

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

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Abstract - This study employs annual time series data of adolescent fertility rate for Cambodia 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 is expected to increase throughout the out of sample period. Therefore, we encourage authorities in Cambodia to scale up educational campaigns and allocate more funding towards improving access and quality of family planning services in order to avert adverse pregnancy outcomes.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

All 193 UN member states met in September 2015 at the UN Headquarters in New York to discuss and come up with sound resolutions to end global challenges such as poverty, hunger, armed conflicts and diseases amongst other problems. The aim was to provide proper guidance for UN member states to follow as they thrive to achieve sustainable development by 2030. All 193 UN member states consider human health as a key component in the achievement of sustainable development (UN, 2020; WHO, 2019; UNICEF, 2018; UN, 2016, UN, 2015). The 3rd sustainable development goal (SDG-3) focuses on ensuring good health for all at all ages. Target 3.7 seeks to ensure access to quality and affordable sexual and reproductive health services which includes adolescent SRH services. The aim of this target is to substantially reduce adverse sexual and reproductive health outcomes as a result of unwanted pregnancies including teenage pregnancies. Previous studies conducted in developing countries established that teenage pregnancies are associated with complications such as STIs, unsafe abortions, obstetric fistula as a result of difficult vaginal delivery and adverse neonatal outcomes (Chakaet *et al.* 2019; Shibanumaet *et al.* 2018; Kyei-Nimakoh *et al.* 2017; Yejiat *et al.* 2015).

The 1994 International conference on Population and development (ICPD) marked the beginning of an important era for adolescent girls and women as the signatories agreed to address sexual and reproductive health issues for both sexes particularly upholding the rights of women and adolescent girls (WHO, 1998; UN, 1995). WHO developed guidelines to reduce adverse reproductive health outcomes and these included legal reform, strategies to reduce child marriages, increased contraceptive use, reduce coerced sex, unsafe abortions and increase the use of maternity services (WHO, 2011). Family planning is an important intervention for reducing maternal and infant mortality there by stimulating economic development through increased participation of women in labor force and equitable use of resources sue to reduced population growth (Gribbi *et al.* 2012; Canning & Schultz, 2012; Cleland *et al.* 2006). Cambodia continues to face the challenge of adolescent pregnancy and childbirth. According the World Bank, the country's adolescent fertility rate dropped steadily from 101 births per 1000 women aged 15-19 in 1960 to 51 births per 1000 women aged 15-19 years in 2020.

The purpose of this study is to forecast future trends of adolescent fertility rate for Cambodia using Holt's double exponential smoothing technique. Research findings are envisioned to depict the future burden of adolescent births in the out of sample period. This will inform 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 Cambodia. 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

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

C_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 trend estimate at time t

b_{t-1} is the trend estimate at time period t-1

Data Issues

This study is based on annual adolescent fertility rate in Cambodia 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	C
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.523045
Sum Square Error (SSE)	76.372263
Mean Square Error (MSE)	1.252004
Mean Percentage Error (MPE)	0.117686
Mean Absolute Percentage Error (MAPE)	0.669189

Residual Analysis for the Applied Model

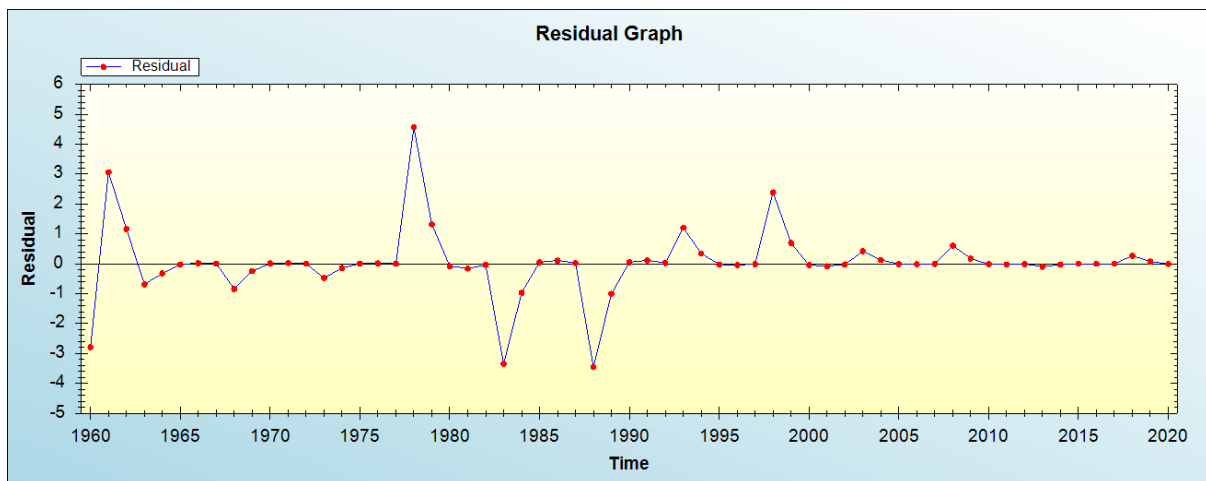


Figure 1: Residual analysis

In-sample Forecast for C

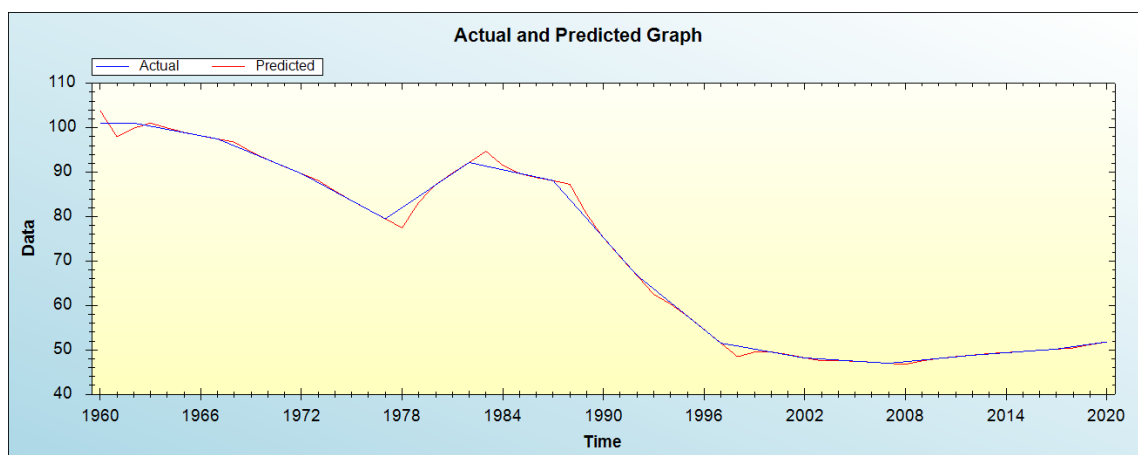


Figure 2: In-sample forecast for the C series

Actual and Smoothed graph for C series

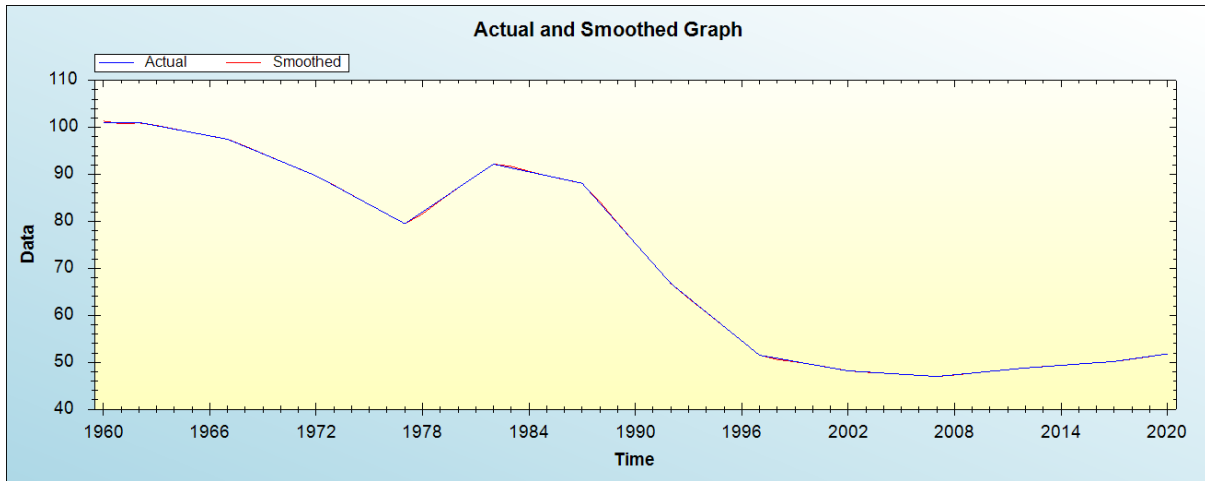


Figure 3: Actual and smoothed graph for C series

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

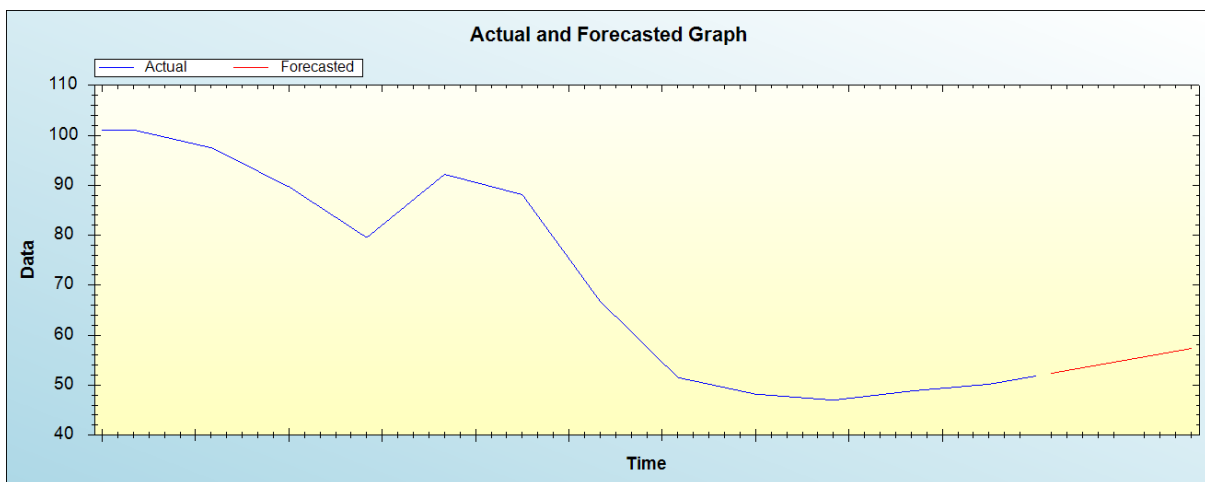


Figure 4: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	52.3597
2022	52.9118
2023	53.4639
2024	54.0159
2025	54.5680
2026	55.1201
2027	55.6722
2028	56.2243
2029	56.7763
2030	57.3284

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 increase throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

In Cambodia teenage pregnancy continues to be an important public health problem. Adolescent fertility dropped steadily from 101 births per 1000 women aged 15-19 in 1960 to 51 births per 1000 women aged 15-19 years in 2020. This can be attributed to the national family planning program and increased educational level among women. This study applies the double exponential smoothing technique to forecast adolescent fertility for Cambodia. Our study findings showed that adolescent fertility is expected to increase throughout the out of sample period. Therefore, the government must scale up educational campaigns and allocate more funding towards improving access and quality of family planning services in order to avert adverse pregnancy outcomes.

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Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Detecting Abnormal Future Trends of Adolescent Fertility for Cambodia Using Holt's Double Exponential Smoothing Technique" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 12, pp 162-166, December 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.612030>