

Detecting Future Trends of Adolescent Fertility for Bolivia Using the Double Exponential Smoothing Technique

¹Smartson. P. NYONI, ²Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - This study uses annual time series data of adolescent fertility rate for Bolivia 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 are 0.9 and 0.1 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 Bolivia to allocate more resources towards addressing all the factors that drive adolescent pregnancies and strictly enforce laws to protect sexual and reproductive rights of adolescent girls and women.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Following the 1994 International Conference on Population and development (ICPD) held in Cairo, Egypt, many countries started to recognize sexual and reproductive health and rights as fundamental human rights. The declaration and upholding of women's rights became pivotal in the quest to achieve gender equality and addressing sexual and reproductive health problems among different populations and age groups (UN, 1995). Many low-middle income countries are struggling to end adolescent pregnancies as a result of child marriage and sexual abuse of women. Previous studies established that adolescent girls are pushed into premarital sex by several reasons which include poverty, hunger, economic crises, bad cultural and religious practices that undermine the rights of the child (Wadoet *al.* 2019; Kaphagawani & Kalipeni, 2015; Odimegwu & Mkwanzani, 2016; Okigbo & Speizer, 2015; Neal *et al.* 2012). Teenage pregnancy has a negative impact on the mother, baby and the society at large. The resultant adverse reproductive health outcomes include maternal and under five mortality, mental trauma for the mother, school dropouts, and continuous cycle of poverty in the families of affected adolescent girls (Walker, 2012). Ending child marriages requires a collective effort by all stake holders. Strong advocacy and communication through various platforms will sensitize everybody on the urgent need to stop forced and voluntary child marriages. National and sub national levels should draft plans and budgets which include activities that address sexual and reproductive health issues of adolescents with particular attention being given to the prevention of teenage pregnancy, STIs and HIV among adolescents. It is also important to incorporate HIV/TB treatment and care in order to improve the quality of life among teenagers to enable them to achieve their life time goals. Furthermore, offering accessible quality and affordable sexual and reproductive health services to adolescents will assist in the reduction and management of adolescent pregnancies. The 3rd sustainable development goal target 3.7 focuses on sexual and reproductive health including adolescent health. Together with targets 3.1 and 3.2, all UN member countries should strive to implement effective policies to end teenage pregnancies that will subsequently lead to a an anticipated decline in maternal, neonatal and under five mortality (UN, 2020; UNICEF, 2019; WHO. 2019; UNICEF, 2018; UN, 2016; UN, 2015). In line with Vision 2030, this paper applies the double exponential smoothing (Holt) technique to forecast future trends of adolescent fertility in Bolivia. The findings are expected to depict the future burden of adolescent births in the country. This will act as a basis for reviewing current legal instruments and policies to protect women's rights and prevent child marriage at all cost.

II. METHODOLOGY

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

$$V_t = \mu_t + \rho_t t + \varepsilon_t$$

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

V_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 slope of the trend at time t

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

Data Issues

This study is based on annual adolescent fertility rate in Bolivia 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	V
Included Observations	61

Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.575959
Sum Square Error (SSE)	82.726130
Mean Square Error (MSE)	1.356166
Mean Percentage Error (MPE)	-0.140013
Mean Absolute Percentage Error (MAPE)	0.628401

Residual Analysis for the Applied Model

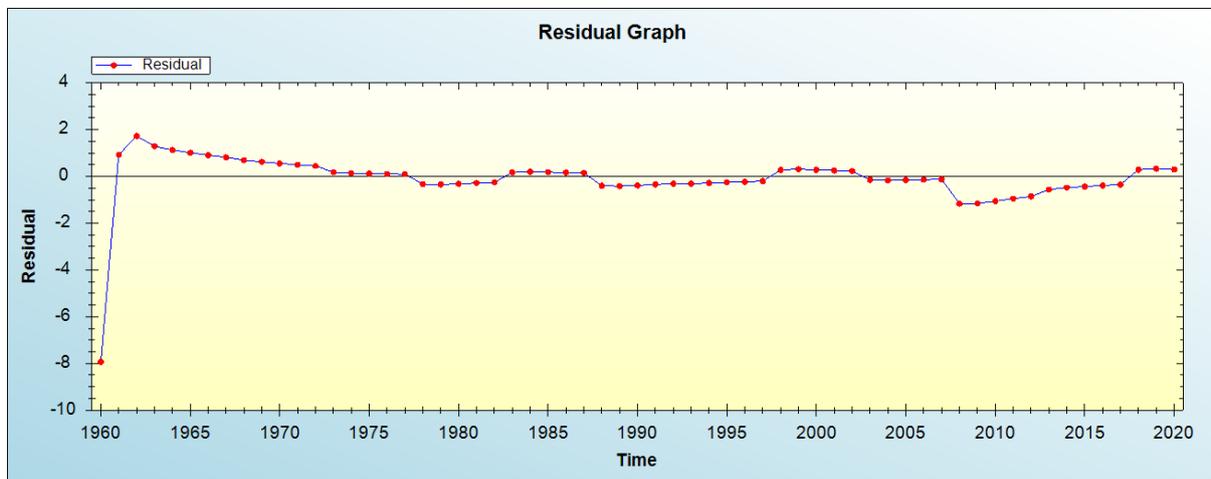


Figure 1: Residual analysis

In-sample Forecast for V

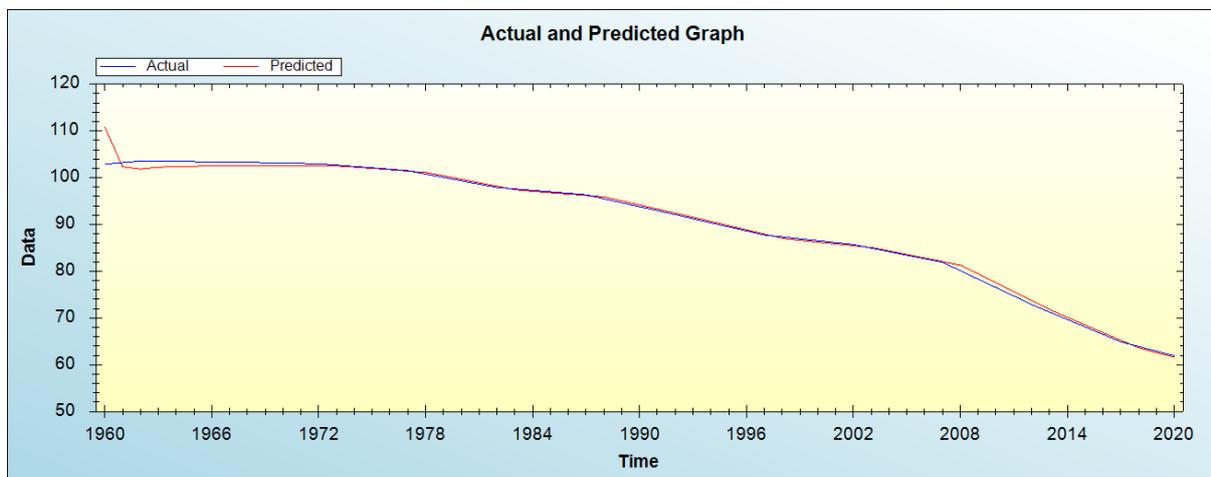


Figure 2: In-sample forecast for the V series

Actual and Smoothed graph for V series

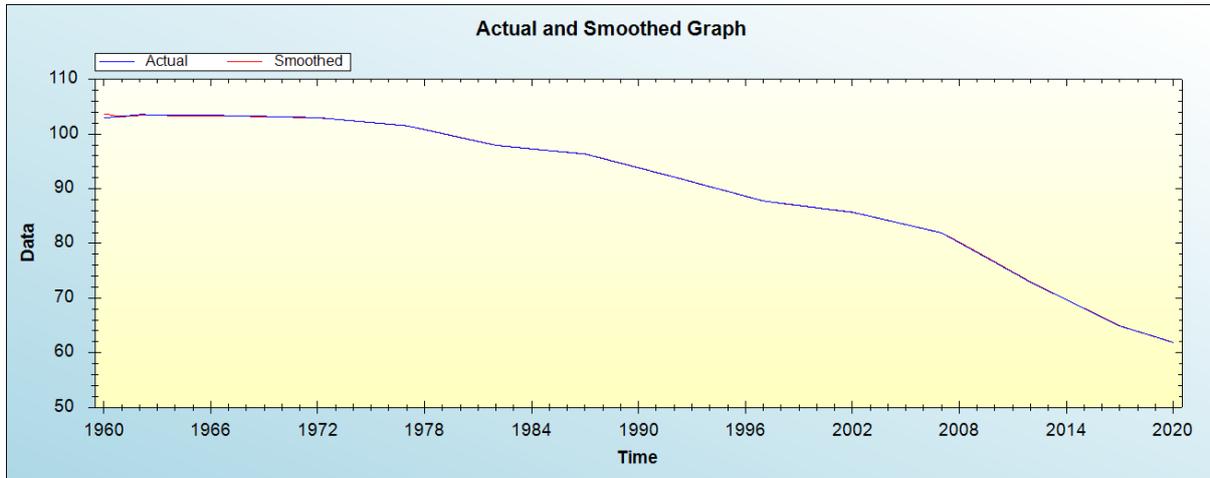


Figure 3: Actual and smoothed graph for V series

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

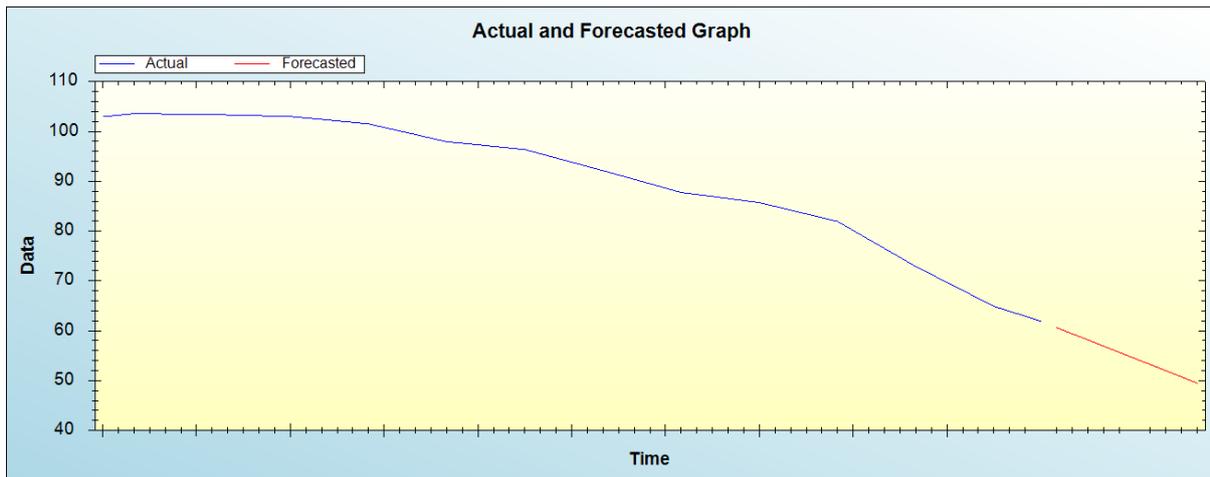


Figure 4: Out-of-sample forecast for V: actual and forecasted graph

Out-of-Sample Forecast for V: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	60.6436
2022	59.4049
2023	58.1662
2024	56.9275
2025	55.6888
2026	54.4501
2027	53.2114
2028	51.9727
2029	50.7340
2030	49.4953

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

Teenage pregnancy continues to be an important public health problem across the globe. Governments are worried of this problem because there is an increased risk of adverse pregnancy outcomes among pregnant teenagers. Infants born to teenage mothers have a greater risk of experiencing complications such as prematurity, low birth weight, birth trauma and sepsis. Poverty, low educational level, inadequate SRH information, low contraceptive use and poor parental guidance have been found to be significant predictors of teenage pregnancy. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Bolivia. Our study results revealed that adolescent fertility will continue to drop throughout the out of sample period. Therefore, the government must allocate more resources towards addressing all the factors that drive adolescent pregnancies and strictly enforce laws to protect sexual and reproductive rights of adolescent girls and women.

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] Walker, J. A. (2012). Early marriage in Africa – Trends, harmful effects, and interventions. *African Journal of Reproductive Health* 16(2): 231-240.
- [3] UN (2020) sustainable development goals. <https://www.un.org/sustainabledevelopment/development-agenda>
- [4] UNICEF (2018). Every Child alive. New York: UNICEF
- [5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
- [6] United Nations (2016). Transforming our world: The 2030 agenda for sustainable development.
- [7] United Nations (1995). United Nations International Conference on Population and Development, Cairo 5-13 September, 1994. Programme of Action. New York: United Nations, Department for Economic and Social Information and Policy Analysis.
- [8] Neal S., Matthews Z., Frost M., Fogstad H., Camacho A.V., and Laski L (2012). Childbearing in adolescents aged 12–15 years in low resource countries: a neglected issue. New estimates from demographic and household surveys in 42 countries. *Acta Obstet Gynecol Scand.* 91(9):1114–8. <https://doi.org/10.1111/j.1600-0412.2012.01467.x>.
- [9] Odimegwu C., and Mkwanzani S (2016). Factors associated with teen pregnancy in sub-Saharan Africa: a multi-country cross-sectional study. *Afr J Reprod Health.* 20(3):94–107. <https://doi.org/10.29063/ajrh2016/v20i3.14>.
- [10] Wado Y.D., Sully E.A., and Mumah J.N (2019). Pregnancy and early motherhood among adolescents in five east African countries: a multi-level analysis of risk and protective factors. *BMC Pregnancy Childbirth.* 19(1):59. <https://doi.org/10.1186/s12884-019-2204-z>
- [11] Okigbo CC., and Speizer I.S (2015). Determinants of Sexual Activity and Pregnancy among Unmarried Young Women in Urban Kenya: A Cross-Sectional Study. *PLoS One.* 10(6):e0129286.
- [12] Kaphagawani N., and Kalipeni E (2017). Sociocultural factors contributing to teenage pregnancy in Zomba district, Malawi. *Glob Public Health.* 12(6):694– 710. <https://doi.org/10.1080/17441692.2016.1229354>.

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, “Detecting Future Trends of Adolescent Fertility for Bolivia Using the Double Exponential Smoothing Technique” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 12, pp 132-136, December 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.612024>
