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Forecasting Adolescent Fertility for Panama Using Holt's Linear Method

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***Abstract* - This study employs annual time series data of adolescent fertility rate for Panama 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 but remain high throughout the out of sample period. Therefore, we encourage authorities in Panama to enforce laws that protect sexual and reproductive health rights of women and girls, promote girl child education and fund empowerment programs for youths, and scale up awareness campaigns among communities.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Teenage pregnancy is one of the most important public health challenges affecting both developing and developed countries (Klein, 2005). Low and middle income countries are consistently reporting disappointing trends of teenage pregnancies and births (Fall *et al.* 2015). Existing challenges in developing countries predispose teenage girls to early unprotected sexual activity and pregnancy. Poverty, lack of adequate SRH information, inaccessible reproductive services and social norms are reportedly among the factors that contribute to adolescent pregnancy (Ochako *et al.* 2015; Chandra-Mouli*et al.* 2014;UNICEF, 2014; Wong, 2012; UNICEF, 2011). Persistent droughts as a result of climate change, economic down turn and civil wars tend to worsen the situation. Sub-Saharan Africa has the highest teenage pregnancy rates in the world followed by Latin America and the Caribbean (PAHO, 2010). Worldwide, the leading causes of death among adolescent girls between 15 and 19years old are related to pregnancy and child bearing (Kaphagawani & Kalipeni, 2017; Sedgh *et al.* 2016; PAHO, 2015; Larsson *et al.* 2002).

Previous studies have reported high school dropouts, social rejection and psychological disorders among pregnant teenage girls (Croft *et al*. 2018; Berthelon & Kruger, 2017; Okigbo & Speizer, 2015; Duflo *et al.* 2014). In addition, complications during the antenatal period, at birth and post natal periods were also highlighted (Odimegwu & Mkwananzi, 2016; WHO, 2016; Neal *et al.* 2012). The long term consequences of teenage pregnancy cannot be over emphasized. Repeat pregnancy, obstetric fistula, failure to attain higher educational level leading to getting lower paying jobs and repeating cycle of poverty (Sychareun *et al*. 2018; Gibbs *et al.* 2012).In Panama, adolescents encounter various health problems such as high rates of unwanted teenage pregnancies, sexual violence, STIs and HIV infections. Approximately 30% of all pregnant women in 2017 were adolescents between 10 and 19years old (MINSA, 2017). Previous studies have indicated that1.1 million adolescent girls and boys in Panama have experienced sexual violence (UNICEF, 2017). Adolescents particularly girls, experience such violence to a larger extent (UNAIDS, 2016; Rico & Trucco, 2014).

This paper aims to model and forecast future trends of adolescent fertility in Panama using the double exponential smoothing technique. The findings of this research are expected to depict the future burden of adolescent births in the country. This will inform policy, decisions, planning and resource allocation 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 Panama. 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 linear method is specified as follows:

Model equation

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

Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

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

P_t is the actual 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 Panama 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	P
Included Observations	61

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Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.700
Forecast performance measures	
Mean Absolute Error (MAE)	0.195549
Sum Square Error (SSE)	11.543730
Mean Square Error (MSE)	0.189241
Mean Percentage Error (MPE)	0.013570
Mean Absolute Percentage Error (MAPE)	0.170950

Residual Analysis for the Applied Model

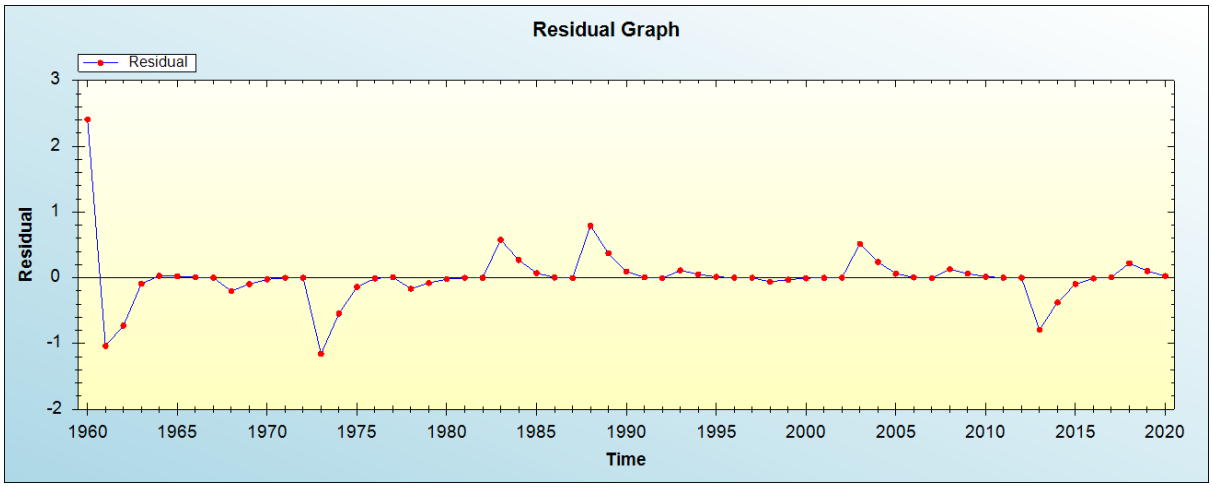

Figure 1: Residual analysis

In-sample Forecast for P

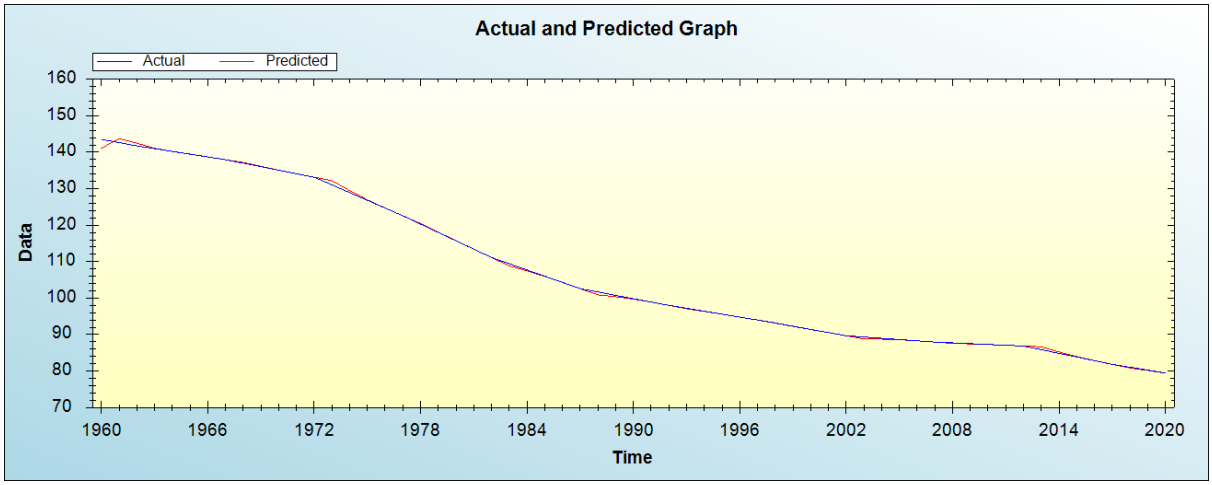

Figure 2: In-sample forecast for the P series

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Actual and Smoothed graph for P series

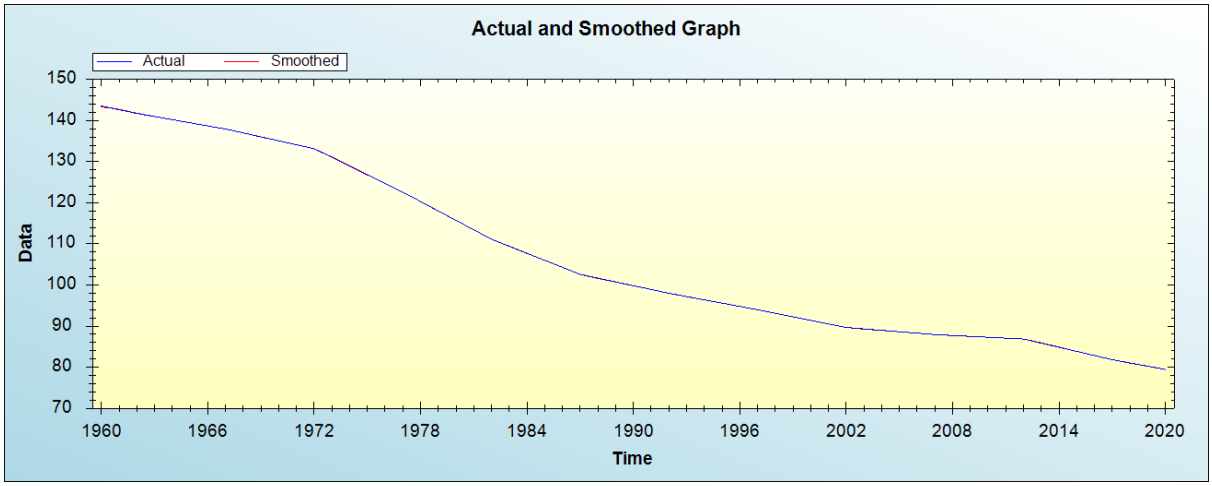

Figure 3: Actual and smoothed graph for P series

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

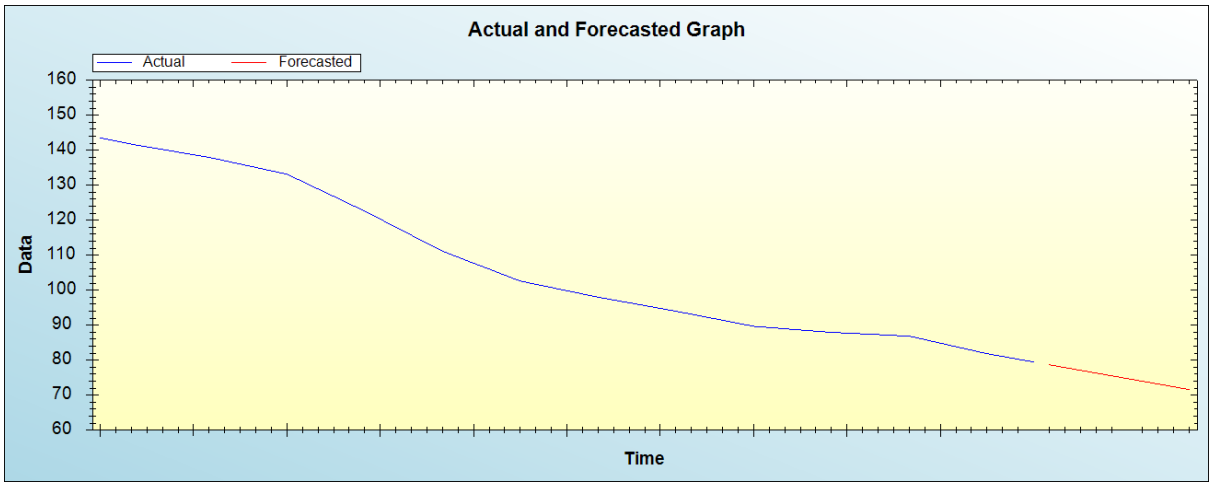

Figure 4: Out-of-sample forecast for P: actual and forecasted graph

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	78.6683
2022	77.8794
2023	77.0906
2024	76.3017
2025	75.5129
2026	74.7240
2027	73.9352
2028	73.1463
2029	72.3575
2030	71.5686

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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 but remain high throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Teenage pregnancy continues to be an important public health problem in Panama. Pregnancy among teenagers in Panama has been associated with adverse sexual and reproductive health outcomes such as STIs, HIV, unsafe abortions and unintended pregnancies. Major drivers of these unintended pregnancies among youths include poverty, lack of education, social norms, peer pressure and sexual violence. The national family planning program has contributed significantly to the decline of adolescent fertility. Adolescent fertility declined from 143 births per 1000 women aged 15-19 years in 1960 to 79 births per 1000 women aged 15-19 years in 2020. This study applies Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Panama. Our study findings indicate that adolescent fertility will continue to decline but will remain high throughout the out of sample period. Therefore, we encourage the government of Panama to enforce laws that protect sexual and reproductive health rights of women and girls, promote girl child education and fund empowerment programs for youths, and scale up awareness campaigns among communities.

REFERENCES

[1] Pan American Health Organization (PAHO) (2010). Adolescent and Youth Regional Strategy and Plan of Action 2010–2018. Washington, DC.

[2] Pan American Health Organization (PAHO) (2015). Violence against Women. Strategy and Plan of Action on Strengthening the Health System to Address Violence against Women. Washington, DC. http://iris.paho.org/xmlui/bitstream/handle/123456789/ 18386/CD549Rev2_eng.pdf? sequence¼7&isAllowed¼y.

[3] Ministerio de Salud de Panama (MINSA). Proportion of Pregnant Teenagers, January to November, 2017. [Proporcio ´n de Adolescentes Embarazadas, Enero a Noviembre, 2017.] Panama, 2017.

[4] Berthelon M., and Kruger DI (2017). Does adolescent motherhood affect education and labor market outcomes of mothers? A study on young adult women in Chile during 1990–2013. Int J Public Health. 2017; 62:293–303.

[5] Fall C.H.D., Sachdev H.S., Osmond C., Restrepo‐Mendez M.C., Victora C., Martorell R (2015). Association between maternal age at childbirth and child and adult outcomes in the offspring: a prospective study in five low‐income and middle‐income countries (COHORTS collaboration). Lancet Glob Health. 2015; 3:e366–77.

[6] Gibbs C.M., Wendt A., Peters S., and Hogue C.J (2012). The impact of early age at first childbirth on maternal and infant health. Paediatr Perinat Epidemiol. 26(Suppl 1):259–84.

[7] Sychareun V., Vongxay V., Houaboun S., Thammavongsa V., Phummavongsa P., Chaleunvong (2018). Determinants of adolescent pregnancy and access to reproductive and sexual health services for married and unmarried adolescents in rural Lao PDR: a qualitative study. BMC Pregnancy Childbirth. 18(1):219.

[8] Neal S., Matthews Z., Frost M., Fogstad H., Camacho AV., and Laski L (2012). Childbearing in adolescents aged 12–15 years in low resource countries: a neglected issue. New estimates from demographic and household surveys in 42 countries. Acta Obstet Gynecol Scand. 91(9):1114–8. https://doi.org/1 0.1111/j.1600-0412.2012.01467.x.

[9] WHO (2016). Global health estimates 2015: deaths by cause, age, sex, by country and by region, 2000-2015. Geneva.

[10] Odimegwu C., and Mkwananzi S (2016). Factors associated with teen pregnancy in sub-Saharan Africa: a multi-country cross-sectional study. Afr J Reprod Health. 20(3):94–107. https://doi.org/10.29063/ajrh2016/v20i3.14.

[11] Klein J.D (2005). Adolescent pregnancy: current trends and issues. Pediatrics. 2005; 116(1):281–6. https://doi.org/10.1542/peds.2005-0999.

[12] UNICEF (2014). Progress and prospects. End Child Marriage Prog Prospect UNICEF. 2014:1-8

[13] Okigbo C.C., and Speizer I.S (2015). Determinants of Sexual Activity and Pregnancy among Unmarried Young Women in Urban Kenya: A Cross-Sectional Study. PLoS One. 10(6):e0129286.

[14] Croft T.N., Aileen M., and Courtney K (2018). Guide to DHS Statistics: DHS-7. Rockville.

[15] Kaphagawani N., and Kalipeni E (2017). Sociocultural factors contributing to teenage pregnancy in Zomba district, Malawi. Glob Public Health.(6):694– 710. https://doi.org/10.1080/17441692.2016.1229354.

[16] Larsson M., Aneblom G., Odlind V., and Tydén T (2002). Reasons for pregnancy termination, contraceptive habits and contraceptive failure among Swedish women requesting an early pregnancy termination. Acta Obstet Gynecol Scand. 81(1):64–71. https://doi.org/10.1046/j.0001-6349.2001.00169.x.

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https://doi.org/10.47001/IRJIET/2023.702047

[17] Sedgh G., Ashford L.S., and Hussain R (2016). Unmet need for contraception in developing countries: examining women's reasons for not using a method. New York: Guttmacher Institute. 2:2015-6.
[18] United Nations Children's Fund (UNICEF). The state of the world's children 2011: Adolescence an age of opportunity. New York: UNICEF; 2011.
[19] Wong LP (2012). An exploration of knowledge, attitudes and behaviours of young multi-ethnic Muslim-majority society in Malaysia in relation to reproductive and premarital sexual practices. BMC Public Health. 2012; https://doi.org/10.1186/1471-2458-12-865.
[20] Chandra-Mouli V., McCarraher D.R., Phillips S.J., Williamson N.E., and Hainsworth G (2014). Contraception for adolescents in low and middle income countries: needs, barriers, and access. Reprod Health. 2014; https://doi.org/10.1186/1742-4755-11-1.
[21] Ochako R et al (2015) Barriers to modern contraceptive methods uptake among young women in Kenya: a qualitative study. BMC Public Health. 2015; https://doi.org/10.1186/s12889-015-1483-1.
[22] United Nations Children's Fund (UNICEF). A Familiar Face: Violence in the Lives of Children and Adolescents. New York, USA: UNICEF, 2017.https://www.unicef.org/publications/files/Violence_in_the_lives_of_children_and_adolescents.pdf.
[23] Rico M., and Trucco D (2014). Adolescents: right to education and future well-being [Adolescentes: derecho a la educacio ´n y al bienestar futuro]. CEPAL-UNICEF/Chile. Serie Polı ´ticas Sociales 2014; 190: 13–49.
[24] Joint United Nations Programme on HIV/AIDS (UNAIDS). Prevention Gap Report 2016. Switzerland: UNAIDS, 2016.
[25] Duflo E., Dupas P., Education K.M (2014). HIV, and early fertility: experimental evidence from Kenya. Cambridge MA: National Bureau of Economic Research.

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