

# Forecasting Adolescent Fertility for Thailand Using Holt's Linear Method

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**Abstract** - This study employs annual time series data of adolescent fertility rate for Thailand 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 will continue to decline throughout the out of sample period. Therefore, we encourage authorities in Thailand to promote girl child education, finance empowerment programs for youths and address local factors that significantly contribute to adolescent pregnancies.

**Keywords:** Exponential smoothing, Forecasting, adolescent fertility rate.

## I. INTRODUCTION

Adolescent pregnancy refers to pregnancy that occurs among girls between the ages of 10 and 19, where the majority is unintended pregnancies (Ganchimeg *et al.* 2014). An estimated 15% of women below 18 years gave birth globally in 2015, and at least 90% of such deliveries occur in developing countries (UNICEF, 2021; Ganchimeg *et al.* 2014). One in every five adolescent girls has given birth globally, and the risk goes up to about one in every three adolescent girls in developing nations (WHO, 2014). According to the World Health Organization (WHO), around 21 million girls of age 15-19 get pregnant every year. About 5.6 million end up with abortion, of which 3.9 million are reported as unsafe in low and middle income countries (WHO, 2020). Sub-Saharan Africa has the highest burden of adolescent pregnancies compared to European and North American nations (UNICEF, 2021). Previous studies highlighted that early marriage, substance abuse, sexual violence, lack of availability of contraceptives, relatives with a history of adolescent birth, early sexual activity, lack of health services, limited maternal education, poverty, lack of parental guidance, child of a broken family, religious beliefs, lack of financial autonomy, social media, and pornography are among few of the risk factors for adolescent pregnancy (Bain *et al.* 2020; WHO, 2020). According to Thai Ministry of Public Health adolescent births declined from 51.1 per 1000 in 2013 to 31.3 per 1000 in 2019. However, this is still above the national goal of less than 25 per 1000 (Thailand MOH, 2016). A large proportion of pregnancies in adolescent women in Thailand are unintended and pose a risk of exposure to unsafe abortion (UNICEF, 2015). Adolescent pregnancy problems are associated with lack of understanding of sexuality education and lack of skills and knowledge in the use of contraceptives. In addition, problems of family relations, poverty, substance abuse, and sexual abuse or rape have been reported as among the factors that contribute to teenage pregnancy (Kumruangrit & Srijundee, 2022; WHO, 2018; WHO, 2016). In Thailand, the proportion of condom use during sexual debut increased from 65.0% in 2014 to 77.6% in 2019 among male adolescents, and from 64.2% to 80.0% among female adolescents. It has been observed that the increased contraception use was consistent with a decline in adolescent pregnancy (UNICEF, 2018; UNICEF, 2015). A survey carried out by the National Statistical Office of Thailand revealed that 88% of married women (aged of 20–24) and 80% of adolescents (15-19 years) were satisfied with modern contraceptive methods (NSOT, 2020). The percentage of girls aged 15–19 years who were using (or whose partner was using) a contraceptive method was about 74%, but a proportion (17%) of these girls still had unmet need for contraception. Regardless of Thai teenagers' experience in sexuality education and their related out-of-class activities, Thailand's adolescent birth rate has remained high in comparison to that of other East Asian countries at 7 births per 1,000 girls (World Health Organization, 2018).

The Thai government has made its commitment to end teenage pregnancies by adopting recommendations that have been suggested by international organizations. These measures include closing pornographic stores that accept minors, utilizing the law to punish rapists, involving the political head in a campaign against early pregnancies, school departure before dark, locally accessible schools, and providing education regarding readily available contraceptives such as condoms, patches, vaginal rings, birth control pills, and injectable birth control methods are few of the steps that are to be taken to reduce the prevalence of adolescent pregnancy (CDC, 2020; Nabugoomu *et al.* 2020). Therefore, in line with government's vision to end teenage pregnancies, this paper applies Holt's double exponential smoothing technique to model and forecast future trends of adolescent

births in Thailand. The findings of this piece of work are envisioned to depict the likely future burden of teen births in the out of sample period. This will then inform policy making, planning and allocation of resources towards programs aimed at reducing teenage pregnancies.

## II. METHODOLOGY

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

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

### Smoothing equation

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

$$0 < \alpha < 1$$

### Trend estimation equation

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

$$0 < \beta < 1$$

### Forecasting equation

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

$Z_t$  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  $t$

$b_{t-1}$  is the trend estimate at  $t-1$

Data Issues

This study is based on annual adolescent fertility rate in Thailand 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	Z
Included Observations	61
Smoothing constants	
Alpha ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.297818
Sum Square Error (SSE)	30.007043
Mean Square Error (MSE)	0.491919
Mean Percentage Error (MPE)	0.030789
Mean Absolute Percentage Error (MAPE)	0.574264

Residual Analysis for the Applied Model

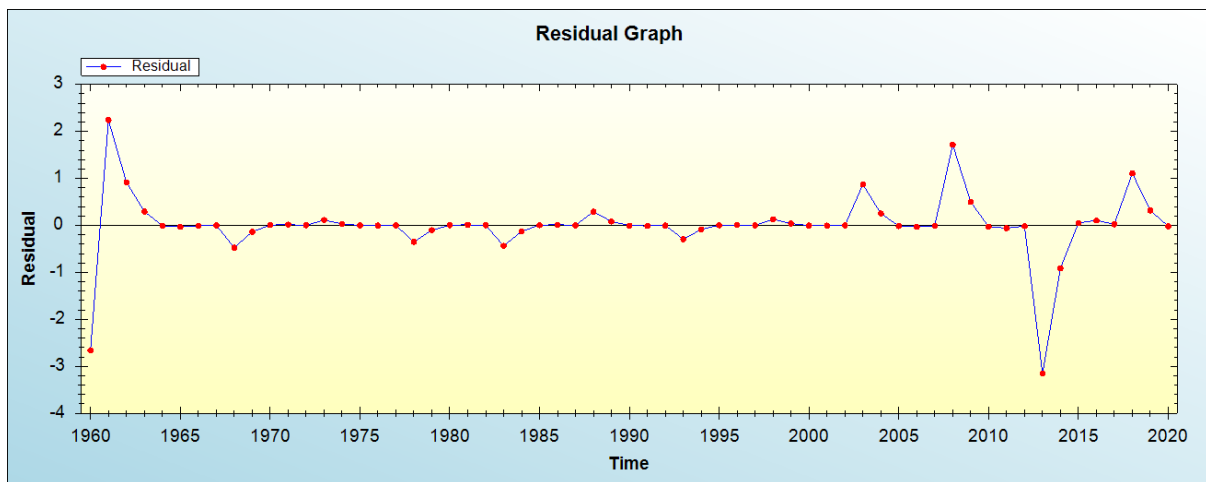


Figure 1: Residual analysis

In-sample Forecast for Z

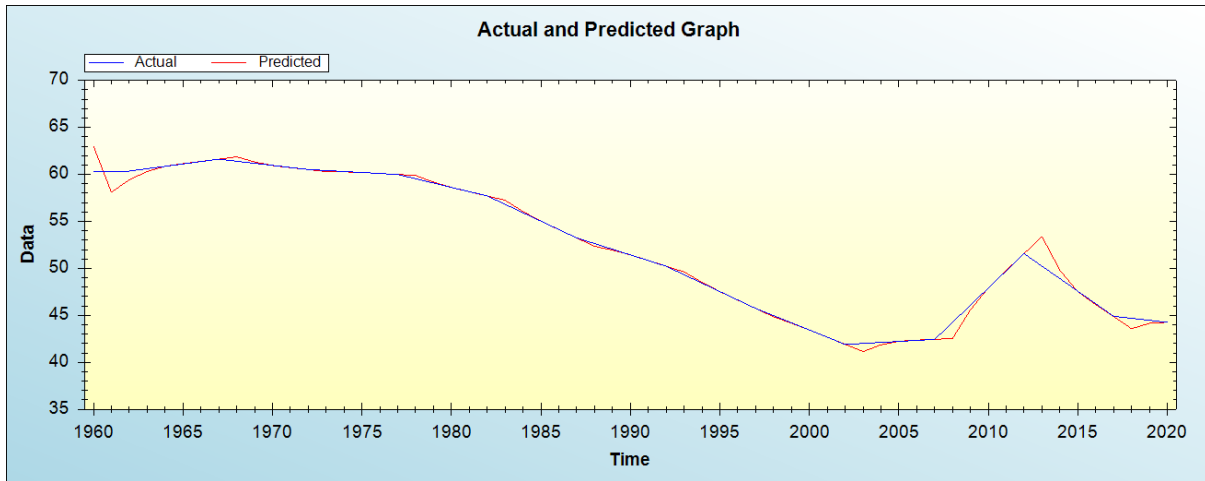


Figure 2: In-sample forecast for the Z series

Actual and Smoothed graph for Z series

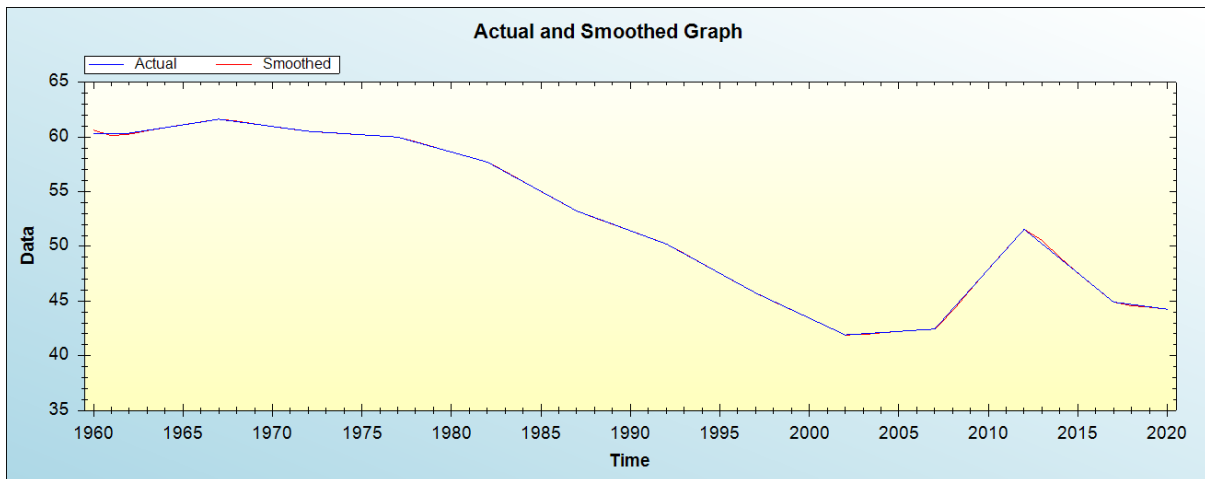


Figure 3: Actual and smoothed graph for Z series

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

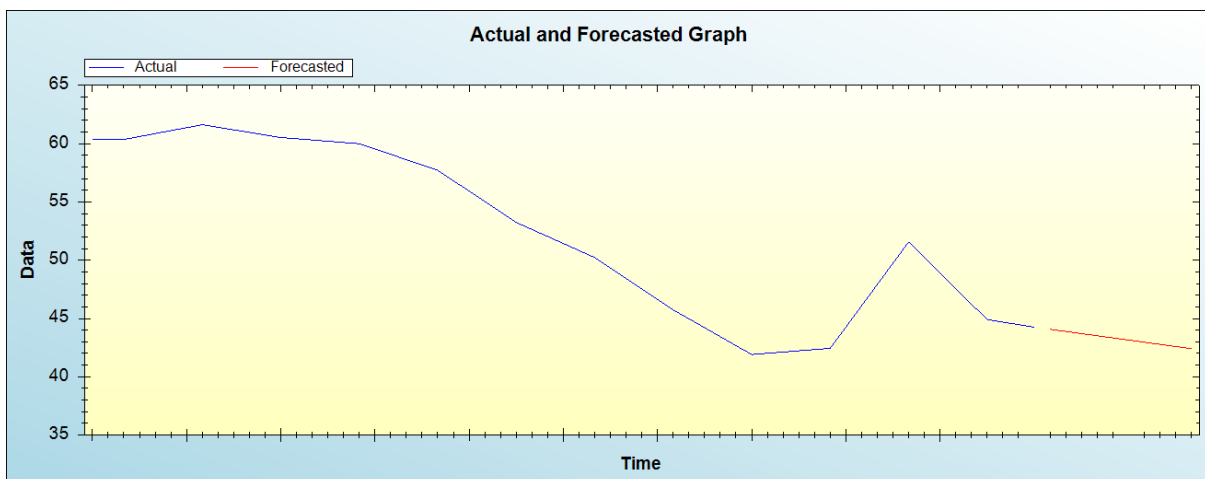


Figure 4: Out-of-sample forecast for Z: actual and forecasted graph

Out-of-Sample Forecast for Z: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted adolescent fertility rate
2021	44.0684
2022	43.8846
2023	43.7008
2024	43.5170
2025	43.3332
2026	43.1493
2027	42.9655
2028	42.7817
2029	42.5979
2030	42.4141

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 throughout the out of sample period.

#### IV. POLICY IMPLICATION & CONCLUSION

Adolescent pregnancy continues to be a challenge in Thailand. Predictors of adolescent pregnancy in this country include lack of understanding of sexuality education, lack of skills and knowledge in the use of contraceptives, problems of family relations, poverty, substance abuse, and sexual abuse among other factors. According to World Bank reports, adolescent fertility for Thailand has been declining over the previous decades although the drop has not been sufficient enough to meet the national target of less than 25 births per 1000 women aged 15-19 years. This study applies the double exponential smoothing technique to forecast future trends of adolescent fertility for Thailand. Research findings suggest that adolescent fertility will continue to decline throughout the out of sample period. However, figures will be above the national target of less 25 births per 1000 women aged 15-19. Therefore, we encourage the Thai government to relentlessly promote girl child education, finance empowerment programs for youths and address local factors that significantly contribute to adolescent pregnancies.

#### REFERENCES

- [1] Ganchimeg T., Ota E., and Morisaki N (2014). Pregnancy and childbirth outcomes among adolescent mothers: a World Health Organization multicountry study. *BJOG*. 121 Suppl 1:40-8. 10.1111/1471-0528.12630
- [2] UNICEF (2021). Early childbearing. <https://data.unicef.org/topic/childhealth/adolescent-health/>
- [3] World Health Organization (2014). Adolescent pregnancy fact sheet. (2014). [https://apps.who.int/iris/bitstream/handle/10665/112320/WHO\\_RHR\\_14.08\\_eng.pdf](https://apps.who.int/iris/bitstream/handle/10665/112320/WHO_RHR_14.08_eng.pdf).
- [4] World Health Organization (2020). Adolescent pregnancy. <https://www.who.int/news-room/fact-sheets/detail/adolescent-pregnancy>.
- [5] Bain LE., Muftugil-Yalcin S., Amoakoh-Coleman M., Zweekhorst MB., Becquet R., and de Cock Buning T (2020). Decisionmaking preferences and risk factors regarding early adolescent pregnancy in Ghana: stakeholders' and adolescents' perspectives from a vignette-based qualitative study. *Reprod Health*. 17:141. 10.1186/s12978-020-00992-x
- [6] Bureau of Reproductive Health Thailand (2016). The act for prevention and solution of the adolescent pregnancy, B.E. 2559. The Minister of Public Health. <http://law.m-society.go.th/law2016/uploads/lawfile/5906c45567a77.pdf>
- [7] UNICEF (2015). UNICEF annual report. [https://www.unicef.org/publications/index\\_92018.html](https://www.unicef.org/publications/index_92018.html).
- [8] National Statistical Office of Thailand (NSOT) (2020). Thailand multiple indicator cluster survey 2019, snapshots of key findings report National statistical office of Thailand. <https://mics-surveys-prod.s3.amazonaws.com/MICS6/East%20Asia%20and%20the%20Pacific/Thailand/2019/Snapshots/Thailand%202019%20MICS%20Statistical%20Snapshots>.
- [9] UNICEF (2018). The state of the world's children 2019 children, food and nutrition: growing well in a changing world. <https://www.unicef.org/reports/state-of-worlds-children-2019>.

- [10] Kumruangrit S. and Srijundee R. (2022). Thai adolescent mothers: perspectives on sexuality education and educational opportunities. *Humanities, Arts and Social Sciences Studies* 22(2): 273-280.
- [11] World Health Organization. (2016). *Global Health Estimates 2015: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2015*. Geneva: World Health Organization.
- [12] World Health Organization. (2018). Adolescent Pregnancy. [www.who.int/en/news-room/factsheets/detail/adolescent-pregnancy](http://www.who.int/en/news-room/factsheets/detail/adolescent-pregnancy).
- [13] Nabugoomu J., Seruwagi G.K., and Hanning R (2020). What can be done to reduce the prevalence of teen pregnancy in rural Eastern Uganda?: multi-stakeholder perceptions. *Reprod Health*. 17:134. 10.1186/s12978-02000984-x
- [14] Centers for Disease Control and Prevention (2020). Contraception. <https://www.cdc.gov/reproductivehealth/contraception/index.htm>.

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