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FORECASTING HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS FOR SURINAME USING HOLT'S LINEAR METHOD

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Abstract:

This study uses annual time series data of HIV prevalence among individuals aged 15-49 years for Suriname 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 0.3 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 continuously support HIV diagnosis, treatment and prevention programs among this age groups with targeting of high risk groups.

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

Introduction

According to the General Bureau of Statistics, Suriname is located in the northern part of South America and has an estimated population size of 567.300 inhabitants from different ethnic backgrounds. The three most prominent ethnic groups are Africans (38%), Indian (27%), and Javanese descent (14%) (Stijnberg *et al.* 2022). The country is made up of ten administrative districts, of which two are urban, six are rural, and two are interior areas. The two urban districts, including the capital Paramaribo, cover only 0.5% of the land surface but contain 70% of the total population (PAHO, 2017). UNAIDS data revealed that approximately 5200 people were living with HIV in 2020 with an estimated HIV sero-prevalence in the general population of 1.1%. In Suriname, HIV remains one of the leading causes of mortality (PAHO, 2017) with a mortality rate of 14.9 per 100000 in 2017 (Stijnberg *et al.* 2019). The National HIV response focuses on HIV testing, ART initiation for all HIV positive individuals, and implementation of the combination HIV prevention strategy (Suriname Ministry of Health, 2014). The purpose of this study is to model and forecast HIV prevalence among the 15-49 year age group using Holt's linear method. The study findings are expected to inform policy, planning and allocation of resources to HIV programs targeting young adults.

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Literature review

Author (s)	Objective (s)	Methodology	Key finding (s)
Stijnberg et al. (2023)	To evaluate the cascade of care for the elimination of mother-to-child-transmission of human immunodeficiency virus (HIV) in Suriname and identify sociodemographic and clinical factors preventing transmission to exposed infants	A mixed-methods study design was used. Antenatal care data from the 2018 cross-sectional multi- indicator cluster survey on 1 026 women aged 15–49 years who had had a live birth in the previous 2 years were used.	Of the pregnant women with HIV, 84.2% received antiretroviral therapy, while 95.5% of their infants received HIV prophylactic treatment. Receiving antiretroviral therapy for the mother (odds ratio (OR) 45.4, 95% confidence interval (CI) 9.6–215.3) and the child (OR 145.7, 95% CI 14.4–1477.4) significantly increased the odds of a negative HIV test result in infants. Conversely, living in the interior decreased the odds (OR 0.2, 95% CI 0.4–0.7) compared with urban living
Karagodina et al. (2023)	To examine the barriers and facilitators of HIV detection, initiation of treatment, and adherence to antiretroviral therapy (ART) among WWID	-in-depth interviews	The ongoing war against Ukraine continues to have a detrimental impact on all aspects of the population's life, particularly affecting WWID
Stijnberg et al. (2022)	To identify sociodemographic and clinical factors influencing HIV diagnosis, linkage to care, antiretroviral therapy (ART) initiation and retention, and viral suppression in Suriname	Applied multiple regression looking into sociodemographic and clinical factors was executed. Indicators evaluated were 'knowing HIV status', people initiating ART, 1-year ART retention, and viral suppression with ART.	Men initiate treatment at a more advanced stage of disease (CD4≤200) than women (47.4% versus 31.4%), leading to higher mortality rates. People from the interior were less likely linked to care (aOR, 0.6; 95% CI, 0.4–0.8) than those from urban regions but did not display significant differences in treatment initiation.
Rozanova et al. (2021)	To examine HIV diagnoses in older people living with HIV (OPWH) in Ukraine, a country emblematic of the EECA region	Analyzed incident HIV diagnoses from 2015–2018 and mortality trends from 2016–2018 for three age groups: 1) 15–24 years; 2) 25–49 years; and 3)50 years. AIDS was defined as CD4<200cells/mL	Newly diagnosed OPWH had the same-year mortality ranging from 3 to 8 times higher than age-matched groups in the Ukrainian general population
Bello et al. (2018)	To reconstruct the spatiotemporal pattern of	Major Guianese/Surinamese	Results showed that the HIV subtype B epidemic

	spread of "BPANDEMIC" lineage and of non-pandemic subtype B viral lineages circulating in French Guiana and Suriname	BPANDEMIC and BCAR lineages were identified by Maximum Likelihood phylogenetic analysis and the spatiotemporal and demographic parameters estimated using a Bayesian coalescent-based method	in French Guiana and Suriname has been driven by multiple active BCAR and BPANDEMIC transmission chains that arose since the middle 1970s onward and operate in both countries simultaneously. Although no significant differences in the epidemic potential of major BCAR and BPANDEMIC lineages were observed, relevant associations between the infecting subtype B lineage and epidemiological and clinical characteristics were detected in French Guiana

Methodology

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

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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 Suriname 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.

Study findings

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	0.300
Forecast performance measures	
Mean Absolute Error (MAE)	0.055161
Sum Square Error (SSE)	0.191564
Mean Square Error (MSE)	0.006179
Mean Percentage Error (MPE)	-2.045798
Mean Absolute Percentage Error (MAPE)	11.085707

Residual Analysis for the Applied Model

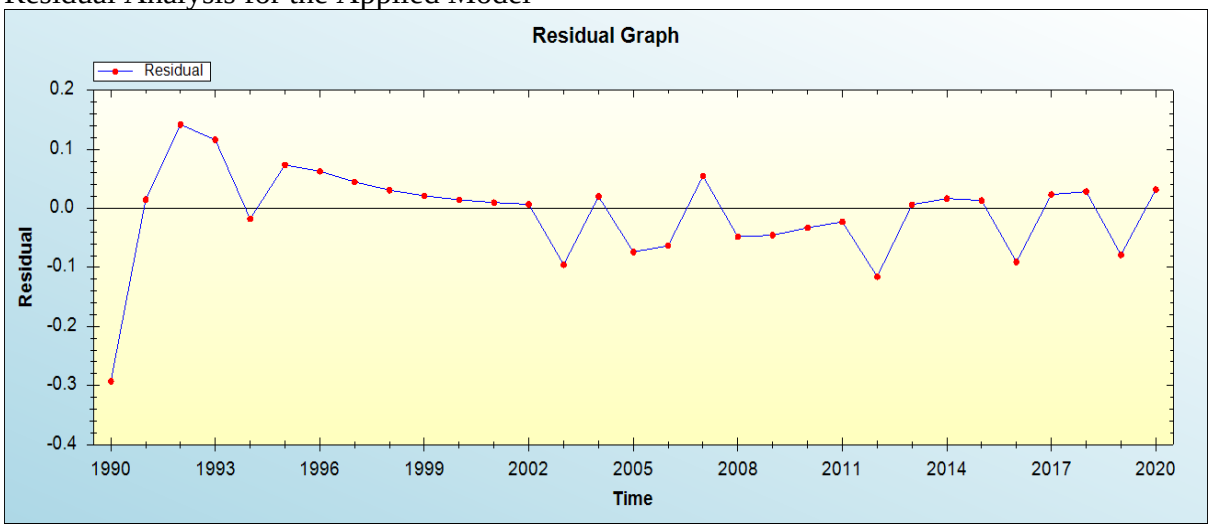

Figure 1: Residual analysis

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In-sample Forecast for A

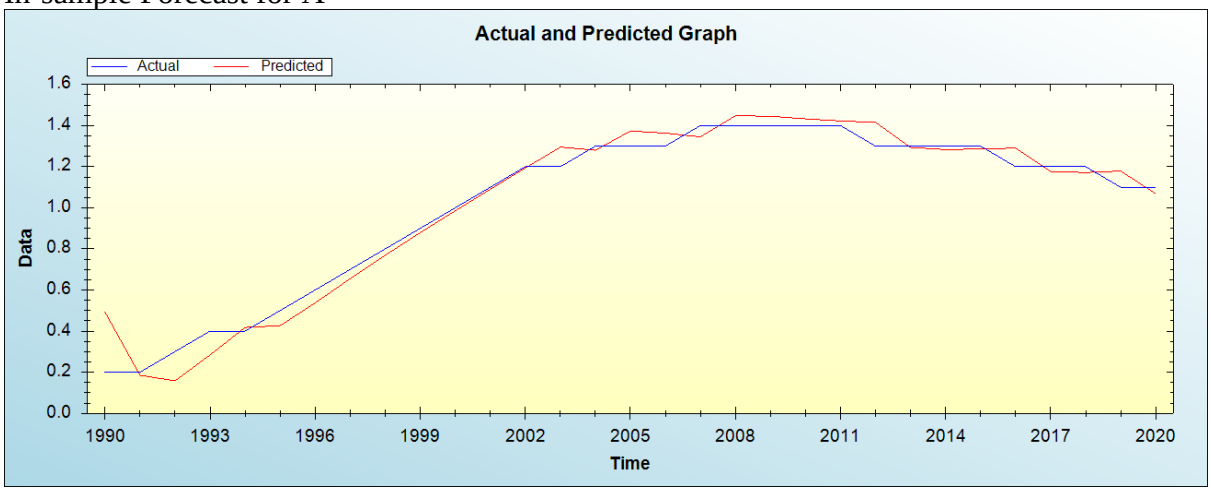

Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

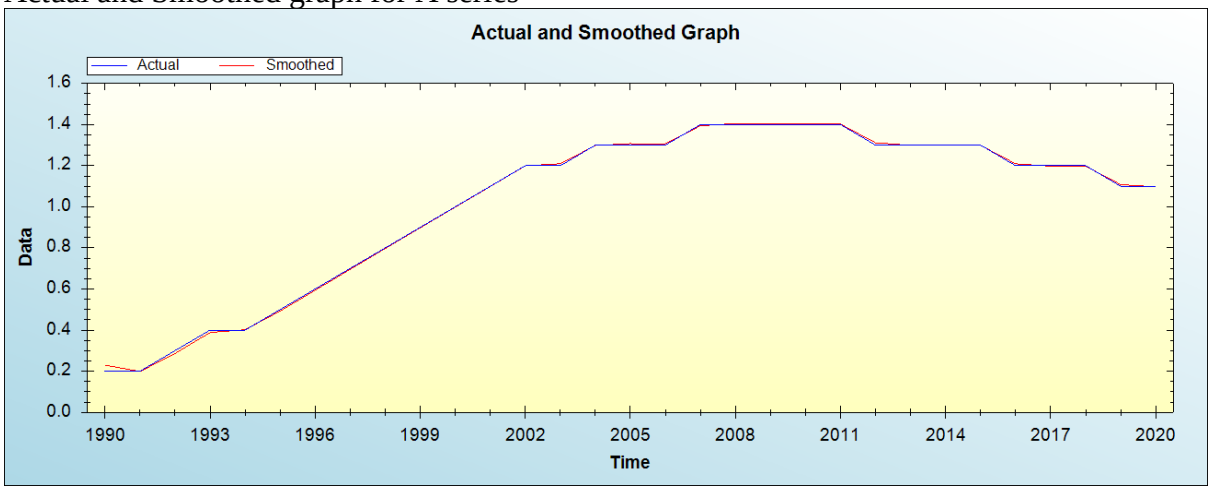

Figure 3: Actual and smoothed graph for A series

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

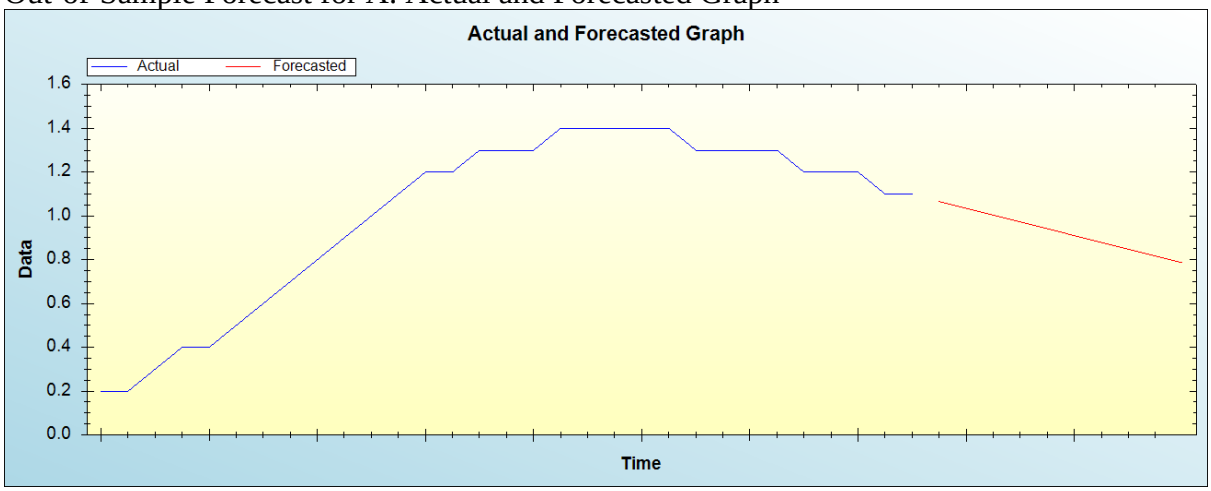

Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted HIV prevalence
2021	1.0657
2022	1.0346
2023	1.0035
2024	0.9723
2025	0.9412
2026	0.9101
2027	0.8790
2028	0.8479
2029	0.8167
2030	0.7856

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

This study establishes that annual HIV prevalence among individuals aged 15-49 years will continue to decline over the out of sample period. Therefore, this paper calls for the authorities to continuously support HIV diagnosis, treatment and prevention programs among this age groups with targeting of high risk groups.

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