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Adolescent Fertility Forecasting for Suriname Using Holt's Double Exponential Smoothing Technique

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***Abstract* - This study uses annual time series data of adolescent fertility rate for Suriname 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 0.7 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 Suriname to focus on improving the quality and accessibility of adolescent health services, promote respect of sexual and reproductive health rights of women and girls, promote girl child education, fund empowerment programs for youths and scale up awareness campaigns among communities.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

According to the World Bank, Suriname has recorded a steady decline of adolescent fertility over the past decades. Suriname's maternal mortality ratio (MMR) is one of the highest in the Latin American Caribbean region and most of these deaths are preventable (Lachmi *et al.* 2021). Ending preventable maternal and under five deaths is a global health priority (UN, 2016; UN, 2015).In the case of Suriname maternal deaths are due to obstetric problems such as unsafe abortions and postpartum cardiomyopathy (Lachmi *et al.* 2021). Adolescent pregnancy is among the leading causes of maternal mortality worldwide (WHO, 2020; Ajala, 2014). Complications happening during pregnancy and child birth emanate from problems such as anemia, antepartum haemorrhage, postpartum haemorrhage, preterm delivery, low birth weight and malnutrition (Woog & Kagesten, 2017). Poverty reduction and improvement in the education system are recognized as effective interventions which can help prevent and reduce teenage pregnancy especially in low and middle income countries (Herrera *et al.* 2019). In addition, addressing gender imbalances and eliminating harmful practices that promote child marriages will have a great impact on curbing adolescent pregnancy (UN, 2016; UN, 2015; UN, 1995). The 3rd sustainable development goal target 3.7 focuses on the improving accessibility and affordability of sexual and reproductive health services especially to adolescents (UN, 2020; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015). Comprehensive SRH services that must be offered to adolescents and other eligible people include comprehensive sexuality education, HIV testing and counselling services, family planning methods, antenatal and postnatal services.

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

II. LITERATURE REVIEW

Author(s)	Topic	Objectives	Methodology	Main findings
Moyano et al. (2021)	Self-Esteem, Attitudes toward Love, and Sexual Assertiveness among Pregnant Adolescents	To analyze the relationship between self-esteem, attitudes toward love, and sexual assertiveness among pregnant and non-pregnant teenagers.	Cross-sectional study	There were differences in self-esteem, attitudes toward love, and sexual assertiveness between pregnant and non-pregnant adolescents.

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Arau ´z-Ledezma (2019)	Behavioral and environmental influences on adolescent decision making in personal relationships: a qualitative multi-stakeholder exploration in Panama	To explore the perceptions and attitudes of different societal actors, namely governmental employees, NGO employees, academics, members from religious groups, teachers and parents.	Qualitative study	Analysis revealed five central themes, i.e. perceptions towards gender roles and equality, adolescents' love (sexual) relationships, capacity needs regarding prevention of risk behaviours and the role of education, comprehensive sexuality education in schools and the potentiality of SEL in the education system
de Botero et al. (2019)	Family life stories among teenage mothers: Qualitative study conducted at HOSPITAL ENGATIVÁ ESE in Bogota, Colombia	To get an insight into the structure and dynamics of the original families of five teenage mothers through their life stories and their own experiences.	Qualitative study with a narrative approach	pregnant adolescents live in the midst of families with unfavorable structure and dynamics that prevent the nuclear family from responding appropriately to teenage pregnancy
Cuberos et al. (2019)	School Dropout of Adolescent Mothers in a Colombian-Venezuelan Border	To compare school dropout of adolescent mothers in the Venezuelan-Colombian border, between the Táchira State and the North of Santander Department.	Quantitative methodology	In the abandonment of studies, the sociological age influences by an advance of roles not linked to chronological age
Rizvi et al. (2019)	Factors Influencing Unintended Pregnancies amongst Adolescent Girls and Young Women in Cambodia	to identify sociodemographic factors potentially associated with unintended pregnancies	-Social ecological model - multiple logistic regression	The burden of unintended pregnancies is associated with young age, multiparity, history of abortions, unemployment, and low autonomy for accessing healthcare.

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III. METHODOLOGY

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

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

$0<\beta<1$

Trend estimation equation

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

Forecasting equation

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

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

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 Suriname 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.

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IV. 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	0.700
Forecast performance measures	
Mean Absolute Error (MAE)	0.510318
Sum Square Error (SSE)	91.322737
Mean Square Error (MSE)	1.497094
Mean Percentage Error (MPE)	0.035670
Mean Absolute Percentage Error (MAPE)	0.417230

Residual Analysis for the Applied Model

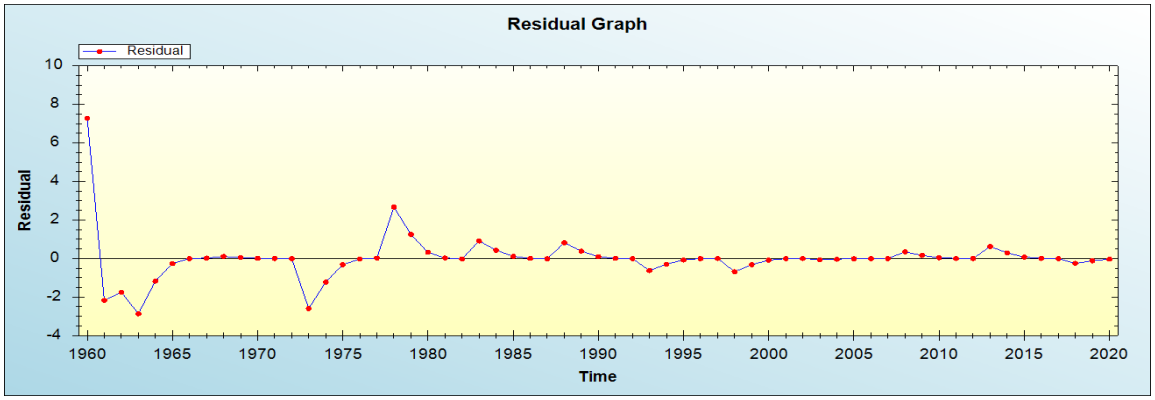

Figure 1: Residual analysis

In-sample Forecast for A

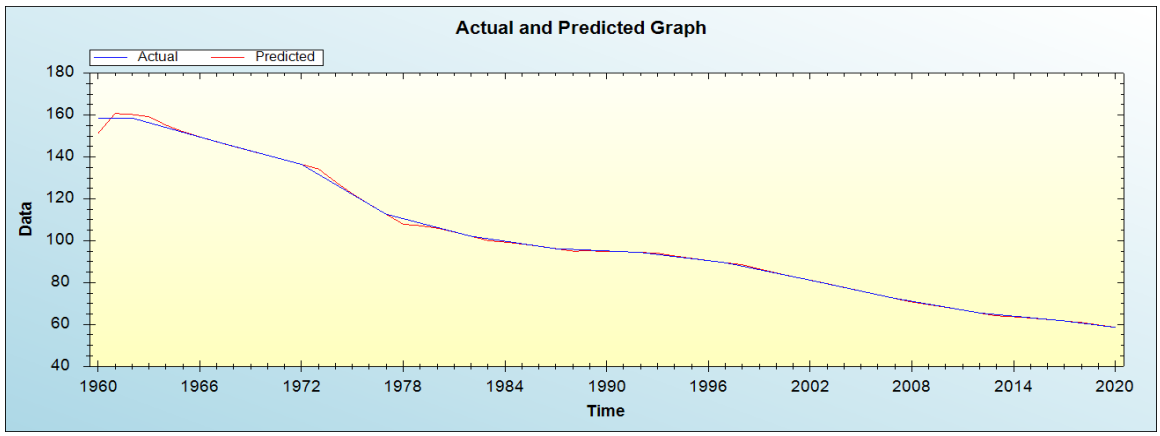

Figure 2: In-sample forecast for the A series

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Actual and Smoothed graph for A series

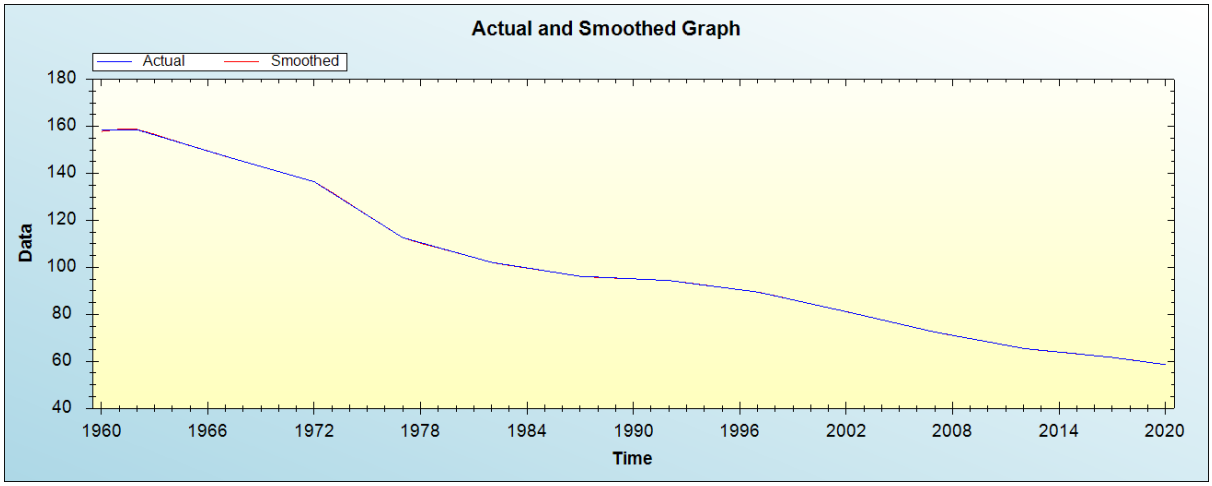

Figure 3: Actual and smoothed graph for A series

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

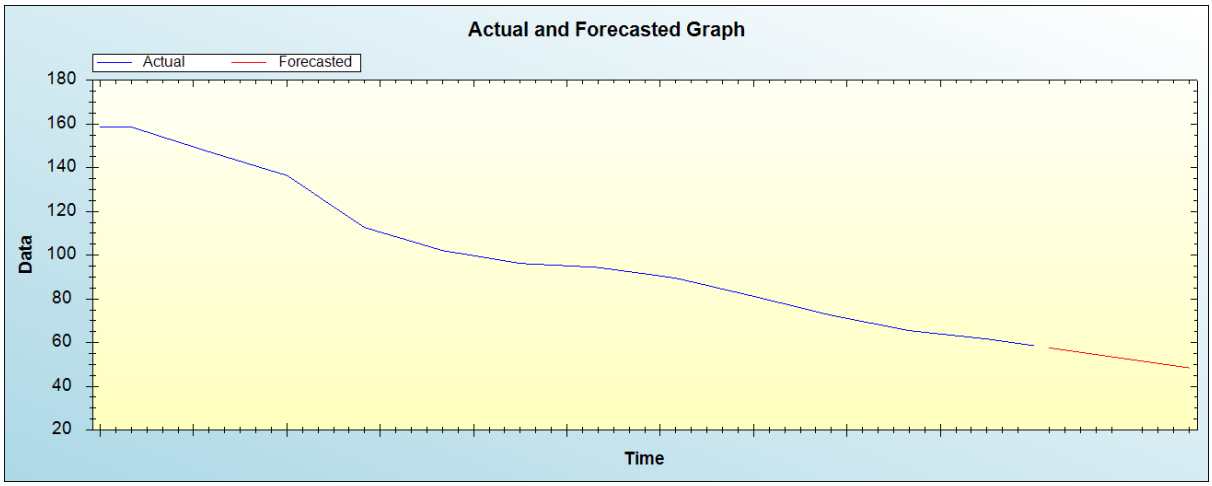

Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	57.5958
2022	56.5798
2023	55.5638
2024	54.5478
2025	53.5318
2026	52.5158
2027	51.4998
2028	50.4838
2029	49.4678
2030	48.4518

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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 rate will continue to decline throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Suriname's maternal mortality ratio (MMR) is one of the highest in the Latin American Caribbean region and most of these maternal deaths are avoidable. The World Bank revealed that Suriname recorded a steady decline of adolescent fertility during the previous decades reflecting the impact of government interventions. Low economic status, low educational level, substance abuse and adherence to social norms are among the factors that influence teenage pregnancy in this country. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Suriname. Research findings indicated that adolescent fertility will continue on a downward path throughout the out of sample period. Therefore, we encourage authorities in Suriname to focus on improving the quality and accessibility of adolescent health services, promote respect of sexual and reproductive health rights of women and girls, promote girl child education, fund empowerment programs for youths and scale up awareness campaigns among communities.

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