

Detecting Future Trends of Adolescent Fertility for Australia Using Holt's Double Exponential Smoothing Technique

¹Smartson. P. NYONI, ²Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - This research article employs annual time series data of adolescent fertility rate for Australia 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 0.9 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will continue to decline to levels below 10 births per 1000 women aged 15-19 years by the end of 2030. Therefore, we encourage authorities in Australia to continue supporting sexual and reproductive health programs by attending to the various factors that contribute to unwanted pregnancies among adolescents.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

The 1994 International conference on Population and development (ICPD) made significant steps towards addressing sexual and reproductive health issues across the globe (UN, 1995). Signatories who attended the conference identified various problems being faced by adolescent girls and women in different regions of the world. Of major concern was sexual abuse of adolescent girls and women, and adverse maternal and child health outcomes associated with teenage pregnancies. Previous studies highlighted that many teenage girls and young women are forced into early marriage as a result of various reasons that include religious, cultural and economic factors (Ochenet *al.* 2019; Ayeleet *al.* 2019; Darrochet *al.* 2016; Nealet *al.* 2012). In addition, adolescent girls and young women in conflict affected areas face gender based violence and sexual abuse. Refugees and migrants is another group that is at a high risk of sexual abuse as they lack legal protection in foreign countries. Child marriage is a violation of fundamental human rights that has a negative impact on the girls' sexual, mental, and physical and well-being (UNICEF, 2015; UNFP, 2012a). Approximately 45% of women aged 20-24 are married before they reach the legal age of majority (UNICEF, 2014b). It has been shown that child marriage and pregnancy are the major risk factors of maternal and child mortality in low and middle income countries (Wadlar, 2012). Despite the visibility of family planning programs in developing countries, many adolescent girls and women face many obstacles in accessing family planning services (STAG, 2017; Alkema et al, 2013). About 214 million women in developing countries in need of contraception do not use any contraceptive method (Guttmacher Institute, 2017).

In this paper we attempt to depict future trends of adolescent births for Australia in the out of sample period using a popular smoothing technique (Holt's method) with a goal to estimate the future burden of adolescent births in the country that will form the basis of reviewing current policies that were designed to promote universal access to sexual and reproductive health services and protect women's sexual and reproductive health rights.

II. METHODOLOGY

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

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

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

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

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

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 trend estimate at time t

b_{t-1} is the trend estimate time $t-1$

Data Issues

This study is based on annual adolescent fertility rate in Australia 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	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.334812
Sum Square Error (SSE)	34.080619
Mean Square Error (MSE)	0.558699
Mean Percentage Error (MPE)	0.112015
Mean Absolute Percentage Error (MAPE)	1.170561

Residual Analysis for the Applied Model

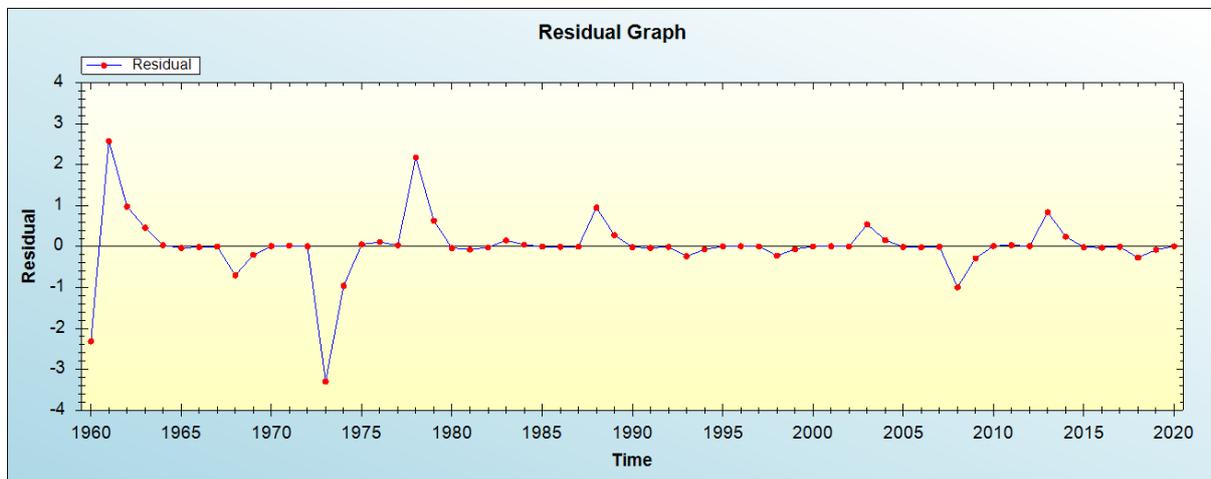


Figure 1: Residual analysis

In-sample Forecast for A

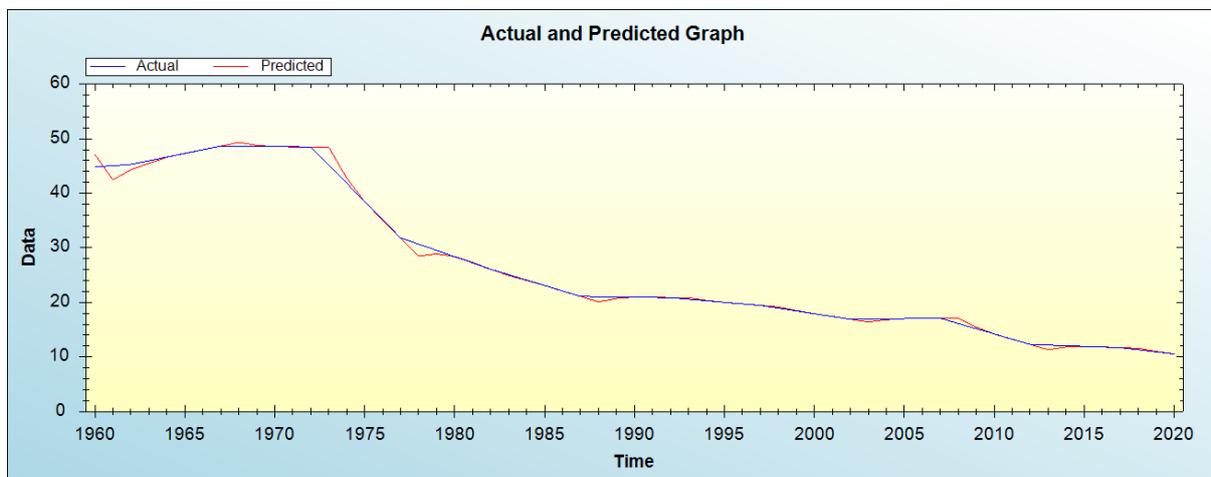


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

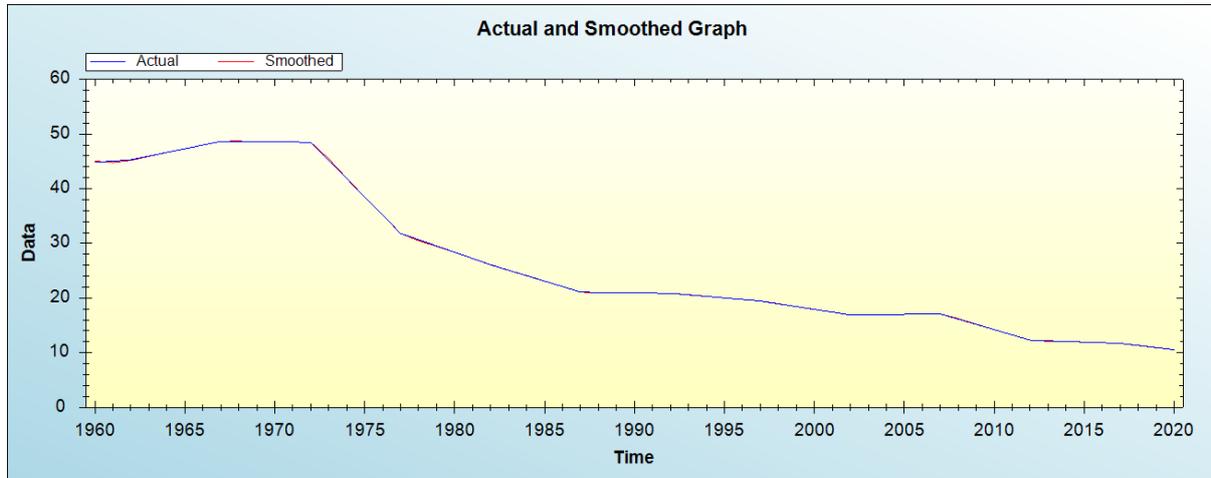


Figure 3: Actual and smoothed graph for A series

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

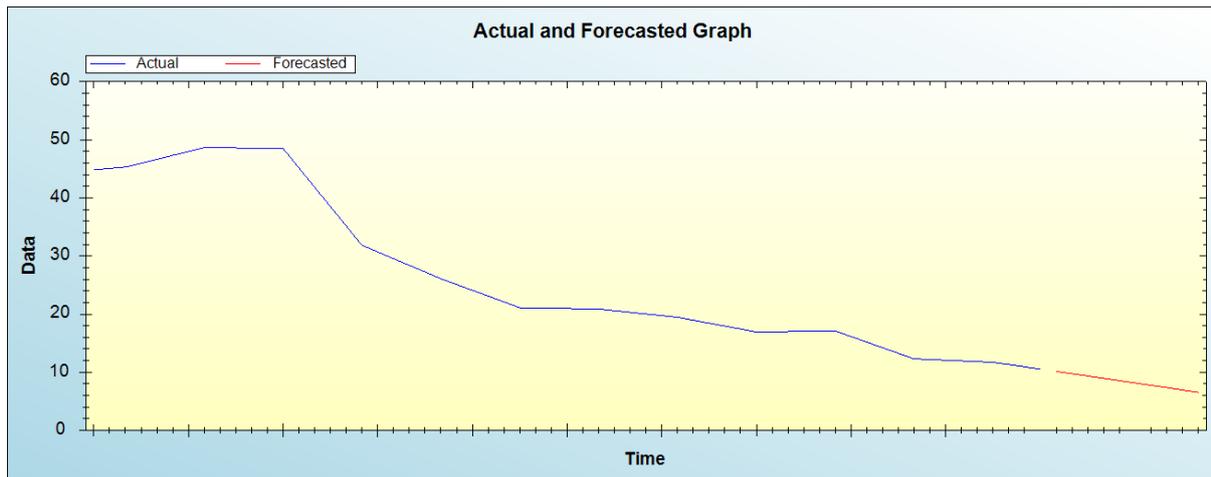


Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	10.1491
2022	9.7513
2023	9.3534
2024	8.9556
2025	8.5577
2026	8.1599
2027	7.7620
2028	7.3642
2029	6.9663
2030	6.5685

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 to levels below 10 births per 1000 women aged 15-19 years by the end of 2030.

IV. POLICY IMPLICATION & CONCLUSION

The 3rd sustainable development goal (SDG-3) emphasizes the need to address adverse maternal and child health outcomes which are more prevalent in developing than developed countries. The objective is to reduce global maternal mortality ratio to less than 70 per 100 000 live births in every country, under five mortality to levels as low as 25 deaths per 1000 live births and neonatal mortality to at least 12 deaths per 1000 live births by the end of 2030. Among the strategies to reduce adverse pregnancy outcomes, reduction of teenage pregnancies and ending child marriages is critical. This study proposed Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Australia. Our study findings indicate that adolescent fertility will continue to decline to levels below 10 births per 1000 women aged 15-19 years by the end of 2030. Therefore, the Australian government is encouraged to continue supporting sexual and reproductive health programs by attending to the various factors that contribute to unwanted pregnancies among adolescents.

REFERENCES

- [1] UNFPA. (2012a). *Marrying too Young: End Child Marriage*. New York, NY: UNFPA.
- [2] UNICEF (2014b). *The State of the World's Children 2015: Reimagine the Future: Innovation for Every Child*, New York
- [3] UNICEF (2014b). *Ending Child Marriage: Progress and prospects*, New York
- [4] Walker, J. A. (2012). Early marriage in Africa – Trends, harmful effects, and interventions. *African Journal of Reproductive Health* 16(2): 231-240.
- [5] UNICEF (2015). *Child marriage, Adolescent pregnancy and Family formation in West and Central Africa*, pp1-86.
- [6] Alkema L., Kantorova V., Menozzi C., Biddlecom A (2013). National, regional, and global rates and trends in contraceptive prevalence and unmet need for family planning between 1990 and 2015: a systematic and comprehensive analysis. *Lancet*, 381(9878):1642–52.
- [7] Scientific and Technical Advisory Group (STAG), The Gender and Rights Advisory Panel (GRAP). *Statement on the promotion, protection and fulfilment of sexual and reproductive health and rights* (2017). Geneva: UNDP/UNFPA/UNICEF/WHO/WORLD BANK Special Programme of Research, Development and Research Training in Human Reproduction.
- [8] Guttmacher Institute (2017). *Adding It Up: Investing in Contraception and Maternal and Newborn Health*. New York.
- [9] 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.
- [10] 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>.
- [11] Ochen A.M., Chi P.C., and Lawoko S (2019). Predictors of teenage pregnancy among girls aged 13–19 years in Uganda: a community based case-control study. *BMC Pregnancy Childbirth*. 19(1):211. <https://doi.org/10.1186/s12884-019-2347-y>.
- [12] Ayele B.G., Gebregzabher T.G., Hailu T.T., and Assefa B.A (2018). Determinants of teenage pregnancy in Degua Tembien District, Tigray, Northern Ethiopia: A community-based case-control study. *PLoS One*. 13(7):e0200898.

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Detecting Future Trends of Adolescent Fertility for Australia Using Holt's Double Exponential Smoothing Technique" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 12, pp 98-102, December 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.612017>
