

# Adolescent Fertility Projection for Kuwait Using Holt's Linear Method

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**Abstract** -This research article uses annual time series data of adolescent fertility rate for Kuwait 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 0.9 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility is expected to remain low throughout the forecast period. Therefore, we encourage authorities in Kuwait to address local challenges that contribute to adolescent fertility and continuously enforce laws that protect the rights of women and girls.

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

## I. INTRODUCTION

The World Health Organization (WHO) reported that approximately 16 million adolescent girls give birth annually with an average global birth rate of 49 births per 1000 women aged 15-19. The largest percentage of these births occur in developing countries with a majority of the births occurring among adolescents who have lower educational levels, poor, and reside in rural areas (WHO, 2014). Despite the global decline in the adolescent fertility since 1990, adolescent fertility remains high in many developing countries. Sub-Saharan Africa has the highest percentage of adolescent births which hovers around 46 percent, followed by Southern and Central Asia at 18 percent then Latin America and the Caribbean standing at 14 percent (UN, 2019). Several researchers have identified that teenage pregnancy is linked to adverse pregnancy outcomes such as anemia, eclampsia, difficult delivery, preterm birth, higher caesarian section rates, prematurity and birth trauma (Grønvik & Fossgard, 2018; Banke-Thomas *et al.* 2017; WHO, 2017; Odimegwu & Mkwanzani, 2016; WHO, 2016; Neal *et al.* 2012). Adolescent girls living in the rural areas, low educational level, lack of knowledge on use of contraceptive methods, lack of parental guidance, peer influence, alcohol and substance abuse, history of physical abuse or domestic violence and poverty are among risk factors for teenage conception (Raharjo *et al.* 2019; Eyasu, 2016; Olorinola, 2016; Patton *et al.* 2016; Azevedo *et al.* 2015; Nyarko, 2012; Alemayehu *et al.* 2010). Countries with higher educational levels, high knowledge levels on sexual and reproductive health and high contraceptive prevalence are known to report very low adolescent fertility levels. Kuwait is a good example of such a countries and its current adolescent fertility level is below 10 births per 1000 women aged 15-19 as revealed by the World Bank.

This paper applies Holt's double exponential smoothing to forecast adolescent fertility in Kuwait. The findings of this study are expected to depict future trends of adolescent fertility in the out of sample period. This will inform policy, planning and allocation of resources to teenage pregnancy prevention programs in order to avert adverse pregnancy outcomes in the country.

## II.METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Kuwait. 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 model is expressed as follows:

Model equation

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

$K_t$  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 slope of the trend at time t

$b_{t-1}$  is the slope of the trend at time t-1

**Data Issues**

This study is based on annual adolescent fertility rate in Kuwait 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	K
Included Observations	61
Smoothing constants	
Alpha ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.900
Forecast performance measures	

Mean Absolute Error (MAE)	0.827399
Sum Square Error (SSE)	222.362756
Mean Square Error (MSE)	3.645291
Mean Percentage Error (MPE)	0.489180
Mean Absolute Percentage Error (MAPE)	1.438614

Residual Analysis for the Applied Model

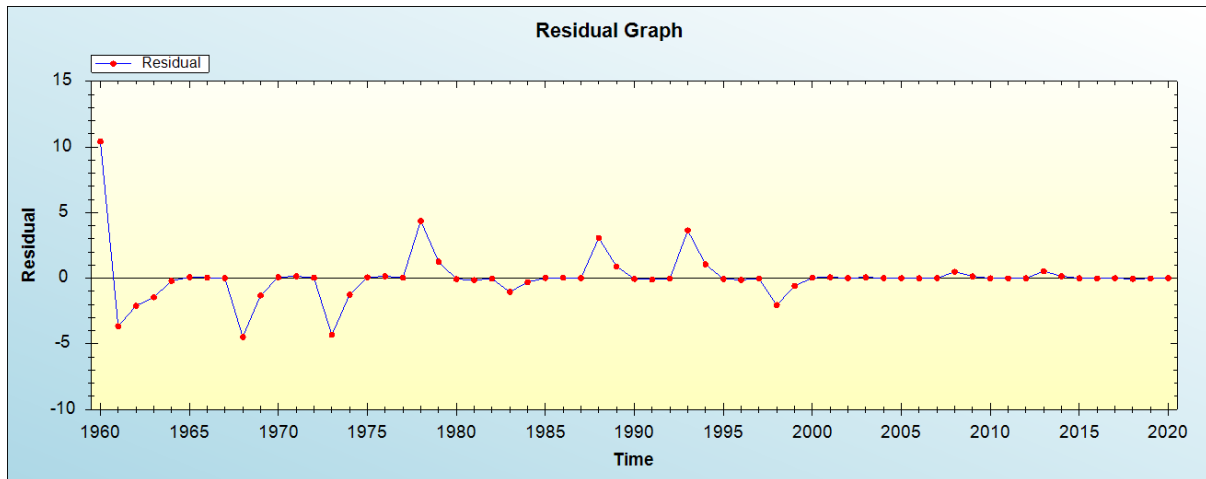


Figure 1: Residual analysis

In-sample Forecast for K

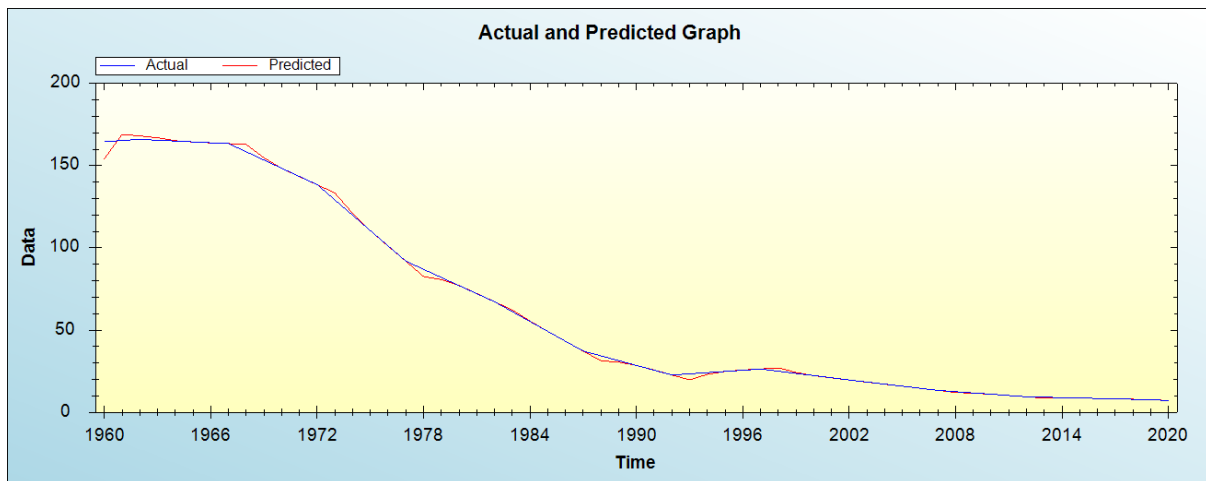


Figure 2: In-sample forecast for the K series

Actual and Smoothed graph for K series

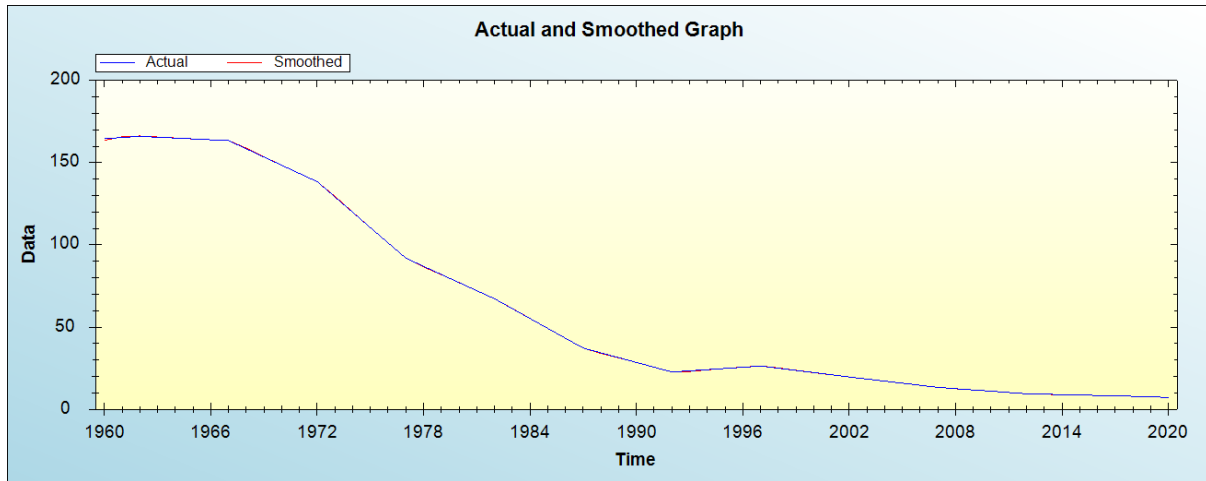


Figure 3: Actual and smoothed graph for K series

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

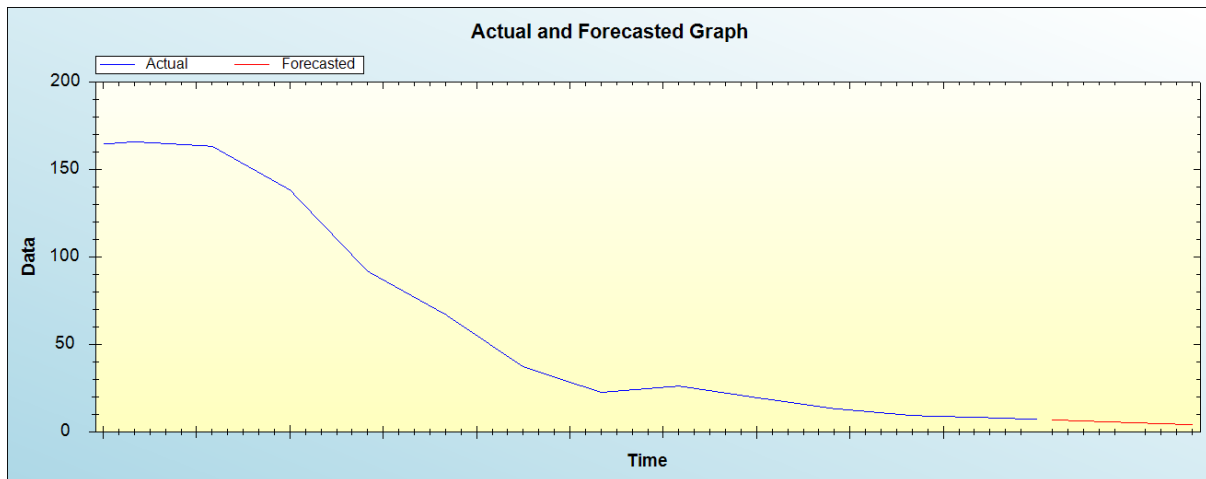


Figure 4: Out-of-sample forecast for K: actual and forecasted graph

Out-of-Sample Forecast for K: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Predicted adolescent fertility rate
2021	6.9593
2022	6.6493
2023	6.3393
2024	6.0292
2025	5.7192
2026	5.4092
2027	5.0992
2028	4.7892
2029	4.4792
2030	4.1692

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 is expected to remain low throughout the out of sample period.

#### IV. POLICY IMPLICATION & CONCLUSION

Adolescent pregnancy is global challenge that affects both developing and developed countries. However developed countries are less affected by this problem due to improvements in the education sector, better job opportunities for women, better knowledge on sexual and reproductive health and increased use of modern methods of contraception among adolescents. Developing countries are more affected by poverty and other serious challenges hence they report higher teenage pregnancy rates. Adolescent fertility levels in the State of Kuwait currently are low and below 10 births per 1000 females aged 15-19 years during the period 2014-2020. These low figures are typical of developed countries. This study proposed Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Kuwait. Our study findings revealed that adolescent fertility will remain low throughout the out of sample period. Therefore, we encourage the State of Kuwait to address local challenges that contribute to adolescent fertility and continuously enforce laws that protect the rights of women and girls.

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