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# Forecasting Adolescent Fertility for Argentina Using the Double Exponential Smoothing Technique

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***Abstract* - This research article uses annual time series data of adolescent fertility rate for Argentina from 1960 to 2020 to predict future trends of adolescent fertility over the period 2021 to 2030. The study utilizes Holt's linear exponential smoothing model. The optimal values of smoothing constants α and β are0.9 and0.5 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 Argentina to address socio-cultural, economic and demographic factors that drive unwanted pregnancies among adolescents.**

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

## I. INTRODUCTION

Low and middle income countries are lagging behind in terms of reduction of unwanted pregnancies especially among adolescent girls. High rates of unintended pregnancies and new HIV infections among adolescent girls and young women poses a threat to the achievement of the 3rd sustainable development goal which aims to substantially reduce maternal mortality to less than 70 per 100 000 and under five mortality to as low as 25 deaths per 1000 live births (Aventin *et al*. 2021). Worldwide approximately 170 000 adolescents aged 10-19 years were newly infected with HIV in 2019 raising alarm in many developing countries where there is a dual epidemic of HIV and TB (UNICEF, 2020). It is worrisome to note that 19% of adolescent girls become pregnant by the time they reach 19 years of age (UNICEF, 2016) and 50% of inpatient deaths among females aged 15 yrs. and above are as are as a result of complications following unsafe abortions (Mosaase & Tiebere1996).Under the 3rd sustainable development goal all UN member countries are mandated to provide universal health coverage leaving no one and no place behind (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF,2018; UN, 2015; UN, 2016). SDG-3 target 3.7 focuses on the provision of quality and affordable sexual and reproductive health services including adolescent SRH services. Many researchers identified lack of adequate resources in low and middle income countries as a major setback for the provision of comprehensive SRH services as constant mass exodus of health workers for greener pastures and shortage of medical supplies takes its toll. Economic challenges are fueling the situation as many women leaving in the rural areas have to walk long distances to access basic family planning services (Honda*et al*.2011; Sharp &Kruse,2011). Therefore UN member countries should come up with strategies that will address various issues that hinder the successful implementation of sexual and reproductive health programs especially in developing countries.

This paper attempts to depict future trends of adolescent births (Adolescent fertility) in the country by applying the double exponential smoothing technique. Forecast results are envisioned to guide policy making and allocation of resources to SRH programs across the country. The results will form a basis for the re-examination of current legal instruments that seek to protect women's sexual and reproductive health rights with the aim of curbing sexual abuse of girls and women.

## II. METHODOLOGY

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

 

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

*Smoothing equation*

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

*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

$\varepsilon_t$ 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 period t

**Data Issues**

This study is based on annual adolescent fertility rate in Argentina 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 (α) for data | 0.900 |
| Beta (β) for trend | 0.500 |
| | |
| Forecast performance measures | |
| | |

 

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| | |
|---|---|
| Mean Absolute Error (MAE) | 0.729675 |
| Sum Square Error (SSE) | 148.100395 |
| Mean Square Error (MSE) | 2.427875 |
| Mean Percentage Error (MPE) | 0.028752 |
| Mean Absolute Percentage Error (MAPE) | 1.082136 |

Residual Analysis for the Applied Model

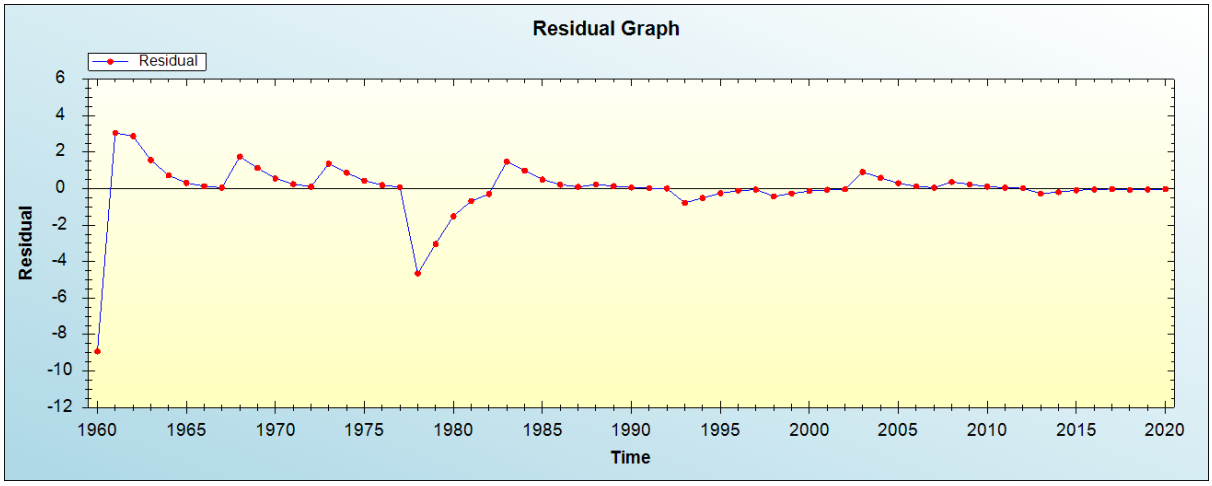


Figure 1: Residual analysis

In-sample Forecast for A

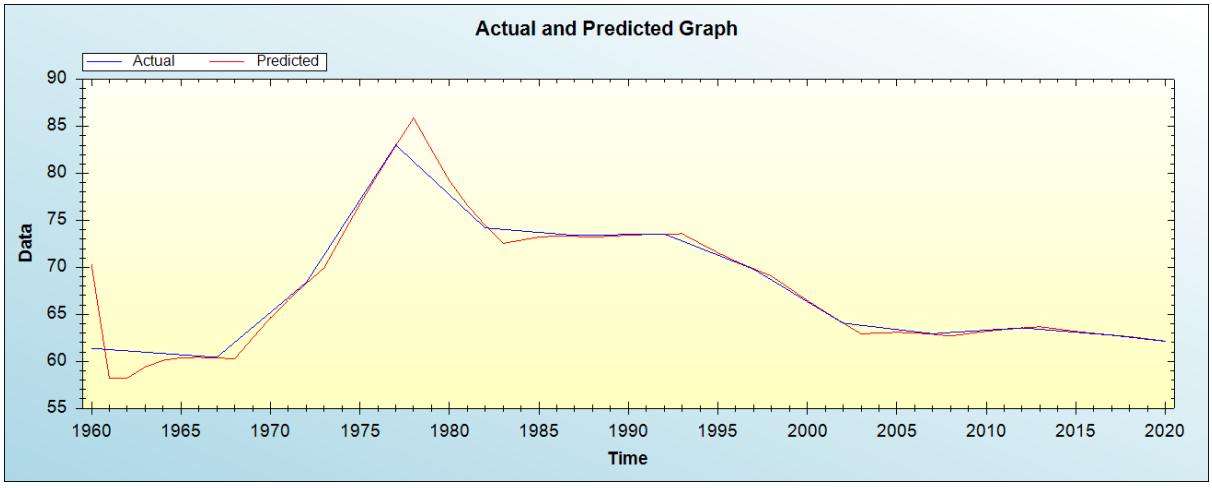


Figure 2: In-sample forecast for the A series

 

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Actual and Smoothed graph for A series

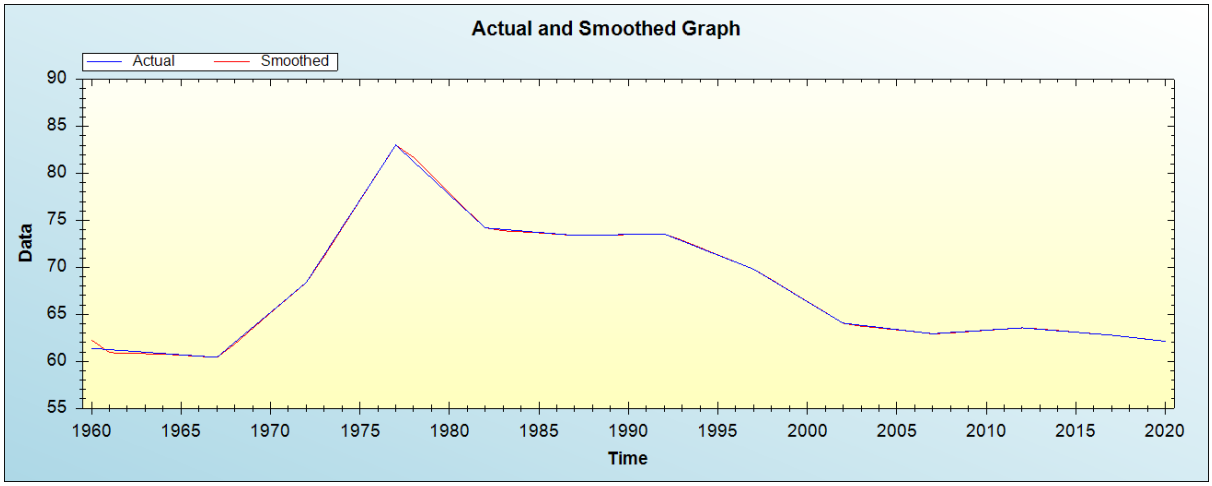


Figure 3: Actual and smoothed graph for A series

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

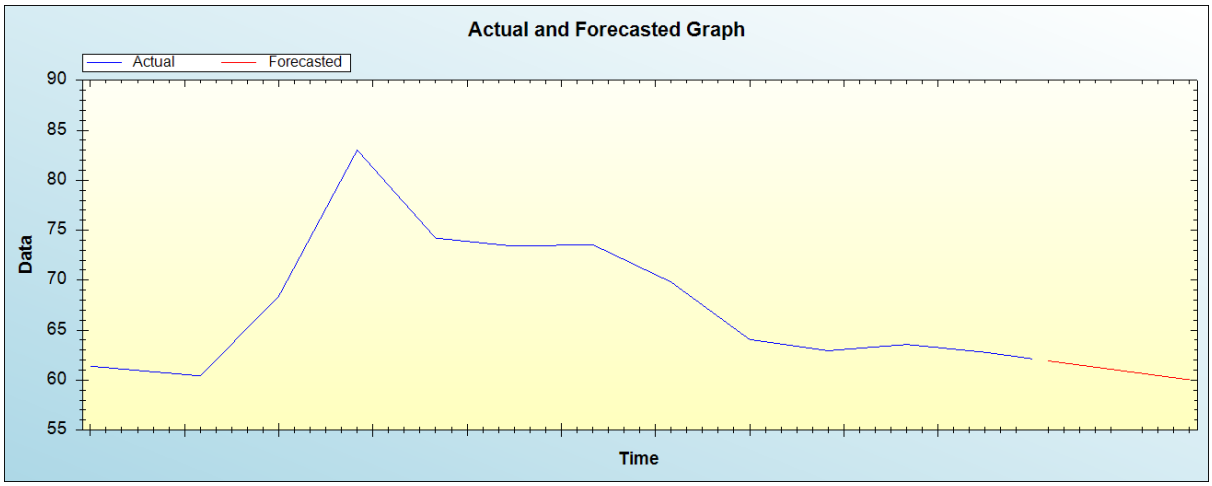


Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| Year | Forecasted adolescent fertility rate |
|---|---|
| 2021 | 61.9247 |
| 2022 | 61.7152 |
| 2023 | 61.5056 |
| 2024 | 61.2961 |
| 2025 | 61.0865 |
| 2026 | 60.8770 |
| 2027 | 60.6675 |
| 2028 | 60.4579 |
| 2029 | 60.2484 |
| 2030 | 60.0388 |

 

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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.

## IV. POLICY IMPLICATION & CONCLUSION

Adolescent birth rates in Argentina significantly contribute to the country's total fertility rate. During the period 1977 to 2020, adolescent fertility has been steadily declining due to improvements in the education sector and the national family planning program. This study proposes Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Argentina. Our study findings indicate that adolescent fertility will continue to decline throughout the out of sample period. Therefore, the government is encouraged to address socio-cultural, economic and demographic factors that drive unwanted pregnancies among adolescents.

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