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Estimating Future Trends of Adolescent Fertility for Colombia Using Holt's Double Exponential Smoothing Technique

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***Abstract* - This study uses annual time series data of adolescent fertility rate for Colombia 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 are0.9 and0.5 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility rate will continue to decline throughout the out of sample period. Therefore, the Colombian government should aim to substantially reduce adolescent births by addressing major drivers of adolescent pregnancies such as socio-cultural, economic and demographic factors.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

In low and middle income countries, many researchers identified multiple factors as causes of teenage pregnancy, top among them is non-use of modern methods of contraception, social norms, poverty, peer pressure, lack of SRH information, delinquency, gender-based violence, gender inequalities, alcohol and drug abuse and poor parental care (WHO, 2018; Joyce *et al.* 2017; Cau, 2015; Bearinger *et al.* 2007;Pettifor*et al.* 2005). Other authors revealed that limited education, early sexual activity, increased access to social media and pornographic sharing, cross-cultural influences and decreased adult supervision have led to early initiation of sexual activity among adolescents (Joesephine & Premraj, 2016; Rachakonda *et al.* 2014; OMS, 2012; Edgardh, 2007; Nour, 2006; Bonell, 2005; Vikat, 2002).Adolescent girls aged 15–19yearsare two times more at risk of dying during pregnancy or childbirth than women 20 years of age or older. In addition, girls below 15 years of age are five times more likely to die during pregnancy or childbirth than women 20 years of age or older (Neal *et al.* 2015;Jewkes*et al.* 2009; Chigona *et al.* 2007). There is an estimated 252millionadolescentgirls living in developing countries,about38millionaresexuallyactiveandthe majority of these girls have an unmet need for family planning. Approximately fifty percent of adolescent pregnancies are unintended (Darroch *et al.* 2019) and WHO estimates revealed that 2 to 4.4million adolescents in developing regions undergo unsafe abortions conducted by unskilled providers under unsafe and unhygienic conditions each year (WHO, 2011). Adolescent fertility in Colombia declined steadily from 137 births per 1000 women aged 15-19 years in 1960 to 63 births per 1000 women aged 15-19 years in 2020 (World Bank, 2020).

This paper applies Holt's double exponential smoothing technique to model and forecast future trends of adolescent fertility in the out of sample period. Findings of this study will depict future trends of adolescent fertility and this will stimulate an appropriate response to the challenge of teenage pregnancy through allocation of adequate resources to teenage pregnancy prevention programs in the country.

II. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Colombia. 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 exponential smoothing technique is expressed as follows:

Model equation

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

Smoothing equation

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

Trend estimation equation

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

Forecasting equation

$f_{t+h} = L_t + \mathrm{h} b_t$

Y_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 Colombia 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	Y
Included Observations	61
Smoothing constants	

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Alpha (α) for data	0.900
Beta (β) for trend	0.500
Forecast performance measures	
Mean Absolute Error (MAE)	1.001666
Sum Square Error (SSE)	343.711435
Mean Square Error (MSE)	5.634614
Mean Percentage Error (MPE)	0.031692
Mean Absolute Percentage Error (MAPE)	0.888918

Residual Analysis for the Applied Model

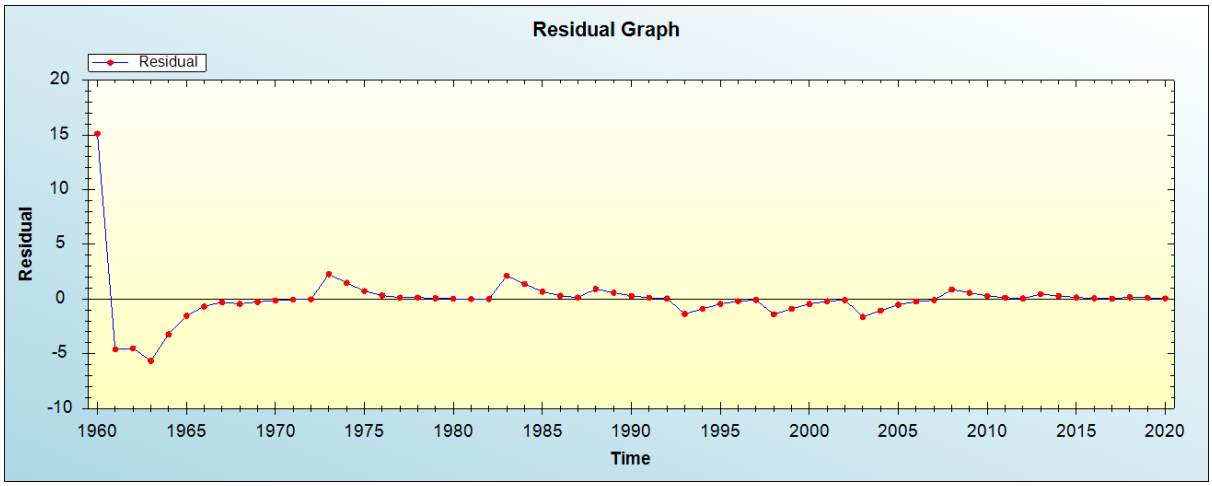

Figure 1: Residual analysis

In-sample Forecast for Y

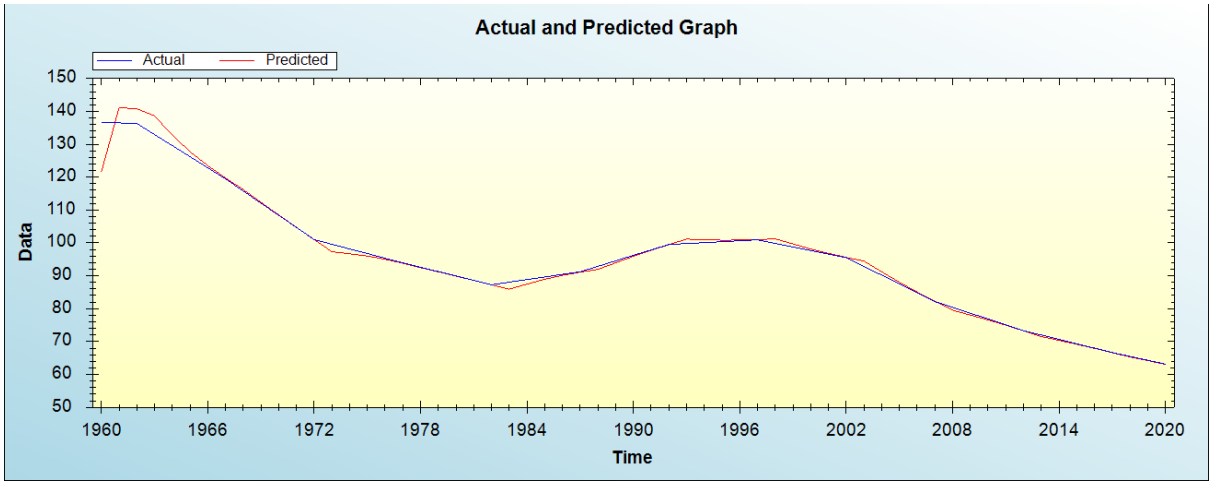

Figure 2: In-sample forecast for the Y series

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Actual and Smoothed graph for Y series

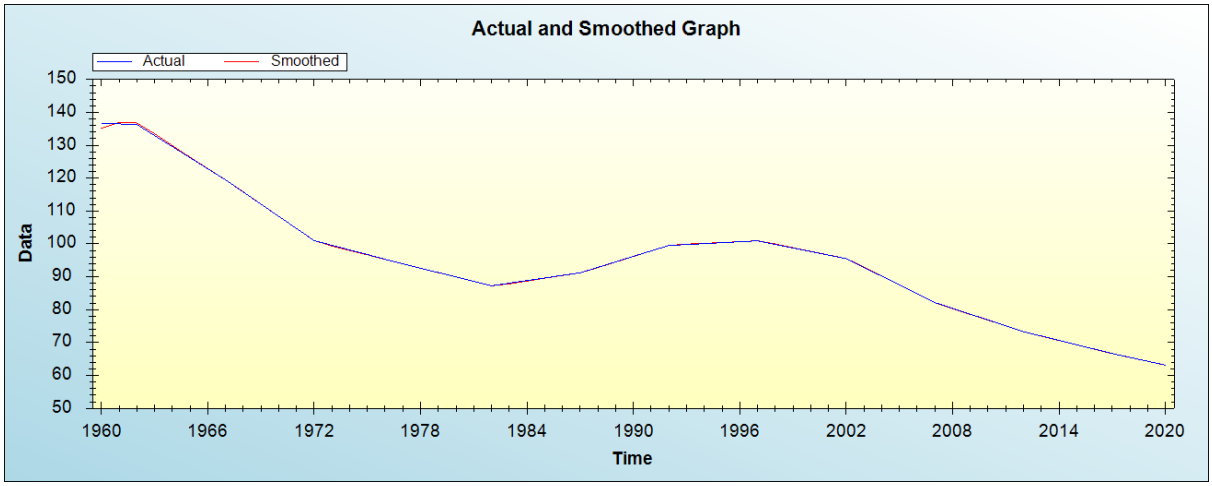

Figure 3: Actual and smoothed graph for Y series

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

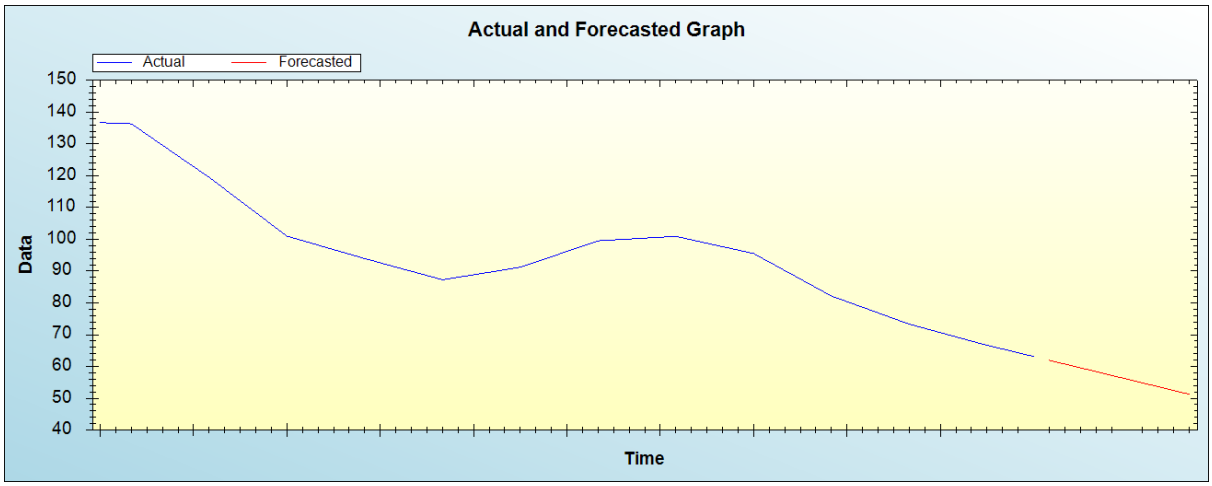

Figure 4: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	61.9505
2022	60.7624
2023	59.5744
2024	58.3863
2025	57.1983
2026	56.0102
2027	54.8222
2028	53.6341
2029	52.4461
2030	51.2581

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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 ratewill continue to decline throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

In low and middle income countries, multiple factors have been found to influence teenage pregnancy, top among them is refusal to use modern methods of contraception, social norms, poverty, peer pressure, lack of SRH information, delinquency, gender-based violence, gender inequalities, alcohol and drug abuse and poor parental care. Prevention of teenage pregnancy is expected to have a positive impact on maternal and child health as this will result in the substantial decline of adverse pregnancy outcomes. This study applied Holt's double exponential smoothing technique to forecast adolescent fertility for Colombia. Our study findings showed that adolescent fertility will continue to decline throughout the out of sample period. Therefore, the Colombian government is encouraged to substantially reduce adolescent births by addressing major drivers of adolescent pregnancies such as socio-cultural, economic and demographic factors.

REFERENCES

[1] Darroch J.E., Woog V., Bankole A., and Ashford LS (2019). Adding It Up: Costs and Benefits of Meeting the Contraceptive Needs of Adolescents. NewYork: Guttmacher Institute; 2016. https://www.guttmacher. Org/sites/default/files/report_pdf/adding-it-up-adolescents report.pdf.

[2] WHO (2018). Family planning_ Contraception WHO.

[3] Joyce C.B., Martinez G.M and Division of vital statistics (2017). National Health Statistics Reports, Number 104.

[4] Cau B.M (2015). Community influences on contraceptive use in Mozambique. Health Place. 31:10–6.

[5] Bearinger L.H., Sieving R.E., Ferguson J., and Sharma V (2007). Global perspectives on the sexual and reproductive health of adolescents: patterns, prevention, and potential. Lancet. 369(9568):1220–31

[6] Pettifor A.E., Rees H.V., Kleinschmidt I., Steffenson A.E., MacPhail C., Hlongwa Madikizela L (2005). Young people's sexual health in South Africa: HIV prevalence and sexual behaviors from a nationally representative household survey. Aids. 19(14):1525–34

[7] Joesephine P., and Premraj, C. (2016) Adolescent Sexual and Reproductive Health. Global Journal for Research Analysis (GJRA), 5, 167-168

[8] Rachakonda L., Rawate, S. and Shiradkar, S. (2014) Teenage Pregnancy. International Journal of Current Medical and Applied Sciences, 4, 2059-2063.

[9] OMS (2012) Early Marriages, Teenage Pregnancies and Young Women. Report of the Secretariat Sixty-Fifth World Health Assembly. Genève

[10] Nour N.M. (2006) Health Consequences of Child Marriage in Africa. Emerging Infectious Diseases, 12, 1644-1649. https://doi.org/10.3201/eid1211.060510

[11] Edgardh K. (2007) Sexual Behaviour and Early Coitarche in a National Sample of 17-Year-Old Swedish Boys. Acta Paediatrica, 91, 985-991. https://doi.org/10.1111/j.1651-2227.2002.tb02889.x

[12] Bonell C. (2005) The Effect of Dislike of School on Risk of Teenage Pregnancy: Testing of Hypotheses Using Longitudinal Data from a Randomized Trial of Sex Education. Journal of Epidemiology & Community Health, 59, 223-230. https://doi.org/10.1136/jech.2004.023374

[13] Vikat A. (2002) Socio demographic Differences in the Occurrence of Teenage Pregnancies in Finland in 1987-1998: A Follow Up Study. Journal of Epidemiology & Community Health, 56, 659-668. https://doi.org/10.1136/jech.56.9.659

[14] Neal S.E., Chandra-Mouli V., and Chou D (2015). Adolescent first births in East Africa: disaggregating characteristics, trends and determinants. Reprod Health. 12(13):13.

[15] Jewkes R., Morrell R., and Christofides N (2009). Empowering teenagers to prevent pregnancy: lessons from South Africa. Cult Health Sex. 11(7):675–88.

[16] Chigona A., and Chetty R (2007). Girls' education in South Africa: special consideration to teen mothers as learners. J Educ Int Dev. 3(1):1–17.

[17] WHO (2011).WHO Guidelines on Preventing Early Pregnancy and Poor Reproductive Outcomes among Adolescents in Developing Countries. Geneva. http://apps.who.int/iris/bitstream/handle/10665/44691/9789241502214_eng.pdf?sequence=1.

[18] World Bank (2020). Adolescent fertility rate women aged 15-19 years.

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