

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

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**Abstract -** This research article uses annual time series data of adolescent fertility rate for Burundi 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 0.1 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 Burundi to strictly enforce laws that protect sexual and reproductive health rights of women and girls, promote girl child education and fund empowerment programs for youths to increase their labor participation.

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

## I. INTRODUCTION

According to WHO, an adolescent is an individual aged 10-19 years (WHO, 2018). Studies conducted in developed and developing countries revealed that adolescent pregnancies are associated with higher maternal and fetal complications such as unsafe abortions, STIs, and neonatal complications (Kassa *et al.* 2018; Mehra *et al.* 2018; Poudel *et al.* 2018; Pradhan *et al.* 2018; Sama *et al.* 2017; Islam *et al.* 2017; Ganchimeg *et al.* 2014). This global public health problem is more prevalent in low and middle income countries in Sub-Saharan Africa and South East Asia. Over the period 2015-2020, sub-Saharan Africa reported the highest number of adolescent births with disparities noted between and within countries and among populations followed by Asia and Latin America and the Caribbean (UN, 2020). Burundi is an East African country which is characterized mainly by a young population having 65% of its population under the age of 25 of which 23% of this young population is made up of adolescents. This country has made tremendous progress in the achievement of the 3<sup>rd</sup> sustainable development goal targets 3.1, 3.2 and 3.7, however, teenage pregnancies which significantly contribute to adverse maternal and child health outcomes remain very high requiring prompt action (Rasmussen *et al.* 2019). Infant mortality among adolescent girls in Burundi is around 59 deaths per 1000 live births and the prevalence of low birth weight is higher among adolescent mothers (7.2%) than among women aged 20-34 years (Nibaruta *et al.* 2019).

The aim of this paper to forecast adolescent birth (fertility) rates over the out of sample period using the Holt's double exponential smoothing model. The results are expected to depict the future burden of adolescent births (ages 15-19). This will assist policy makers to review and enforce laws that protect sexual and reproductive health rights of women and allocate adequate resources to national programs and activities designed to curb child marriages and teenage pregnancies.

## II. METHODOLOGY

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

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

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

$\varepsilon_t$  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 time t

$b_{t-1}$  is the slope of the trend (trend estimate) at time period t-1

**Data Issues**

This study is based on annual adolescent fertility rate in Burundi 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	B
Included Observations	61
Smoothing constants	
Alpha ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.100

Forecast performance measures	
Mean Absolute Error (MAE)	0.694617
Sum Square Error (SSE)	100.456803
Mean Square Error (MSE)	1.646833
Mean Percentage Error (MPE)	-0.082727
Mean Absolute Percentage Error (MAPE)	0.837687

Residual Analysis for the Applied Model

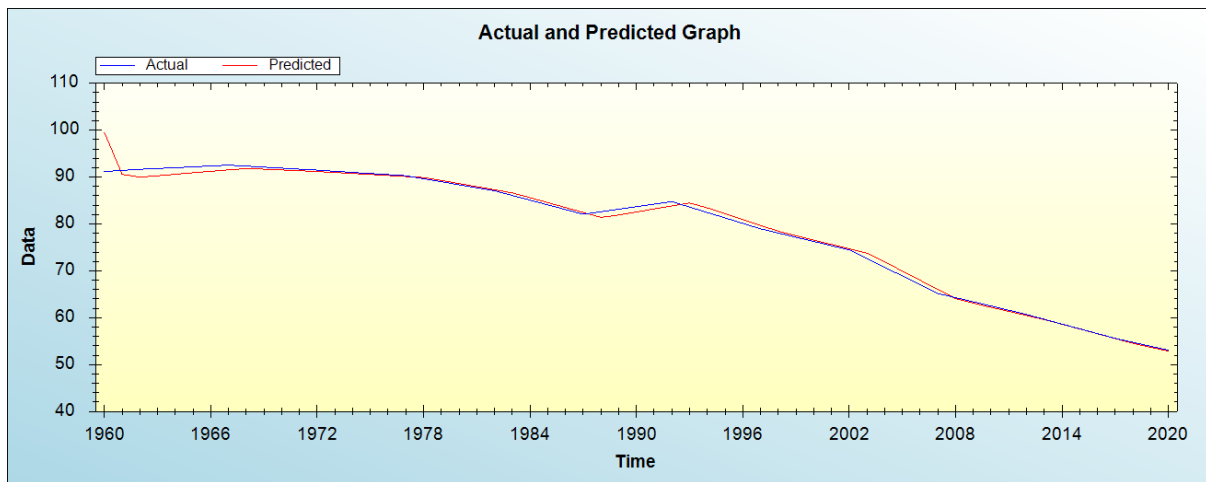


Figure 1: Residual analysis

In-sample Forecast for B

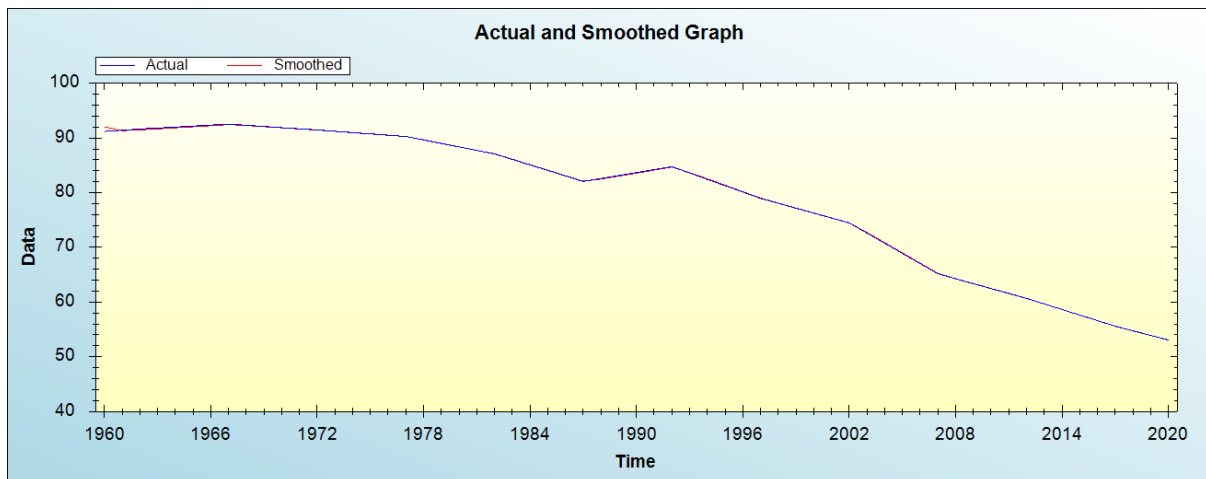


Figure 2: In-sample forecast for the B series

Actual and Smoothed graph for B series

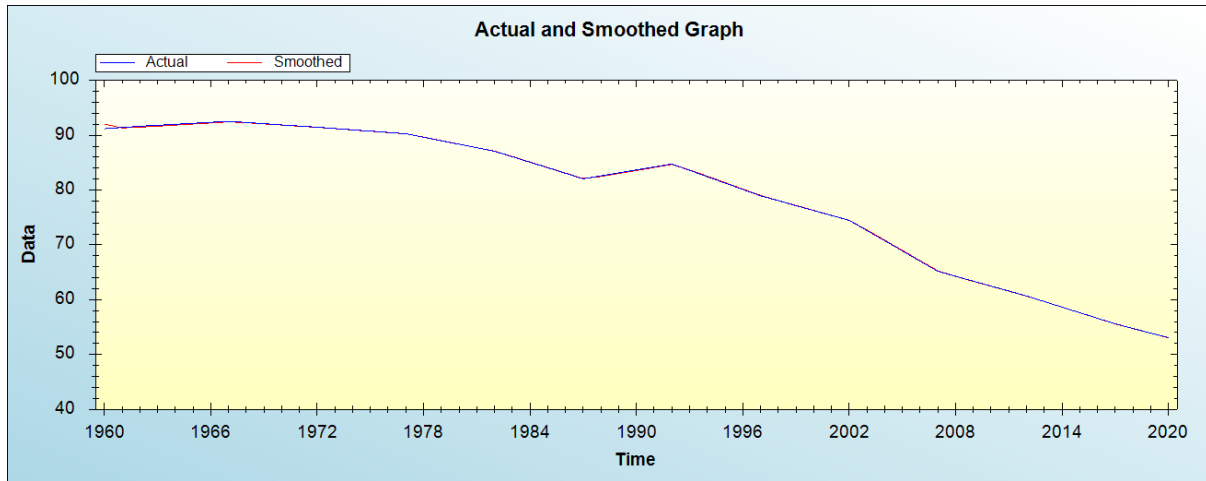


Figure 3: Actual and smoothed graph for B series

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

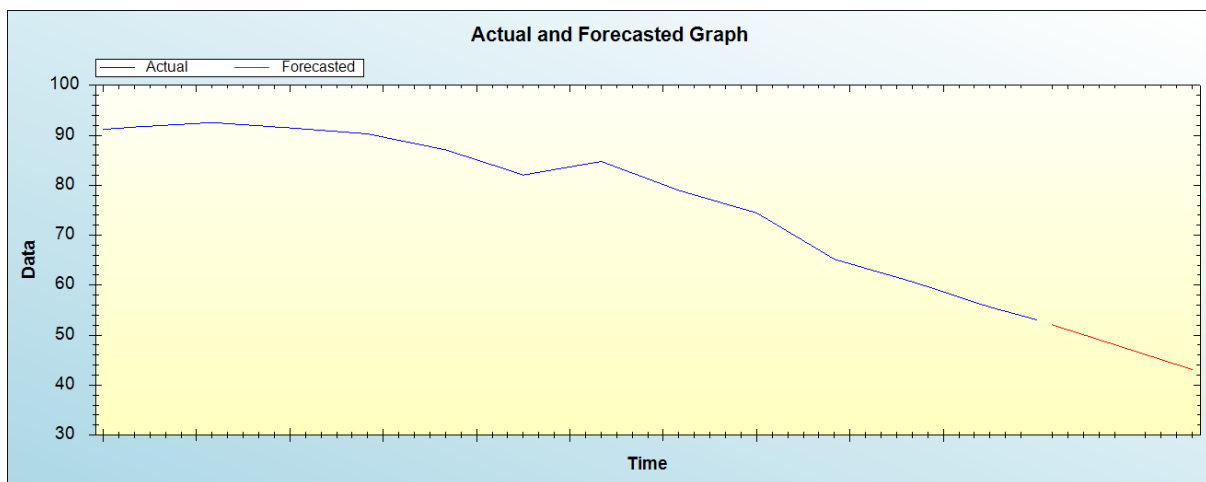


Figure 4: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	52.0625
2022	51.0695
2023	50.0765
2024	49.0835
2025	48.0905
2026	47.0975
2027	46.1045
2028	45.1115
2029	44.1185
2030	43.1255

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 adolescent fertility will continue to decline throughout the out of sample period.

#### IV. POLICY IMPLICATION & CONCLUSION

Burundi has made tremendous progress towards the achievement of the 3<sup>rd</sup> sustainable development goal targets 3.1, 3.2 and 3.7, however, teenage pregnancies which significantly contribute to adverse maternal and child health outcomes remain very high requiring urgent action. Infant mortality among adolescent girls in Burundi is around 59 deaths per 1000 live births and the prevalence of low birth weight is higher among adolescent mothers than among women aged 20-34 years. Several challenges such as poverty, sexual abuse of women, substance abuse, poor parental guidance, inadequate SRH information and inconsistent use of contraceptive methods are linked to these teenage pregnancy rates. This research paper applies Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Burundi. Our research findings indicate that adolescent fertility will continue to fall throughout the out of sample period. Therefore, the government is encouraged to strictly enforce laws that protect sexual and reproductive health rights of women and girls, promote girl child education and fund empowerment programs for youths to increase their labor participation.

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