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

ISSN (online): 2581-3048
Volume 6, Issue 12, pp 137-141, December-2022
https://doi.org/10.47001/IRJIET/2022.612025

Applying the Double Exponential Smoothing Technique to Detect Future Trends of Adolescent Fertility for Botswana

[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 employs annual time series data of adolescent fertility rate for Botswana from 1960 to 2020 to predict future trends of adolescent fertility 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 and0.3 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 Botswana to tirelessly address all the socio-cultural, geographic and economic factors that contribute to unwanted pregnancies among adolescents.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

High fertility rates in developing countries are considered an immense public health issue of concern due to the anticipated increase in the population size resulting in increased demand and competition for local resources (UN, 2020). The agenda 2030 for sustainable development was designed to solve this challenge through universal health coverage (WHO, 2020; Chandra-Mouli *et al.* 2015). Previous studies found that there are multiple risk factors associated with high rates of adolescent pregnancies such as poverty, history of family member who had teenage pregnancy, parental absence, single parent house hold, peer pressure, curiosity, inadequate SRH information and inconsistent and incorrect use of condoms (Kassa *et al.* 2018; Yakubu *et al.* 2018). The adverse effects of teen pregnancy are well documented in literature and these include hypertensive disorders, anemia and mental stress (Patton *et al.* 2016; Azevedo*et al.* 2015). Furthermore, low birth weight, prematurity and poor nutrition will affect the new born baby (Nguyen *et al.* 2019; de Onis &Branca, 2016). World Bank revealed that adolescent fertility in Botswana declined gradually from 161 births per 1000 women aged 15-19 in 1960 to 44 births per 1000 women aged 15-19 in 2020.

The aim of this paper is to model and project adolescent fertility for Botswana using Holt's double exponential smoothing technique. Findings of this study will depict future trends of adolescent fertility in the out of sample period. This is expected to facilitate policymaking, planning and allocation of 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 Botswana. 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 expressed as follows:

Model equation

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

Smoothing equation

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

ISSN (online): 2581-3048

Volume 6, Issue 12, pp 137-141, December-2022

https://doi.org/10.47001/IRJIET/2022.612025

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

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

Y_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 period t-1

Data Issues

This study is based on annual adolescent fertility rate in Botswana 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	Y
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.300
Forecast performance measures	
Mean Absolute Error (MAE)	1.385439

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 6, Issue 12, pp 137-141, December-2022
https://doi.org/10.47001/IRJIET/2022.612025

Sum Square Error (SSE)	621.591986
Mean Square Error (MSE)	10.190033
Mean Percentage Error (MPE)	0.378900
Mean Absolute Percentage Error (MAPE)	1.315170

Residual Analysis for the Applied Model

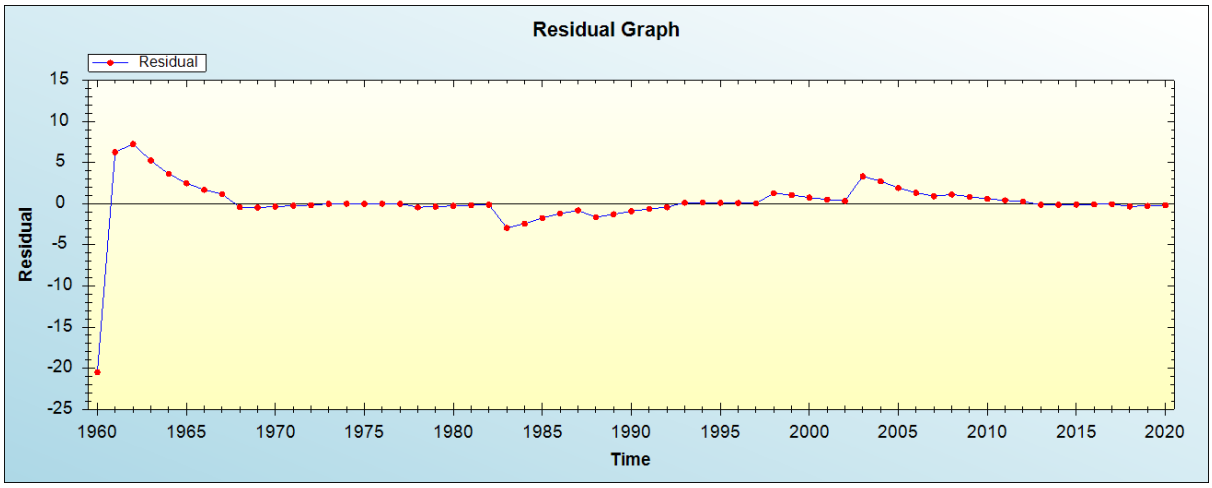

Figure 1: Residual analysis

In-sample Forecast for Y

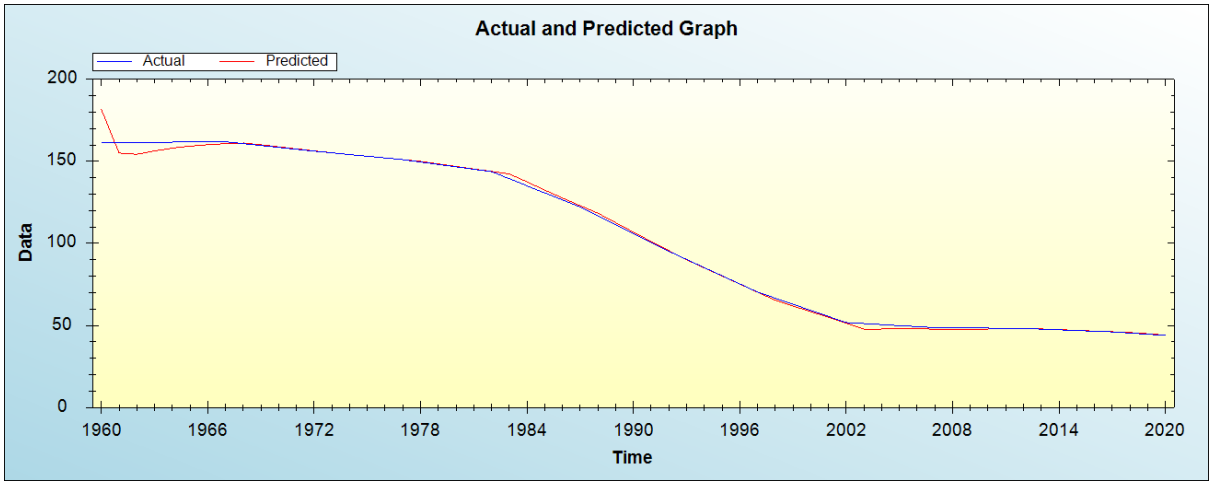

Figure 2: In-sample forecast for the Y series

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 6, Issue 12, pp 137-141, December-2022
https://doi.org/10.47001/IRJIET/2022.612025

Actual and Smoothed graph for Y series

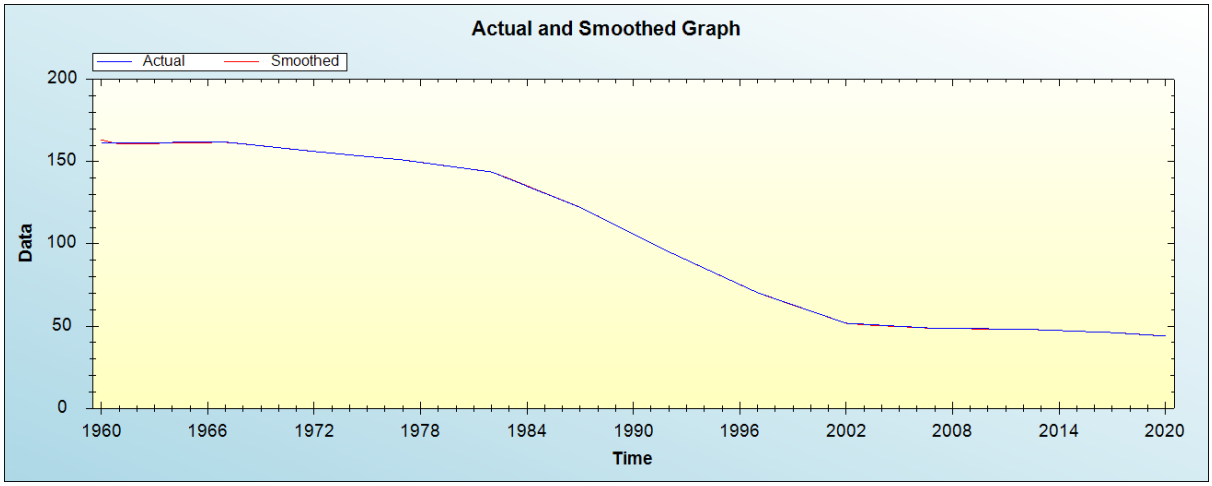

Figure 3: Actual and smoothed graph for Y series

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

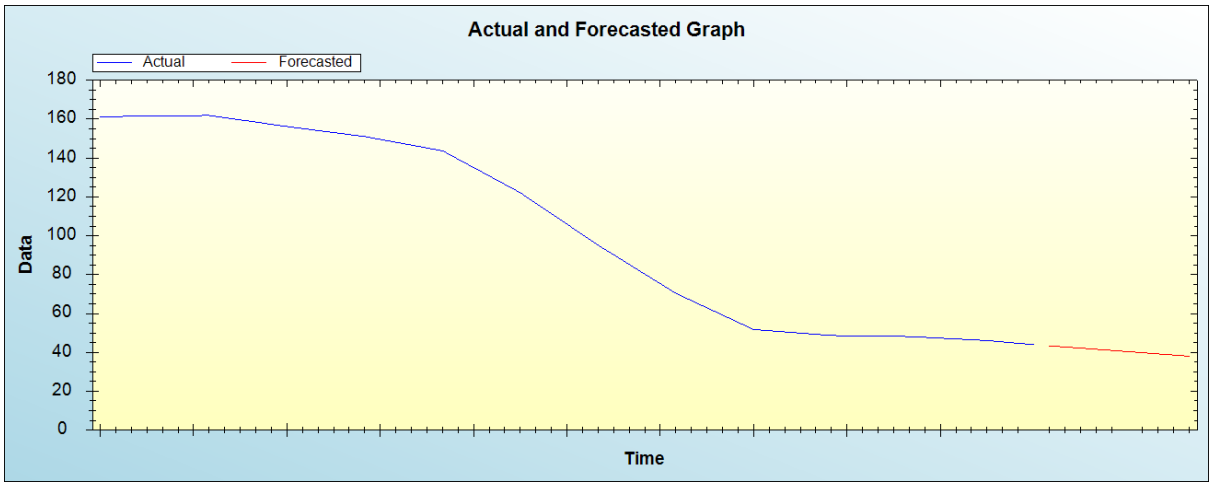

Figure 4: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	43.3748
2022	42.7793
2023	42.1838
2024	41.5883
2025	40.9929
2026	40.3974
2027	39.8019
2028	39.2064
2029	38.6109
2030	38.0154

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

ISSN (online): 2581-3048

Volume 6, Issue 12, pp 137-141, December-2022

https://doi.org/10.47001/IRJIET/2022.612025

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 fertility rates in low and middle countries are regarded as a big public health issue of concern due to the expected increase in the population size resulting in increased demand and competition for local resources. Adolescent fertility in Botswana declined gradually from 161 births per 1000 women aged 15-19 in 1960 to 44 births per 1000 women aged 15-19 in 2020. This can be attributed to improvements in the education sector, family planning services and increased public awareness. This paper applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Botswana. Our study findings indicate that adolescent fertility will continue to drop throughout the out of sample period. Therefore, we encourage the government to address all the socio-cultural, geographic and economic factors that result in unwanted pregnancies among adolescents.

REFERENCES

[1] United Nations (2020). Global indicator framework for the sustainable development goals and targets of the 2030 agenda for sustainable development. Work Stat Comm Pertain to 2030 Agenda Sustain Dev. 2020; 1–21.

[2] Chandra-Mouli V., Svanemyr J., Amin A., Fogstad H., Say L., Girard F (2015). Twenty years after international conference on population and development: Where are we with adolescent sexual and reproductive health and rights? J Adolesc Heal. 56(1):S1-6.

[3] Adolescent pregnancy fact sheet (2020). World Health Organization.

[4] Kassa G. M., Arowojolu AO., Odukogbe A. A., and Yalew A.W (2018). Prevalence and determinants of adolescent pregnancy in Africa: a systematic review and meta-analysis. Reprod Health. 15(1):1–17.

[5] Yakubu I., and Salisu W. J. (2018). Determinants of adolescent pregnancy in sub-Saharan Africa: a systematic review. Reprod Health. 15(1):1–11.

[6] Patton G. C., Sawyer S. M., Santelli J. S., Ross D.A, Afifi R., Nicholas B (2016). Our future: a Lancet commission on adolescent health and wellbeing. Lancet. 387(10036):2423–78.

[7] Azevedo W. F., Diniz M. B., Fonseca E. S., Azevedo LM., Evangelista CB (2015). Complications in adolescent pregnancy: systematic review of the literature. Einstein (Sao Paulo). 13(4):618–26.

[8] de Onis M., and Branca F (2016). Childhood stunting: a global perspective. Matern Child Nutr. 12:12–26.

[9] Nguyen P.H., Scott S., Neupane S., Tran LM., Menon P (2019). Social, biological, and programmatic factors linking adolescent pregnancy and early childhood undernutrition: a path analysis of India's 2016 National Family and Health Survey. Lancet Child Adolesc Heal. 3(7):463–73.

[10] World Bank (2020). Adolescent fertility rate women aged 15-19 years.

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Applying the Double Exponential Smoothing Technique to Detect Future Trends of Adolescent Fertility for Botswana" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 12, pp 137-141, December 2022. Article DOI https://doi.org/10.47001/IRJIET/2022.612025

****

