

# Prediction of Adolescent Fertility for Maldives Using Holt's Linear Method

<sup>1</sup>Smartson. P. NYONI, <sup>2</sup>Thabani NYONI

<sup>1</sup>ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

<sup>2</sup>Independent Researcher & Health Economist, Harare, Zimbabwe

**Abstract** -This research article uses annual time series data of adolescent fertility rate for Maldives 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  $\alpha$  and  $\beta$  are 0.9 and 0.3 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will remain low throughout the out of sample period. Therefore, we encourage authorities in Maldives to continue providing funding for adolescent health services and address local problems that lead to teenage pregnancies.

**Keywords:** Exponential smoothing, Forecasting, adolescent fertility rate.

## I. INTRODUCTION

Adolescent pregnancy is a public health problem affecting both developing and developed countries (WHO, 2020; WHO, 2014). Complications associated with teenage pregnancy can affect the mother and the baby. Several research papers have highlighted the importance of preventing teenage pregnancy as this has a huge impact on maternal & child health and the society (Kassa *et al.* 2019; Poudel *et al.* 2018; Pradhan *et al.* 2018; Islam *et al.* 2017; Ganchimeg *et al.* 2014). Teenage pregnancy prevention helps in the reduction of maternal and perinatal mortality. It also helps in averting long term complications such as mental disorders, repeat pregnancy and loss of future opportunities for teenage parents and their children (WHO, 2020; Wall-Wieler *et al.* 2019; Grønvik & Fossgard, 2018). According to Maldives 2016-2017 DHS, the country's total fertility rate is standing at replacement level fertility of 2.1 births per woman. Total fertility rate dropped from 2.5 births per woman in 2009 to 2.1 in 2016-17. Generally, women gave birth to one child by their late 20s, almost two children by their early 30s and three children by their early 40s. Teenage pregnancy is still a problem in Maldives because of its association with adverse maternal and child health outcomes. The percentage of teenagers who have given birth or are pregnant with their first child has remained more or less the same since 2009 (2%). There is a geographic variation of adolescent pregnancy, it is highest in Central region (5%) and lowest in South region (1%). The proportion of births that are unwanted has declined over time, from 16% in 2009 to 7% in 2016-17. However, the proportion of mistimed births increased from 10% in 2009 to 16% in 2016-17. Contraceptive use by currently married women has declined sharply since 2009, dropping from 35% of women using any contraceptive method in 2009 to 19% in 2016-17. Use of modern methods has also decreased, from 27% of married women in 2009 to 15% in 2016-17.

This paper applies the double exponential smoothing technique to model and forecast future trends of adolescent fertility in Maldives. The findings are expected to depict the future burden of adolescent births in the out of sample period. This will inform national policies, planning and allocation of 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 Maldives. 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 double exponential smoothing method is specified as follows:

Model equation

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

$M_t$  is the actual value of adolescent fertility rate at time t

$\epsilon_t$  is the time varying **error term**

$\mu_t$  is the time varying mean (**level**) term

$\rho_t$  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

$\alpha$  is the exponential smoothing constant for the data

$\beta$  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 Maldives 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	M
Included Observations	61
Smoothing constants	
Alpha ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.300
Forecast performance measures	

Mean Absolute Error (MAE)	3.709947
Sum Square Error (SSE)	3924.648660
Mean Square Error (MSE)	64.338503
Mean Percentage Error (MPE)	2.892755
Mean Absolute Percentage Error (MAPE)	4.794543

Residual Analysis for the Applied Model

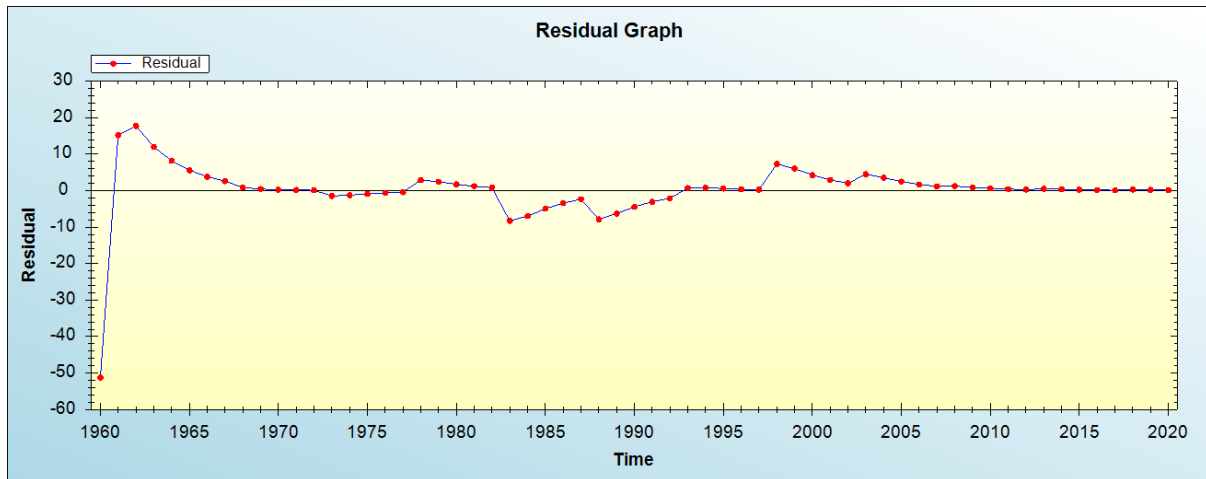


Figure 1: Residual analysis

In-sample Forecast for M

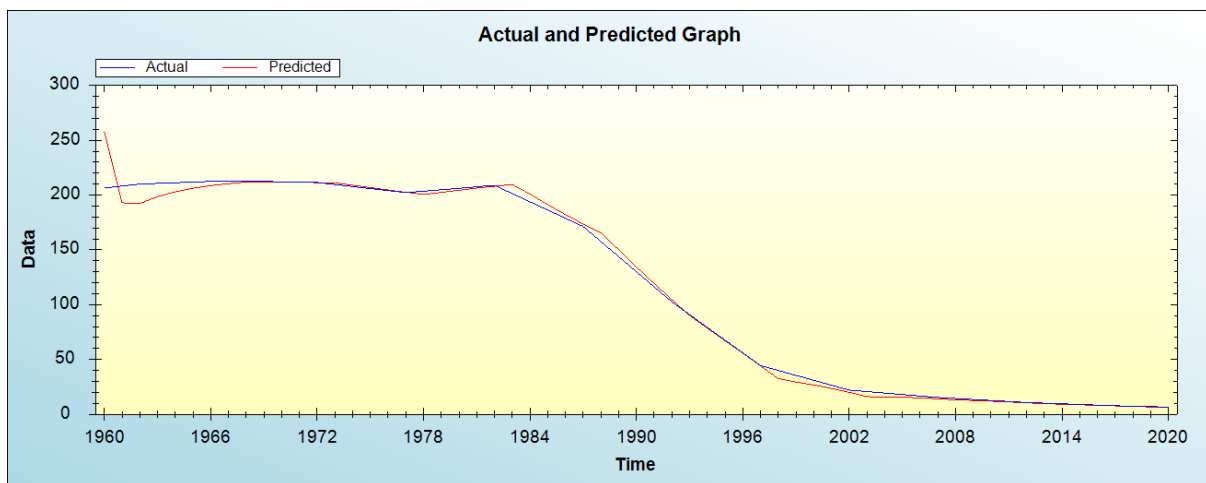


Figure 2: In-sample forecast for the M series

Actual and Smoothed graph for M series

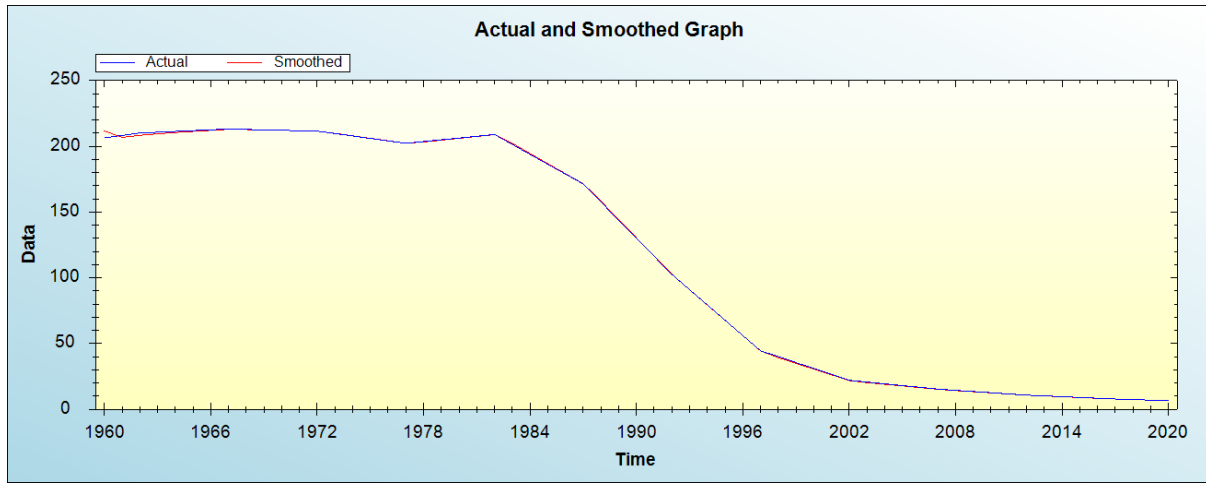


Figure 3: Actual and smoothed graph for M series

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

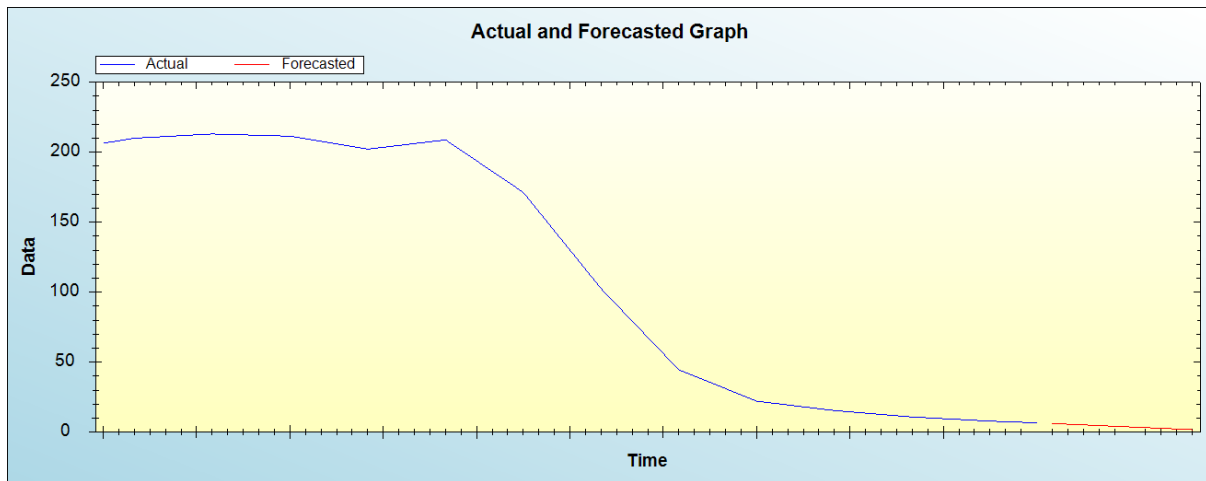


Figure 4: Out-of-sample forecast for M: actual and forecasted graph

Out-of-Sample Forecast for M: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	6.1150
2022	5.6247
2023	5.1343
2024	4.6440
2025	4.1536
2026	3.6633
2027	3.1729
2028	2.6826
2029	2.1922
2030	1.7018

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 remain low throughout the out of sample period.

#### IV. POLICY IMPLICATION & CONCLUSION

Teenage pregnancy continues to be an important public health problem in Maldives because of its association with adverse maternal and child health outcomes. The percentage of teenagers who have given birth or are pregnant with their first child has remained more or less the same since 2009 (2%). There is a geographic variation of adolescent pregnancy, it is highest in Central region and lowest in South region. Adolescent fertility gradually declined during the period 1960-2020 to levels below 10 births per 1000 females aged 15-19 years. This fertility decline is partly due to increase in age at marriage and use of modern methods of contraception. This study proposes Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Maldives. We established that adolescent fertility will remain low throughout the out of sample period. Therefore, we encourage the government to continue providing funding for adolescent health services and address local problems that lead to teenage pregnancies.

#### REFERENCES

- [1] Ministry of Health (MOH) [Maldives] and ICF. 2018. Maldives Demographic and Health Survey 2016-17. Malé, Maldives, and Rockville, Maryland, USA: MOH and ICF.
- [2] World Health Organization (2014). Adolescent pregnancy. Factsheets. Available at: <http://www.who.int/mediacentre/factsheets/fs364/en/>
- [3] Ganchimeg T., Ota E., and Morisaki N (2014). Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicounty study. BJOG. 121Suppl:40–8.
- [4] Islam M.M., Islam M.K., and Hasan MS (2017). Adolescent motherhood in Bangladesh: Trends and determinants. PLoS One. 12(11):1–14.
- [5] Pradhan R., Wynter K., and Fisher J (2018). Factors associated with pregnancy among married adolescents in Nepal: secondary analysis of the National Demographic and Health Surveys from 2001 to 2011. Int J Environ Res Public Health. 15(229):12.
- [6] Poudel S., Upadhaya N., and Khatri R.B (2018). Trends and factors associated with pregnancies among adolescent women in Nepal: pooled analysis of Nepal Demographic and Health Surveys (2006, 2011 and 2016). PLoS One. 13(8):1–13.
- [7] Grønvik T., and Fossgard Sandøy I (2018). Complications associated with adolescent child bearing in sub-Saharan Africa: a systematic literature review and meta-analysis. PLoS One. 13(9):e0204327.
- [8] Wall-Wieler E., Lee J.B., Nickel N (2019). The multigenerational effects of adolescent motherhood on school readiness: a population-based retrospective cohort study. PLoS One. 14(2):e0211284.
- [9] World Health Organization (2020). Preventing early pregnancy through appropriate legal, social and economic measures. <https://www.who.int/reproductivehealth/topics/adolescence/laws/en/>.
- [10] Kassa G.M., Arowojolu A.O., and Odukogbe AA (2019). Adverse neonatal outcomes of adolescent pregnancy in northwest Ethiopia. PLoS One. 2019;14(6):e0218259.

#### Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Prediction of Adolescent Fertility for Maldives Using Holt's Linear Method" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 200-204, February 2023. Article DOI <https://doi.org/10.47001/IRJIET/2022.702032>

\*\*\*\*\*