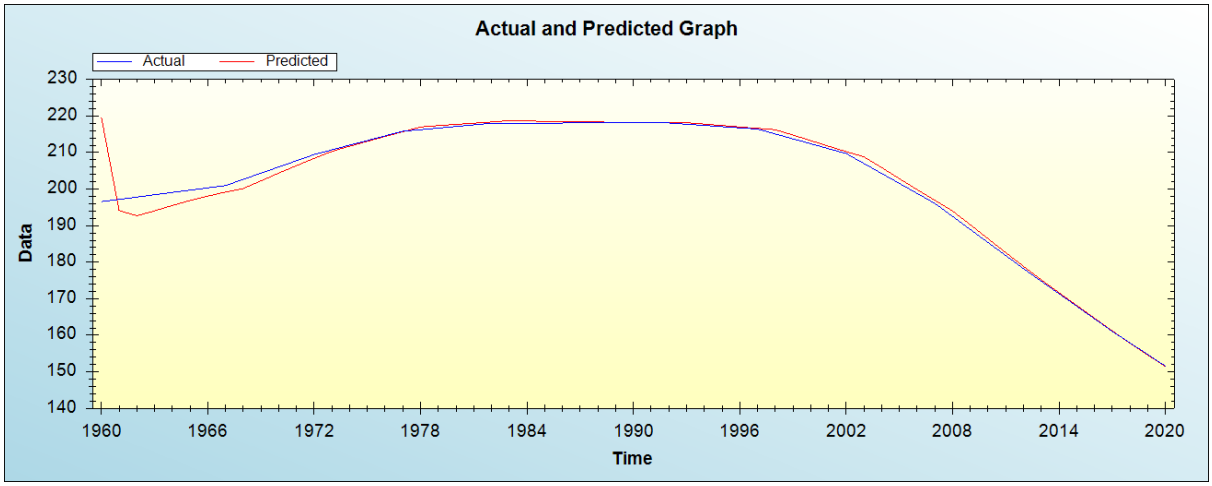

Figure 2: In-sample forecast for the C series

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Actual and Smoothed graph for C series

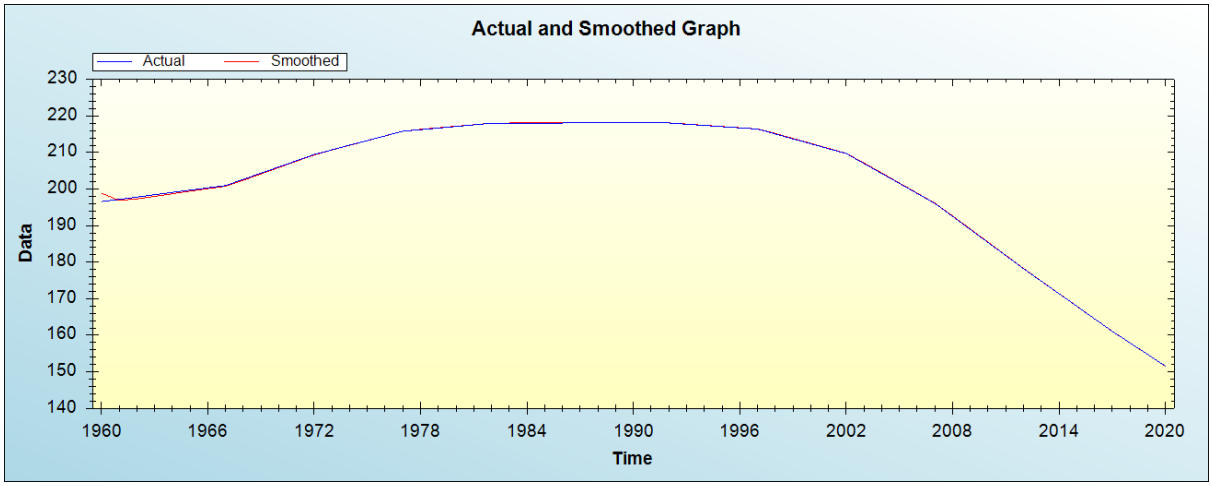

Figure 3: Actual and smoothed graph for C series

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

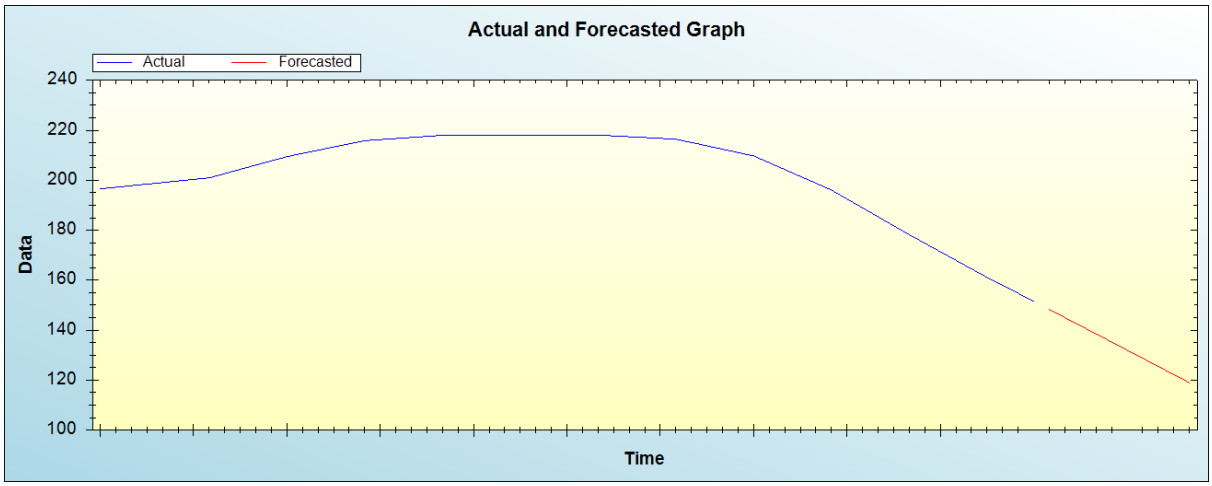

Figure 4: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	148.2939
2022	145.0364
2023	141.7789
2024	138.5214
2025	135.2638
2026	132.0063
2027	128.7488
2028	125.4913
2029	122.2337
2030	118.9762

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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 rateis expected to decline and also remain very high throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Chad is one of the countries in Africa with very high teenage pregnancy rates. In 2020, 38.3 percent of adolescent girls aged 15-19 were already in union and 66.9 percent were married before 18 years of age. Predictors of teenage pregnancy in this country were reported to be poverty, low educational level, peer pressure, sexual abuse, poor parental guidance and substance abuse. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Chad. Our study findings revealed that adolescent fertility will continue to decline but still remain very high throughout the out of sample period. Therefore, the government should scale up educational campaigns among communities, strictly enforcing laws to protect women's rights, promote girl child education, fund empowerment programs for youths and create adolescent friendly health facilities and improving access to quality and affordable SRH services.

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