Adolescent Fertility Forecasting for Namibia Using Holt's Linear Method

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Abstract - **This study uses annual time series data of adolescent fertility rate for Namibia 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 authorities in Namibia to scale educational campaigns among communities, continuously promote girl child education and protect sexual and reproductive rights of women and girls.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

In recent times there has been a growing interest to understand the future trends of various health phenomena which is fundamental in policymaking and allocation of resources. Teenage child births trends is one of the public health challenges that require an in-depth study. According to the World Health Organization (WHO) an 'adolescent' is an individual aged 10-19 years (WHO, 2020). It is estimated that 12 million girls aged 15– 19 years and at least 777,000 girls aged under 15 years give birth each year in low and middle income countries (WHO, 2020). Worldwide, babies born to adolescent girls constitute about 11% of all births, and 95% of these are found in developing countries. In Africa, the estimated prevalence of adolescent pregnancy is 18.8%; a higher prevalence is observed in the East African sub-region (21.5%) and the lowest is in the North Africa (9.2%) (Kassa *et al.*2018). Literature indicates that teenage pregnancy is a public health problem both in developed and developing countries (Papri *et al.* 2016; Lawlor & Shaw, 2004; Johnson *et al.* 2001). In low-middle income countries, approximately 7.3 million girls under the age of 18 years give birth every year, out of which girls under the age of 15 years account for 2 million births (UNFPA, 2013). In addition, adverse SRH outcomes resulting from pregnancy and childbirth are the leading cause of maternal mortality in young women aged 15–19, with the highest risk being in Africa, Afghanistan, Bangladesh, Guatemala, Haiti, Nepal, Nicaragua and Yemen (Liabsuetrakul, 2012). The risk of death due to pregnancy-related complications has been found to be twice in adolescents compared with women who are in their twenties (WHO, 2005). A wide range of factors contribute to the high rates of unintended pregnancy and unplanned births among adolescents such as poor knowledge of sexual and reproductive health services, legal barriers to accessing services, provider bias, stigma around premarital sex and lower decision making autonomy of married teenagers (Wado *et al.* 2019).In Namibia, adolescent pregnancy has risen from 15% in 2006 to 18.6% in 2013 (NNPC, 2018). The number of adolescent pregnancies has remained high in the country, with some areas recording up to 38.9% adolescent pregnancies (Namibia MOH, 2016). Teenage girls are more likely to experience pregnancy-related complications due to obstructed labor and eclampsia, thereby increasing their risk of death (WHO *et al.* 2015). The Government of Namibia has implemented various measures to reduce teenage pregnancy and its adverse effects. The measures include amending and implementing a law against early marriage and a national adolescent and youth reproductive health strategy (Indongo, 2020). Despite this effort, teenage pregnancy continues to be a serious public health and demographic challenge in the country. This study applies the double exponential smoothing technique to forecast future trends of adolescent fertility in Namibia in the out of sample period. The study findings are expected to depict future trends of adolescent births in the country and trigger a timeous national response to the challenge of child marriage and teen pregnancy.

II. METHODOLOGY

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

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

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

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

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**

$\mathbf{t}$ 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 Namibia 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

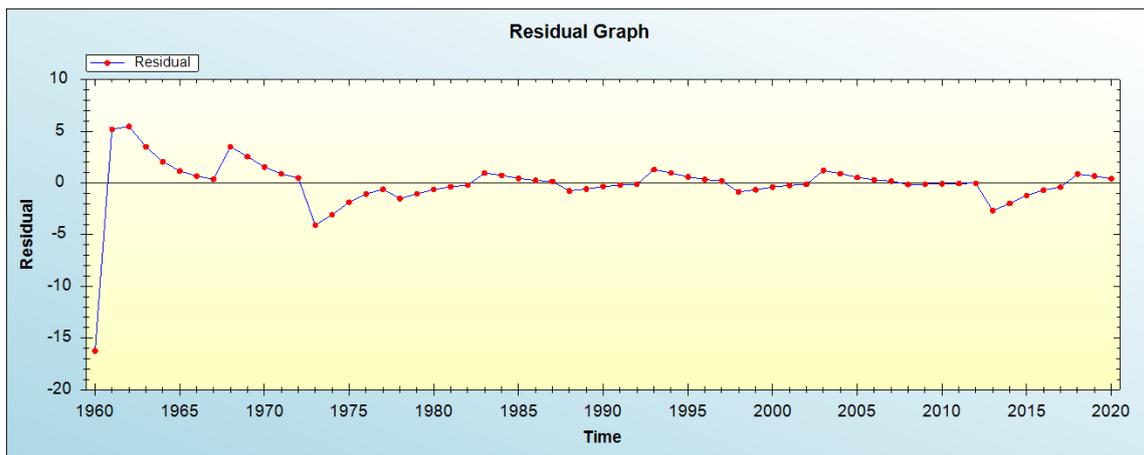| Variable	A
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.400
Forecast performance measures	
Mean Absolute Error (MAE)	1.322725
Sum Square Error (SSE)	420.781940
Mean Square Error (MSE)	6.898065
Mean Percentage Error (MPE)	-0.058822
Mean Absolute Percentage Error (MAPE)	1.342470

Residual Analysis for the Applied Model

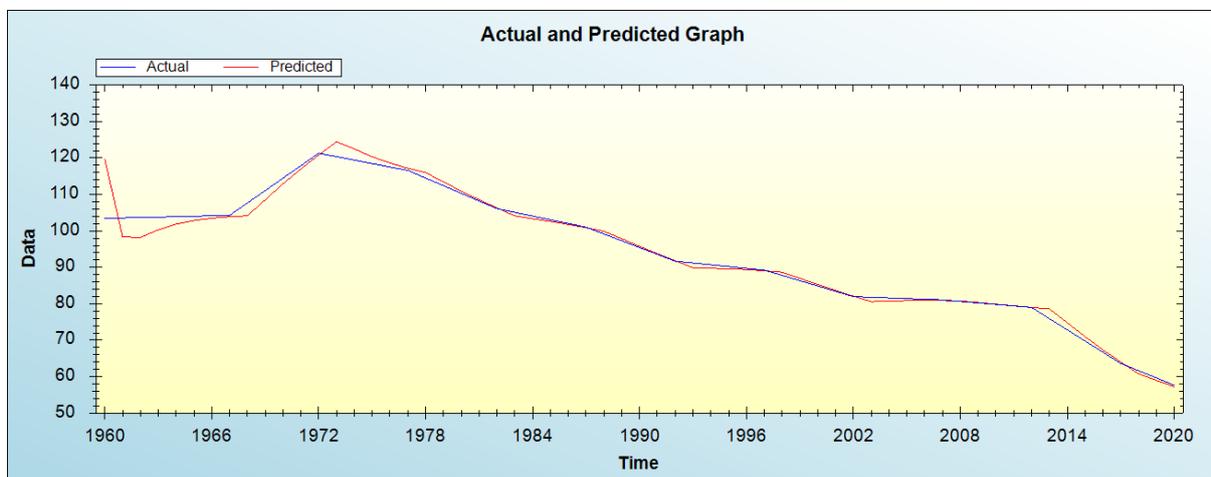Figure 1: Residual analysis

In-sample Forecast for A

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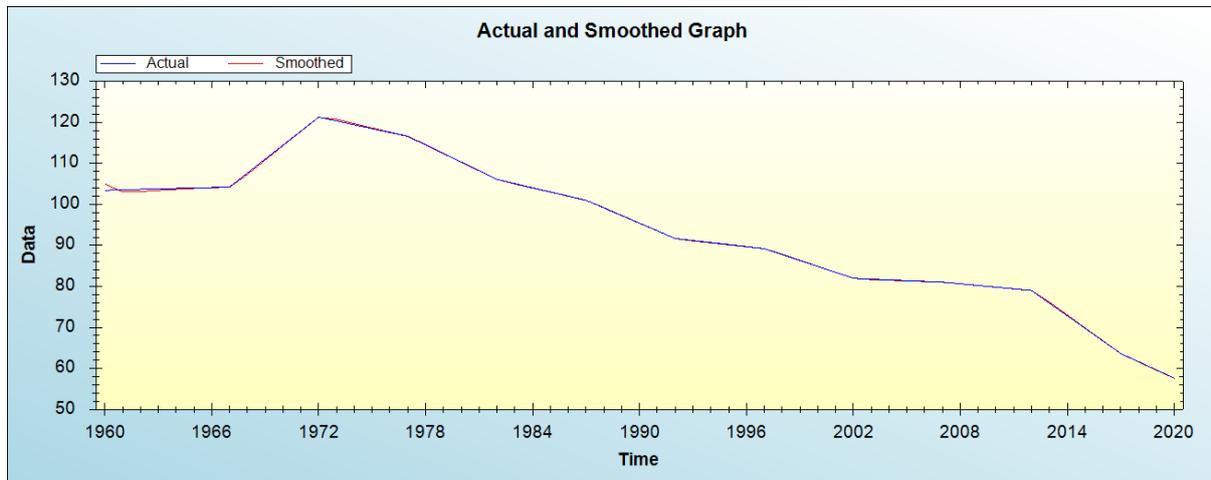
Actual and Smoothed graph for A series

Figure 3: Actual and smoothed graph for A series

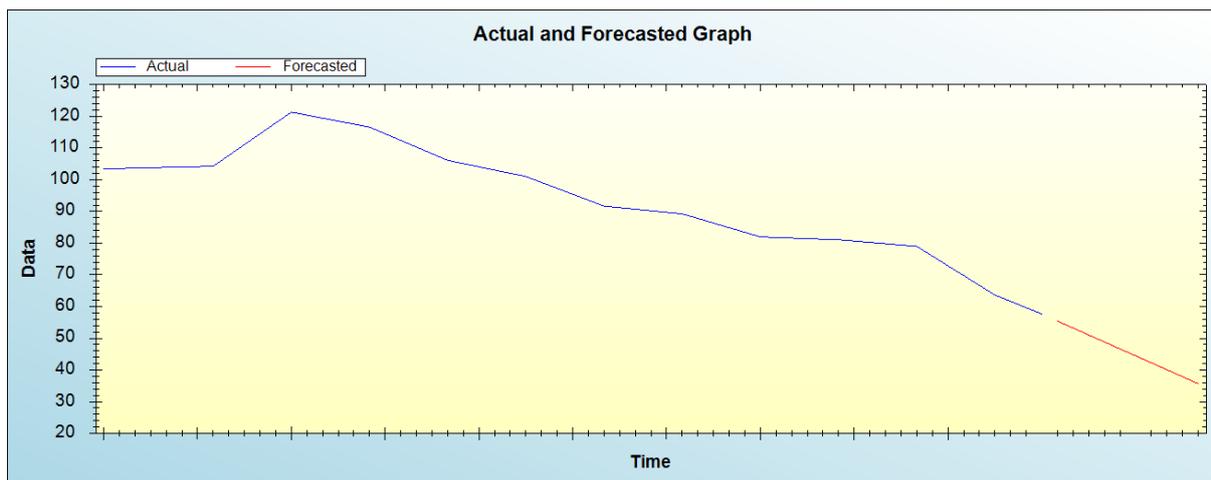Out-of-Sample Forecast for A: Actual and Forecasted Graph

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	55.4091
2022	53.2174
2023	51.0257
2024	48.8341
2025	46.6424
2026	44.4507
2027	42.2591
2028	40.0674
2029	37.8757
2030	35.6841

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

Teenage pregnancy remains a huge public health problem in Namibia. Teenagers continue to experience adverse pregnancy outcomes such as eclampsia, ante partum hemorrhage, obstructed labor and preterm delivery. These unintended pregnancies can be attributed to poor knowledge of sexual and reproductive health services, legal barriers to accessing services, provider bias, stigma around premarital sex and lower decision making autonomy of married teenagers. As highlighted by the World Bank adolescent fertility has been gradually declining during the past years due to investments in the family planning program. This study applies the double exponential smoothing technique to forecast adolescent fertility for Namibia. Our study findings show that adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage the government to scale educational campaigns among communities, continuously promote girl child education and protect sexual and reproductive rights of women and girls.

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