International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 455-460, February-2023

https://doi.org/10.47001/IRJIET/2023.702076

Tracking the Future Path of Adolescent Fertility for the United Kingdom Using Holt's Linear Method

[1]Smartson. P. NYONI, [2]Thabani NYONI

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

***Abstract* - The burden of teenage pregnancy in Western Europe is reportedly highest in the UK and has been found to have a geographic variation. This study employs annual time series data of adolescent fertility rate for the United Kingdom (UK) 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 drop to levels below 5 births per 1000 women aged 15-19 years by the end of 2030.Therefore, we encourage authorities in the United Kingdom to address local factors that contribute to teenage pregnancies so as to avert adverse pregnancy outcomes.**

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adolescent pregnancy is a well-recognized global health problem that affects both developed and developing countries (Sedgh *et al.* 2015; WHO, 2014; Klein, 2005). This problem has emerged to be an issue of concern in recent times in the United Kingdom (Kirchengast, 2016; Santelli&Melnikas,2010). The burden of teenage pregnancy in Western Europe is reportedly highest in the UK (ONS, 2016; TPSE, 2005). It has been reported in various studies that adolescent pregnancy is linked to socioeconomic factors (Chirwa *et al.* 2019; ONS, 2018; Ahorlu*et al.* 2015; Penman-Aguilar*et al*. 2013; McLeod, 2001;). The resultant adverse maternal and child health outcomes include maternal and neonatal deaths (Kassa *et al.*2018; Pradhan *et al.* 2018; Mehra *et al.* 2018; Sama *et al.* 2017; Odimegwu*et al.* 2016; WHO, 2016; Envuladu *et al.* 2014; Neal *et al.* 2012). There is a geographical variation of the burden of adolescent pregnancies. In England, the teenage pregnancy rates tend to follow the north-south divide. The most deprived areas in the northeast have high teen pregnancy rates but lower abortion rates while the affluent areas of the southeast have low conception but higher abortion rates (ONS, 2018).In 1999, the United Kingdom labor government launched a 10 year adolescent pregnancy strategy for England designed to reduce teenage pregnancy by 50% (Hadley *et al.* 2016). The under-18 pregnancy rate in England and Wales declined from an average of 45.1 per 1000 to an average of 16.8 per 1000 among girls aged 15-17 years from 1999 to 2018 (ONS, 2018). However, the percentage of under-18 conceptions that led to abortion increased from 46.5% in 1999 to over 50% in 2018 (ONS, 2018;Conrad, 2012).Literature indicates that sociocultural norms and availability of abortion services are the major contributors of high abortion rates in affluent areas (Smith and Roberts, 2009). Low rates of adolescent pregnancy are being reported in the Netherlands and Scandinavian countries due to the wider use of modern methods of contraception, adequate SRH information, and cultures that promote free and open discussion of sexual matters (Cook and Cameron, 2017). In addition, low contraceptive use has been reported among sexually active teenagers In the United Kingdom (Aluga and Okolie, 2021).

This study applies Holt's double exponential smoothing technique to predict future trends of adolescent fertility in the out of sample period. The findings of this study are expected to depict likely future burden of adolescent births in the UK. This will trigger review of current policies and legal instruments to protect adolescent pregnancy and prevent sexual abuse of women

II. METHODOLOGY

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

International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 2, pp 455-460, February-2023

https://doi.org/10.47001/IRJIET/2023.702076

Holt's double exponential smoothing model is specified as follows:

Model equation

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

Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

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

Y_t is the 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 the UK 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

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 7, Issue 2, pp 455-460, February-2023
https://doi.org/10.47001/IRJIET/2023.702076

Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.500
Forecast performance measures	
Mean Absolute Error (MAE)	1.159658
Sum Square Error (SSE)	610.571919
Mean Square Error (MSE)	10.009376
Mean Percentage Error (MPE)	0.297713
Mean Absolute Percentage Error (MAPE)	2.219798

Residual Analysis for the Applied Model

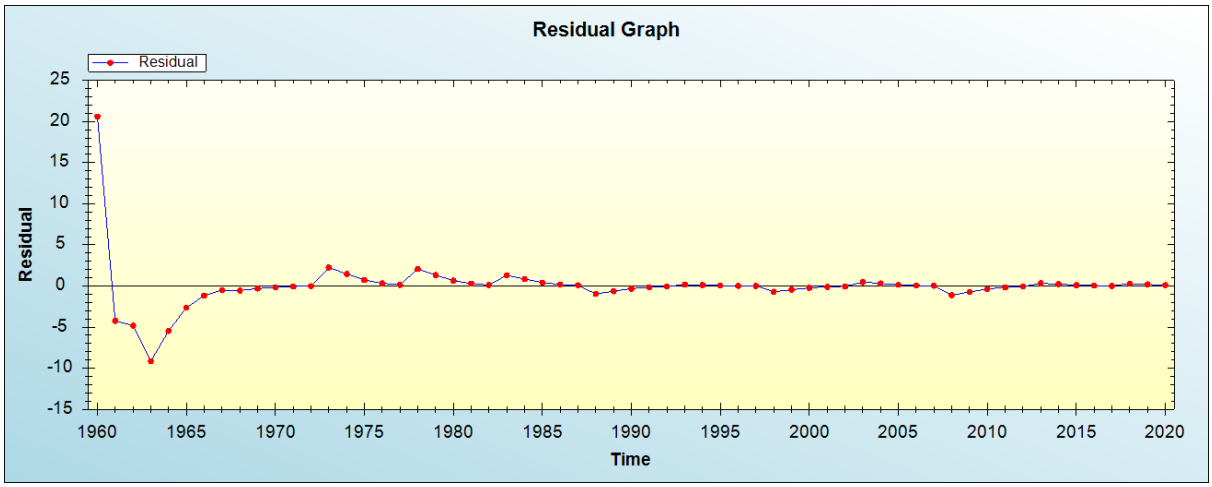

Figure 1: Residual analysis

In-sample Forecast for Y

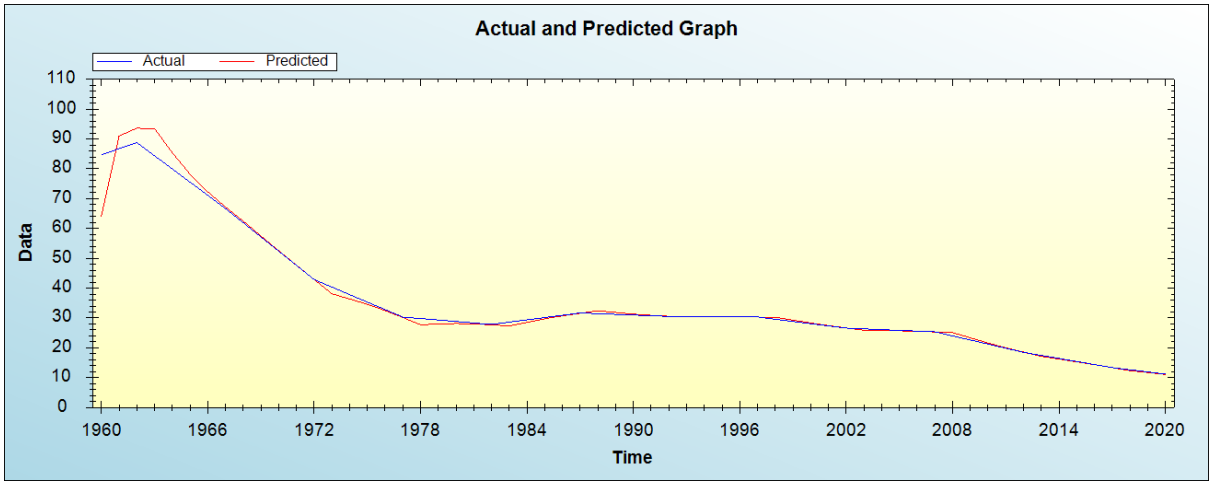

Figure 2: In-sample forecast for the Y series

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 7, Issue 2, pp 455-460, February-2023
https://doi.org/10.47001/IRJIET/2023.702076

Actual and Smoothed graph for Y series

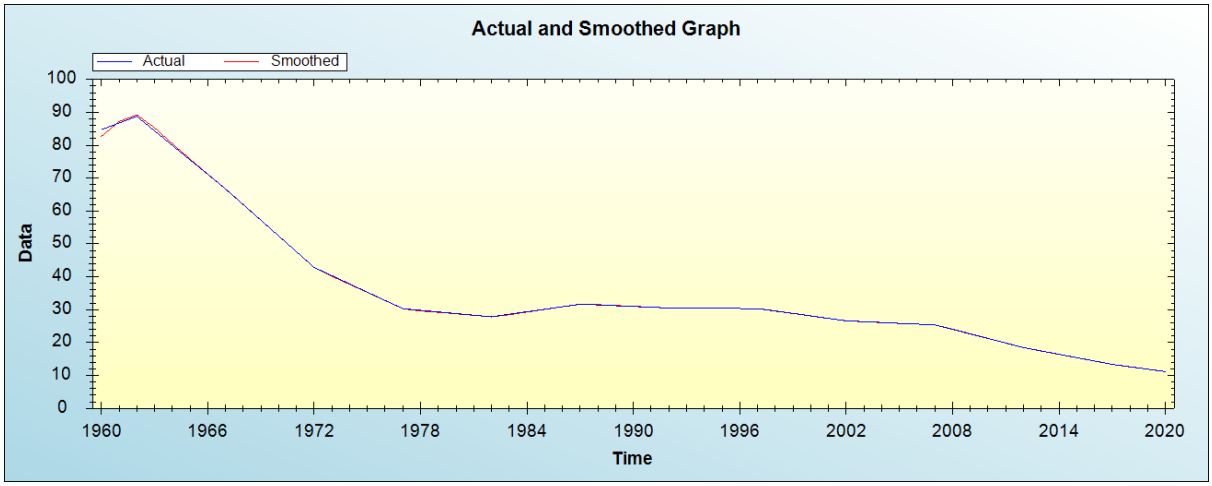

Figure 3: Actual and smoothed graph for Y series

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

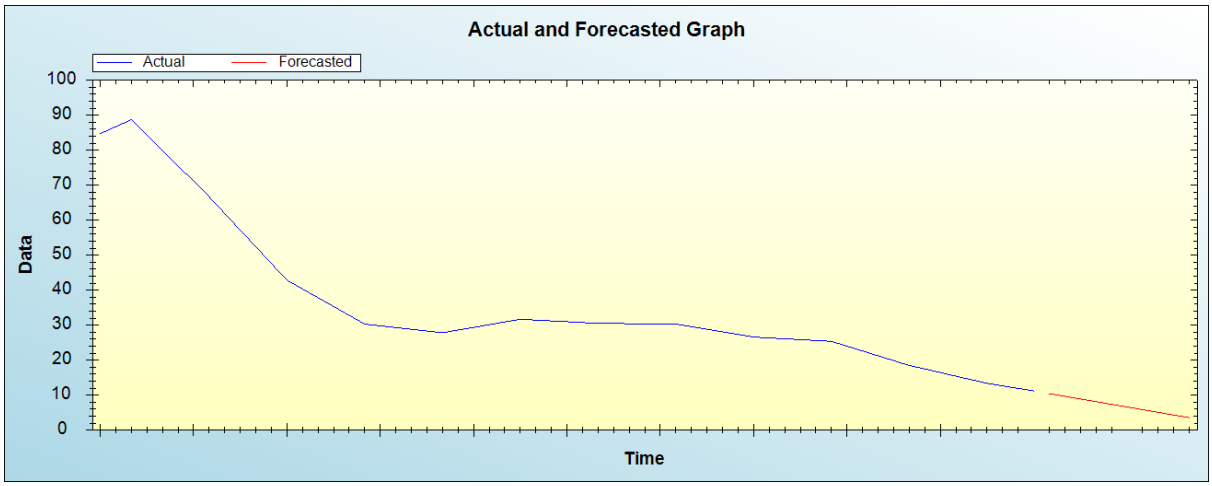

Figure 4: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasting adolescent fertility rate
2021	10.4111
2022	9.6487
2023	8.8864
2024	8.1240
2025	7.3617
2026	6.5993
2027	5.8370
2028	5.0746
2029	4.3123
2030	3.5499

ISSN (online): 2581-3048
Volume 7, Issue 2, pp 455-460, February-2023
https://doi.org/10.47001/IRJIET/2023.702076

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 drop throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Teenage pregnancy has emerged to be an issue of concern in recent times in the United Kingdom. The burden of teenage pregnancy in Western Europe is reportedly highest in the UK. Literature shows that there is a geographic variation of teenage pregnancy across the United Kingdom with low contraceptive use among teenagers being reported as one of the risk factors for adolescent pregnancy. Over the past decades, adolescent fertility in the UK declined gradually indicating huge achievements made by existing family planning programs in the country. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for the UK. Forecast results indicate that adolescent fertility will continue to drop to levels below 5 births per 1000 women aged 15-19 years by the end of 2030. Hence, we encourage the UK government to address local factors which drive unintended pregnancies among teenagers.

REFERENCES

[1] Santelli J.S., &Melnikas AJ (2010). Teen fertility in transition: recent and historic trends in the United States. AnnuRev Public Health. 31:371-83 4 p following 83. doi: 10.1146/annurev. publhealth.29.020907.090830.

[2] Kirchengast S (2016). Teenage pregnancies: a worldwide social and medical problem. In: Laratta R, Ed. An Analysis of Contemporary Social Welfare Issues. Intech Open;doi: 10.5772/65462.

[3] Office for National Statistics (2016). Live births women aged 'Under 18' and 'under 20', (per 1,000 women aged 15 to 17 and 15 to 19) in EU28 countries, 2004, 2013 and 2014.

[4] McLeod A. Changing patterns of teenage pregnancy: population based study of small areas. BMJ. 2001;323(7306):199-203. doi: 10.1136/bmj.323.7306.199. 8

[5] Penman-Aguilar A, Carter M, Snead MC, Kourtis AP. Socioeconomic disadvantage as a social determinant of teen childbearing in the U.S. Public Health Rep. 2013;128 Suppl 1:5-22. doi: 10.1177/00333549131282s102.

[6] Ahorlu CK., Pfeiffer C., and Obrist B (2015). Socio-cultural and economic factors influencing adolescents' resilience against the threat of teenage pregnancy: a cross-sectional survey in Accra, Ghana. Reprod Health. 12:117. doi: 10.1186/s12978-0150113-9

[7] Office for National Statistics (2018). Conceptions in England and Wales: 2019. Available from: https:// www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/conceptionandfertilityrates/ bulletins/conceptionstatistics.

[8] Chirwa GC., Mazalale J., Likupe G., Nkhoma D., Chiwaula L., and Chintsanya J (2019). An evolution of socioeconomic related inequality in teenage pregnancy and childbearing in Malawi. PLoS One. 14(11):e0225374. doi: 10.1371/journal.pone.0225374

[9] World Health Organization. Causes of death among adolescents; 2016. Available from: https://www.who.int/maternal child adolescent/data/causes-death-adolescent

[10] Conrad D(2012). Deprivation-based inequalities in under-18 conception rates and the proportion of under-18 conceptions leading to abortion in England, 1998-2010. J Public Health (Oxf). 34(4):609-14. doi: 10.1093/pub med/fds031.

[11] Smith D.M., and Roberts R (2009). Social acceptance; a possible mediator in the association between socio-economic deprivation and under-18 pregnancy rates? J Youth Stud. 12(6):669-83. doi: 10.1080/13676260902897418.

[12] Cook SMC., and Cameron ST (2017). Social issues of teenage pregnancy. Obstet Gynaecol Reprod Med. 27(11):327-32. doi: 10.1016/j.ogrm.2017.08.005

[13] David Aluga., and Elvis Anyaehiechukwu Okolie (2021). Socioeconomic determinants of teenage pregnancy and early motherhood in the United Kingdom: A perspective, 11(4), 426-429 doi: 10.34172/hpp.2021.52

[14] World Health Organization (2014). Adolescent pregnancy. Factsheets. Available at: http://www.who.int/mediacentre/factsheets/fs364/en/

[15] Envuladu EA., Agbo HA., Ohize VA (2014). Determinants and outcome of teenage pregnancy in a rural community in Jos, Plateau State, Nigeria.Sub-Saharan Afr J Med. 1(1):48–52.

[16] Sedgh G., Finer L.B., Bankole A., Eilers M.A., and Singh S (2015). Adolescent Pregnancy, Birth, and Abortion Rates across Countries: Levels and Recent Trends. J. Adolescent. Health. 56, 223–230.

ISSN (online): 2581-3048
Volume 7, Issue 2, pp 455-460, February-2023
https://doi.org/10.47001/IRJIET/2023.702076

[17] Kassa G.M., Arowojolu A.O., Odukogbe, A.A., and Yalew A.W(2018). Prevalence and determinants of adolescent pregnancy in Africa: A systematic review and Meta-analysis. Reprod. Health 2018, 15, 195.

[18] Pradhan R., Wynter K., and Fisher J (2018). Factors Associated with Pregnancy among Married Adolescents in Nepal: Secondary Analysis of the National Demographic and Health Surveys from 2001 to 2011. Int. J. Environ. Res. Public Health 2018, 15, 229.

[19] Mehra D., Sarkar A., Sreenath P., Behera J., and Mehra S (2018). Effectiveness of a community based intervention to delay early marriage, early pregnancy and improve school retention among adolescents in India. BMCPublic Health 2018, 18, 732.

[20] Sama C.B., Ngasa S.N., Dzekem B.S., and Choukem S. P (2017). Prevalence, predictors and adverse outcomes of adolescent pregnancy in sub-Saharan Africa: A protocol of a systematic review. Syst. Rev. 2017, 6, 247

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

[22] 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. ActaObstetGynecol Scand. 91(9):1114–8. https://doi.org/1 0.1111/j.1600-0412.2012.01467.x.

[23] 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.

[24] Hadley A., Ingham R., and Chandra-Mouli V (2016). Implementing the United Kingdom's ten-year teenage pregnancy strategy for England (1999-2010): How was this done and what did it achieve? Reprod Health. 13:139. doi:10.1186/s12978-016-0255-4

[25] Teenage Pregnancy Strategy Evaluation (TPSE). Final Report, Synthesis. 2005.

Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Tracking the Future Path of Adolescent Fertility for the United Kingdom Using Holt's Linear Method" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 455-460, February 2023. Article DOI https://doi.org/10.47001/IRJIET/2022.702076

****

