

Estimating The Future Burden of Adolescent Births for Haiti Using Holt's Double Exponential Smoothing Technique

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Abstract - This study uses annual time series data of adolescent fertility rate for Haiti 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 rate will continue to decline throughout the out of sample period. Therefore, we encourage policy makers in Haiti to scale up awareness campaigns among communities, strictly enforce laws that protect women's rights, promote girl child education and provide funding for youth projects to improve their labor participation.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Teenage pregnancy is a global medical, economic and social problem that affects both developed and developing countries (Klein, 2005). Nearly twenty five percent of adolescent women are pregnant worldwide (Kassa *et al.* 2018; Kaphagawani & Kalipeni, 2017). The prevalence of adolescent pregnancy in Africa is 18.8 percent, of this, 19.3 percent occurred in Sub-Saharan Africa and 21.5 percent in eastern Africa (Kassa *et al.* 2018). The prevalence of adolescent pregnancy in eastern Africa ranges from 18 to 29 percent and around 50 percent of these pregnancies are unintended (Wado *et al.* 2019). Globally, approximately 3.9 million adolescents experience unsafe abortions, STIs and unintended pregnancies which contribute to high maternal mortality and morbidity (Darroch *et al.* 2016; Franklin & Corcoran, 2000). Previous studies highlighted that pregnant teenagers have an increased risk of experiencing adverse pregnancy outcomes such as hypertension, anemia, obstructed labour, preterm delivery, low birth and antepartum hemorrhage (Mathewos., & Mekuria, 2017; Sedgh *et al.* 2016; Larsson *et al.* 2002). According to the World Bank adolescent fertility in Haiti declined gradually from around 86 births per 1000 women aged 15-19 in 1982 down to 49.5 births per 1000 women aged 15-19 in 2020. This reflects significant progress towards reduction of teenage pregnancy, however there is need to create new strategies to end child marriages and teenage pregnancy in the country. The objective of this paper is to forecast adolescent fertility in Haiti using the double exponential smoothing technique. Findings of this paper will guide national policy, 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 Haiti. 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

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

H_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 Haiti 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	H
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.404714

Sum Square Error (SSE)	59.692069
Mean Square Error (MSE)	0.978559
Mean Percentage Error (MPE)	0.017650
Mean Absolute Percentage Error (MAPE)	0.548147

Residual Analysis for the Applied Model

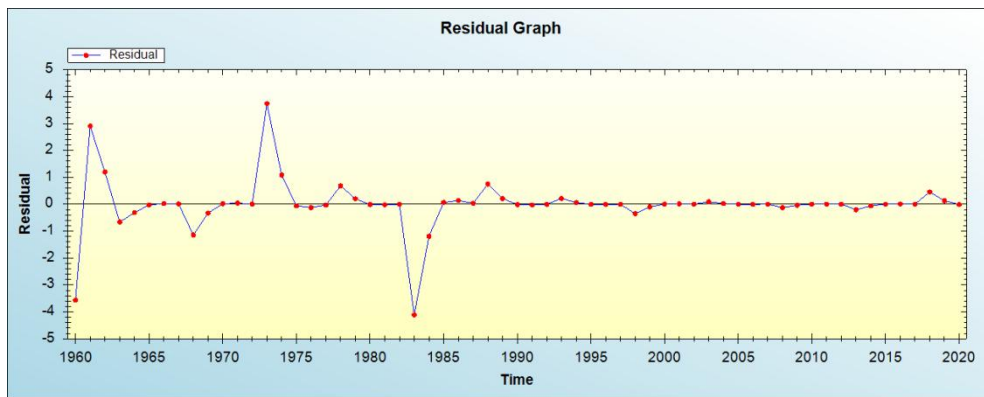


Figure 1: Residual analysis

In-sample Forecast for H

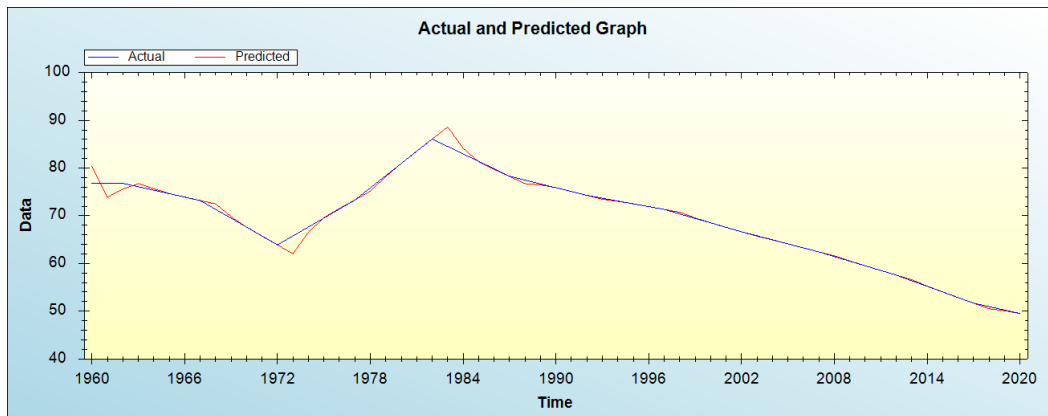


Figure 2: In-sample forecast for the H series

Actual and Smoothed graph for H series

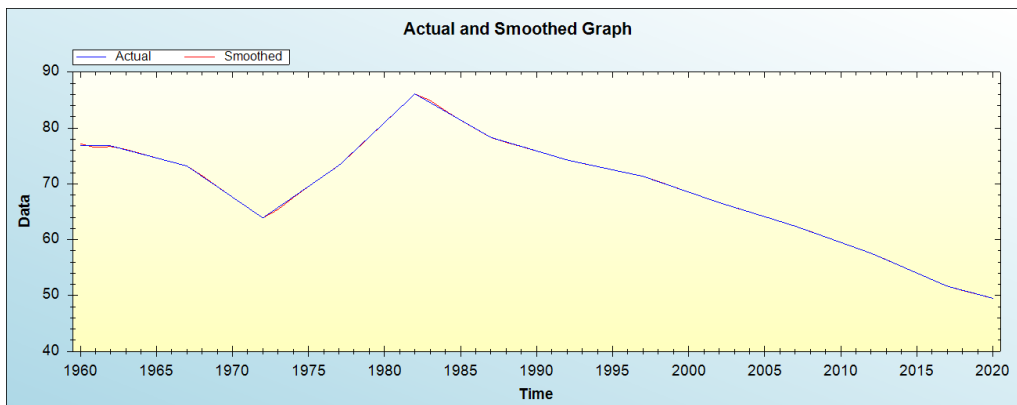


Figure 3: Actual and smoothed graph for H series

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

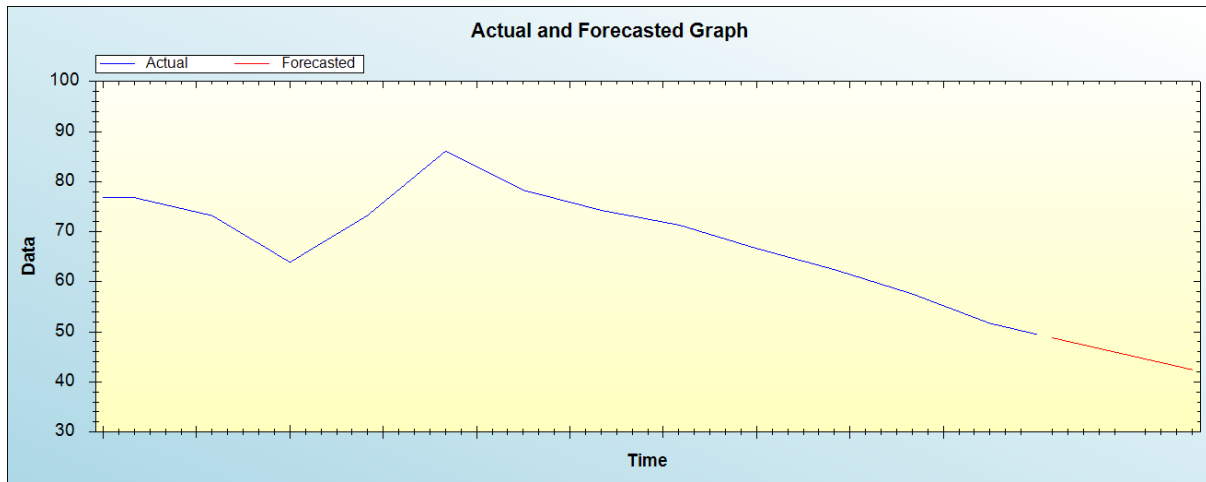


Figure 4: Out-of-sample forecast for H: actual and forecasted graph

Out-of-Sample Forecast for H: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	48.8017
2022	48.0939
2023	47.3861
2024	46.6782
2025	45.9704
2026	45.2626
2027	44.5548
2028	43.8469
2029	43.1391
2030	42.4313

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

Adolescent fertility in Haiti declined gradually from around 86 births per 1000 women aged 15-19 in 1982 down to 49.5 births per 1000 women aged 15-19 in 2020. This shows that there has been significant progress towards the reduction of teenage pregnancy, however there is need to create new initiatives to end child marriages and teenage pregnancy in the country. This study applied Holt’s double exponential smoothing technique to forecast future trends of adolescent fertility for Haiti. Our study findings indicated that adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage the Haitian government to scale up awareness campaigns among communities, promote girl child education, strictly enforce laws that protect women’s rights and provide funding for youth projects to improve their labor participation.

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