

Forecasting Adolescent Fertility for Mozambique Using Holt's Linear Method

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Abstract - This research article employs annual time series data of adolescent fertility rate for Mozambique 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 0.2 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will continue to decline but remain very high throughout the out of sample period. Therefore, we encourage authorities in Mozambique to strictly enforce laws that protect sexual and reproductive health rights of women and girls, scale up educational campaigns among the communities, promote girl child education and fund empowerment programs for youths.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Mozambique is among the developing countries with the highest HIV/ AIDS burden. It is reported that in 2014, an estimated 1.5 million people were living with HIV and the prevalence of HIV among adults aged 15-49 years was estimated to be 10.6%, the eighth highest in the world. Approximately 68,000 adolescents (10-19) were living with HIV in 2015 and new infections among adolescents (15-19) were reported to be around 9,400 (UNICEF, 2016). Adolescent pregnancy remains a public health problem in Mozambique, affecting girls' and young women's health and their social, economic and political empowerment. The country has one of the highest rates of child marriage in the world, affecting approximately 50 percent of girls (Mozambique, 2015; UNICEF, 2015). According to the 2011 Mozambique Demographic and Health Survey (DHS), 48% of women aged 20-24 married before they were 18 years old and 14% before they were even 15. In rural areas, 56% of women aged 20-24 were married by the age of 18, compared to 36% in urban areas. The risk of mortality due to pregnancy-related complications is twice in adolescents compared with women who are in their twenties (WHO, 2005). Previous studies indicated that adolescent women are at risk of unwanted pregnancy, sexually transmitted infections, unsafe abortions, and repeat pregnancy (Atuyambe *et al.* 2015; Ganchimeg *et al.* 2014; WHO, 2014; Chandra-Mouli *et al.* 2013). Furthermore, pregnant adolescent mothers are likely to dropout of school and spoil their future prospects of getting better jobs (Lee, 2010). Infants who are born to adolescent mothers are more likely to be preterm and face a higher risk of dying compared with infants born to older mothers who are between the ages of 20 and 24 (Neal *et al.* 2016; Pradhan *et al.* 2015; Ganchimeg *et al.* 2014; WHO, 2014; Chandra-Mouli *et al.* 2013; NAC & CHO, 2009). These children are prone to a host of problems including poor development, malnutrition and inadequate education (Ganchimeg *et al.* 2014; Hodgkinson *et al.* 2014).

The government of Mozambique adopted Mozambique's National Strategy for Prevention and Combating of Child Marriage (2016-2019) in December 2015 (Mozambique, 2015). This strategy was drafted in response to the challenge of early marriage with mission "to promote a socio-economic and cultural framework to prevent and combat, continuously, early marriages". Children living in economically disadvantaged circumstances such as rural areas or families with low income are likely to have limited access to education and push factor for child marriage (Arthur, 2010). Despite all these efforts teenage pregnancy continues to be a problem especially in the rural areas. This study was carried out in line with Mozambique's National strategy for Prevention and combating of Child Marriage and the agenda 2030 for sustainable development to forecast future trends of adolescent fertility using the double exponential smoothing technique. The findings of this research are expected to depict the future burden of adolescent births and trigger an appropriate response to the problem of child marriage and teenage pregnancies in the country with a goal of averting adverse sexual and reproductive health outcomes through implementation of effective policies.

II. METHODOLOGY

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

$$Q_t = \mu_t + \rho_t t + \varepsilon_t$$

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 Mozambique 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	0.200
Forecast performance measures	
Mean Absolute Error (MAE)	1.622770
Sum Square Error (SSE)	669.462410
Mean Square Error (MSE)	10.974794
Mean Percentage Error (MPE)	-0.122566
Mean Absolute Percentage Error (MAPE)	1.091734

Residual Analysis for the Applied Model

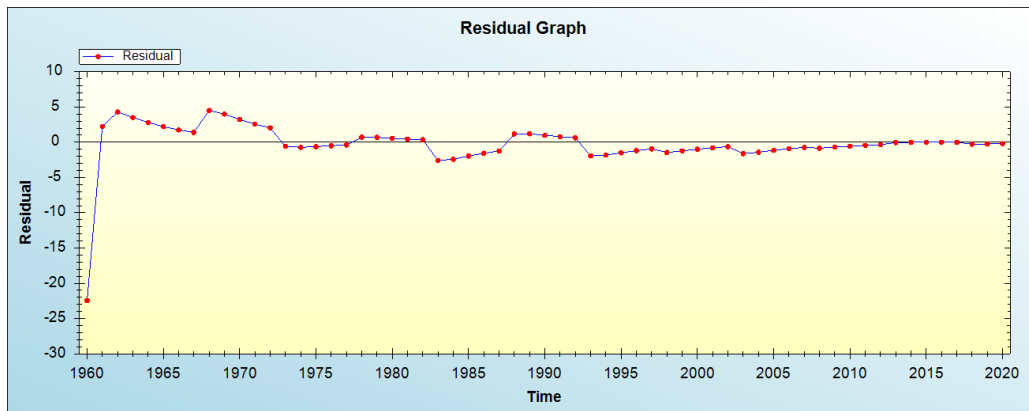


Figure 1: Residual analysis

In-sample Forecast for Q

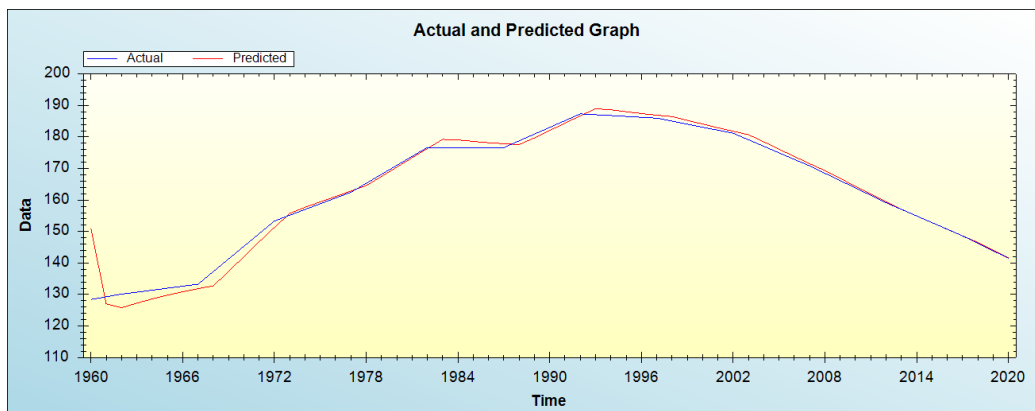


Figure 2: In-sample forecast for the Q series

Actual and Smoothed graph for Q series

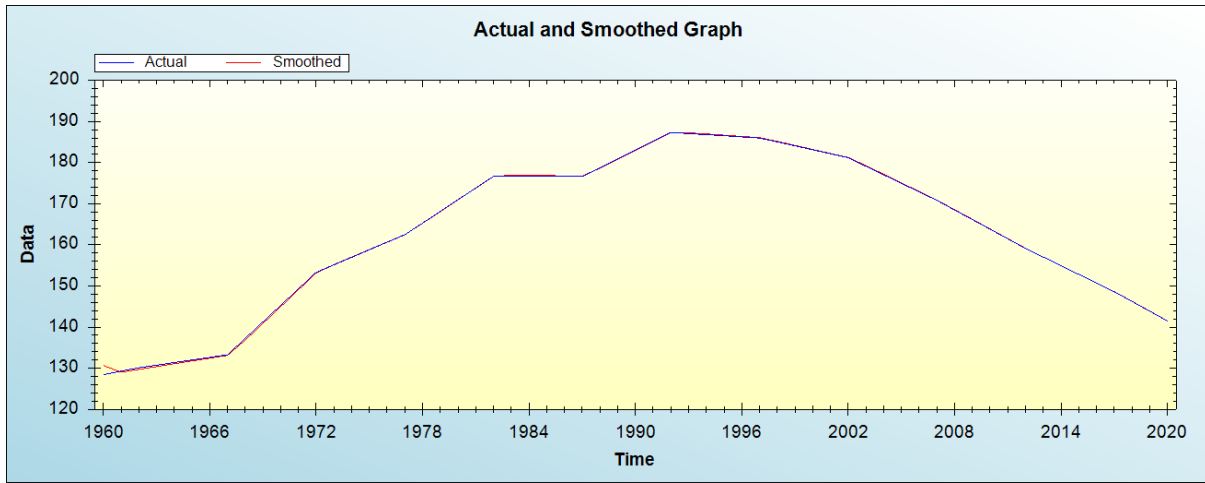


Figure 3: Actual and smoothed graph for Q series

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

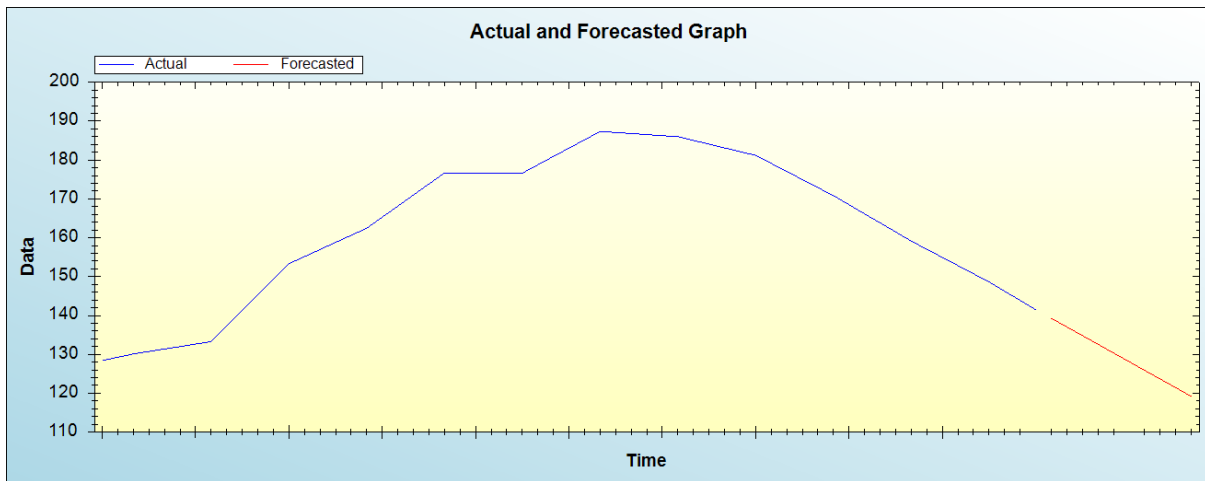


Figure 4: Out-of-sample forecast for Q: actual and forecasted graph

Out-of-Sample Forecast for Q: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	139.2870
2022	137.0534
2023	134.8197
2024	132.5860
2025	130.3524
2026	128.1187
2027	125.8850
2028	123.6513
2029	121.4177
2030	119.1840

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 but remain very high throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Adolescent pregnancy remains a huge public health problem in Mozambique, affecting girls' and young women's health and their social, economic and political empowerment. Adverse pregnancy outcomes experienced by pregnant teenagers include hypertensive disorders, anemia, obstructed labor, preterm delivery and low birth weight. Early child marriage, social norms, poverty, low educational level, peer pressure and refusal to use modern methods of contraception are among the leading causes of teenage pregnancy. Adolescent fertility gradually declined in Mozambique over the period 1992 to 2020, however it remains very high. This study applied Holt's double exponential smoothing technique to forecast adolescent fertility for Mozambique. Our study findings indicated that adolescent fertility will continue to decline but remain very high throughout the out of sample period. Therefore, we encourage the government to strictly enforce laws that protect sexual and reproductive health rights of women and girls, scale up educational campaigns among the communities, promote girl child education and fund empowerment programs for youths.

REFERENCES

- [1] UNICEF (2016). FOR EVERY END AIDS Seventh Stocktaking Report, 2016. [Pdf] Available at <https://data.unicef.org/wp-content/uploads/2016/12/HIV-and-AIDS-2016-SeventhStocktaking-Report.pdf>
- [2] Ministerio da Saude (MISAU), Instituto Nacional de Estatística (INE) e ICF International (ICFI). Moçambique Inquérito Demográfico e de Saúde 2011. Calverton, Maryland, USA: MISAU, INE e ICFI.
- [3] World Health Organization (2005). Facts and figures form the World Health Report [Internet]. Geneva: World Health Organization. Available: http://www.who.int/whr/2005/media_centre/facts_en.Pdf
- [4] World Health Organization (2014). Adolescent pregnancy factsheet [Internet]. World Health Organization. <http://www.who.int/mediacentre/factsheets/fs364/en/>
- [5] Ganchimeg T., Ota E., and Morisaki N (2014). Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. *BJOG: Int J Obstet Gy.* 121(Suppl. 5):40–8.
- [6] Chandra-Mouli V., Camacho AV., and Michaud P-A (2013). WHO guidelines on preventing early pregnancy and poor reproductive outcomes among adolescents in developing countries. *J Adolesc Health.* 52:517–22.
- [7] Lee D (2010). The early socioeconomic effects of teenage childbearing: a propensity score matching approach. *Demogr Res* 2010;23.
- [8] Horgan RP., and Kenny LC (2007). Management of teenage pregnancy. *Obstet Gynaecol.* 9:153–8.
- [9] National Association of County & City Health Officials. Meeting the needs of pregnant and parenting teens. Washington: Local Health Department Programs and Services, 2009.
- [10] Hodgkinson S., Beers L., and Southammakosane C (2014). Addressing the mental health needs of pregnant and parenting adolescents. *Pediatrics.* 133:114–22.
- [11] Neal S., Mahendra S., and Bose K (2016). The causes of maternal mortality in adolescents in low and middleincome countries: a systematic review of the literature. *BMC Pregnancy Childbirth.* 16:352.
- [12] Pradhan R., Wynter K., and Fisher J (2015). Factors associated with pregnancy among adolescents in low-income and lower middle-income countries: a systematic review. *J Epidemiol Community Health.* 69:918–924.
- [13] Atuyambe L., Kibira S., Bukonya J., Muhumuza C., Apolot R., and Mulogo E(2015). Understanding sexual and reproductive health needs of adolescents: evidence from a formative evaluation in Wakiso district, Uganda. *Reprod Health.* 12(1):35
- [14] Mozambique. Ministry of Gender, Child and Social Action. Mozambique's National Strategy for Prevention and Combating of Early Marriage (2016-2019). 2015, Maputo, Government Print.
- [15] Arthur M (2010). Casamento prematuro como violação dos direitos humanos: um exemplo que vem da Gorongosa. *Boletim "Outras Vozes"*, Agosto/Novembro, n.31-32.

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