

# Tracking Future Trends of Adolescent Fertility for St Vincent and the Grenadines Using Holt's Linear Method

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**Abstract -** This research paper uses annual time series data of adolescent fertility rate for St Vincent and the Grenadines 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 0.4 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 the country to enforce laws that safeguard sexual and reproductive health rights of women, promote girl child education and provide accessible and affordable adolescent health services.

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

## I. INTRODUCTION

According to the United Nations, an adolescent is regarded as an individual who falls within the ages of 13-19 years (UNFPA, 2013). Adolescent pregnancy occurs when this female individual gets pregnant. Teenage pregnant mothers are likely to encounter greater risks of complications during pregnancy and child birth (Ganchimeg *et al.* 2014; WHO, 2014; Chandra-Mouli *et al.* 2013). Adolescent pregnancy is strongly linked to a number of adverse health outcomes such as preterm delivery and/or with low birth weight, anemia, antepartum hemorrhage, preeclampsia and high rates of cesarean sections which in turn have been associated with higher maternal mortality rates. (Woog & Kagesten, 2017; Margret, 2015; Glassman *et al.* 2012; Tebeu *et al.* 2012). Previous studies have revealed that teenage pregnancy can be attributed to poverty, lack of access to education, risky behaviors that lead to poor health outcomes, peer influence, incorrect condom use, inadequate sexual and reproductive health knowledge and lack of parental guidance (Mushwana *et al.* 2015; Ahorlu *et al.* 2015; Yidana *et al.* 2015; Kumi-Kyeremeet *et al.* 2014; Ahlberget *et al.* 2001; Adinma *et al.* 1999). Going to school becomes difficult for the teenage mother due to stigmatization and social rejection resulting in reduced economic opportunities, earnings and maintenance of financial security throughout their lifetime, which in turn ends up perpetuating an intergenerational cycle (UNFPA, 2013). Evidence shows that in Caribbean countries, pregnant teenagers are expelled from school and in South American countries pregnant school going girls are pressured to leave school even though official guidelines recommend and should continue to support their education (Kennedy, 2017). The government of St Vincent and the Grenadines has made significant progress in the reduction of adolescent fertility over the past decades. However, there is need to revisit existing policies and reconfigure them so that they effectively address the problem of teenage pregnancy in the country.

The aim of this paper is to model and forecast future trends of adolescent fertility in the country using the double exponential smoothing technique. The findings will inform policy, planning and allocation of resources to teenage pregnancy prevention programs.

## II. METHODOLOGY

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

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

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

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

$A_t$  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 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 St Vincent and the Grenadines 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 ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.400
Forecast performance measures	
Mean Absolute Error (MAE)	1.005379
Sum Square Error (SSE)	335.670715
Mean Square Error (MSE)	5.502799
Mean Percentage Error (MPE)	0.168374
Mean Absolute Percentage Error (MAPE)	0.736831

Residual Analysis for the Applied Model

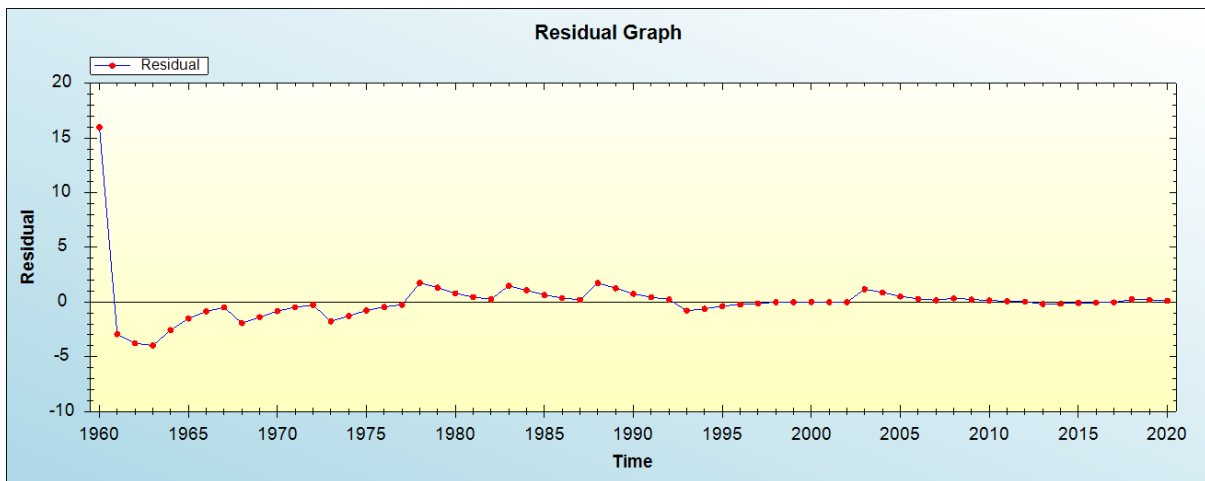


Figure 1: Residual analysis

In-sample Forecast for A

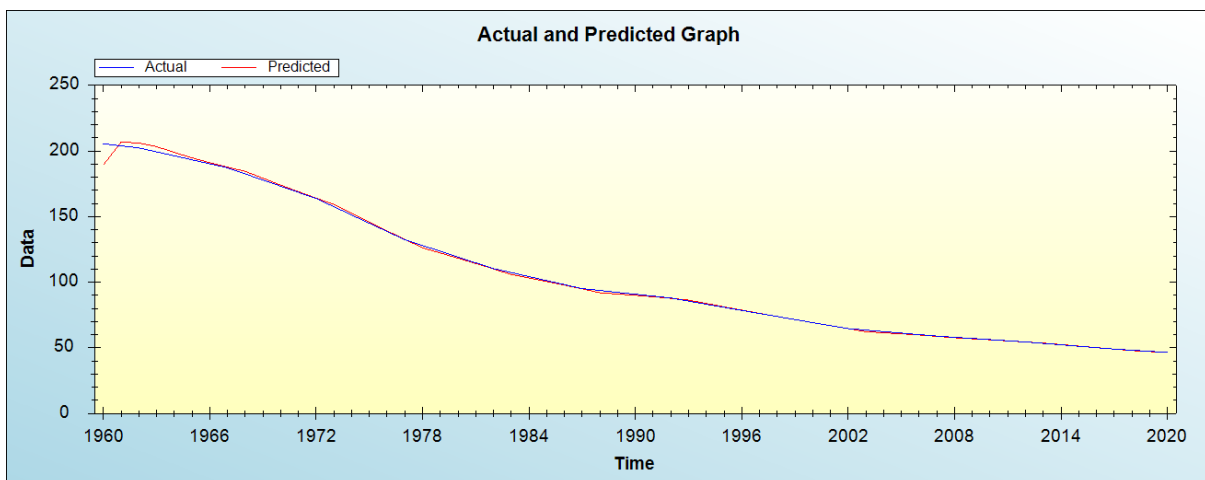


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

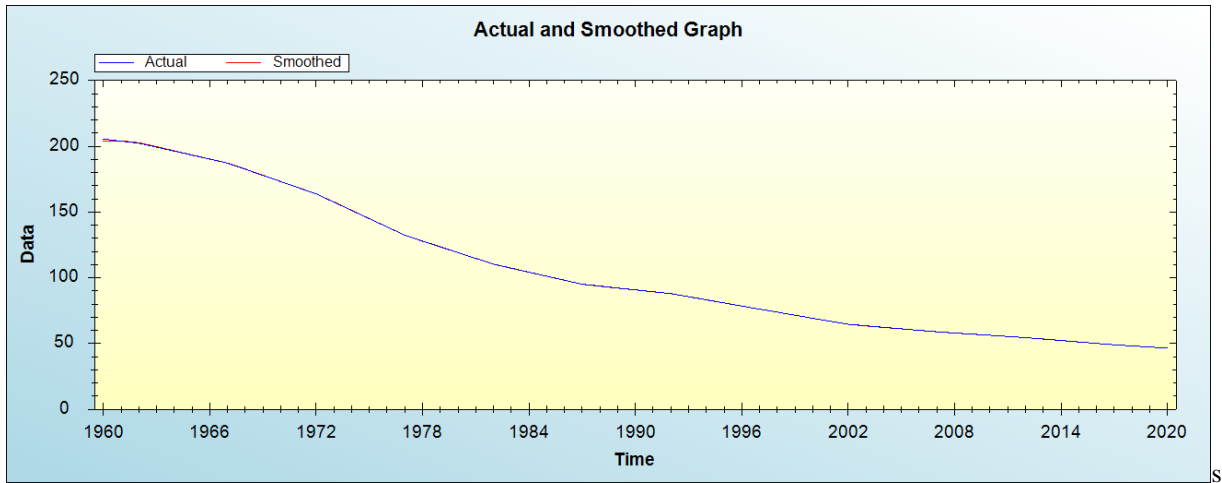


Figure 3: Actual and smoothed graph for A series

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

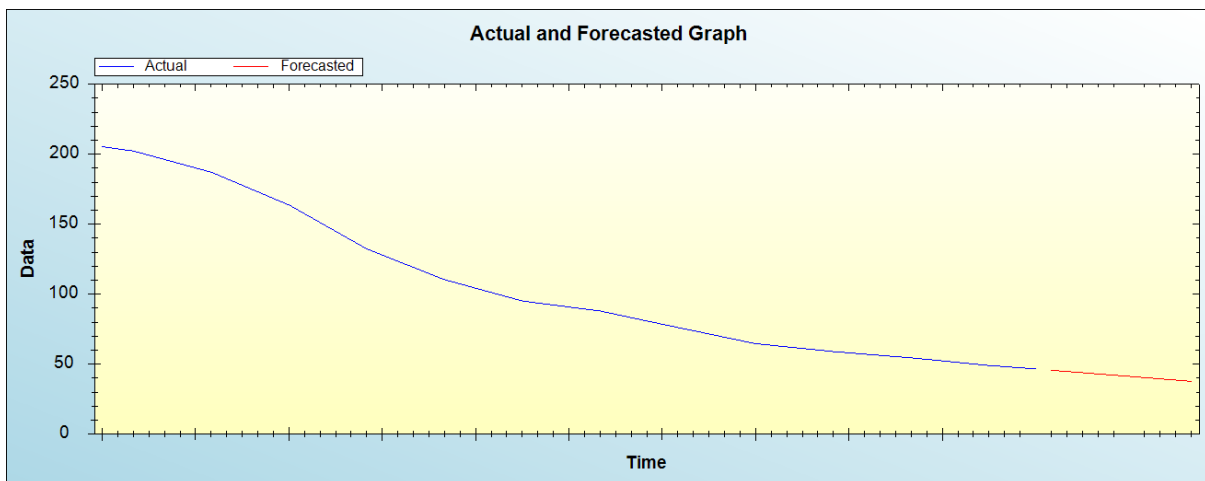


Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	45.6333
2022	44.7486
2023	43.8639
2024	42.9793
2025	42.0946
2026	41.2099
2027	40.3253
2028	39.4406
2029	38.5559
2030	37.6713

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

Adolescent fertility in St Vincent and the Grenadines has been on a downward path over the years as a result of multiple interventions such as use of modern contraceptive methods, increase in girl child educational level and SRH knowledge levels among teenagers. In this study we applied Holt's double exponential smoothing technique to forecast adolescent fertility for St Vincent and the Grenadines. Findings of this piece of work revealed that adolescent fertility will continue to decline throughout the out of sample period. Therefore, we encourage authorities in this country to enforce laws that safeguard sexual and reproductive health rights of women, support girl child education and provide accessible and affordable adolescent health services.

#### REFERENCES

- [1] Kennedy D (2017). Echidna Global Scholars Program Jamaica's Policy for the School Reintegration of School-Age Mothers How Are We Doing and Where Do We Need to Go?; 2017
- [2] United Nations Population Funds (UNFPA). Adolescent pregnancy: A review of the evidence; 2013.
- [3] Glassman A., Silverman R., and McQueston K (2012). Adolescent Fertility in Low- and Middle Income Countries: Effects and Solutions. *Cent Glob Dev Work*. 2012: 295.
- [4] Ahorlu C.K., Pfeiffer C., and Obrist B (2015). Socio-cultural and economic factors influencing adolescents' resilience against the threat of teenage pregnancy: a cross-sectional survey in Accra, Ghana. *Reprod Health*. 2015; 12:117.
- [5] Kumi-Kyereme A., Awusabo-Asare K., and Darteh EK (2014). Attitudes of gatekeepers towards adolescent sexual and reproductive health in Ghana. *Afr J Reprod Health*. 18(3):142–53.
- [6] Mushwana L., Monareng L., Richter S., and Muller H (2015). Factors influencing the adolescent pregnancy rate in the Greater Giyani municipality, Limpopo Province - South Africa. *Int J Afr Nurs Sci*. 2015; 2:10–8.
- [7] A Yidana., S.D Ziblim., T.B Azongo., and Abass Y.I (2015). Socio-cultural determinants of contraceptives use among adolescents in northern Ghana. *Public Health Res*. 5(4):83–89.
- [8] Adinma J.I., Agbai A.O., Okeke., and Okaro J.M (1999). Contraception in teenage Nigerian school girls. *Adv Contracept*. 15(4):283–91.
- [9] Ahlberg B.M., Jylkas E., and Krantz I (2001). Gendered construction of sexual risks: implications for safer sex among young people in Kenya and Sweden. *Reprod Health Matters*. 9(17):26–36.
- [10] Woog V., and Kagesten A (2017). The sexual and reproductive health needs of very young adolescents in developing countries. *Guttmacher Inst*. <https://www.guttmacher.org/fact-sheet/srh-needs-very-young-adolescents-in-developing-countries>.
- [11] Margret Greene T.M (2015). The case for investing in research to increase access to and use of contraception among adolescents. 2015;1–80. [https://www.usaid.gov/sites/default/files/.../RH\\_adol\\_contraception\\_rpt\\_508.pdf](https://www.usaid.gov/sites/default/files/.../RH_adol_contraception_rpt_508.pdf).
- [12] Tebeu P.M., Fomulu J.N., Khaddaj S., De B.L., Delvaux T., and Rochat C.H (2012). Risk factors for obstetric fistula : a clinical review. *Int Urogynecol*. 23:387–94
- [13] World Health Organization (2014). Adolescent pregnancy factsheet. <http://www.who.int/mediacentre/factsheets/fs364/en/>
- [14] Ganchimeg T., Ota E., 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.
- [15] Chandra-Mouli V., Camacho A.V., 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.

**Citation of this Article:**

Smartson. P. NYONI, Thabani NYONI, “Tracking Future Trends of Adolescent Fertility for St Vincent and the Grenadines Using Holt’s Linear Method” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 389-394, February 2023. Article DOI <https://doi.org/10.47001/IRJIET/2022.702065>

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