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UTILIZING HOLT'S LINEAR METHOD TO PREDICT HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS IN THAILAND

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Abstract:

This study uses annual time series data of HIV prevalence among individuals aged 15-49 years for Thailand from 1990 to 2020 to predict future trends of HIV prevalence 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 0.1 respectively based on minimum MSE. The results of the study indicate that annual HIV prevalence among individuals aged 15-49 years will continue to decline over the out of sample period. Therefore, we encourage authorities to persistently support HIV testing, treatment and prevention programs particularly for key populations.

Keyword(s): - Exponential smoothing, Forecasting, HIV prevalence

Introduction

The HIV epidemic remains serious public health and social problem in all the regions of the world. In the past 10 years, Thailand witnessed a rapid rise in HIV cases and the cumulative number of Thai people living with HIV continues on an upward trend regardless of implementation of preventive health interventions (NAC, 2015; NAC, 2014). According to UNAIDS 2017, Thailand reported approximately 440,000 people living with HIV (PLWH) and 15,000 deaths due to AIDS-related illnesses annually. The Thai government implemented several strategies in order to curb new HIV infections and these interventions included the condom use programme (CUP). The CUP contributed significantly to the reduction of new HIV infections among female sex workers and their clients (Surit *et al.* 2017; Decker *et al.* 2010; Ministry of Health, 2010; Brown *et al.* 2005; WHO & MOH, 2005). The sentinel surveillance of HIV infection conducted during the period 1989-2009 revealed that the National HIV prevalence declined from 27% to 5% among FCSWs in brothels and from 10% to 3% in non-brothel sex settings. In addition, HIV prevention programs reduced the number of annual new HIV infections from 115,000 in 1992 to 6400 in 2016 (UNAIDS, 2017; Siraprapasiri *et al.* 2016; Punyacharoensin & Viwatwongkasem, 2009). These public health interventions were most successful in decreasing HIV transmission among reproductive age adult populations and people who inject drugs (PWID) (Chaivooth *et al.* 2017). In Thailand, HIV prevalence is higher among sex workers. In 2014, there were approximately 141,769 sex workers in Thailand and

HIV prevalence was around 12% among male sex workers (MSWs) and 2% among FCSWs (Surit *et al.* 2022). Urban areas usually report higher HIV prevalence among FCSWs (Decker *et al.* 2010). Thai government has successfully managed to rapidly scale up access to HIV testing and antiretroviral therapy for key populations, including MSM. HIV prevalence in MSM is nearly 10 times higher than in reproductive age adults nationwide (UNAIDS, 2017). Incentives to motivate key populations to access HIV testing include providing free tests and rapid results (Muccini *et al.* 2019). The purpose of this paper is to model and forecast HIV prevalence among individuals aged 15-49 years for Thailand using Holt's double exponential smoothing technique. The research findings are expected to inform policy, planning and allocation of resources towards targeted HIV prevention and treatment programs in the country in order to control the HIV epidemic.

Literature Review

Author (s)	Objective (s)	Methodology	Key finding (s)
Uthis et al. (2023)	To describe the development and validation of a contextually appropriate internalized HIV-related Stigma Scale for people living with HIV in Thailand.	-cross-sectional survey	The exploratory factor analysis showed that the Thai-IHSS consisted of four components: negative thoughts toward self (5 items), anticipated negative thoughts (7 items), effects of negative thought toward self (6 items), and effects of negative thoughts toward family and access to healthcare services (4 items)
Harris and Thaiprayoon (2022)	To offer a comparative and historical understanding the process by which three of the country's most well-known initiatives came into being: a civil society campaign to promote condom usage; a Ministry of Public Health program that aimed to prevent the spread of Human Immunodeficiency Virus (HIV) by targeting high-risk populations (the 100% condom program); and a universal Prevention of Mother-To-Child Transmission (PMTCT) program	The research relied on existing literature and interviews with high-ranking ministerial officials, representatives from international and non-governmental organizations, professors, and philanthropic organizations, in addition to a review of the existing literature.	Common factors in HIV/AIDS prevention that cut across the three key cases include policy entrepreneurs who championed the programs, successful demonstration projects that produced a credible evidence base for policy adoption, and a diverse set of institutional partners that played critical roles in helping to mainstream their initiatives into national HIV/AIDS policy and scale programs nationally
Phuphuakrat et al. (2022)	To quantify and characterize missed opportunity (MO) for earlier diagnosis of HIV	The medical records of adults who were newly diagnosed with HIV between 2019 and 2020 at the two tertiary	Missed opportunities for earlier diagnosis of HIV infection occurred in both participating hospitals in Thailand. Skin

	infection in PLHIV in Thailand	hospitals in Thailand were reviewed	manifestations were the most common clinical indicator diseases that were missed
Surit et al. (2022)	To explore HIV/AIDs Risk Perception and Sexual Behavior among Commercial Female Sex Worker in Thailand	-A cross-sectional study was conducted among 141 CFSWs in Bangkok, Thailand -Applied logistic regression	Most CFSWs reported that they did not consistently use condom (57.45%), factors associated with perception risk of HIV/AIDs including education level, knowledge of HIV and STDs, years engaged in sex work, age of initiating in sex work, frequency of sex work in the last month and unplanned sex work were significant with risk perception of HIV/AIDs, and had HIV/STDs test
van Griensven et al. (2022)	To analyze epidemiologic and program data and reach agreement between experts and stakeholders on the evolving state of the HIV epidemic among MSM and TGW in Thailand	A customized Delphi process was used to consult and consolidate viewpoints of experts and stakeholders	At the current rate of new HIV infections in MSM and TGW, Thailand will not reach its goal of ending AIDS by 2030
Jose et al. (2021)	To determine prevalence of HIV infection and associated risk factors among young Thai Men in 2018	A cross-sectional study was conducted among the male army conscripts in 2018 at 36 military training units nationwide	The prevalence of HIV infection among men who have sex with men (MSM) was 4.0%. The proportion of consistent condom use with a male partner was 39.7%. The risk factors of HIV infection included having sex with another man, history of sexually transmitted infection and history of sex in exchange for gifts/money. Only 1.4% of MSM used pre-exposure prophylaxis (PrEP).
Jommaroeng et al. (2019)	To investigate the effectiveness of the national HIV prevention outreach program for men who have sex with men (MSM) and transgender women (TGW).	The study applied mixed methods of both quantitative and qualitative approaches	There were 16,539 MSM, and TGW reached at least three times in the program during October 2011–September 2012. The program was found to affect changes in condom use with steady

			partners (po0.000), condom use with casual partners (po0.000), water-based lubricant use (po0.000), HTC uptake (po0.000) and STIs screening uptake (po0.000).

Methodology

This study utilizes an exponential smoothing technique to model and forecast future trends of HIV prevalence among individuals aged 15-49 years 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

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

Smoothing equation

$S_t= \alpha A_t + (1-\alpha) (S_{t-1} + b_{t-1})$

$0<\propto<1$

Trend estimation equation

$b_t= \beta (S_t-S_{t-1}) + (1-\beta) b_{t-1}$

$0<\beta<1$

Forecasting equation

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

A_t is the actual value of HIV prevalence 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
S_t is the exponentially smoothed value of HIV prevalence 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 (slope of the trend) at time t
b_{t-1} is the trend estimate at time t-1

Data Issues

This study is based on annual HIV prevalence among individuals aged 15-49 years in Thailand for the period 1990 – 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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Findings of the study

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	A
Included Observations	31
Smoothing constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.139904
Sum Square Error (SSE)	2.357396
Mean Square Error (MSE)	0.076045
Mean Percentage Error (MPE)	-3.697963
Mean Absolute Percentage Error (MAPE)	12.177674

Residual Analysis for the Applied Model

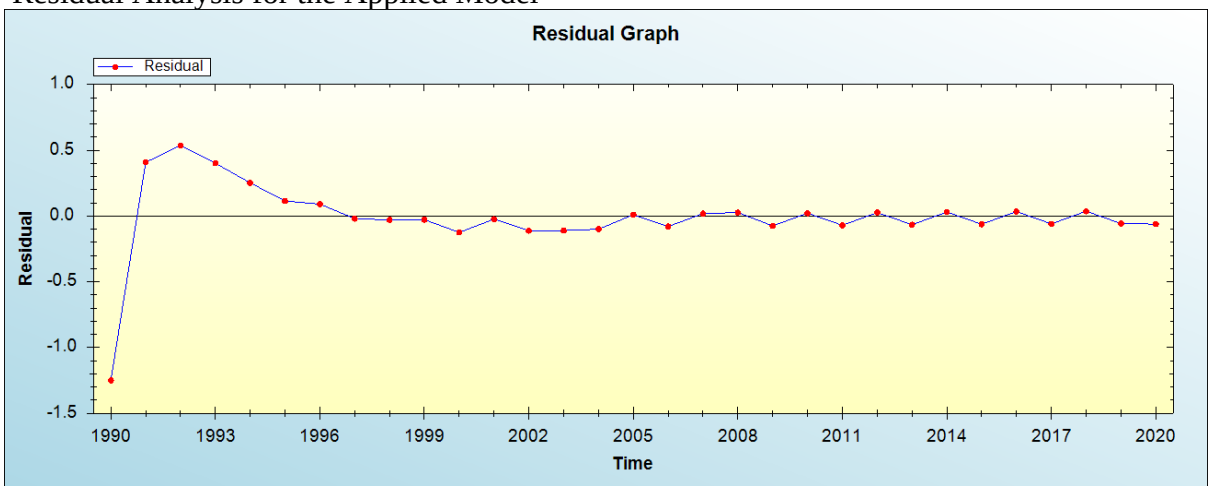

Figure 1: Residual analysis

In-sample Forecast for A

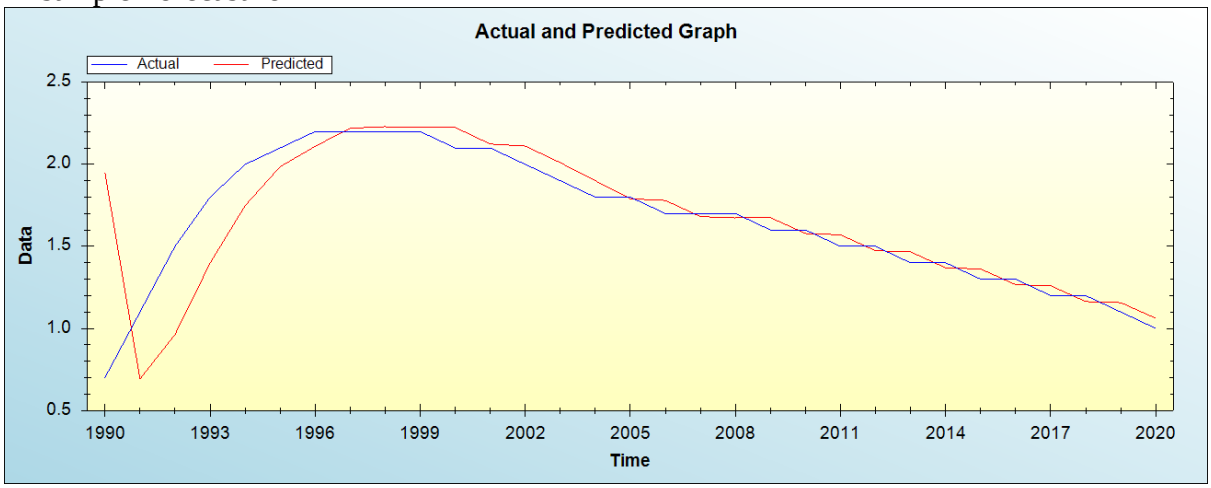

Figure 2: In-sample forecast for the A series

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Actual and Smoothed graph for A series

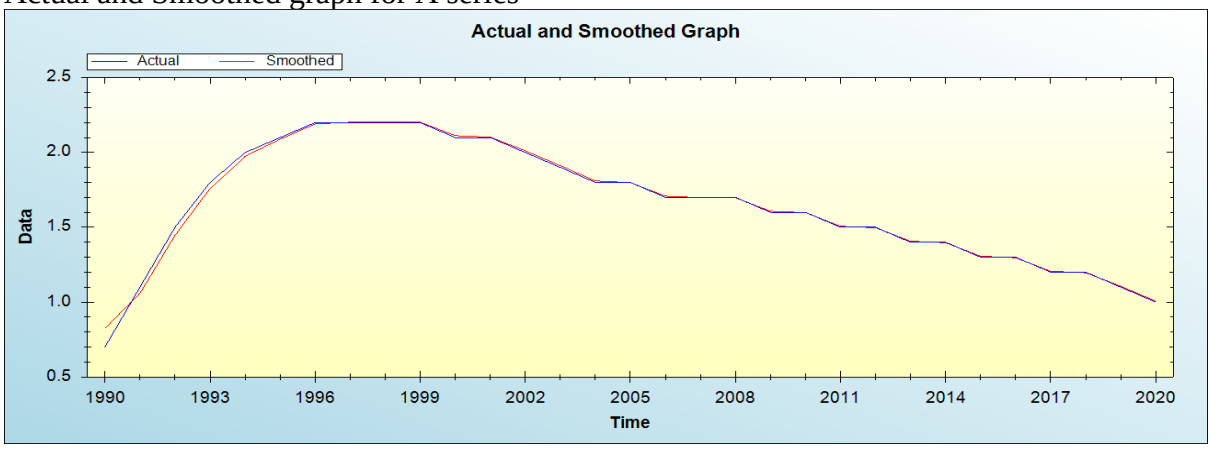

Figure 3: Actual and smoothed graph for A series

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

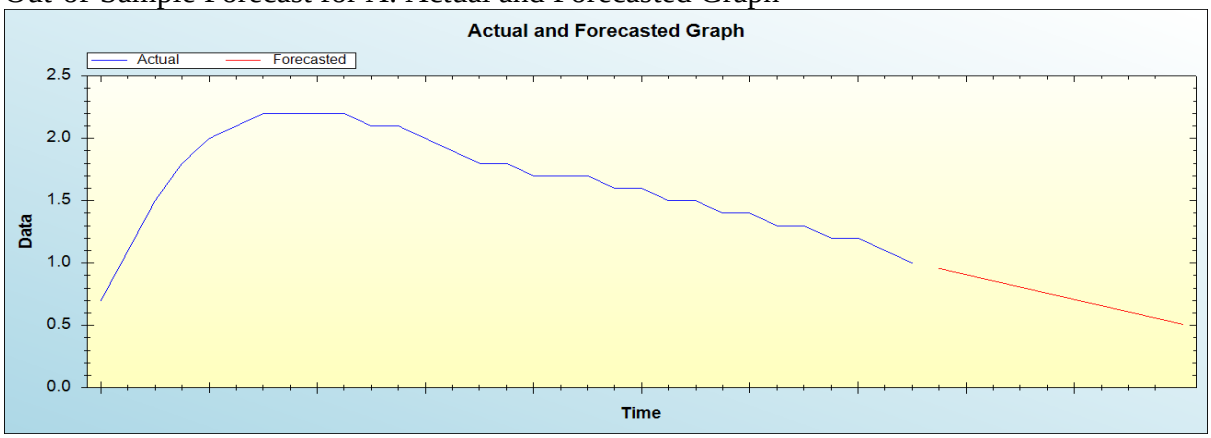

Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted HIV prevalence
2021	0.9564
2022	0.9067
2023	0.8570
2024	0.8073
2025	0.7576
2026	0.7078
2027	0.6581
2028	0.6084
2029	0.5587
2030	0.5090

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 HIV prevalence among individuals aged 15-49 years will continue to decline over the out of sample period.

Policy implication and conclusion

Our study results indicate that annual HIV prevalence among individuals aged 15-49 years will continue to decline over the out of sample period. Therefore, this paper emphasizes the need to persistently support HIV testing, treatment and prevention programs particularly for key populations.

References

1. NAC (2014) Thailand National Operating Plan Accelerating Ending AIDS 2015-2019.
2. NAC (2015) "Thailand AIDs Response Process Report 2015" and Thai MoH/NAC/UNAIDS "AIDS Zero Portal: Data Use Tool".
3. Ministry of Health (2010) NACP, UNGASS Country Progress Report 2010: Thailand Reporting Period January 2008-December 2009. National AIDS Control Programme.
4. Brown, T. and Thailand A2 Team (2005) Preliminary Results of HIV/AIDS Projection 2005-2025. The Integrated Analysis and Advocacy — HIV / AIDS Projection Meeting, Bangkok, 12-14 August 2005, 102-104.
5. Decker, M.R., McCauley & H.L (2010) Sex Trafficking, Sexual Risk, Sexually Transmitted Infection and Reproductive Health among Female Sex Workers in Thailand. Journal of Epidemiology and Community Health, 100, 52-56.
6. Surit, P., Jariya, W., Zheng, N., Yi, H., Yu, X.J., Srithong, W. and Mirasena, S. (2017) Risk Factors Affecting Condom Use among Royal Thai Army Conscripts in Thailand. World Journal of AIDS, 7, 92-105. https://doi.org/10.4236/wja.2017.72009
7. WHO South-East Asia Regional Office and Ministry of Public Health (2005) External Review of the Health Sector Response to HIV/AIDS in Thailand. Bangkok
8. Surit, P., Yasothornsrikul, S. and Mitkitti, R. (2022) HIV/AIDs Risk Perception and Sexual Behavior among Commercial Female Sex Worker in Thailand. World Journal of AIDS, 12, 141-155. https://doi.org/10.4236/wja.2022.123011
9. Country factsheets Thailand 2017. UNAIDS; https://www.unaid s.org/en/ regions cou ntries/countries/thailand.
10. Siraprapasiri T, Ongwangdee S, Benjarattanaporn P, Peerapatanapokin W, & Sharma M (2016). The impact of Thailand's public health response to the HIV epidemic 1984–2015: understanding the ingredients of success. J Virus Erad. 2016; 2(Suppl 4):7–14.
11. Data book 2017. UNAIDS; https://www.unaid s.org/sites /default/files /media _asset /20170 720_Data_book_2017_en.pdf.
12. Punyacharoensin N & Viwatwongkasem C (2009). Trends in three decades of HIV/AIDS epidemic in Thailand by nonparametric backcalculation method. AIDS. 2009;23:1143–52
13. Chaivooth S, Bhakeecheep S, Ruxrungtham K, Teeraananchai S, Kerr SJ, & Teeraratkul A (2017). The challenges of ending AIDS in Asia: outcomes of the Thai National AIDS Universal Coverage Programme, 2000–2014. J Virus Erad. 2017; 3:192–9.
14. Camilla Muccini., Trevor A. Crowell., Eugène Kroon., Carlo Sacdalan., Reshmie Ramautarsing., Pich Seekaew., Praphan Phanuphak., Jintanat Ananworanich., Donn J. Colby and Nittaya Phanuphak (2019). Leveraging early HIV diagnosis and treatment in Thailand to conduct HIV cure research, AIDS Res Ther (2019) 16:25 https://doi.org/10.1186/s12981-019-0240-4.