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# Tracking Future Trends of Adolescent Fertility for Tajikistan Using Holt's Linear Method

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Abstract - This research paper employs annual time series data of adolescent fertility rate for Tajikistan 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  $\alpha$  and  $\beta$  are 0.9 and 0.9 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility is expected to increase throughout the out of sample period. Therefore, we encourage authorities in Tajikistan to scale up educational campaigns among communities, support girl child education, promote and uphold women's rights and provide accessible and affordable adolescent SRH services.

Keywords: Exponential smoothing, Forecasting, adolescent fertility rate.

## I. INTRODUCTION

Trends of adverse maternal and child health outcomes in the developing world is a global health concern. Persistent high morbidity and mortality among pregnant mothers and under five children in Sub-Saharan Africa and South Central Asia needs urgent attention as this will shutter the prospects of achieving set targets under the 3<sup>rd</sup> sustainable development goal. One of the leading causes of morbidity and mortality is adolescent pregnancy. An adolescent is an individual in the age group 10-19 years (WHO, 1999). Literature shows that pregnancy and child birth during this stage increases the risk of complications to the mother and the baby (CSA, 2012; Mangiaterra *et al.* 2008). The negative health consequences include pre-eclampsia/eclampsia, obstetric fistula, increased risk of acquiring STIs, anemia in pregnancy, preterm delivery, low birth weight and malnutrition (Nguyen *et al.* 2019; Santelli *et al.* 2017; de Onis & Branca, 2016;Patton *et al.* 2016;Azevedo *et al.*2015; Rosenburg *et al.* 2015; UNFPA *et al.* 2015; Chandra-Mouli*et al.* 2014). It has been reported that social rejection, stigma and school dropouts contribute to the development of mental disorders among teenage mothers (Ochen *et al.* 2019; Ayele *et al.* 2018; Odimegwu & Mkwananzi, 2016; WHO, 2016; UNICEF, 2014; Neal *et al.* 2012). Several previous studies have highlighted that poverty, peer influence, substance abuse, lack of SRH knowledge, social media and poor parental support are the main drivers of teenage pregnancies (Croft *et al.* 2018; Okigbo& Speizer, 2015).

Tajikistan is a land locked country located in Central Asia. More than two thirds of the country's population live in rural areas and are engaged in agricultural production (WHO, 2020). It has a total fertility rate of 3.8 live children per woman (Tajikistan 2017 DHS). In addition, according to the 2017 DHS report almost 75 percent of women aged 15-49 are married. Thirteen percent of women age 25-49 were married by age 18 and 47% were married by age 20. Seven percent of adolescent women age 15-19 have begun childbearing; that is, they are already mothers or are pregnant with their first child. Teenage childbearing is most common in DRS (9%) and least common in GBAO (2%). Young women with no education/primary only education are most likely to have begun childbearing (13%). Approximately 27% of married women age 15-49 are currently using a modern method of family planning and twenty-three percent of married women age 15-49 have an unmet need for family planning.

In line with the National vision 2021-2030, this paper applies the double exponential smoothing technique to forecast future trends of adolescent fertility in Tajikistan. The findings are expected to indicate the likely burden of adolescent births in the out of sample period. This will facilitate policy making, planning and allocation of resources to programs designed to end teenage pregnancies in the country.



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## II. METHODOLOGY

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

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

Smoothing equation

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

0<α<1

Trend estimation equation

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

0<β<1

Forecasting equation

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

 $X_t$  is the actual 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

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b_{t-1} is the trend estimate at time t-1
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#### **Data Issues**

This study is based on annual adolescent fertility rate in Tajikistan 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.



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## **III. FINDINGS OF THE STUDY**

## Exponential smoothing Model Summary

Table 1: ES model summary

Variable	Х
Included Observations	61
Smoothing constants	
Alpha ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.240491
Sum Square Error (SSE)	14.899475
Mean Square Error (MSE)	0.244254
Mean Percentage Error (MPE)	0.053169
Mean Absolute Percentage Error (MAPE)	0.434181

Residual Analysis for the Applied Model



Figure 1: Residual analysis

In-sample Forecast for X







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Actual and Smoothed graph for X series



Figure 3: Actual and smoothed graph for X series

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



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

Out-of-Sample Forecast for X: Forecasts only

Table 2:	Tabulated	out-of-sample	forecasts
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Year	Forecasted adolescent fertility rate
2021	58.6230
2022	58.9877
2023	59.3523
2024	59.7170
2025	60.0817
2026	60.4463
2027	60.8110
2028	61.1757
2029	61.5404
2030	61.9050

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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 is expected to increase throughout the out of sample period.

## **IV. POLICY IMPLICATION & CONCLUSION**

Tajikistan is land locked country in central Asia whose main economic activity is agriculture. The majority of its population is in the rural areas. Alongside other Asian countries, Tajikistan is still facing the problem of adolescent pregnancy. Risk factors for teenage pregnancy in this country include low educational level, low economic status and nonuse of contraceptive methods. Adolescent fertility steadily declined during the period 1960-2002 and then started going up over the period 2003-2020 as indicated by the World Bank data base. This study applied Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Tajikistan. Research findings indicated that adolescent fertility is likely to continue on an upward trend throughout the out of sample period. Therefore, we implore authorities in Tajikistan to scale up educational campaigns among communities, support girl child education, promote and uphold women's rights and provide accessible and affordable adolescent sexual and reproductive health services.

## REFERENCES

- [1] Rosenberg M., Pettifor A., Miller W.C., Thirumurthy H., Emch M., Afolabi S.A., and Tollman S (2015). Relationship between school dropout and teen pregnancy among rural South African young women. Int. J. Epidemiol. 2015, 44, 928–936
- [2] 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. <u>https://doi.org/10.1111/j.1600-0412.2012.01467.x</u>
- [3] WHO (2016). Global health estimates 2015: deaths by cause, age, sex, by country and by region, 2000-2015. Geneva.
- [4] 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. <u>https://doi.org/10.29063/ajrh2016/v20i3.14</u>.
- [5] Ochen AM., Chi P.C., and Lawoko S (2019). Predictors of teenage pregnancy among girls aged 13–19 years in Uganda: a community based case-control study. BMC Pregnancy Childbirth. 19(1):211. https://doi.org/10.1186/s12 884-019-2347-y.
- [6] Ayele BG., Gebregzabher T.G., Hailu T. T., and Assefa BA (2018). Determinants of teenage pregnancy in Degua Tembien District, Tigray, Northern Ethiopia: A community-based case-control study. PLoS One. 13(7):e0200898.
- [7] UNICEF (2014). Progress and prospects. End Child Marriage Prog Prospect UNICEF [Internet]. 2014:1-8
- [8] Okigbo CC., and Speizer IS(2015). Determinants of Sexual Activity and Pregnancy among Unmarried Young Women in Urban Kenya: A Cross-Sectional Study. PLoS One. 10(6):e0129286.
- [9] Croft TN., Aileen M., and Courtney K (2018). Guide to DHS Statistics: DHS-7. Rockville.
- [10] UNFPA, UNESCO and WHO (2015). Sexual and Reproductive Health of Young People in Asia and the Pacific: A Review of Issues, Policies and Programmes. Bangkok, Thailand: United Nations Population Fund (UNFPA), United Nations Educational, Scientific and Cultural Organization (UNESCO) and World Health Organization (WHO).
- [11] Santelli J.S., Song X., Garbers S., Sharma V., and Viner RM (2017). Global trends in adolescent fertility, 1990–2012, in relation to national wealth, income inequalities, and educational expenditures. J Adolesc Health. 60(2):161–8.
- [12] 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. 11(1):1–15.
- [13] Patton G.C., Sawyer S.M., Santelli J.S., Ross D.A., Afifi R., and Nicholas B (2016). Our future: a Lancet commission on adolescent health and wellbeing. Lancet. 387(10036):2423–78.
- [14] Azevedo W.F., Diniz M.B., Fonseca E.S., Azevedo L.M., and Evangelista C.B (2015). Complications in adolescent pregnancy: systematic review of the literature. Einstein (Sao Paulo). 13(4):618–26.
- [15] de Onis M., and Branca F (2016). Childhood stunting: a global perspective. Matern Child Nutr. 2016;12:12–26.
- [16] Nguyen P.H., Scott S., Neupane S., Tran L.M., and Menon P (2019). Social, biological, and programmatic factors linking adolescent pregnancy and early childhood under nutrition: a path analysis of India's 2016 National Family and Health Survey. Lancet Child Adolesc Heal. 3(7):463–73.
- [17] World health organization (WHO). Programming for adolescent health and development: report of WHO/UNFPA/UNICEF study group on programming for adolescents health. Geneva: WHO; 1999.
- [18] Mangiaterra V., Pendse R., McClure K., and Rosen J (2008). MPS Notes: Adolescent Pregnancy. In. Edited by Heine M.A, vol. 1. Geneva: Department of Making Pregnancy Safer.

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- [19] Central Statistical Agency: Addis Ababa: Ethiopia, ICF International, Calverton: Maryland: USA: Ethiopia Demographic and Health Survey (EDHS) 2011: 2012.
- [20] WHO (2020). Supporting national implementation of International Health Regulations. Geneva. https://www.who.int/activities/supporting-national-implementation-ofinternational-health-regulations

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