

Analysing Future Trends of Adolescent Fertility for Togo Using Holt's Double Exponential Smoothing Technique

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Abstract - This research paper employs annual time series data of adolescent fertility rate for Togo 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 0.5 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility will continue to decline but still remain high throughout the out of sample period. Therefore, we encourage authorities in Togo to support girl child education, finance youth empowerment projects and relentlessly enforce laws that protect sexual and reproductive health rights of women and girls amongst other measures.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Developing countries are currently facing numerous health challenges including that of adolescent pregnancy (UNICEF, 2018; Darroch *et al.* 2016; Ganchimeng *et al.* 2014; UNECA *et al.* 2013; UNFPA, 2013; Loaiza & Liang, 2013; UNICEF, 2011; UNICEF, 2008; Klein, 2005). Teenage pregnancy is unacceptable to the society because the negative consequences that follow can be life threatening to the mother and fetus (Odimegwu & Mkwanzani, 2016; Sedgh *et al.* 2016; WHO, 2016; Althabe *et al.* 2015; Ganchimeg *et al.* 2014; Neal *et al.* 2012; Malabarey *et al.* 2012; Larsson *et al.* 2002). Adolescent girls aged 15–19 years are 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 252 million adolescent girls living in developing countries, about 38 million are sexually active and the majority of these girls have an unmet need for family planning. Approximately fifty percent of adolescent pregnancies are unplanned (Darroch *et al.* 2016) and WHO estimates indicate that 2 to 4.4 million adolescents in developing countries undergo unsafe abortions conducted by unskilled providers under unsafe and unhygienic conditions each year (WHO, 2011).

Existing evidence shows that in low and middle income countries, several factors have been found to cause teenage pregnancy chief among them is refusal to use contraceptives, 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). In Togo, the birth rate among adolescents (15 - 19 years) was 89 births per 1000 in 2016 (Lancet Global health, 2020). Previous authors in the country revealed that causes of adolescent pregnancy include low socioeconomic status, 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 (Josephine & Premraj, 2016; Rachakonda *et al.* 2014; OMS, 2012; Edgardh, 2007; Nour, 2006; Bonell, 2005; Vikat, 2002).

This paper applies the double exponential smoothing technique to model and forecast future trends of adolescent fertility for Togo. The findings are expected to depict the future burden of adolescent births in the country. This will inform policy, decisions, planning and allocation of resources to programs which are meant to reduce teenage pregnancy in the country.

II. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Togo. 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 double exponential smoothing method is specified as follows:

Model equation

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

G_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 Togo 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	G
Included Observations	61
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.500
Forecast performance measures	
Mean Absolute Error (MAE)	0.491954
Sum Square Error (SSE)	62.500249
Mean Square Error (MSE)	1.024594
Mean Percentage Error (MPE)	0.050264
Mean Absolute Percentage Error (MAPE)	0.388251

Residual Analysis for the Applied Model

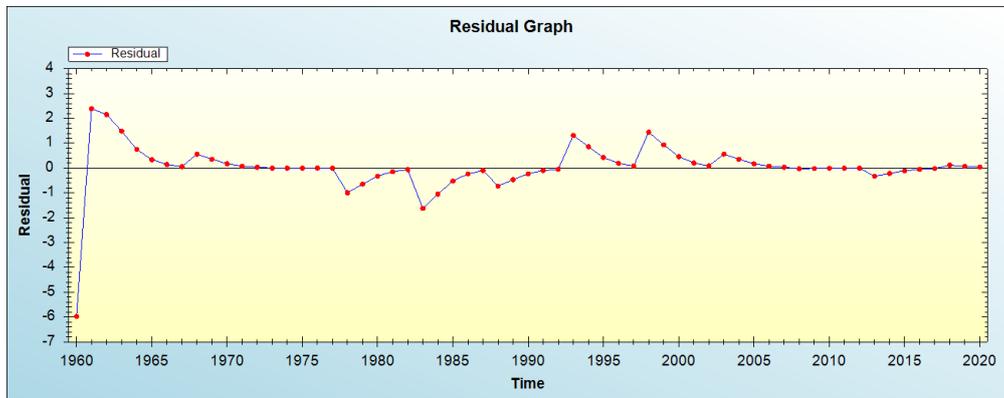


Figure 1: Residual analysis

In-sample Forecast for G

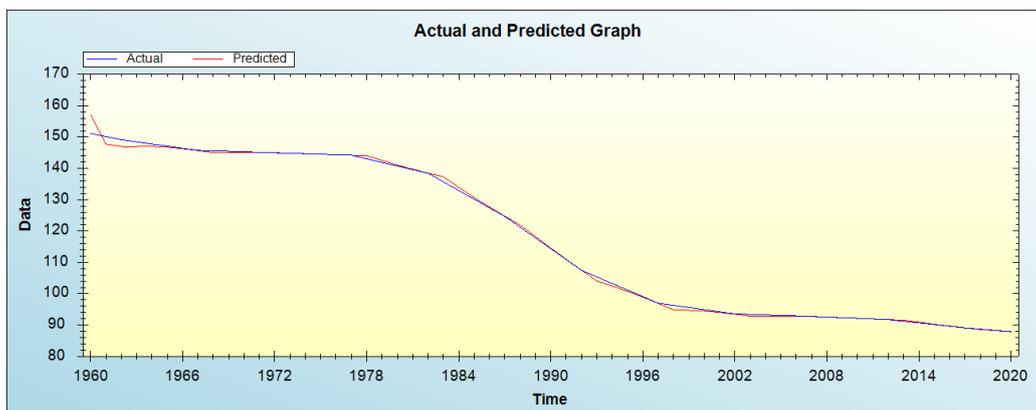


Figure 2: In-sample forecast for the G series

Actual and Smoothed graph for G series

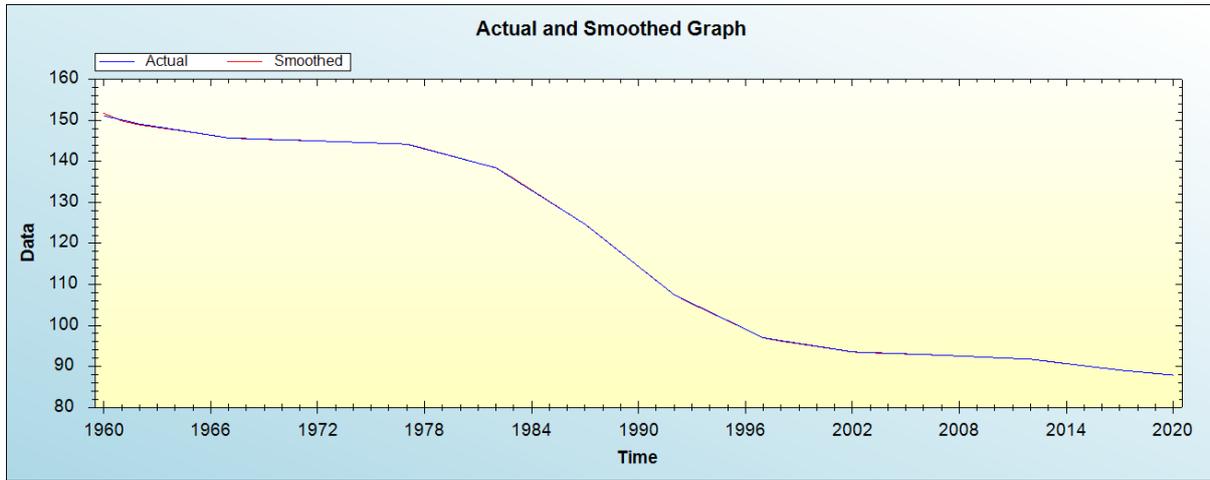


Figure 3: Actual and smoothed graph for G series

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

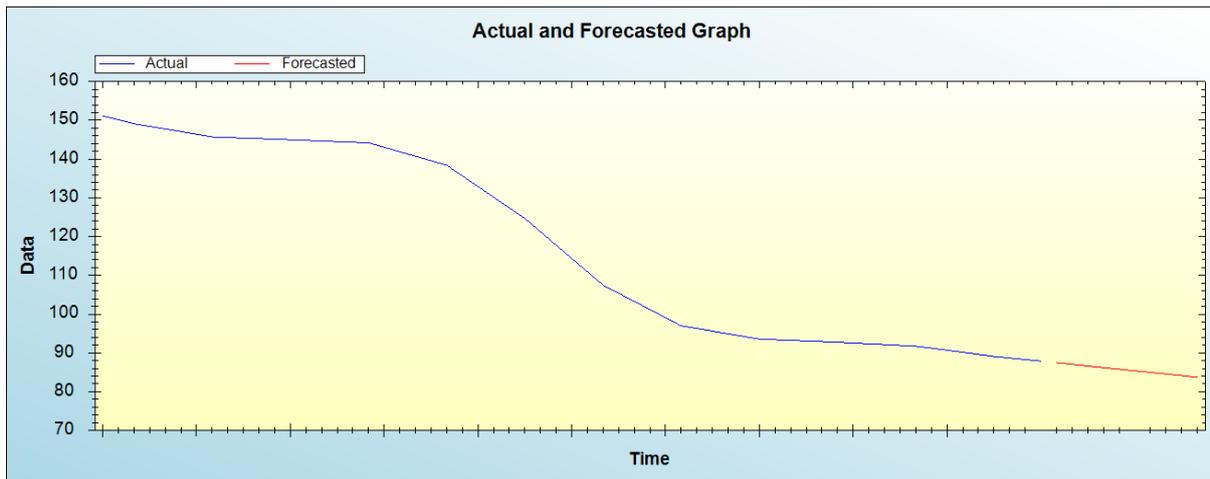


Figure 4: Out-of-sample forecast for G: actual and forecasted graph

Out-of-Sample Forecast for G: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	87.4605
2022	87.0436
2023	86.6267
2024	86.2097
2025	85.7928
2026	85.3759
2027	84.9589
2028	84.5420
2029	84.1251
2030	83.7081

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

High maternal and child mortality rates and other adverse pregnancy outcomes in developing regions are important public health problems. Teenage pregnancy is among the leading causes of adverse maternal and child health outcomes. In Togo causes of adolescent pregnancy include low socioeconomic status, limited education, early sexual activity, increased access to social media and pornographic sharing, cross-cultural influences and decreased adult supervision. World Bank reports indicate that adolescent fertility in Togo has been decreasing during the previous decades, however the problem remains huge. This study employed the double exponential smoothing technique to forecast adolescent fertility for Togo. The results of this piece of work revealed that adolescent fertility will continue to drop but remain high throughout the out of sample period. Therefore, we encourage authorities in Togo to support girl child education, finance youth empowerment projects and relentlessly enforce laws that protect sexual and reproductive health rights of women and girls amongst other measures.

REFERENCES

- [1] Darroch JE., Woog V., Bankol A., and Ashford LS (2019). Adding It Up: Costs and Benefits of Meeting the Contraceptive Needs of Adolescents. New York: Guttmacher Institute; 2016. https://www.guttmacher.Org/sites/default/files/report_pdf/adding-it-up-adolescentsreport.pdf.
- [2] 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.
- [3] Althabe F., Moore J.L., Gibbons L., Berrueta M., Goudar S.S., Chomba E., Derman R.J., Patel A., Saleem S., and Pasha O (2015). Adverse maternal and perinatal outcomes in adolescent pregnancies: The Global Network's Maternal Newborn Health Registry study. *Reprod Health*. 12(Suppl 2):S8.
- [4] Ganchimeg T., Ota E., Morisaki N., Laopaiboon M., Lumbiganon P., Zhang J., Yamdamsuren B., Temmerman M., Say L., Tuncalp O (2014). Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicounty study. *BJOG*. 121(Suppl 1):40–8.
- [5] Malabarey O.T., Balayla J., Klam S.L., Shrim A., and Abenheim HA (2012). Pregnancies in young adolescent mothers: a population-based study on 37 million births. *J Pediatr Adolesc Gynecol*. 25(2):98–102.
- [6] Klein J.D (2005). Adolescent pregnancy: current trends and issues. *Pediatrics*. 116(1):281–6. <https://doi.org/10.1542/peds.2005-0999>.
- [7] Neal S., Matthews Z., Frost M., Fogstad H., Camacho A.V., 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/10.1111/j.1600-0412.2012.01467.x>.
- [8] WHO (2016). Global health estimates 2015: deaths by cause, age, sex, by country and by region, 2000–2015. Geneva.
- [9] Odimegwu C and Mkwanzani 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>.
- [10] Larsson M., Aneblom G., Odland 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>.
- [11] 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.
- [12] United Nations Economic Commission for Africa (UNECA), African Union and African Development Bank Group U (2013). Assessing Progress in Africa toward Development Goals the Millennium: Food security in Africa: Issues, challenges and lessons. Addis Ababa.
- [13] United Nations Population Fund (UNFPA). Adolescent pregnancy: A Review of the Evidence. New York: UNFPA; 2013.
- [14] United Nations Children's Fund (UNICEF): World population Day: Young People and Family Planning: Teenage Pregnancy 2008.
- [15] United Nations Children's Fund (UNICEF). The state of the world's children 2011: Adolescence an age of opportunity. New York: UNICEF; 2011.

- [16] UNICEF (2018). Child Marriage: Latest trends and future prospects. <https://data.unicef.org/resources/childmarriage-latest-trends-and-future-prospects/>.
- [17] 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.
- [18] Jewkes R., Morrell R., and Christofides N (2009). Empowering teenagers to prevent pregnancy: lessons from South Africa. *Cult Health Sex*. 11(7):675–88.
- [19] 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.
- [20] 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.
- [21] 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
- [22] Cau B.M (2015). Community influences on contraceptive use in Mozambique. *Health Place*. 31:10–6.
- [23] United Nations Population Fund (UNFPA) (2017). Adolescent Pregnancy: UNFPA; 2017. <http://www.unfpa.org/adolescent-pregnancy>.
- [24] Joyce C.B., Martinez G.M and Division of vital statistics (2017). National Health Statistics Reports, Number 104.
- [25] WHO (2018). Family planning_ Contraception WHO.
- [26] Loaiza E. and Liang, M. (2013) Teenage Pregnancy: A Review of the Evidence. UNFPA, New York.
- [27] 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>
- [28] Vikat A. (2002) Sociodemographic 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>
- [29] Nour, N.M. (2006) Health Consequences of Child Marriage in Africa. *Emerging Infectious Diseases*, 12, 1644-1649. <https://doi.org/10.3201/eid1211.060510>
- [30] 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>
- [31] Joesephine P. and Premraj C (2016) Adolescent Sexual and Reproductive Health. *Global Journal for Research Analysis (GJRA)*, 5, 167-168
- [32] Rachakonda L., Rawate S and Shiradkar S. (2014) Teenage Pregnancy. *International Journal of Current Medical and Applied Sciences*, 4, 2059-2063.
- [33] OMS (2012) Early Marriages, Teenage Pregnancies and Young Women. Report of the Secretariat Sixty-Fifth World Health Assembly. Genève.
- [34] The Lancet Global Health. Countdown 2017 Report Annexes-Countdown to 2030 for Women’s, Children’s and Adolescents’ Health. <http://www.countdown2030.org/annexes>

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