

# Solving the Problem of High Adolescent Fertility in the DRC Using Empirical Evidence from Holt’s Double Exponential Smoothing Technique

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**Abstract -** This research article uses annual time series data of adolescent fertility rate for the DRC 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  $\alpha$  and  $\beta$  are 0.9 and 0.3 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 the DRC to allocate more resources towards adolescent health in order to facilitate setting up of adolescent friendly clinics, funding of awareness campaigns and ensuring the availability of medical supplies that are required in the sexual and reproductive health program.

**Keywords:** Exponential smoothing, Forecasting, adolescent fertility rate.

## I. INTRODUCTION

The Democratic Republic of Congo (DRC) is among the poorest countries of the world ranking 178 out of 188 for human development index (UNDP, 2016). Approximately 52 percent of the population is below 15 years of age (MSP, 2014). High teenage or adolescent pregnancies contribute significantly to the high fertility levels (MSP, 2014). In 2019, the modern contraceptive prevalence rate among married women or in union was 11.2 percent, the unmet need for family planning among married women was 40.6 percent and the number of maternal deaths averted by use of contraception was 34 000 (DRC FP 2020). The country has made significant progress towards the reduction of adolescent birth rates over the past decades as a result of various strategies such as family planning services, universal education for all and enacting laws to increase the legal age of marriage or consent to 18 years and supporting developmental programs for women. World Bank data shows that adolescent fertility declined over the years from 188.5 births per 1000 women aged 15-19 years in 1960 to 119 births per 1000 women aged 15-19 years in 2020. This means that teenage pregnancy and child births are a huge challenge in this country. In this paper we propose Holt’s linear method to forecast future trends of adolescent fertility for the DRC and forecast results are expected to inform policy makers in planning, decision making and allocation of resources to sexual and reproductive health programs in the country.

## II. LITERATURE REVIEW

Author	topic	Objectives	Methodology	Findings
Dombola et al. (2021)	Factors influencing contraceptive decision making and use among young adolescents in urban Lilongwe, Malawi: a qualitative study	To assess factors that influence contraceptive decision-making and use among young adolescents aged 10–14 years	qualitative study that used the Theory of Reasoned Action (TRA) model to understand the processes that influence contraceptive decision-making among young adolescents (10–14	contraceptive decision-making is influenced by social factors (individual, interpersonal, society) and adolescents’ perceptions regarding hormonal contraceptives

			years old) in urban Lilongwe	
Njim et al. (2020)	Prevalence of adolescent deliveries and its complications in Cameroon: a systematic review and meta-analysis	To systematically assess the prevalence of adolescent deliveries in the country and its maternal and neonatal outcomes.	Systematic review	The prevalence of adolescent deliveries in Cameroon is high.
Nelago Indongo (2020)	Analysis of Factors Influencing Teenage Pregnancy in Namibia	To assess spatial differentials of factors influencing teenage pregnancy in Namibia to help policy makers, program managers and health care authorities make better targeted decisions in planning and problem solving.	Multilevel binary logistic regression	Significant spatial association with contraceptive use and age at first sexual debut.
Amadi Stella (2019)	Teenage pregnancy and its influence on secondary education in Nigeria	To analyze the influence of teenage pregnancy on secondary school education in Nigeria using a case study of Obio-Akpor L.G.A, Rivers State.	Cross-sectional study	teenage pregnancy significantly impacted school enrollment, that a significant percentage of teenagers are pregnant before 15, lack of education of parents and teenagers increased the probability of teenage pregnancy, poverty and drug abuse increased the likelihood of teenage pregnancy while teenager mothers 61.2 percent likely to withdraw from school because of the financial obligations of being a mother
Egbe et al. (2015)	Prevalence and outcome of teenage hospital births at the buea health district,	To determine the prevalence of hospital teenage deliveries in the	retrospective study of case files of patients who gave birth in the Buea	Maternal factors like age and gravidity were discovered to lead

	South West Region, Cameroon	Buea Health District and compares the delivery outcomes and demographic characteristics between pregnant teenage mothers (14–19) and adult mothers (20–29 years). –to identify factors associated with adverse pregnancy outcomes.	Regional Hospital during the period 2009–2012	to adverse fetal outcomes in adolescents, while maternal factors like age, unemployment, marital status and gravidity were, for their part, directly responsible for adverse maternal outcomes in adolescents
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### III. METHODOLOGY

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

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

$D_t$  is the actual value of adolescent fertility rate at time t

$\varepsilon_t$  is the time varying **error term**

$\mu_t$  is the time varying mean (**level**) term

$\rho_t$  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  $t$

$\alpha$  is the exponential smoothing constant for the data

$\beta$  is the smoothing constant for trend

$f_{t+h}$  is the  $h$  step ahead forecast

$b_t$  is the slope of the trend at time  $t$

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

### Data Issues

This study is based on annual adolescent fertility rate in the DRC 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	D
Included Observations	61
Smoothing constants	
Alpha ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.300
Forecast performance measures	
Mean Absolute Error (MAE)	1.133305
Sum Square Error (SSE)	406.250016
Mean Square Error (MSE)	6.659836
Mean Percentage Error (MPE)	-0.002919
Mean Absolute Percentage Error (MAPE)	0.702454

### Residual Analysis for the Applied Model

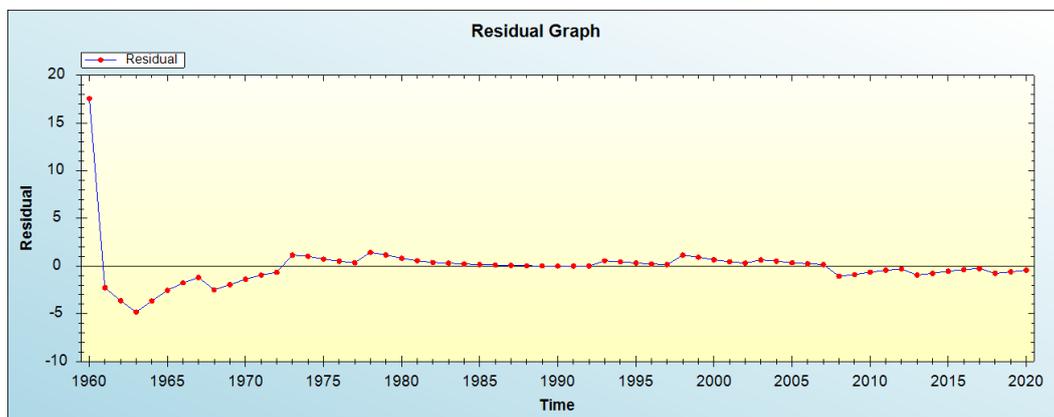


Figure 1: Residual analysis

In-sample Forecast for D

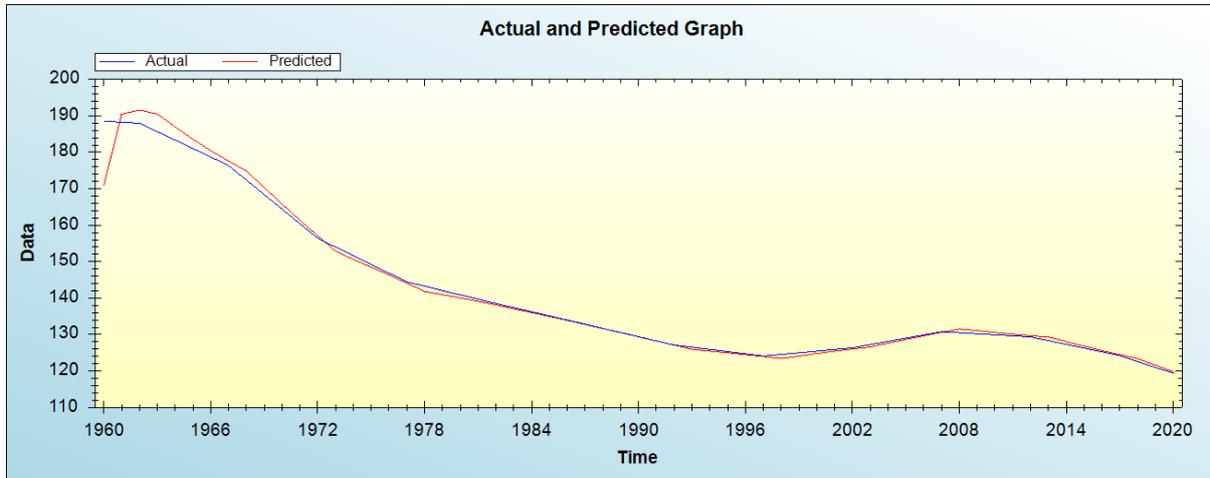


Figure 2: In-sample forecast for the D series

Actual and Smoothed graph for D series

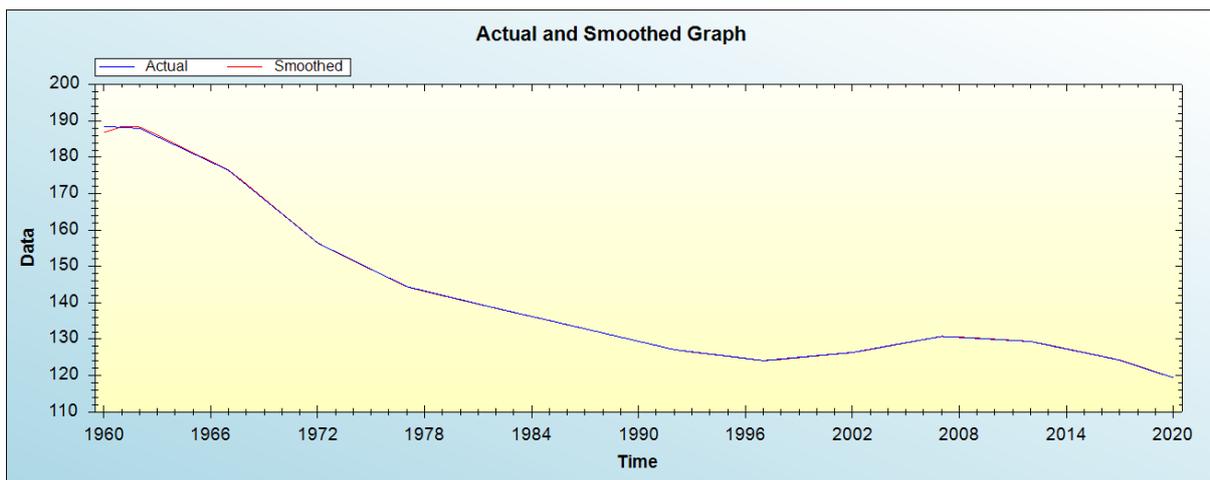


Figure 3: Actual and smoothed graph for D series

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

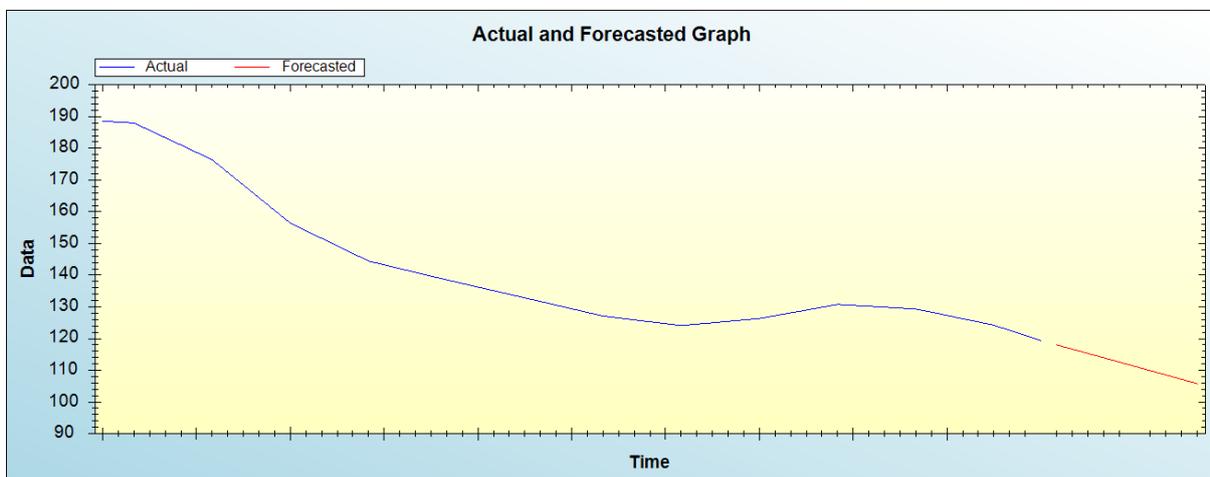


Figure 4: Out-of-sample forecast for D: actual and forecasted graph

Out-of-Sample Forecast for D: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Predicted adolescent fertility rate
2021	118.0564
2022	116.6933
2023	115.3302
2024	113.9670
2025	112.6039
2026	111.2408
2027	109.8777
2028	108.5145
2029	107.1514
2030	105.7883

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 decline but remain very high throughout the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

The Democratic Republic of Congo has made significant progress towards the reduction of adolescent birth rates over the past decades as a result of various strategies such as family planning services, universal education for all and enacting laws to increase the legal age of marriage or consent to 18 years and supporting developmental programs for women. Adolescent fertility gradually declined during the previous years from 188.5 births per 1000 women aged 15-19 years in 1960 to 119 births per 1000 women aged 15-19 years in 2020. This study applied the double exponential smoothing technique to forecast future trends of adolescent fertility for the DR Congo. Our study results revealed that adolescent fertility will continue to decline but remain very high throughout the out of sample period. Therefore, we encourage the government to allocate more resources towards adolescent health in order to facilitate setting up of adolescent friendly clinics, funding of awareness campaigns and ensuring the availability of medical supplies that are required in the sexual and reproductive health program.

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