

Projecting Future Trends of Adolescent Fertility for Tunisia Using Holt's Linear Method

¹Smartson. P. NYONI, ²Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - This research paper employs annual time series data of adolescent fertility for Tunisia 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 0.7 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will hover around 7.9 births per 1000 women aged 15-19 throughout the out of sample period. Therefore, we encourage authorities in Tunisia to continue supporting girl child education and enforcing laws that protect sexual and reproductive health rights of women and girls.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Falling pregnant during the adolescent stage is regarded as a shameful act in many African societies, hence many pregnant teenagers experience psychological trauma, get expelled from school, and even rejected by their own families (Croft *et al.* 2018; UNIFPA, 2016; Chalasani *et al.* 2013; Muula, 2008). The magnitude of the mental trauma experienced by pregnant teenagers is sometimes unbearable prompting them to commit suicide. The resultant negative sexual and reproductive health consequences are far reaching (Nguyen *et al.* 2019; Woog & Kagesten, 2017; Kaphagawani & Kalipeni 2017; Neal *et al.* 2016; Patton *et al.* 2016; de Onis & Branca, 2016; Azevedo *et al.* 2015; Margret, 2015; Okigbo CC., & Speizer, 2015; Tebeuet *et al.* 2012; WHO, 2007; Larsson *et al.* 2002). Many previous studies reported that being sexually active at an early age, early marriage, older teenage, married women, educational attainment, age at 1st sex, household wealth, family structure, exposure to media, community poverty level, and contraceptive use are significantly associated with adolescent pregnancy (Birhanu *et al.* 2019; Wadoet *et al.* 2019; Brahmbhatt *et al.* 2014). There is noticeable significant progress that has been made by the government of Tunisia towards the achievement of set targets under the 3rd sustainable development goal. According to the World Bank, maternal mortality has significantly declined over the years from 66 in 2000 to 43 in 2017. In 2019 adolescent fertility rate was reported to be 8 births per 1000 women aged 15-19 years. In this study we apply the double exponential smoothing technique to forecast future trends of adolescent fertility for Tunisia. The findings of this study will guide policy making, planning and allocation of resources to programs which are designed to reduce child marriages, teenage pregnancy and sexual abuse of adolescent girls and women.

II. METHODOLOGY

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

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

N_t is the actual adolescent fertility rate at time period 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 Tunisia 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	N
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.700
Forecast performance measures	
Mean Absolute Error (MAE)	0.419522
Sum Square Error (SSE)	75.615841
Mean Square Error (MSE)	1.239604

Mean Percentage Error (MPE)	0.547331
Mean Absolute Percentage Error (MAPE)	1.378099

Residual Analysis for the Applied Model

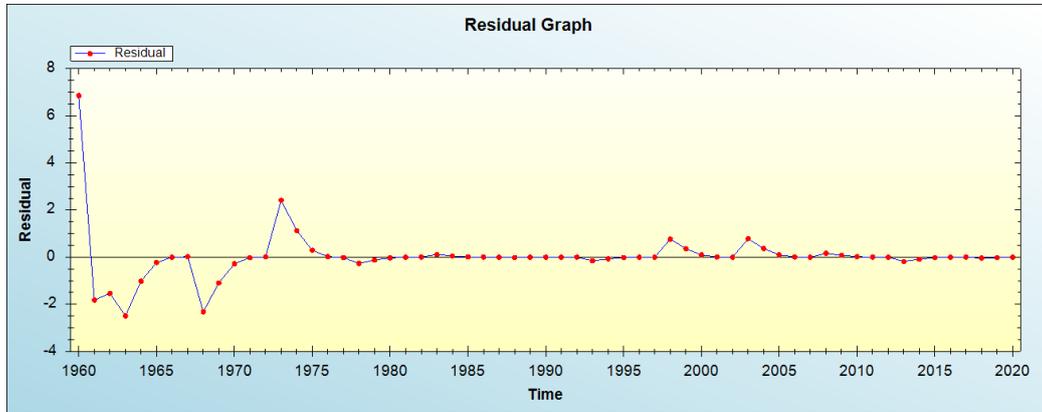


Figure 1: Residual analysis

In-sample Forecast for N

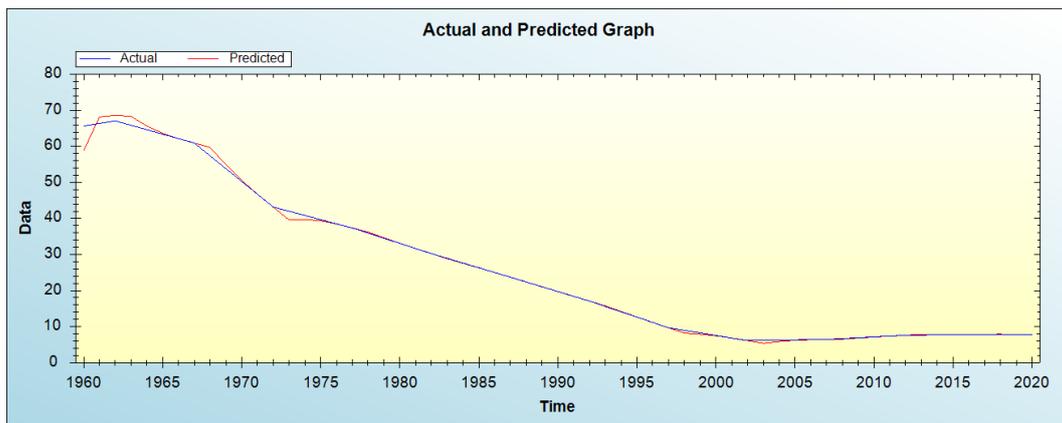


Figure 2: In-sample forecast for the N series

Actual and Smoothed graph for N series

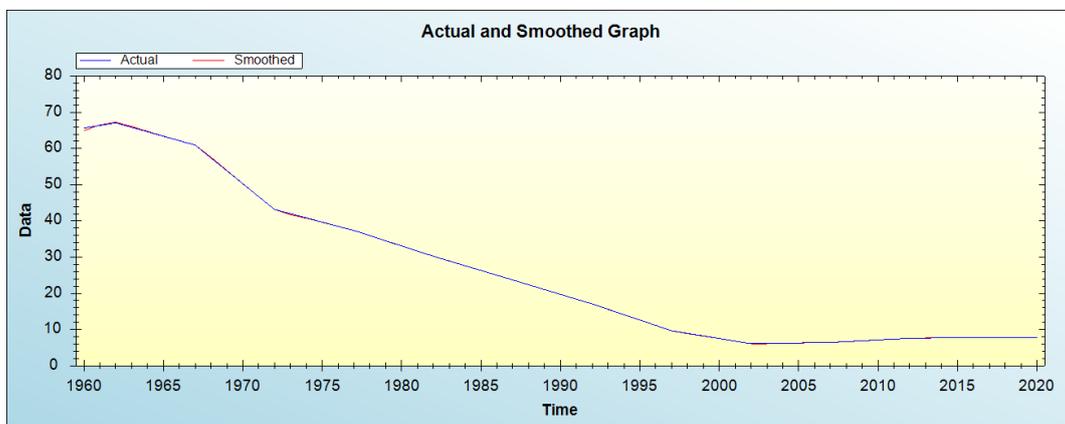


Figure 3: Actual and smoothed graph for N series

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

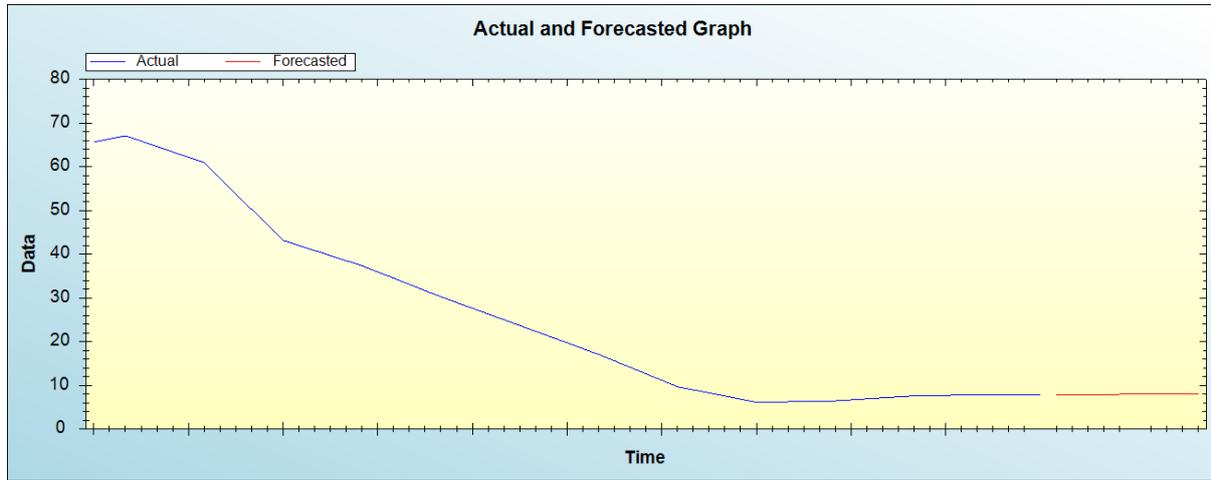


Figure 4: Out-of-sample forecast for N: actual and forecasted graph

Out-of-Sample Forecast for N: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Predicted adolescent fertility rate
2021	7.8774
2022	7.8863
2023	7.8953
2024	7.9042
2025	7.9131
2026	7.9220
2027	7.9309
2028	7.9398
2029	7.9488
2030	7.9577

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 hover around 7.9 births per 1000 women aged 15-19 throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adolescent fertility in Tunisia has been declining over the previous decades which indicate huge investments made in the country’s family planning program. It also reflects great improvements in educating the girl child and women empowerment. Low adolescent fertility is a strong pointer of effective national policies and legal instruments that safeguard women’s rights. This study is undertaken to forecast future trends of adolescent fertility for Tunisia using the double exponential smoothing technique. Research findings revealed that adolescent fertility will hover around 7.9 births per 1000 women aged 15-19 throughout the out of sample period. Therefore, we encourage the Tunisian government to continue supporting girl child education and enforcing laws that protect sexual and reproductive health rights of women and girls.

REFERENCES

[1] World Health Organization (2007). Adolescent pregnancy: unmet needs and undone deeds: a review of the literature and programmes. Geneva: World Health Organization.

- [2] Neal S., Mahendra S., and Bose K (2016). The causes of maternal mortality in adolescents in low and middle-income countries: a systematic review of the literature. *BMC Pregnancy Childbirth*. 16:352.
- [3] Pradhan R., Wynter K., and Fisher J (2015). Factors associated with pregnancy among adolescents in low-income and lower middle-income countries: a systematic review. *J Epidemiol Community Health*. 69:918–924.
- [4] Patton G.C., Sawyer S.M., Santelli J.S., Ross DA., Afifi R., Nicholas B (2016). Our future: a Lancet commission on adolescent health and wellbeing. *Lancet*. 387(10036):2423–78.
- [5] 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.
- [6] de Onis M., nd Branca F (2016). Childhood stunting: a global perspective. *Matern Child Nutr*. 12:12–26.
- [7] Nguyen PH., Scott S., Neupane S., Tran LM., nd Menon P (2019). Social, biological, and programmatic factors linking adolescent pregnancy and early childhood under nutrition: a path analysis of India’s 2016 National Family and Health Survey. *Lancet Child Adolesc Heal*. 3(7):463–73.
- [8] Woog V., &Kagesten A (2017). The sexual and reproductive health needs of very young adolescents in developing countries. *Guttmarker Inst*. [https:// www.guttmacher.org/ fact- sheet/ srh- needs- very- young- adolescents- in- developing- countries](https://www.guttmacher.org/fact-sheet/srh-needs-very-young-adolescents-in-developing-countries).
- [9] Margret Greene TM(2015). The case for investing in research to increase access to and use of contraception among adolescents. 2015; 1–80. [https:// www.usaid.gov/ sites/default files/.../ RH_ adol contraception_ rpt_ 508. pdf](https://www.usaid.gov/sites/default/files/.../RH_adol_contraception_rpt_508.pdf).
- [10] Tebeu PM., Fomulu JN., Khaddaj S., De BL., Delvaux T., &Rochat CH (2012). Risk factors for obstetric fistula : a clinical review. *Int Urogynecol*. 23:387–94.
- [11] UNIFPA. Brief report 2016. Lilongwe; 2016.
- [12] Chalasani S., Kelly CA., Mensch BS., &Soler-hampejsek E (2013). Adolescent pregnancy and education trajectories in Malawi. *Comp Educ Rev*. 51(3):281–305.
- [13] Muula AS (2008). Trends in contraceptive knowledge and use among adolescent married women in Malawi. *Croat Med J*. 49(4):561–3.
- [14] Okigbo CC., &Speizer IS (2015). Determinants of Sexual Activity and Pregnancy among Unmarried Young Women in Urban Kenya: A Cross-Sectional Study. *PLoS One*. 10(6):e0129286.
- [15] Larsson M, Aneblom G., Odlin V., &Tydén T (2002). Reasons for pregnancy termination, contraceptive habits and contraceptive failure among Swedish women requesting an early pregnancy termination. *Acta Obstet Gynecol Scand*. 81(1):64–71. <https://doi.org/10.1046/j.0001-6349.2001.00169.x>.
- [16] Kaphagawani N & 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>.
- [17] Croft TN., Aileen M., &Courtney K (2018). Guide to DHS Statistics: DHS-7. Rockville.
- [18] Wado YD., Sully E.A., &Mumah JN (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>.
- [19] Birhanu B.E., Kebede D.L., Kahsay AB., &Belachew AB (2019). Predictors of teenage pregnancy in Ethiopia: a multilevel analysis. *BMC Public Health*. 19(1): 601. <https://doi.org/10.1186/s12889-019-6845-7>.
- [20] Brahmhatt H., Kågesten A., Emerson M., Decker MR., Olumide AO., Ojengbede O., Lou C., Sonenstein FL., Blum RW., &Delany-Moretlwe S (2014). Prevalence and determinants of adolescent pregnancy in urban disadvantaged settings across five cities. *J Adolesc Health*. 55(6):S48– 57. <https://doi.org/10.1016/j.jadohealth.2014.07.023>.
- [21] World bank <https://genderdata.worldbank.org/countries/tunisia/>

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, “Projecting Future Trends of Adolescent Fertility for Tunisia Using Holt’s Linear Method” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 444-448, February 2023. Article DOI <https://doi.org/10.47001/IRJIET/2022.702074>
