International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 172-177, February-2023

https://doi.org/10.47001/IRJIET/2023.702027

Predicting Adolescent Fertility for Liberia Using Holt's Double Exponential Smoothing Technique

[1]Smartson. P. NYONI, [2]Thabani NYONI

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

***Abstract* - This study uses annual time series data of adolescent fertility rate for Liberia 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 0.4 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility rate will continue to decline but remain very high throughout the out of sample period. Therefore, we encourage policy makers in Liberia to address socio-cultural, economic and geographic factors that significantly contribute to teenage pregnancies. There is need to enforce laws that protect the rights of women and girls, promote girl child education and establish adolescent friendly health facilities that will provide affordable comprehensive sexual and reproductive health services.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

The challenge of teenage pregnancy is a global health issue mainly affecting adolescent girls in developing countries. Its occurrence calls for governments to improve access to education, health and employment opportunities for women. Adoption of WHO recommendations on ending teenage pregnancy should be among the top priorities in the reduction of adverse maternal and child health outcomes. The 3rd sustainable development goal (SDG3) has a target which focuses on improving access to quality and affordable sexual and reproductive health services including that of adolescents (UN, 2020; UNICEF, 2019; WHO, 2019. UNICEF, 2018; UN, 2016; UN, 2015). More than 1 million adolescent girls aged 10–14 years and an estimated 16 million ages 15–19 y give birth each year (WHO, 2020). About one-third (29–33%) of pregnancies in sub-Saharan Africa (SSA) have been described as unintended: mistimed (occurring when a woman did not want to become pregnant at the time of pregnancy) or unwanted (Bain *et al.* 2020; Ameyaw *et al.* 2019). Above 50% of unintended pregnancies end up as abortions and 97% of these in Africa are classified as unsafe (WHO, 2020). In addition, 12 million women aged 15–19 y and at least 777 000 girls below 15 years of age give birth each year in low- and middle-income countries (LMICs). In a systematic review and meta-analysis carried out in 2018, the prevalence of adolescent pregnancy in SSA was reported to be 19.3% (Kassa *et al.* 2018).Previous literature has indicated that many adverse outcomes of teen pregnancy are being reported in developing countries and these have been found to occur in the antenatal period, during delivery and post natal periods (Noori *et al.*2022; Ahinkorah *et al.* 2021; Harrington *et al.* 2021; Kaforau *et al.* 2021;UNICEF, 2019). These include eclampsia, anemia, preterm delivery and low birth weight (Kassa *et al.* 2019; Wall-Wieler*et al.* 2019; Grønvik *et al.* 2018). In addition, morbidity and mortality among adolescent pregnant mothers and children born to teenage mothers was found to be higher than that of women of an older age group (WHO, 2020). Post war Liberia is currently facing numerous challenges including that of child marriages. The government has implemented several strategies including family planning services and laws that prohibit child marriage. However more needs to be done to end harmful practices which promote child marriage. In this paper we apply Holt's double exponential smoothing to forecast future trends of adolescent fertility over the out of sample period. The findings will guide policymaking, planning and allocation of resources towards activities designed to curb child marriages and protection of women's rights.

II. METHODOLOGY

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

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 172-177, February-2023

https://doi.org/10.47001/IRJIET/2023.702027

Holt's linear method is specified as follows:

Model equation

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

Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

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

A_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 Liberia 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	A
Included Observations	61

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 7, Issue 2, pp 172-177, February-2023
https://doi.org/10.47001/IRJIET/2023.702027

Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.400
Forecast performance measures	
Mean Absolute Error (MAE)	0.612093
Sum Square Error (SSE)	95.892403
Mean Square Error (MSE)	1.572007
Mean Percentage Error (MPE)	0.051557
Mean Absolute Percentage Error (MAPE)	0.323473

Residual Analysis for the Applied Model

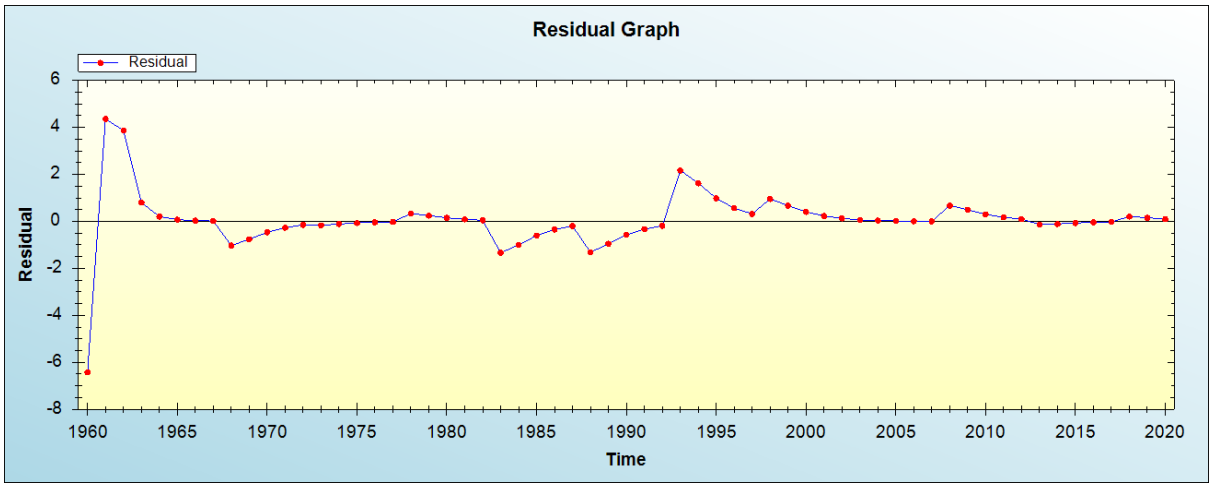

Figure 1: Residual analysis

In-sample Forecast for A

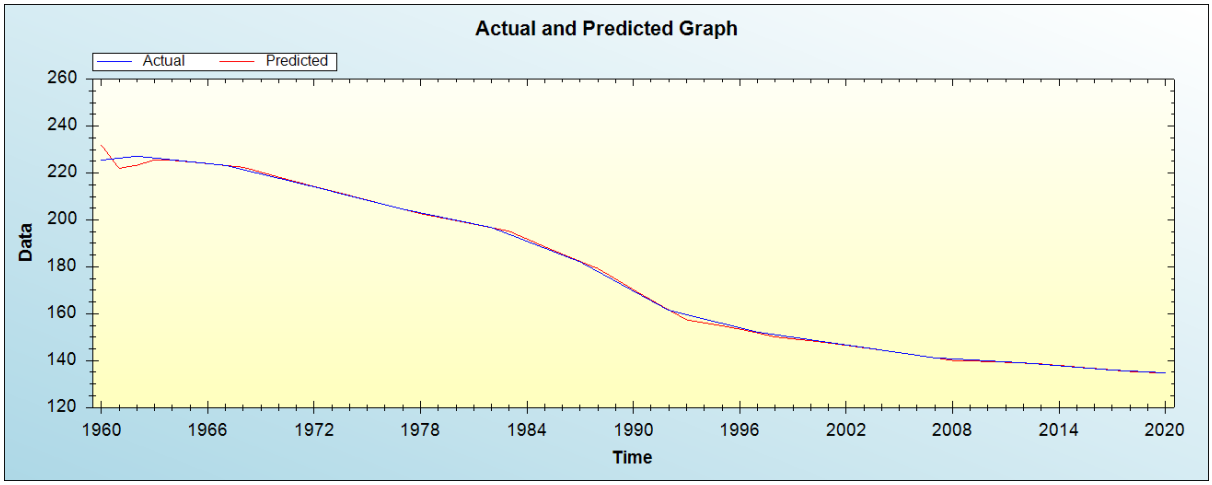

Figure 2: In-sample forecast for the A series

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 7, Issue 2, pp 172-177, February-2023
https://doi.org/10.47001/IRJIET/2023.702027

Actual and Smoothed graph for A series

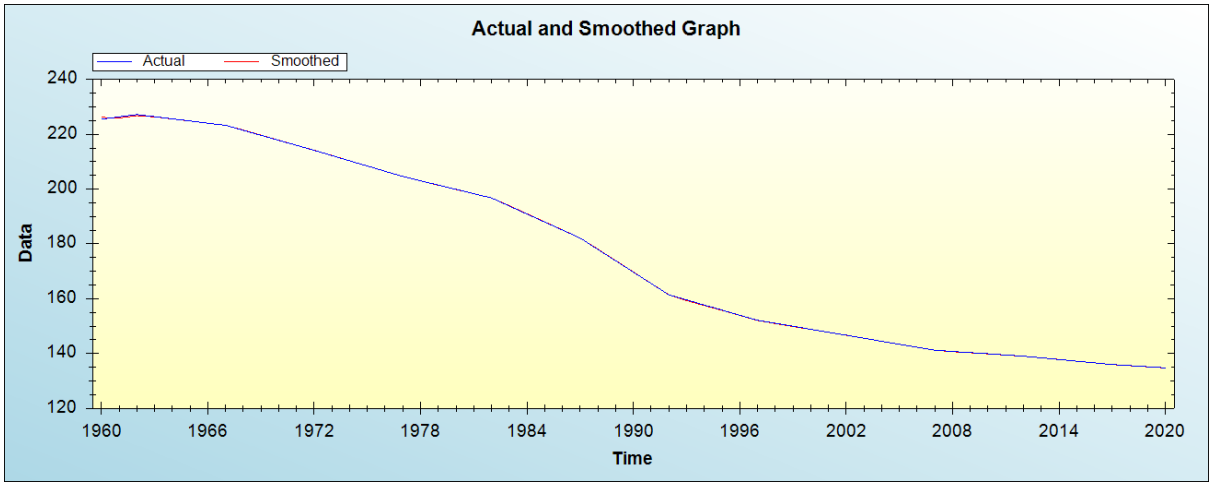

Figure 3: Actual and smoothed graph for A series

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

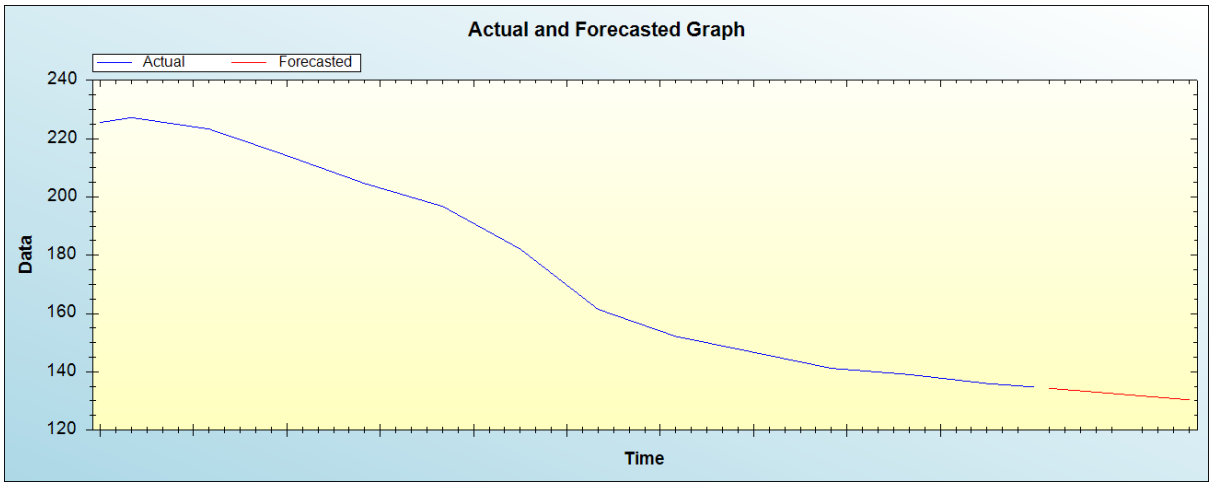

Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	134.3244
2022	133.8836
2023	133.4428
2024	133.0020
2025	132.5612
2026	132.1205
2027	131.6797
2028	131.2389
2029	130.7981
2030	130.3573

ISSN (online): 2581-3048
Volume 7, Issue 2, pp 172-177, February-2023
https://doi.org/10.47001/IRJIET/2023.702027

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 ratewill continue to decline but remain very high throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Post war Liberia is currently facing numerous challenges including that of child marriages. The government has implemented several strategies including family planning services and laws that prohibit child marriage. However more needs to be done to end harmful practices which promote child marriage. This study applied the double exponential smoothing technique to forecast future trends of adolescent fertility for Liberia. We found out that adolescent fertility will continue to decline but remain very high throughout the out of sample period. Therefore, we encourage the government to address socio-cultural, economic and geographic factors that significantly contribute to teenage pregnancies. There is need to enforce laws that protect the rights of women and girls, promote girl child education and establish adolescent friendly health facilities that will provide affordable comprehensive sexual and reproductive health services.

REFERENCES

[1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.
[2] World Health Organization (2020). Preventing early pregnancy through appropriate legal, social and economic measures https: //www.who.int/reproductivehealth/topics/adolescence/laws/en/.
[3] Ameyaw EK., Budu E., Sambah F (2019). Prevalence and determinants of unintended pregnancy in sub-Saharan Africa: A multicounty analysis of demographic and health surveys. PLoS One. 14(8):e0220970.
[4] BainL.E., Zweekhorst MBM., and deBuningTC (2020).Prevalence and determinants of unintended pregnancy in sub-Saharan Africa: asystematic review. Afr J Reprod Health. 24(2):187–205.
[5] Grønvik T., Fossgard Sandøy I (2018). Complications associated with adolescentchildbearinginsub-SaharanAfrica:asystematicliteraturereview andmeta-analysis. PLoS One. 13(9):e0204327.
[6] Wall-Wieler E., Lee JB., Nickel N (2019). The multigenerational effects of adolescent motherhood on school readiness: a population-based retrospective cohortstudy. PLoS One. 14(2):e0211284.
[7] Kassa GM., Arowojolu AO., and Odukogbe AA (2019). Adverse neonatal outcomes of adolescent pregnancy in northwest Ethiopia. PLoS One. 14(6):e0218259.
[8] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
[9] UN (2020) sustainable development goals. https://www.un.org/sustainabl development/development-agenda
[10] UNICEF (2018). Every Child alive. New York: UNICEF
[11] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
[12] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.
[13] Noori N., Proctor J.L., Efevbera Y (2022). The Effect of Adolescent Pregnancy on Child Mortality in 46 Low- and Middle-Income Countries. BMJ Global Health 2022; 7:e007681. doi:10.1136/ bmjgh-2021-007681
[14] Kaforau L.S.K., Tessema G.A., Jancey J (2021). Prevalence and risk factors of adverse birth outcomes in the Pacific Island region: a scoping review protocol. BMJ Open 2021; 11:e042423. doi:10.1136/ bmjopen-2020-042423
[15] HarringtonR.B., Harvey N., Larkins S., and Redman-MacLaren M (2021) Family planning in Pacific Island Countries and Territories (PICTs): A scopingreview. PLoS ONE 16(8): e0255080. https://doi.org/10.1371/journal.pone.0255080
[16] Ahinkorah B.O., Kang M., Perry L., Brooks F., and Hayen A (2021) Prevalence of first adolescent pregnancy and its associated factors in sub-Saharan Africa: A multi-country analysis. PLoS ONE 16(2):e0246308.https://doi.org/10.1371/ journal.pone.0246308.

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 172-177, February-2023

https://doi.org/10.47001/IRJIET/2023.702027

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Predicting Adolescent Fertility for Liberia Using Holt's Double Exponential Smoothing Technique" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 172-177, February 2023. Article DOI https://doi.org/10.47001/IRJIET/2022.702027

****

