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Early Detection of Abnormal Future Trends of Adolescent Fertility for Burkina Faso Using Holt's Double Exponential Smoothing Technique

[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 article uses annual time series data of adolescent fertility rate for Burkina Faso 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 are0.9and 0.9respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will continue to decline but remain high throughout the out of sample period. Therefore, we encourage authorities in Burkina Faso to adopt an aggressive approach when addressing the problem of adolescent pregnancies which includes scaling up educational campaigns, creating adolescent friendly clinics, strictly enforce laws that prevent child marriages and solving all socio cultural, demographic and economic issues that lead to unwanted pregnancies among adolescents.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

High absolute numbers of unwanted adolescent pregnancies in Burkina Faso particularly in schools is a cause for concern (AFP, 2016). The country has a low modern contraceptive prevalence rate of 22.8 % and a high unmet need for family planning of 24.2%. The country has one of the highest adolescent birth rates in Sub-Saharan Africa which is approximately 122 births per 1000 girls aged 15-19 years old (Burkina Faso National institute of Statistics and Demography, 2016). The resultant complications associated with these unwanted pregnancies include unsafe abortions, stigmatization and school drop outs (UNICEF, 2013). Although adolescent birth rates have been declining in Burkina Faso over the years, the rates still remain high in the African region and this calls for urgent action in order to reduce the number of teenage pregnancies by implementing effective policies. Therefore, in this paper we propose Holt's linear method to forecast future trends of adolescent fertility rate for Burkina Faso. Forecast results are expected to depict future trends of adolescent fertility and assist policy makers to review current legal instruments that protect sexual and reproductive rights of women and allocate adequate resources towards various programs that are designed to curb child marriages and empower adolescent girls and women.

II. LITERATURE REVIEW

Author (s)	Topic	Objectives	Methodology	Main findings
Monari et al. (2022)	Adolescent fertility and its determinants in Kenya: Evidence from Kenya demographic and health survey 2014	To establish determinants of adolescent fertility in Kenya.	Chi square test	age at first sex, current age, marital status, and contraceptive use are the main determinants of adolescent childbearing
Mutea et al. (2022)	Trends and determinants of adolescent pregnancy: Results from Kenya demographic health	To analyze the trends in prevalence and factors associated with adolescent pregnancy in Kenya	Binary Logistic regression and pooled regression analysis were used to explore factors associated with	Education status, marital status, religion and wealth quintile were associated with adolescent

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	surveys 2003–2014	using data from three national Demographic Health Surveys (2003, 2008/2009, and 2014).	adolescent pregnancy.	pregnancy. Trend analysis shows that there was an overall decreasing trend in adolescent pregnancy between 2003 and 2014.
Seidu (2021)	Factors associated with early antenatal care attendance among women in Papua New Guinea: a population- based cross- sectional study	to assess the prevalence and factors associated with early initiation of ANC among women in Papua New Guinea (PNG	population-based cross-sectional study	The study found a relatively low prevalence of early ANC uptake among women in PNG. The factors associated with early ANC attendance were region of residence, parity, and working status of mothers.
Samandari et al. (2019)	"It is a thing that depends on God": barriers to delaying first birth and pursuing alternative futures among newly married adolescent girls in Niger	To examine the underlying social, individual and structural factors influencing married girls' early first birth and participation in alternative opportunities (such as education or economic pursuits) in Niger.	conducted in-depth interviews	Participants recognized the health benefits of delaying first birth, but stigma around infertility and contraceptive use, desire for children, and belief that childbirth is "God's will" interfere with a girl's ability to delay.
Kumar et al. (2019)	Adolescent Pregnancy and Challenges in Kenyan Context: Perspectives from Multiple Community Stakeholders	to provide a phenomenological account of the mental health challenges and experiences of adolescent new mothers	-grounded theory approach -interviews	Pregnant and parenting adolescents faced several adversities such as social stigma, lack of emotional support, poor healthcare access, and stresses around new life adjustments

III. METHODOLOGY

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

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

Smoothing equation

$S_t = \alpha A_t + (1-\alpha)(S_{t-1} + b_{t-1})$

Trend estimation equation

$b_t = \beta (S_t - S_{t-1}) + (1-\beta) b_{t-1}$

Forecasting equation

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

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**

t is the trend component of the time series

S_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

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

Data Issues

This study is based on annual adolescent fertility rate in Burkina Faso 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.

IV. FINDINGS OF THE STUDY

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	A
Included Observations	61

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Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.258523
Sum Square Error (SSE)	16.492265
Mean Square Error (MSE)	0.270365
Mean Percentage Error (MPE)	-0.013660
Mean Absolute Percentage Error (MAPE)	0.166476

Residual Analysis for the Applied Model

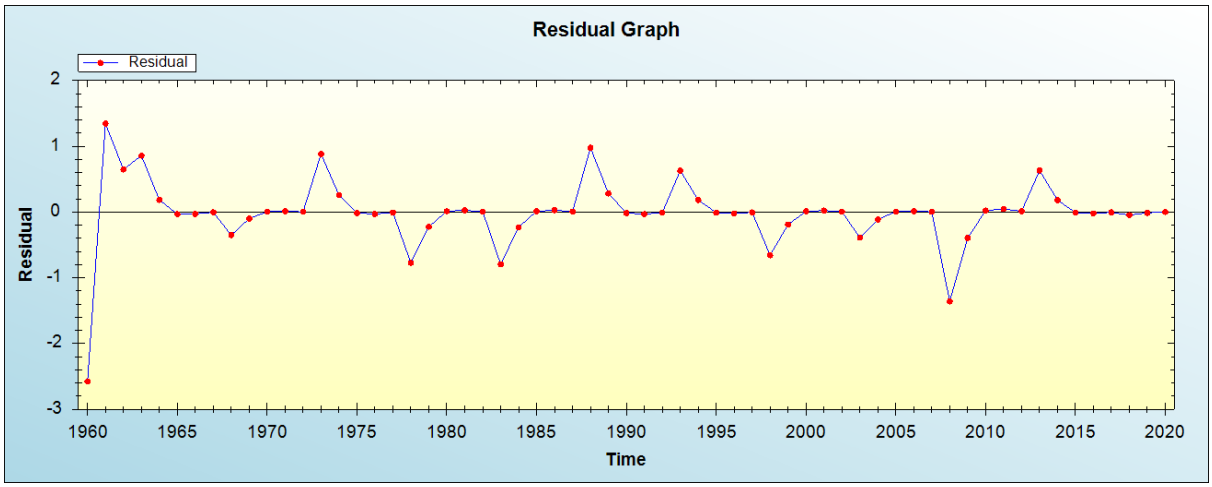

Figure 1: Residual analysis

In-sample Forecast for A

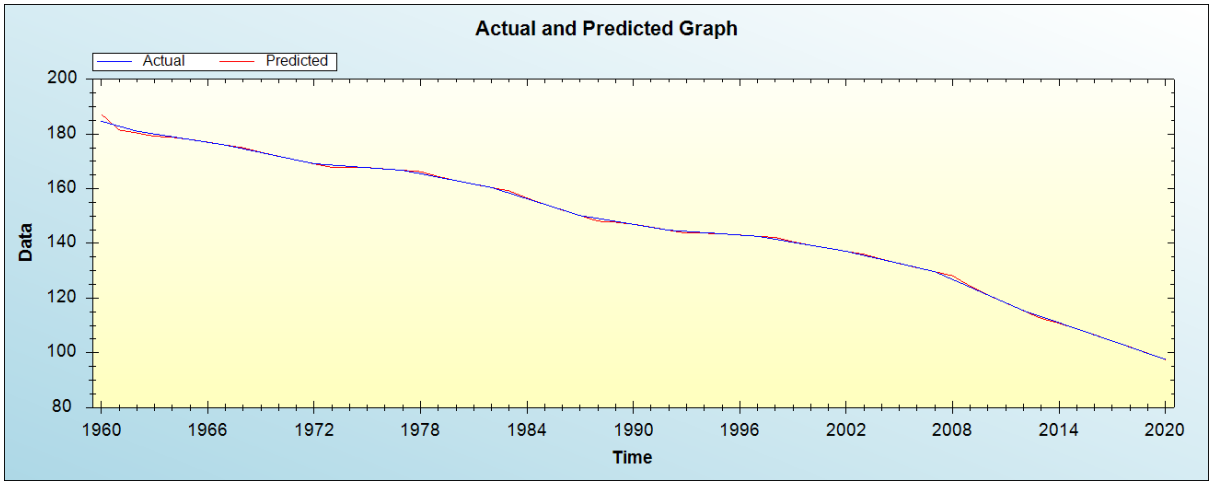

Figure 2: In-sample forecast for the A series

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Actual and Smoothed graph for A series

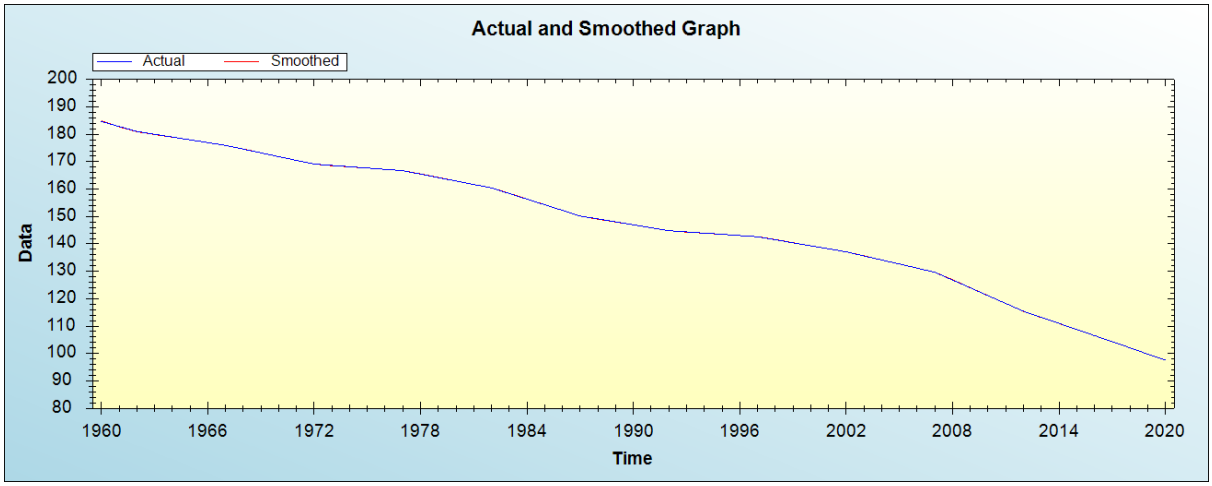

Figure 3: Actual and smoothed graph for A series

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

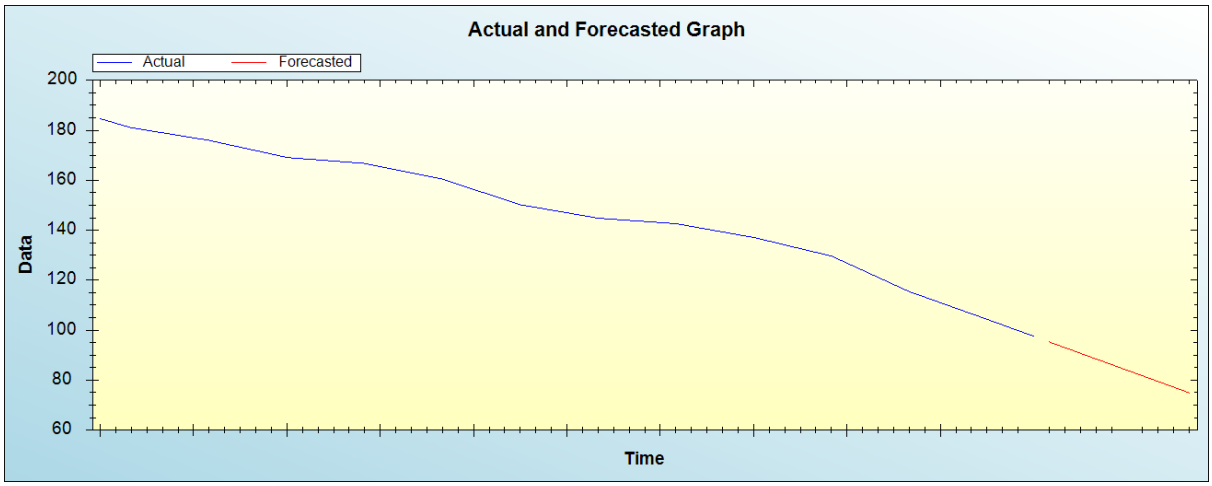

Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	95.2746
2022	93.0100
2023	90.7453
2024	88.4806
2025	86.2159
2026	83.9513
2027	81.6866
2028	79.4219
2029	77.1572
2030	74.8926

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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 will continue to decline but remain high throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

High rates of adolescent pregnancy in Burkina Faso especially in schools is a cause for concern. The resultant complications associated with these unwanted pregnancies include unsafe abortions, stigmatization and school drop outs. Poverty, peer pressure, substance abuse, poor parental guidance and refusal to use contraceptive methods are among the leading causes of pregnancy among adolescents. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Burkina Faso. Our research findings indicate that adolescent fertility will continue to decline but remain high throughout the out of sample period. Therefore, the government must adopt an aggressive approach when addressing the problem of adolescent pregnancies which includes scaling up educational campaigns, creating adolescent friendly clinics, strictly enforce laws that prevent child marriages and solving all socio cultural, demographic and economic issues that lead to unwanted pregnancies among adolescents.

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