

Detection of Future Trends of Adolescent Fertility for Austria Using Holt's Double Exponential Smoothing Technique

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Abstract - This research paper uses annual time series data of adolescent fertility rate for Austria 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 0.4 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage the Austrian government to attend to various problems that contribute to adolescent pregnancies especially in marginalized communities.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

In September 1994, the United Nations Population Fund (UNFPA) organized a conference in the Egyptian Capital, Cairo. The conference was attended by 179 country representatives from all over the World. The main objective of the meeting was to declare and uphold fundamental women's rights including sexual and reproductive health and rights (UN, 1995). Previous studies conducted in both developing and developed countries recognized the urgent need to curb teenage pregnancies that have become a global public health problem especially in low and middle income countries because they have been shown to be associated with pregnancy complications such as unsafe abortions, eclampsia and pre-eclampsia, and mental disorders (Kassa *et al.* 2018; Mehra *et al.* 2018; Pradhan *et al.* 2018; Islam *et al.* 2017; Sama *et al.* 2017; WHO, 2014; Ganchimeg *et al.* 2014). Many teenage pregnancies occur in South East Asia and the Sub-Saharan Africa. Around 12 million young girls aged 15-19 years get pregnant every year, especially in socially and economically disadvantaged regions with 75% of teenage pregnancies occurring in Sub-Saharan Africa (Kassa *et al.* 2018). The 1994 conference discussed various strategies to reduce teenage pregnancies that included enacting and enforcing laws to increase the legal age of consent and marriage to 18 years and crafting policies that promote girl child education. The Agenda 2030 for sustainable development added its voice to the call for the reduction of adolescent pregnancies. SDG-3 target 3.7 focuses on ensuring universal access to sexual and reproductive health services including that of teenagers (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). Under this specific goal, UN member states should come up with strategies to mitigate the problem of teenage pregnancies by drafting legislation to prevent child marriages and sexual abuse of adolescent girls and women. In addition, there is an urgent need to allocate resources that are required for the management of teenage pregnancies and its complications.

In this paper we focus on predicting adolescent birth (fertility) rates for Austria using a popular smoothing technique (Holt's linear method). The findings are expected to highlight likely future trends of adolescent births in the country and trigger appropriate action to curb teenage pregnancy and avert adverse maternal and child health outcomes.

II. METHODOLOGY

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

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 Austria 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 (α) for data	0.900
Beta (β) for trend	0.400
Forecast performance measures	
Mean Absolute Error (MAE)	0.819230
Sum Square Error (SSE)	169.982121
Mean Square Error (MSE)	2.786592
Mean Percentage Error (MPE)	0.379953
Mean Absolute Percentage Error (MAPE)	2.351795

Residual Analysis for the Applied Model

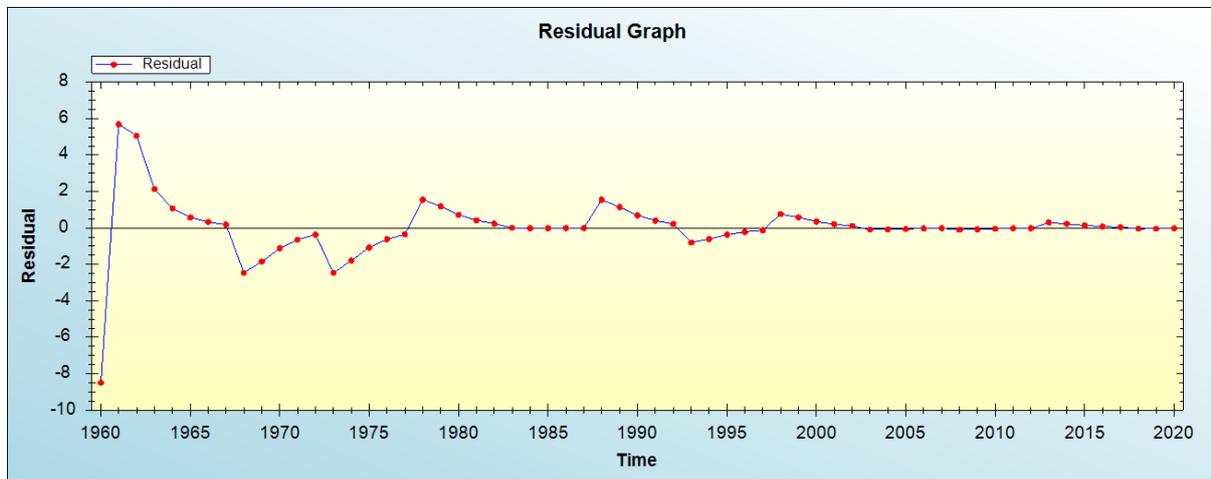


Figure 1: Residual analysis

In-sample Forecast for A

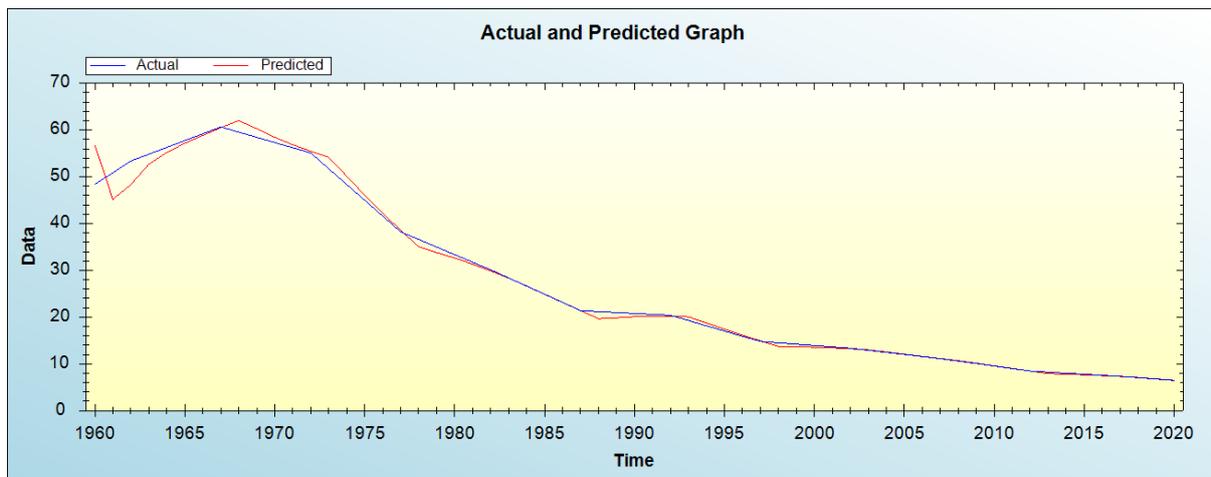


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

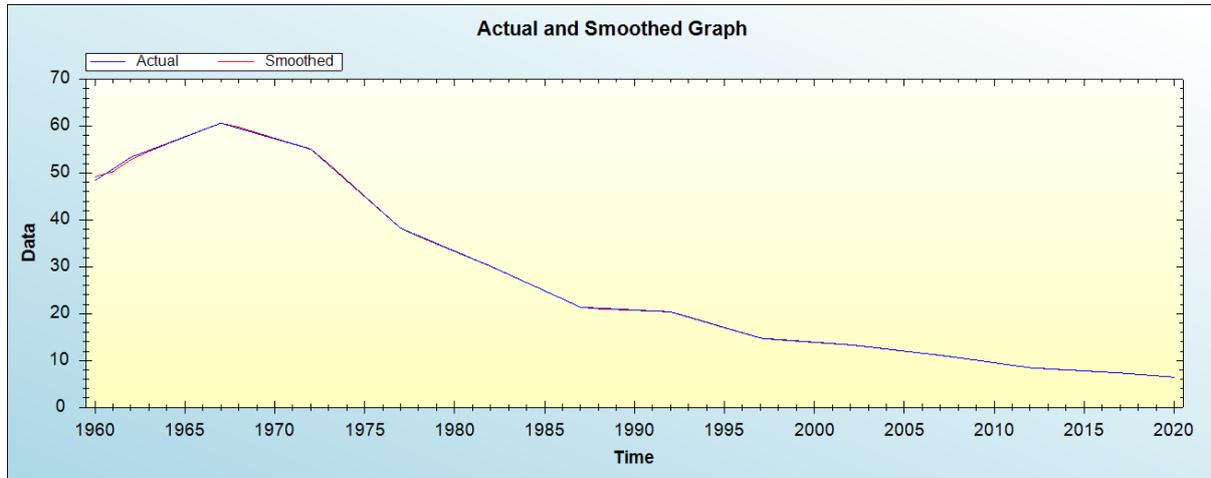


Figure 3: Actual and smoothed graph for A series

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

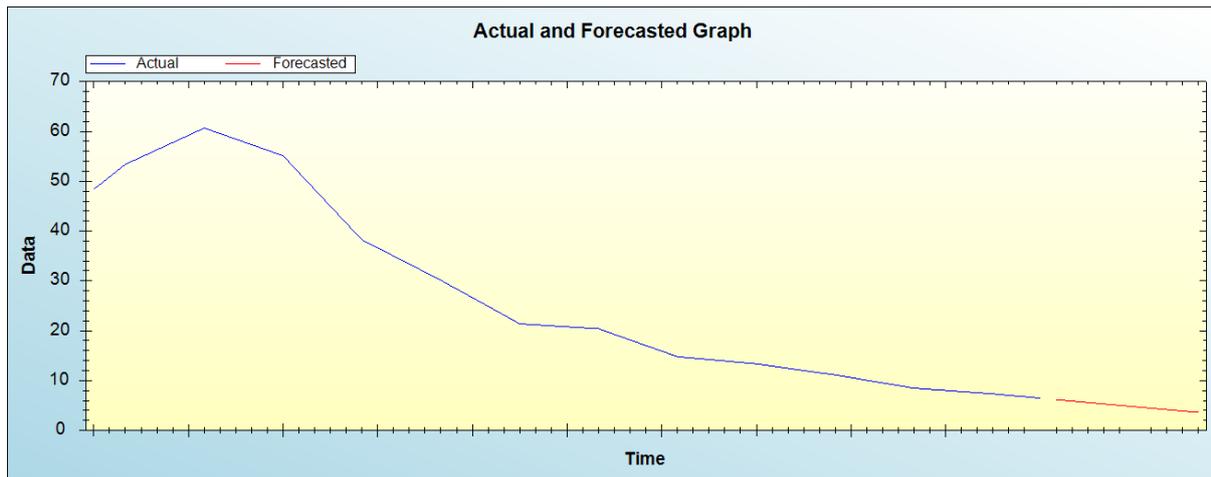


Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	6.1714
2022	5.8872
2023	5.6030
2024	5.3189
2025	5.0347
2026	4.7505
2027	4.4663
2028	4.1821
2029	3.8979
2030	3.6138

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

By the end of 2030, all UN member countries should have managed to substantially reduce maternal and child mortality. Focusing on adolescent sexual and reproductive health is crucial because adolescent pregnancy is associated with a higher risk of adverse pregnancy outcomes when compared with women in their twenties. It is also important to solve various challenges encountered by teenagers such as forced child marriage, sexual abuse, low education levels and inadequate knowledge of sexual and reproductive health. This paper applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Austria. Our study results indicated that adolescent fertility will continue to drop throughout the out of sample period. Therefore, we encourage the Austrian government to attend to various problems that contribute to adolescent pregnancies especially in marginalized communities.

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