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Adolescent Fertility Projection for Malaysia Using Holt's Linear Method

[1]Smartson. P. NYONI, [2]Thabani NYONI

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

***Abstract* - This research paper uses annual time series data of adolescent fertility rate for Malaysia 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 is expected to slightly increase in the out of sample period. Therefore, we encourage authorities in Malaysia to continue supporting adolescent health programs and address local factors that drive adolescent fertility.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adolescent pregnancy is a worldwide problem affecting developing and developed countries with varying degrees (Papri *et al*. 2016; Johson *et al*. 2001). Sub-Saharan Africa has the highest teen pregnancy rates followed by South Asia and Latin America and the Caribbean (UNICEF, 2020). Several previous authors have revealed that child marriage, early unions and adolescent pregnancy are a common finding in some of the South Asian countries and there is need to implement effective strategies to eliminate harmful practices that fuel child marriages(Plan International, 2021; Bernama, 2019;Said, 2019). Global adolescent fertility has significantly dropped, however age specific fertility rate for the 15-19 year age group remains constant or on an upward trend trajectory in the South East Asian region (Fatimah *et al.* 2020). The United Nations Populations Fund revealed that average adolescent fertility rate for the South East Asian region stands at 47 births per 1000 women aged 15 to 19, higher than the average of 35 in South Asia and this is close to the global average of 50 (UNFPA, 2018). Adolescent pregnancy rates in Malaysia are of great concern. The Ministry of Health indicated that in 2014 approximately 18,000 teenage pregnancies were reported. These teenage pregnancies were as a result of lack of comprehensive sexual and reproductive health knowledge among adolescents, social problems, and poor parental guidance (The Sun Daily, 2015).

This paper applies the double exponential smoothing technique to model and forecast future trends of adolescent fertility rate for Malaysia. The results of the study are envisioned to highlight the burden of adolescent fertility in the out of sample period. This is anticipated to inform national policies, 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 Malaysia. 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 method is specified as follows:

Model equation

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

Smoothing equation

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

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$0<\alpha<1$

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 Malaysia 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)	0.853477
Sum Square Error (SSE)	280.058286
Mean Square Error (MSE)	4.591119

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Mean Percentage Error (MPE)	0.697449
Mean Absolute Percentage Error (MAPE)	2.043668

Residual Analysis for the Applied Model

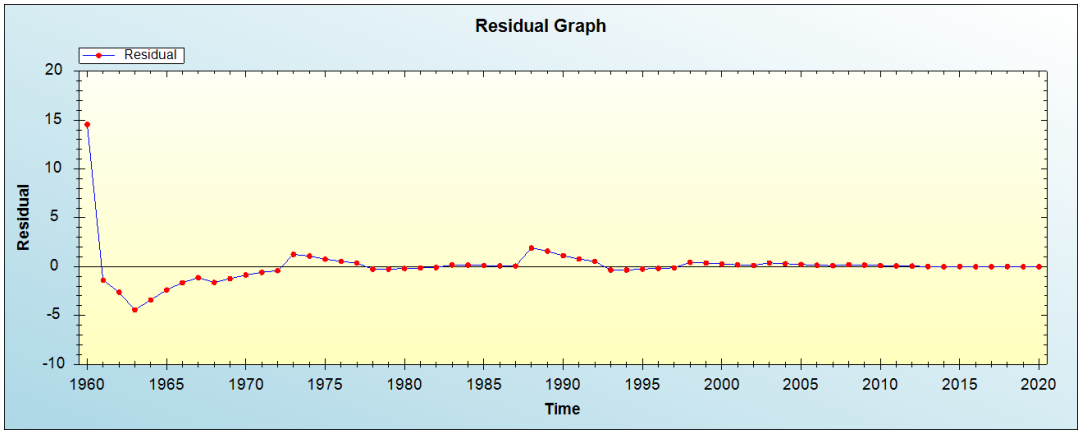

Figure 1: Residual analysis

In-sample Forecast for Q

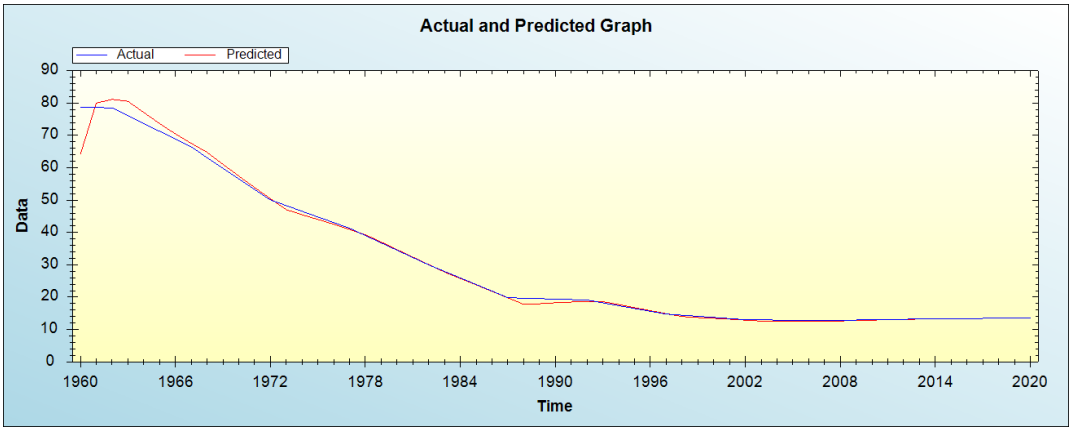

Figure 2: In-sample forecast for the Q series

Actual and Smoothed graph for Q series

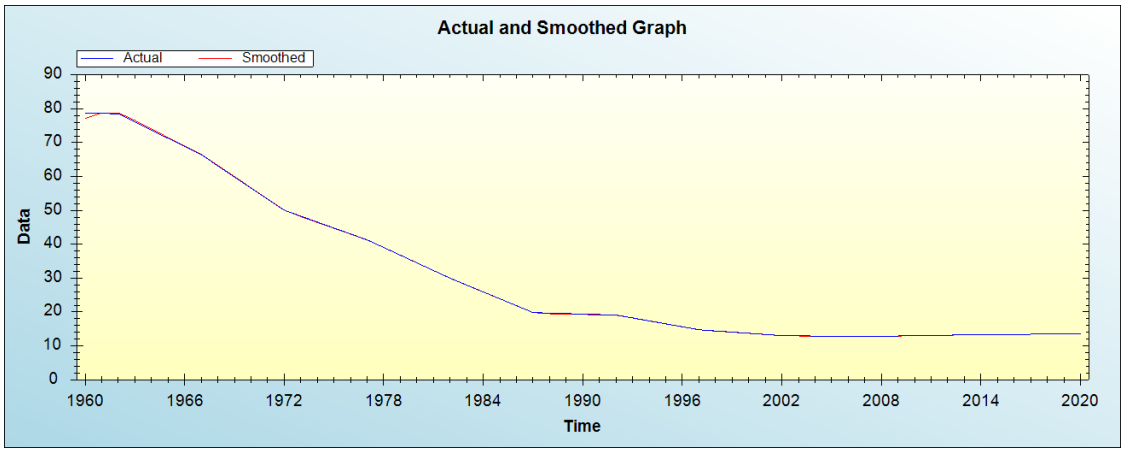

Figure 3: Actual and smoothed graph for Q series

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

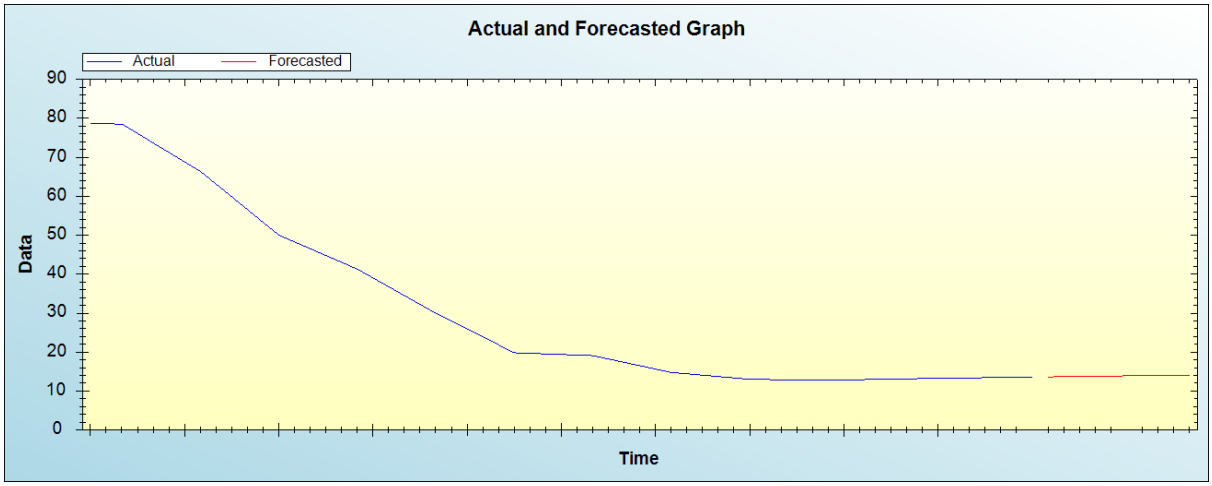

Figure 4: Out-of-sample forecast for Q: actual and forecasted graph

Out-of-Sample Forecast for Q: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	13.6253
2022	13.6781
2023	13.7309
2024	13.7838
2025	13.8366
2026	13.8895
2027	13.9423
2028	13.9952
2029	14.0480
2030	14.1009

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 rateis expected to slightly increase throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adolescent pregnancy remains a public health problem in Malaysia. High absolute numbers of unintended pregnancies among teenagers are still being reported. These teenage pregnancies are due to lack of comprehensive sexual and reproductive health knowledge among adolescents, social problems, and poor parental guidance. Adolescent fertility has been gradually declining during the period 1960-2020. This is a reflection of effective government interventions such as the national family program, increase in age at marriage and better SRH knowledge levels. This study applied Holt's double exponential smoothing technique to predict adolescent fertility for Malaysia. We found out that adolescent fertility will slightly increase throughout the out of sample period. Therefore, the government is encouraged to continue supporting adolescent health programs and address local factors that drive adolescent fertility.

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