

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

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**Abstract** - This research article uses annual time series data of adolescent fertility rate for Azerbaijan 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 0.4 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will increase throughout the out of sample period. Therefore, we encourage authorities in Azerbaijan to scale up awareness campaigns, promote girl child education and strictly enforce laws to protect sexual and reproductive health rights of adolescent girls and women in order to reverse the projected upward trend of adolescent fertility.

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

## I. INTRODUCTION

The 1994 programme action of the International conference on population and development (ICPD) declared and upheld women's sexual and reproductive health and rights as fundamental human rights (UN, 1995). The sexual and reproductive rights of every individual or couple must be respected. All 179 signatories to the conference recognized the need to uphold the SRH rights of women and adolescent girls who are suffering from gender-based or intimate violence and sexual abuse in many countries all over the world. Adolescent girls and young women have the right to information on family planning services (Darroch & Singh, 2013). The Agenda 2030 for sustainable development added more weight to the growing need to support women's rights, promote girl child education and enforcement of laws to protect women against gender based violence. The 3<sup>rd</sup> sustainable development goal aims to substantially reduce maternal and under five mortality by 2030 by implementing effective strategies that will prevent child marriages, ensure availability of family planning services, prevent and attend to unwanted pregnancies, and offer health education. Low and middle countries continue to report high maternal and infant mortality (Horvath S & Schreiber, 2017; Dastgiri et al, 2017). Previous studies showed that adolescent girls and young women are at high risk of having STIs, early unwanted pregnancies, unsafe abortions and obstetric complications (Melese et al. 2017; Bishwajit et al. 2017; Chandra-Mouhi et al. 2015). Many adolescents lack comprehensive information on SRH and thus end up having unprotected sexual intercourse leading to unintended pregnancies and STIs (Yakubu et al. 2018).

Therefore, this paper applies Holt's exponential smoothing technique to forecast adolescent fertility rate for Azerbaijan. The results are envisioned to highlight likely future burden of adolescent births in the country. This will help policy makers to come up with effective strategies to curb teenage pregnancies among the communities.

## II. METHODOLOGY

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

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

$A_t$  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 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 Azarbaijan 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 ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.400

Forecast performance measures	
Mean Absolute Error (MAE)	1.330786
Sum Square Error (SSE)	391.380668
Mean Square Error (MSE)	6.416077
Mean Percentage Error (MPE)	0.592894
Mean Absolute Percentage Error (MAPE)	3.680400

Residual Analysis for the Applied Model

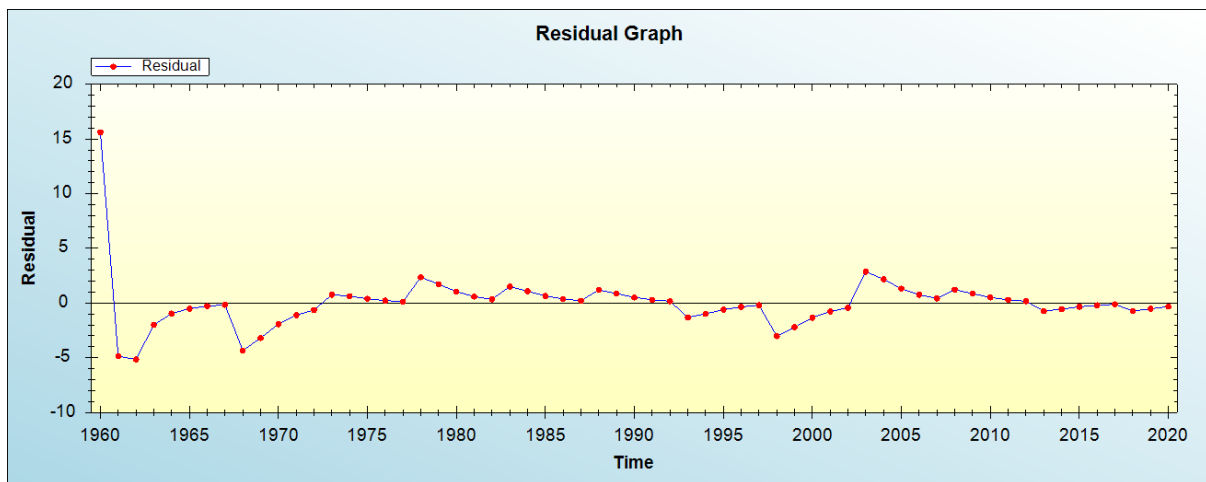


Figure 1: Residual analysis

In-sample Forecast for A

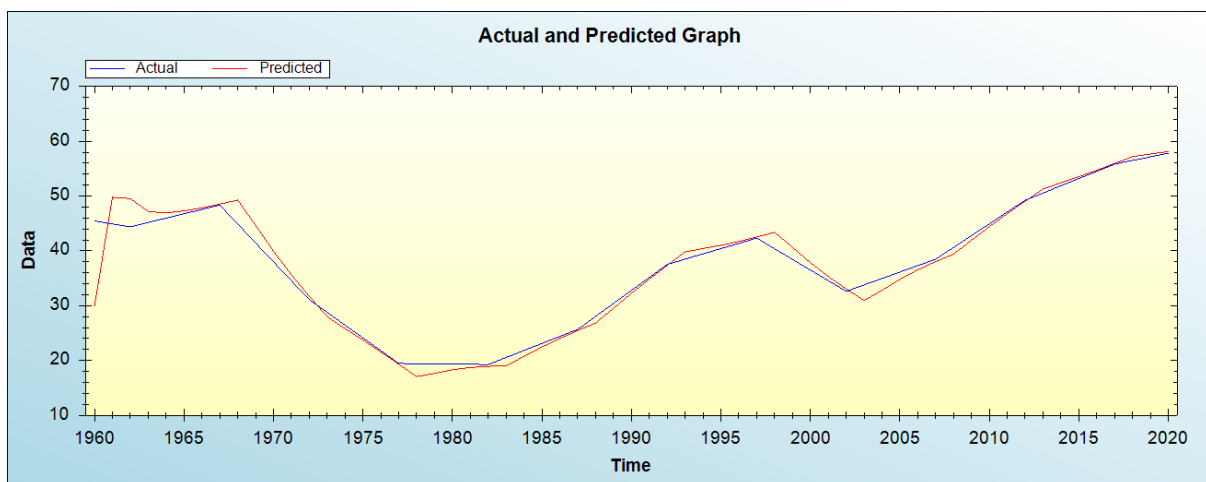


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

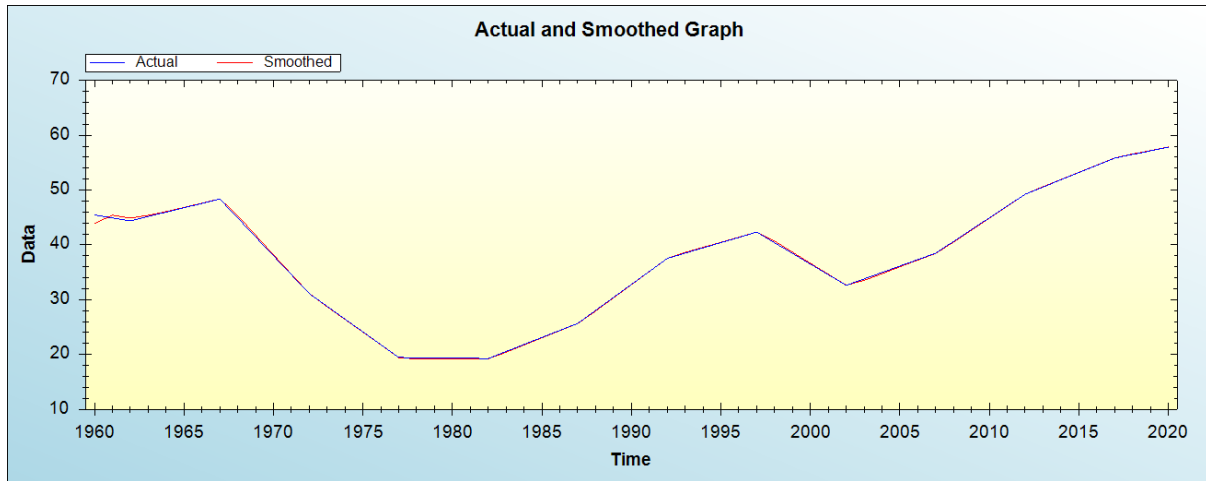


Figure 3: Actual and smoothed graph for A series

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

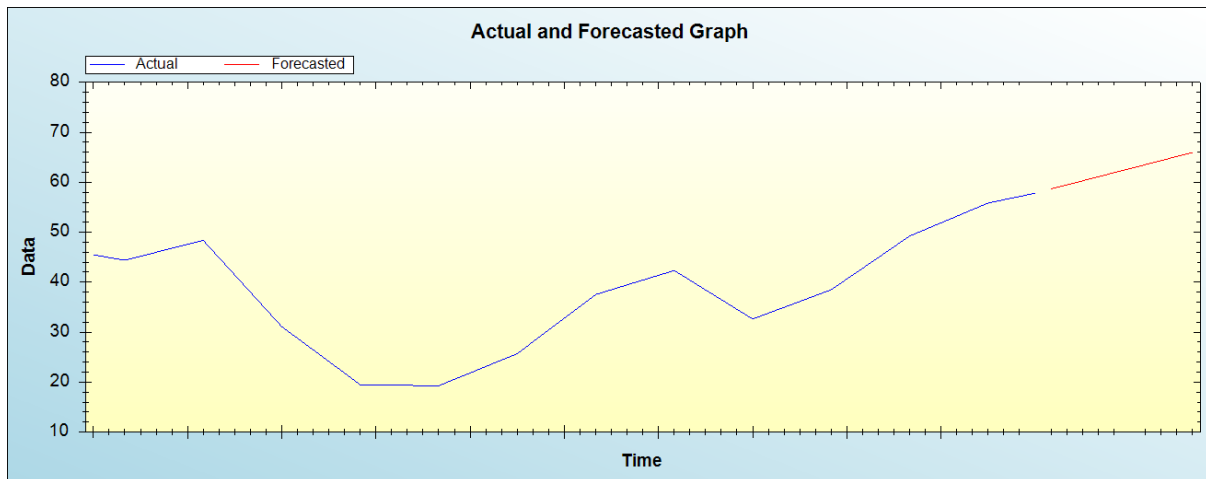


Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	58.6574
2022	59.4664
2023	60.2754
2024	61.0844
2025	61.8934
2026	62.7025
2027	63.5115
2028	64.3205
2029	65.1295
2030	65.9385

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

Maternal and child mortality is a cause for concern especially in developing countries. All UN member states are expected to channel adequate resources to the maternal and child health program to address all the problems which affect pregnant and breast feeding women. Causes of mortality among pregnant and breastfeeding women can be socio-demographic, economic, proximate and health system related factors. The occurrence of pregnancy among teenagers has been found to increase the risk of adverse pregnancy outcomes. In addition, infants born to teenage mothers have a higher risk of dying when compared with ones of older women. Narrowing national goals on adolescent sexual and reproductive health will have a huge impact on maternal and child health. In the case of Azerbaijan, adolescent fertility over the period 1982-2020 has generally been on an upward trend. This means that there is an urgent need to review current national policies with the aim of reversing this undesirable trend. This paper applied Holt's double exponential smoothing technique to forecast adolescent fertility for Azerbaijan. Our research findings indicate that adolescent fertility will continue on an upward trajectory throughout the out of sample period. Therefore, we encourage authorities in Azerbaijan to scale up awareness campaigns, promote girl child education and strictly enforce laws to protect sexual and reproductive health rights of adolescent girls and women in order to reverse the projected upward trend of adolescent fertility.

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