Forecasting adolescent Fertility for Antigua and Barbuda Using the 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 employs annual time series data on adolescent fertility rate for Antigua and Barbuda 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 and0.4 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 Antigua and Barbuda to address issues that significantly contribute to unwanted pregnancies among adolescents and improve access to quality and affordable SRH services.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adolescent pregnancy continues to be an important public health problem around the world. Socio-cultural, economic and demographic reasons have been identified as major drivers of pregnancy among adolescent girls aged 10-19 years (Yakubu & Salisu, 2018).Adolescent girls and young women are at high risk of having STIs, early unwanted pregnancies, unsafe abortions and obstetric complications (Chandra-Mouhi *et al.* 2015). Previous studies highlighted that young women lack comprehensive information on SRH and thus end up having unprotected sexual intercourse leading to unintended pregnancies and STIs (Yakubu & Salisu, 2018).Developing countries continue to report high absolute numbers of adverse maternal and neonatal health outcomes (Horvath S &Schreiber, 2017; Dastgiri *et al.* 2017; Melese *et al.* 2017; Bishwajit *et al.* 2017). Hence, the Agenda 2030 for sustainable development and the 1994 programme action of the International conference on population and development (ICPD) recognized sexual and reproductive health as a fundamental human right. The sexual and reproductive rights of every individual or couple must be respected. The signatories to the conferences recognized the need to uphold the SRH rights of women and adolescent girls who are suffering from gender-based or intimate violence and sexual abuse in many countries across the globe. Adolescent girls and young women have the right to information on family planning services (Darroch& Singh, 2013). In addition, the 3rd sustainable development goal focuses on ensuring good health for all at all stages of life. Under this SDG, universal access to quality and affordable health is essential in order to have health populations that will make meaningful contribution towards socio-economic development. Target 3.7 specifically addresses issues pertaining to sexual and reproductive health including that of adolescents. The aim is to ensure availability of SRH services for adolescents and adults leaving no one and no place behind. Governments are expected to establish legal frameworks that are effective in curbing sexual offenses against adolescent girls and women in general. It is also critical for authorities to establish surveillance mechanisms that will keep track of adolescent births that signals an alarm to the policing arms of the state. Strategies to eliminate early child marriages should be implemented in accordance to international law and justice in order to end bad socio-cultural and religious practices.

This paper is presented in line with the Agenda 2030 for sustainable development and focuses on forecasting future trends of adolescent fertility for Antigua and Barbuda. The findings thereof are envisioned to depict the likely future burden of adolescent births in the country and provide guidance to policy makers so that effective policies are crafted and implemented timorously in order to substantially reduce adverse maternal and child health outcomes.

II. METHODOLOGY

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

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

Smoothing equation

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

$0 < \alpha < 1$

Trend estimation equation

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

$0 < \beta < 1$

Forecasting equation

$f_{t+h} = S_t + h b_t$

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**

$\mathbf{t}$ 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 slope of the trend at time t

b_{t-1} is the slope of the trend at time t-1

Data Issues

This study is based on annual adolescent fertility rate in Antigua and Barbuda 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

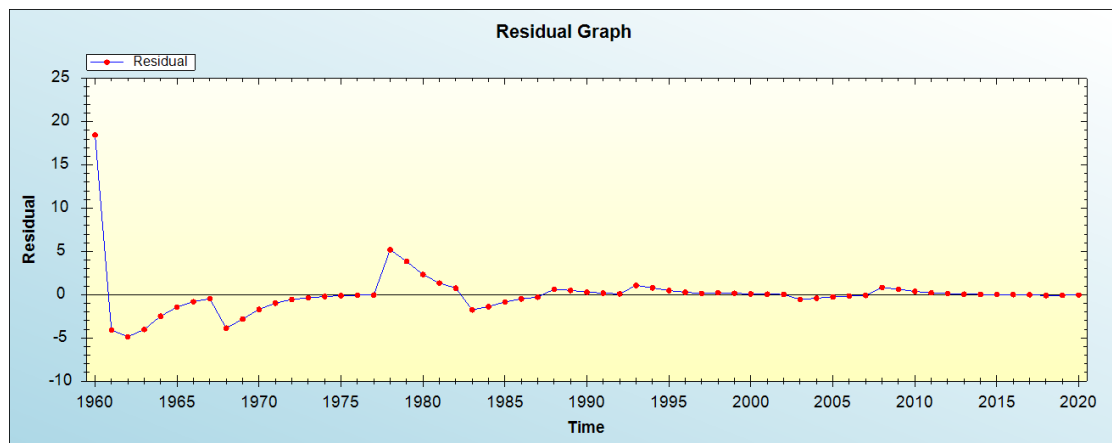| Variable	A
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.400
Forecast performance measures	
Mean Absolute Error (MAE)	1.222155
Sum Square Error (SSE)	494.537388
Mean Square Error (MSE)	8.107170
Mean Percentage Error (MPE)	0.153484
Mean Absolute Percentage Error (MAPE)	1.004053

Residual Analysis for the Applied Model

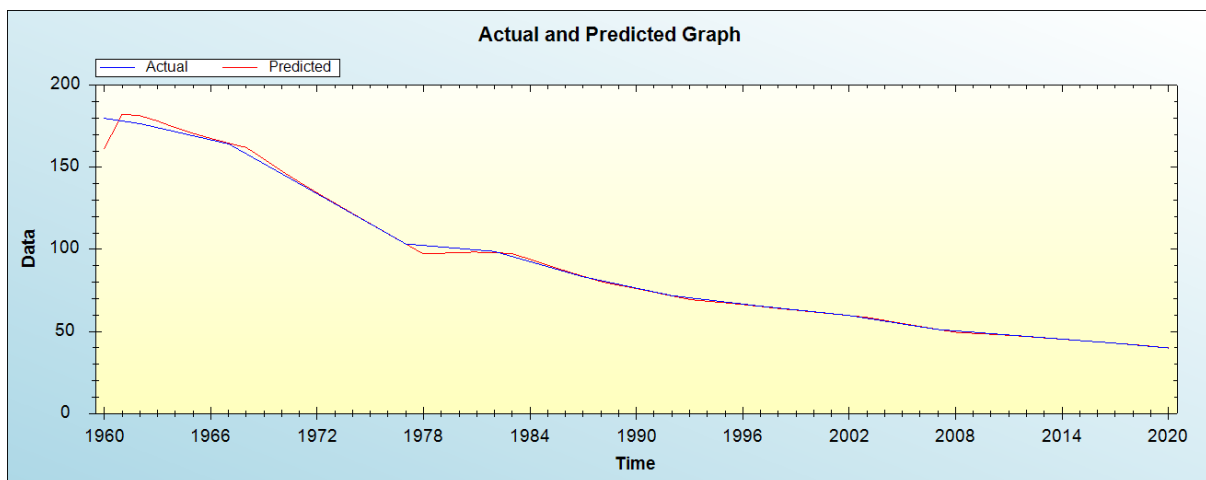Figure 1: Residual analysis

In-sample Forecast for A

Figure 2: In-sample forecast for the A series
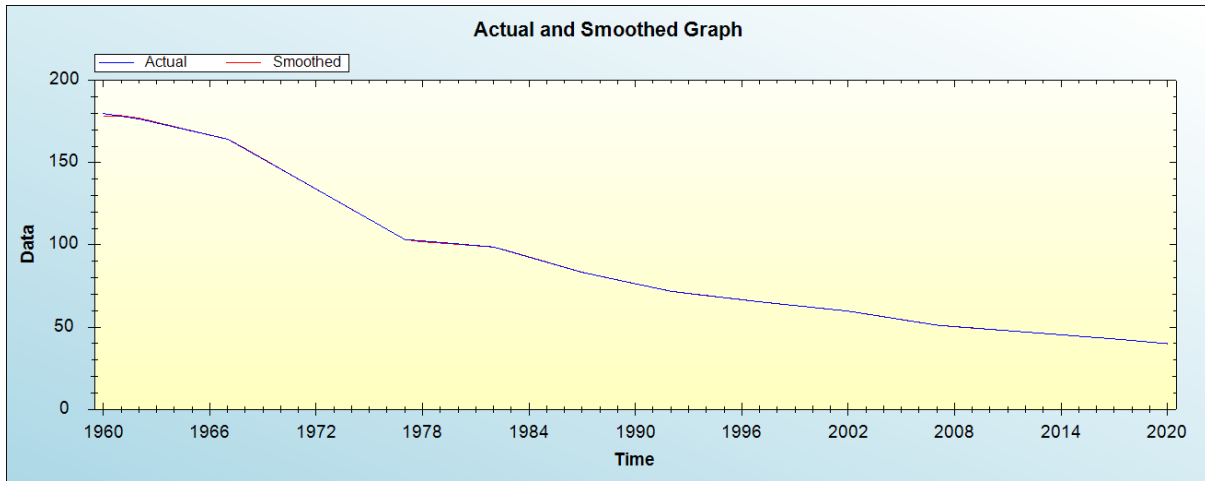
Actual and Smoothed graph for A series

Figure 3: Actual and smoothed graph for A series

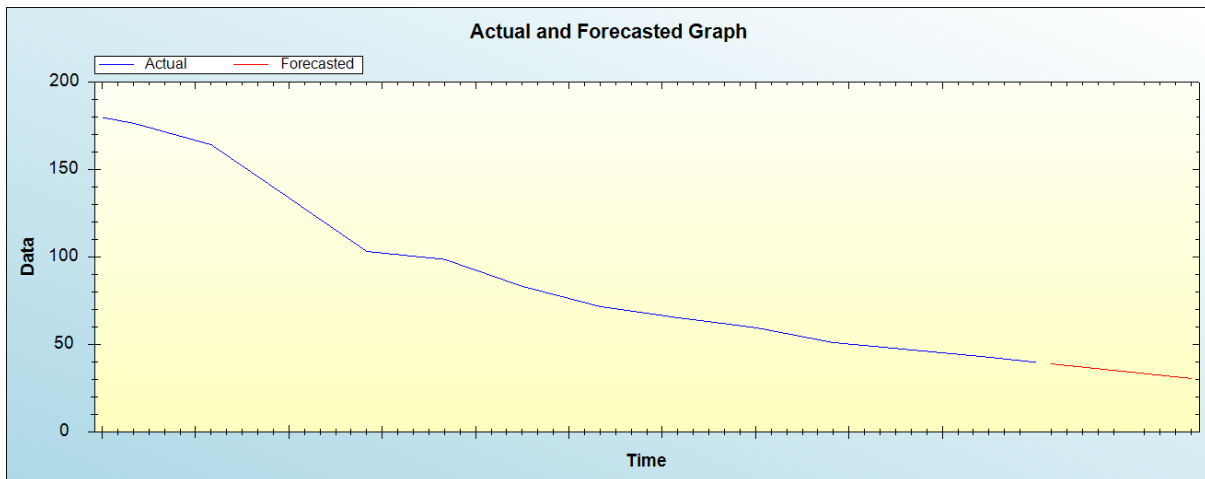Out-of-Sample Forecast for A: Actual and Forecasted Graph

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	39.0051
2022	38.0765
2023	37.1479
2024	36.2193
2025	35.2907
2026	34.3621
2027	33.4334
2028	32.5048
2029	31.5762
2030	30.6476

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 will continue to decline throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adolescent pregnancy is a cause for concern in developing and developed countries due to the increased risk of adverse pregnancy outcomes experienced by pregnant teenagers. Addressing most of the challenges being encountered by adolescents will help reduce maternal and child morbidity and mortality. Several challenges have been identified such as poverty, inadequate SRH information, refusal to use modern methods of contraception, peer pressure, parental absence, substance abuse and sexual abuse of adolescent girls. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Antigua and Barbuda. Our study findings revealed that adolescent fertility for Antigua and Barbuda will continue to decline throughout the out of sample period. Therefore, we encourage the government to address issues that significantly contribute to unwanted pregnancies among adolescents and improve access to quality and affordable SRH 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] Chandra-Mouli V., Svanemyr J., Amin A., Fogstad H., Say L., Girard F., & Temmerman M (2015). Twenty years after international conference on population and development: where are we with adolescent sexual and reproductive health and rights? J Adolesc Health. 2015;56:1–6

[3] Yakubu I., & Salisu WJ (2018). Determinants of adolescent pregnancy in sub-Saharan Africa: a systematic review. Reprod Health. 2018;15(1):15

[4] Horvath S., & Schreiber CA (2017). Unintended Pregnancy, Induced Abortion, and Mental Health. Curr Psychiatry Rep. 2017; 19:77. https://doi.org/10.1007/s11920-017-0832-4 PMID: 28905259

[5] Dastgiri S., Yoosefian M., Garjani M., & Kalankesh LR (2017). Induced Abortion: a Systematic Review and Metaanalysis. Mater Socio-Medica. 2017; 29:58–67.

[6] Melese T., Habte D., Tsima BM., Mogobe KD., Chabaesele K., & Rankgoane G (2017). High Levels of Post-Abortion Complication in a Setting Where Abortion Service Is Not Legalized. PLoS ONE. 2017; 12. https://doi.org/10.1371/journal.pone.0166287 PMID: 28060817

[7] Bishwajit G., Tang S., Yaya S., & Feng Z (2017). Unmet need for contraception and its association with unintended pregnancy in Bangladesh. BMC Pregnancy Childbirth. 2017; 17:186. https://doi.org/10.1186/s12884- 017-1379-4 PMID: 28606062

[8] Darroch J. E., & Singh S (2013). Trends in contraceptive need and use in developing countries in 2003, 2008, and 2012: an analysis of national surveys. Lancet Lond Engl, 381:1756–62.

****