Projecting Adolescent Fertility for Qatar Using Holt's Linear Method

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Abstract - **This study uses annual time series data of adolescent fertility rate for Qatar 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 0.3 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will remain low throughout the out of sample period. Therefore, we encourage authorities in Qatar to continuously enforce laws that safeguard sexual and reproductive health rights of women and girls, and address local factors that significant contribute to teenage pregnancy.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

According to the World Health Organization, teenage pregnancy and childbirth to girls below 18 years old remains a major global public health problem, affecting more than 16 million girls and young women worldwide. Estimates indicate that more than 90% of adolescent pregnancies occur in low and middle-income countries (Chandra-Mouli *et al.*2013; Kirbas *et al.* 2016; WHO, 2014).Worldwide, pregnancy and child birth complications are the major cause of death in adolescent girls and 99% of all adolescent maternal death occurs in developing countries (WHO, 2014).Previous literature has revealed that teenage pregnancies increase the risk of adverse maternal and child health outcomes (Pradhan *et al.* 2018;Poudel*et al.* 2018;Islam *et al.*2016;Ganchimeg*et al.*2016;Sayem and Nury, 2011). Having a baby outside marriage is prohibited in the State of Qatar, however teen pregnancy still occurs. World Bank reports indicate that adolescent fertility declined from around 90 births per 1000 women aged15-19 years in1960 to around 10 births per 1000 women in 2019. Drug and substance abuse among teenagers has a big influence on teenagers to engage on unsafe unprotected sexual activity putting them at risk of having unplanned pregnancies and sexually transmitted infections.

This paper applies the double exponential smoothing technique to forecast future trends of adolescent fertility in Qatar. The findings will facilitate 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 Qatar. 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

$$Q_t = \mu_t + \rho_t \mathbf{t} + \varepsilon_t$$

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$0 < \beta < 1$

Forecasting equation

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

Q_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 t-1

Data Issues

This study is based on annual adolescent fertility rate in Qatar 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	Q
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.300
Forecast performance measures	
Mean Absolute Error (MAE)	0.899245
Sum Square Error (SSE)	218.331096
Mean Square Error (MSE)	3.579198
Mean Percentage Error (MPE)	0.888361
Mean Absolute Percentage Error (MAPE)	2.161787

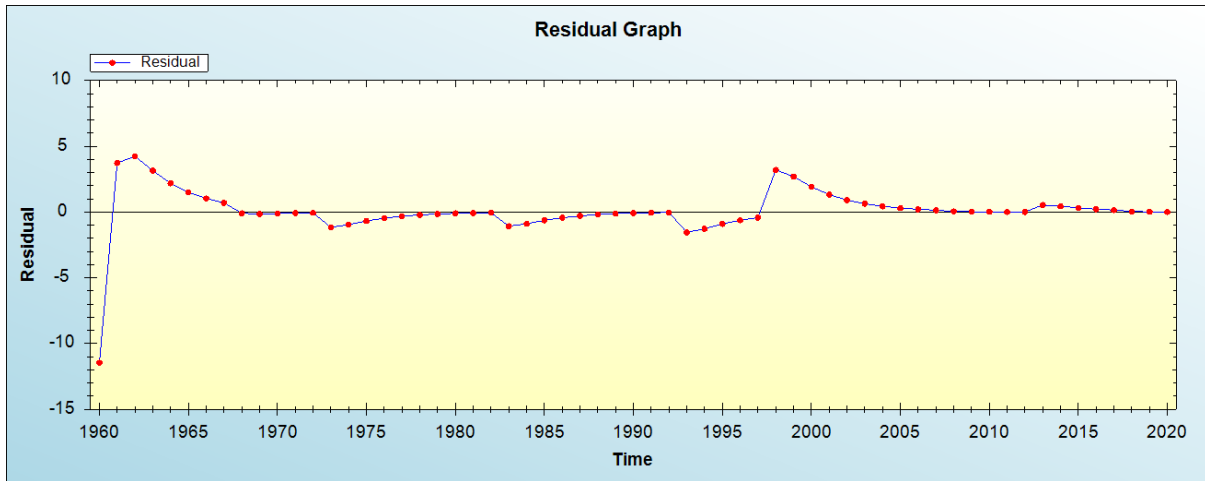Residual Analysis for the Applied Model

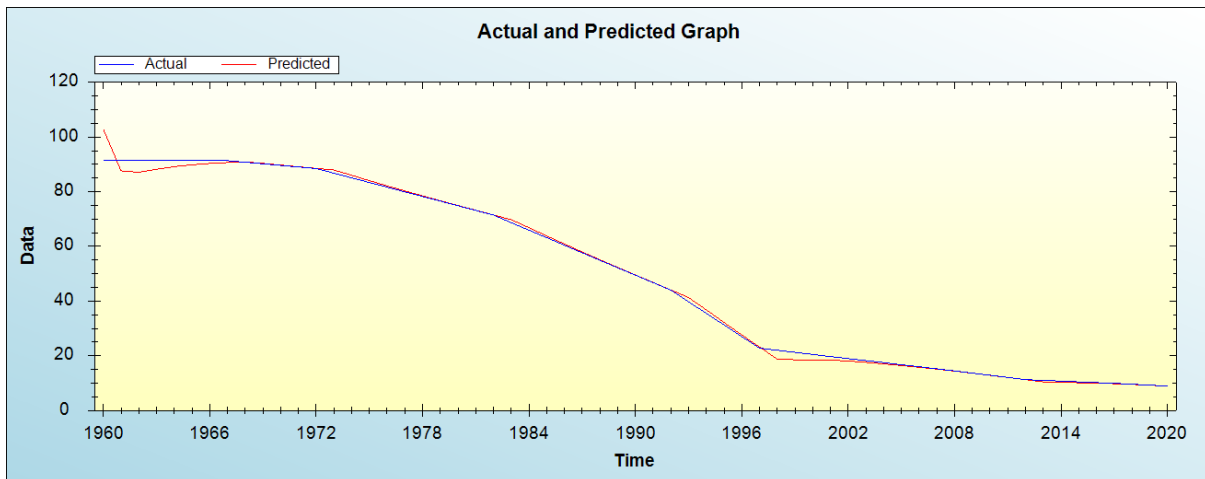Figure 1: Residual analysis

In-sample Forecast for Q

Figure 2: In-sample forecast for the Q series
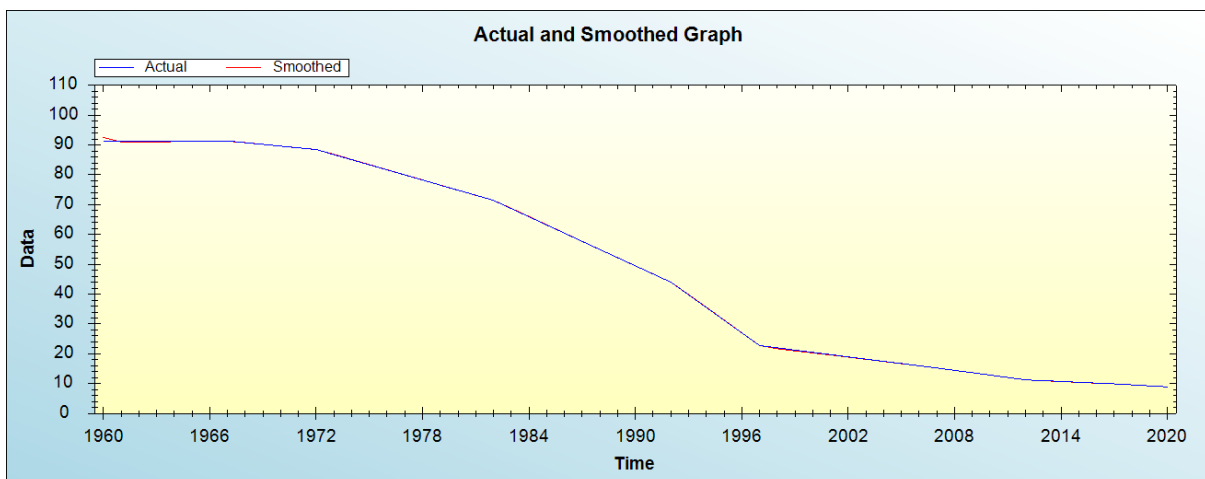
Actual and Smoothed graph for Q series

Figure 3: Actual and smoothed graph for Q series

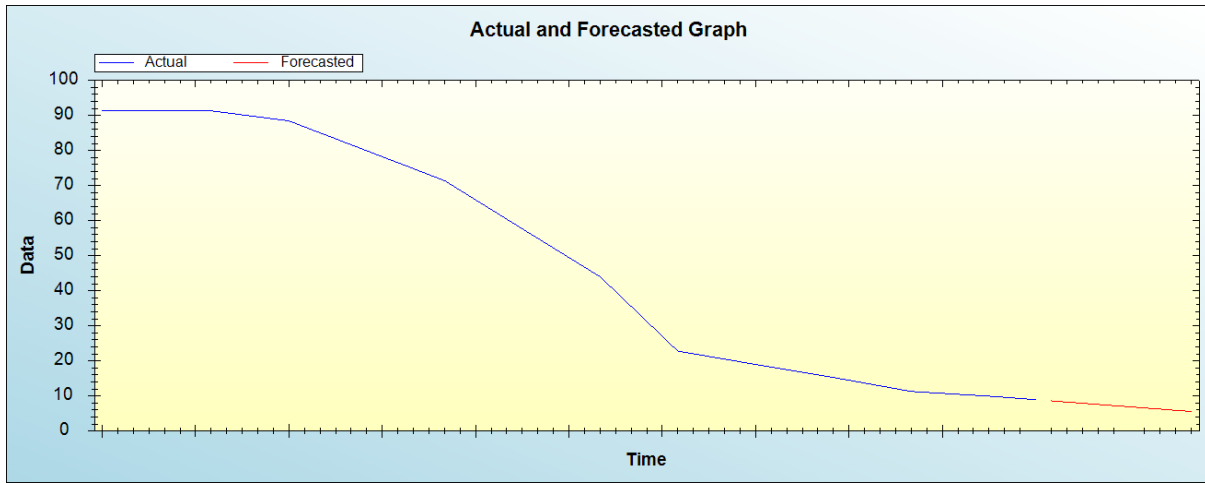Out-of-Sample Forecast for Q: Actual and Forecasted Graph

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

Out-of-Sample Forecast for Q: Forecasts only

Table 2: Tabulated out-of-sample forecast

Year	Predicted adolescent fertility rate
2021	8.5859
2022	8.2479
2023	7.9099
2024	7.5720
2025	7.2340
2026	6.8961
2027	6.5581
2028	6.2202
2029	5.8822
2030	5.5442

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 ratewill remain low throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

The national family planning program has contributed immensely to the substantial reduction of adolescent fertility in Qatar. Adolescent fertility declined substantially from 91 births per 1000 women aged 15-19 years in 1960 to 8.9 births per 1000 women aged 15-19 in 2020. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Qatar. Our study findings indicated that adolescent fertility will continue to decline and remain low throughout the out of sample period. Therefore, we encourage authorities in this country to continuously enforce laws that safeguard sexual and reproductive health rights of women and girls, and address local factors that significant contribute to teenage pregnancy.

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