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Forecasting Future Trends of Adolescent Fertility for the Philippines Using Holt's Linear Method

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***Abstract* - This research paper uses annual time series data of adolescent fertility rate in the Philippines 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 0.1 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility rate is expected to rise throughout the out of sample period. In order to reverse the projected trend of adolescent fertility, authorities in the Philippines must continuously enforce laws that safeguard sexual and reproductive health rights of women and girls, promote girl child education, fund empowerment programs for youths and scale up awareness campaigns among communities.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Childbearing during adolescence stage carries an increased risk of adverse health outcomes for both the mother and baby. Pregnancy during adolescence is associated with a higher risk of health problems like anemia, sexually transmitted infections (STIs), obstetric hemorrhage, and poor mental health outcomes such as depression, and suicide. Adolescents who become pregnant at an early age have a higher risk of domestic violence, as well as acquiring HIV and other STIs (Christofides *et al.*2014; WHO, 2014). Teenage pregnancy is a major challenge among youths in the Philippines (UNFPA, 2020). Childbearing among Filipino adolescents showed an increasing trend over the last 20 years (UN, 2019). According to Philippines Statistic Authority, teenage pregnancy rate in the Philippines was 10% in 2008, down to 9% in 2017. Live births by teenage mothers (aged 10-19) in 2016 amounted to 203,085, which slightly declined to 196,478 in 2017 and 183,000 in 2018.World Bank data indicates that the Philippines has 47 births annually per 1,000 women aged 15-19, higher than the average adolescent birth rates of 44 globally and 33.5 in the Asian region. This means that more than 500 Filipino adolescent girls are getting pregnant and giving birth every day. The 2017Demographic and Health Survey revealed that two out of three women (aged 20–24) who experienced adolescent sexual initiation before their 20th birthday also experienced adolescent pregnancy (Habito *et al.* 2019) and that the younger their age at first birth, the more likely they were to experience a repeat pregnancy (Maravilla *et al.* 2019). In addition, sexually active adolescent women aged 15–19, whether married or unmarried, also had the highest unmet need for family planning among all women of reproductive age (PSA, 2018).Literature indicates that teenage pregnancies in the country are largely attributed to lack of responsibility, morale decline, poverty, inequality and sexual violence (Juan *et al.*2019; PDI, 2019; Santos, 2019;Crisostomo, 2019; Salvador *et al.* 2016).

In 2012, the Responsible Parenthood and Reproductive Health Act was signed into law to help improve maternal health and SRH outcomes through the provision of essential SRH resources, emergency obstetric care, and comprehensive sexuality education for adolescents in formal and non-formal education systems, among others (Melgar *et al.* 2018). Therefore, this paper applies Holt's double exponential smoothing technique to model and forecast future trends of adolescent fertility for the Philippines. The findings of the study will depict the future burden of adolescent fertility in the country. This will inform policies, decisions, planning and allocation of resources to activities or programs that reduce teenage pregnancy and child marriage.

II. METHODOLOGY

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

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Holt's linear method is specified as follows:

Model equation

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

Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

$f_{t+h} = L_t + \mathrm{h} b_t$

P_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

b_{t-1} is the trend estimate at time t-1

Data Issues

This study is based on annual adolescent fertility rate in the Philippines 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	P
Included Observations	61

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Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.636817
Sum Square Error (SSE)	90.645200
Mean Square Error (MSE)	1.485987
Mean Percentage Error (MPE)	0.086408
Mean Absolute Percentage Error (MAPE)	1.100764

Residual Analysis for the Applied Model

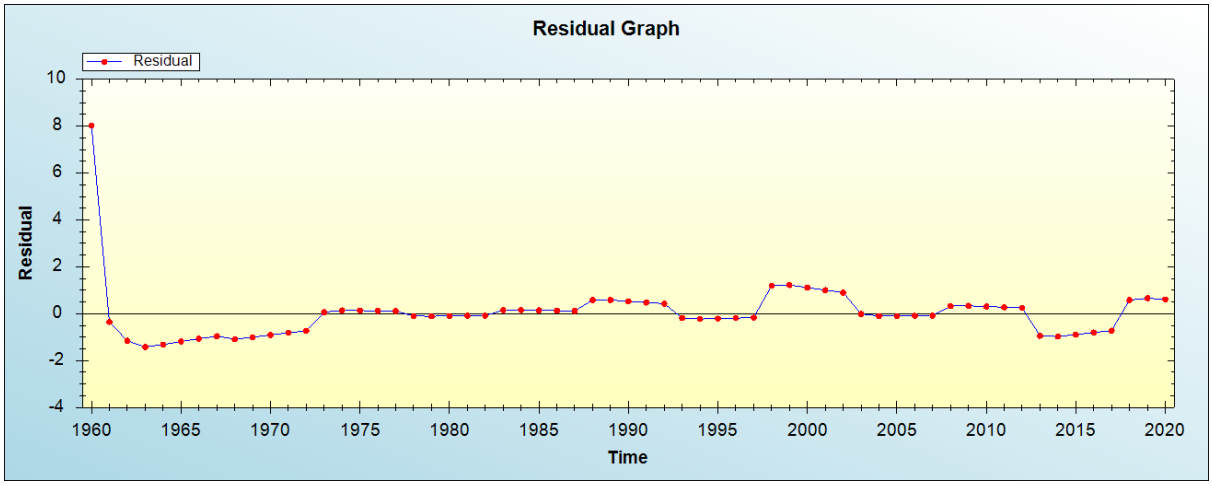

Figure 1: Residual analysis

In-sample Forecast for P

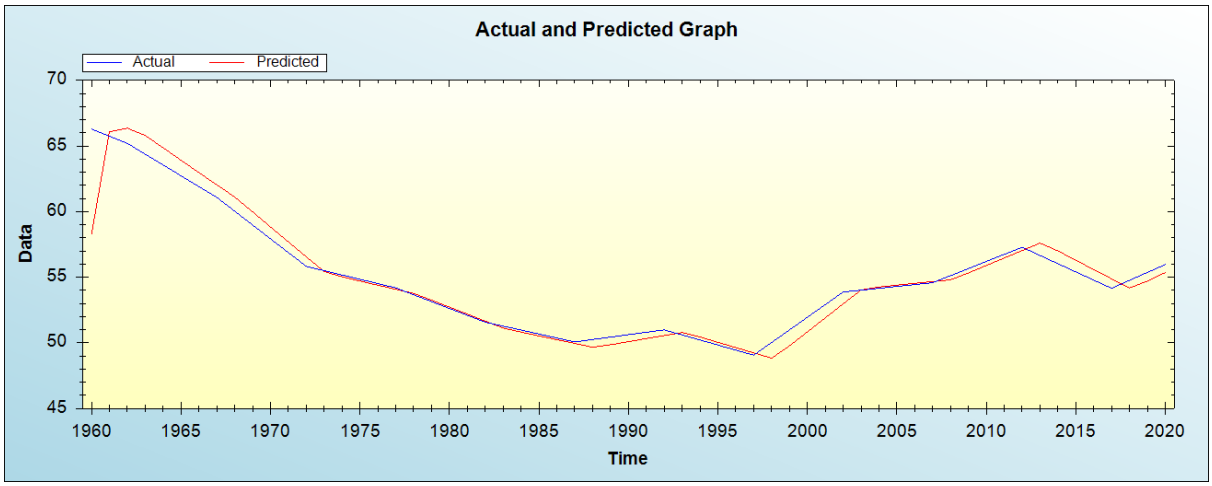

Figure 2: In-sample forecast for the P series

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Actual and Smoothed graph for P series

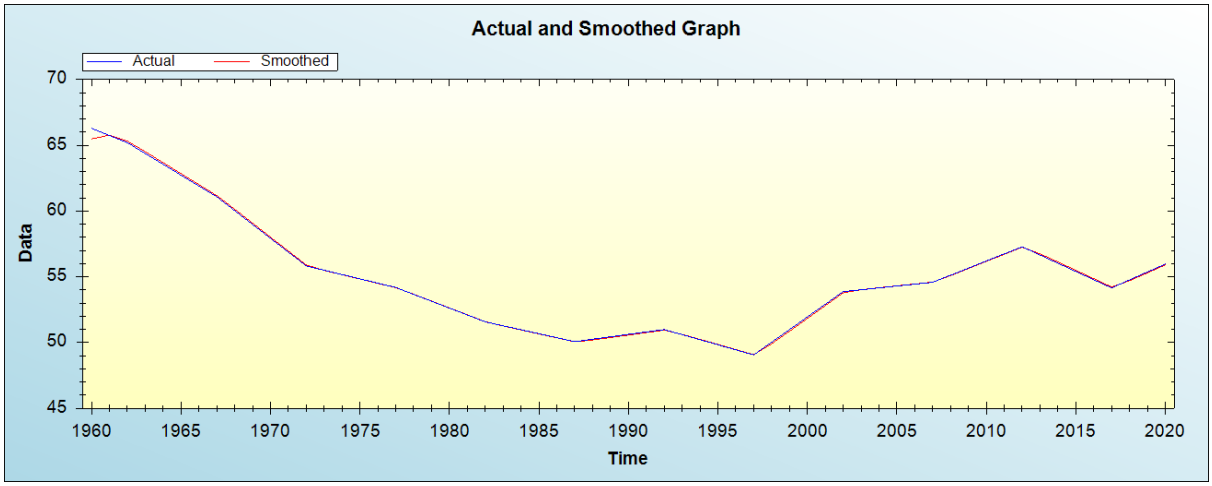

Figure 3: Actual and smoothed graph for P series

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

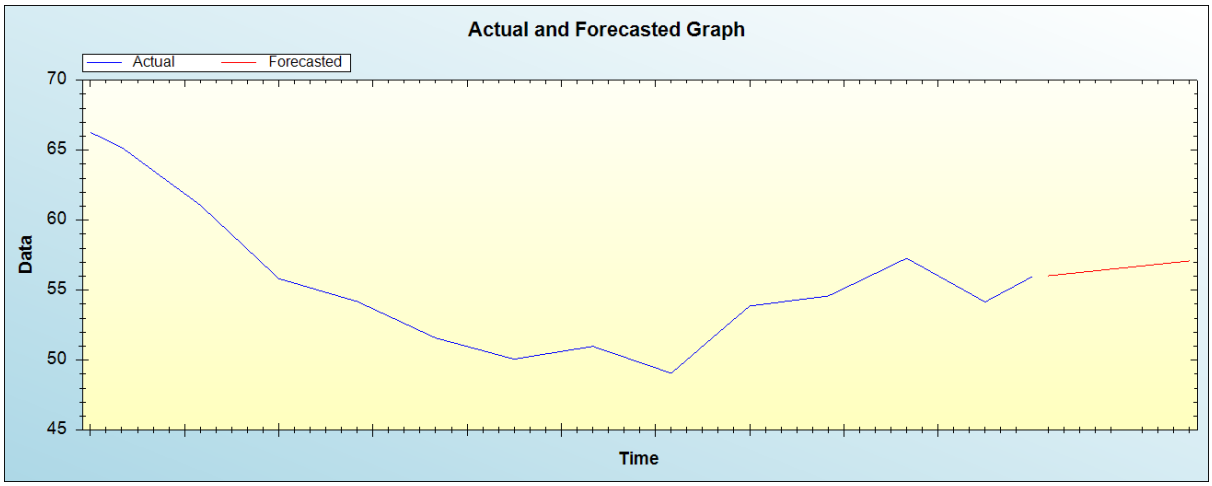

Figure 4: Out-of-sample forecast for P: actual and forecasted graph

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	56.0265
2022	56.1443
2023	56.2620
2024	56.3798
2025	56.4975
2026	56.6153
2027	56.7330
2028	56.8508
2029	56.9685
2030	57.0863

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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 rise throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adolescent pregnancy is a major public health challenge among youths in the Philippines. Childbearing among Filipino adolescents has been on an upward trend over the previous two decades. Pregnancy among teenagers in the country is largely attributed to lack of responsibility, morale decline, poverty, inequality and sexual violence. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for the Philippines. We established that adolescent fertility will continue on an upward trajectory throughout the out of sample period. Therefore, we encourage authorities in the Philippines to continuously enforce laws that safeguard sexual and reproductive health rights of women and girls, promote girl child education, fund empowerment programs for youths and scale up awareness campaigns among communities.

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