



PREDICTING HIV PREVALENCE AMONG PEOPLE AGED 15-49 YEARS FOR ANGOLA USING BROWN'S DOUBLE EXPONENTIAL SMOOTHING TECHNIQUE

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Article history:	Abstract:
Received: April 20 th 2024 Accepted: May 14 th 2024	<i>This study uses annual time series data on HIV prevalence among people aged 15-49 years for Angola from 1990 to 2021 to predict future trends of HIV prevalence over the period 2021 to 2030. The study utilizes double (Brown) exponential smoothing model. The optimal value of the smoothing constant α is 0.6 based on minimum MSE. The results of the study indicate that annual HIV prevalence among individuals aged 15-49 years will decline slightly over the out of sample period. Therefore, we encourage authorities in Angola to address local drivers of HIV transmission, strengthen detection of new HIV cases, prompt ART initiation, and strengthen HIV preventive measures.</i>

Keywords: Exponential smoothing, Forecasting, HIV prevalence

BACKGROUND

The rapid scale up of comprehensive and effective HIV services is an initiative made by the Joint United Nations Programme (UNAIDS) to achieve zero new HIV infections by 2030 (UNAIDS, 2015). Under this initiative, the aim is to ensure that 95% of people living with HIV (PLHIV) know their HIV status, 95% of those infected with HIV are on treatment and 95% of those on treatment have viral suppression. People living in low-middle countries are disproportionately affected by HIV, constituting more than half of the global PLHIV with 20.6 million people currently estimated to be HIV positive (UNAIDS, 2019). Statistics indicate that, as of 2018, 85% of PLHIV in this region were aware of their HIV status, of whom 79% were accessing treatment. Moreover, 25% of new HIV infections in East and Southern Africa were concentrated among key populations such as female sex workers, men having sex with men, prisoners and, people who inject drugs (Orel *et al.* 2020). According to UNAIDS the national HIV prevalence for the 15–49 year age group is 1.9%, with higher prevalence rates in provinces with international borders (Angola, 2010). This relatively low prevalence is partly attributed to the country's long civil war (1975–2002) and closed borders (Kendall *et al.* 2016). Angola has witnessed a slight decline in HIV incidence in women (ages 15-49) between 2009 and 2010 –from 0.3% in 2009 to 0.2% in 2010. Among young people (15-24 years), HIV prevalence was nearly three times higher among young women (1.6%) than young men (0.6%) in 2009 (Angola, 2016). The aim of this study is to model and forecast HIV prevalence among the 15-49 years age group for Angola using Brown exponential smoothing model. The findings of this research are expected to reveal likely future impact of HIV prevention strategies, ART treatment and care services.

LITERATURE REVIEW

Author (s)	Objective (s)	Methodology	Key finding (s)
Vueba et al. (2021)	To analyze the spatial pattern of HIV and HBV infections in pregnant women in Luanda, Angola, and the statistical association between HIV and HBV and socio-economic characteristics, hygiene, and health status.	The potential risk factors associated with HIV HBV infection were evaluated using bivariate and multivariate binomial logistic regression analysis	Anti-HIV antibodies were positive in 118 samples (13.4%) and HBV infection were positive in 226 (25.7%). -The results showed that the seroprevalence of HBV was similar in most municipalities



			-For HIV, the seroprevalence was also close ranges among the municipalities
Orel et al. (2020)	To predict the HIV status of individuals based on socio-behavioral characteristics	Analyzed over 3,200 variables from the most recent Demographic Health Survey from 10 countries in East and Southern African and trained four machine-learning algorithms and selected the best based on the f1 score.	The study was able to identify PLHIV and those at high risk of infection who may be offered pre-exposure prophylaxis and/or voluntary medical male circumcision
Kendall et al. (2015)	To conduct the first population size estimation and biological and behavioral surveillance survey among men who have sex with men (MSM) in Angola	Univariate, bivariate, and multivariate analyses examined factors associated with HIV and unprotected sex	Risk behaviors are widely reported, but HIV seroprevalence is lower than expected
Chitsama et al. (2012)	To explore deminers' HIV/AIDS knowledge in Cassinga, southern Angola.	The survey included 45 in depth interviews with deminers in Cassinga in southern Angola.	The demining workplace has insufficient HIV/AIDS prevention and education services for deminers

METHODOLOGY

This study utilizes double (Brown) exponential smoothing technique to model and forecast future trends of HIV prevalence among people aged 15-49years in Angola. In exponential smoothing forecasts are generated from the smoothed original series with the most recent historical data points having greater influence than those in the more distant past as more recent values are allocated more weights than those in the distant past.

Double (Brown) exponential smoothing is specified as follows:

Model equation

$$A_t = \mu_t + \beta_t t + \varepsilon_t \dots \dots \dots [1]$$

Smoothing equation

$$S_t = \alpha A_t + (1-\alpha)S_{t-1} \dots \dots \dots [2]$$

$$0 < \alpha < 1$$

Trend estimation equation

$$T_t = \alpha (S_t - S_{t-1}) + (1-\alpha)T_{t-1} \dots \dots \dots [3]$$

Forecasting equation

$$f_{t+h} = S_t + [(h-1) + 1/\alpha] T_t \dots \dots \dots [4]$$

A_t is the actual value of HIV prevalence among people aged 15-49 years at time t

ε_t is the time varying **error term**

μ_t is the time varying mean (**level**) term

β_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 among people aged 15-49 years at time t (used to estimate the level term)

α is the exponential smoothing constant for the data and trend

f_{t+h} is the h step ahead forecast

T_t is the trend estimate (used to estimate the **slope term**) at time t



T_{t-1} is the trend estimate at time t-1

DATA ISSUES

This study is based on annual HIV prevalence among people aged 15-49 years in Angola 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.

FINDINGS OF THE STUDY

Exponential smoothing Model Summary

Table 1: ES model summary

Variable	A
Included Observations	31
Smoothing constant	
Alpha (α) for data	0.600
Forecast performance measures	
Mean Absolute Error (MAE)	0.044808
Sum Square Error (SSE)	0.096611
Mean Square Error (MSE)	0.003220
Mean Percentage Error (MPE)	0.879912
Mean Absolute Percentage Error (MAPE)	5.372842

Residual Analysis for the Applied Model

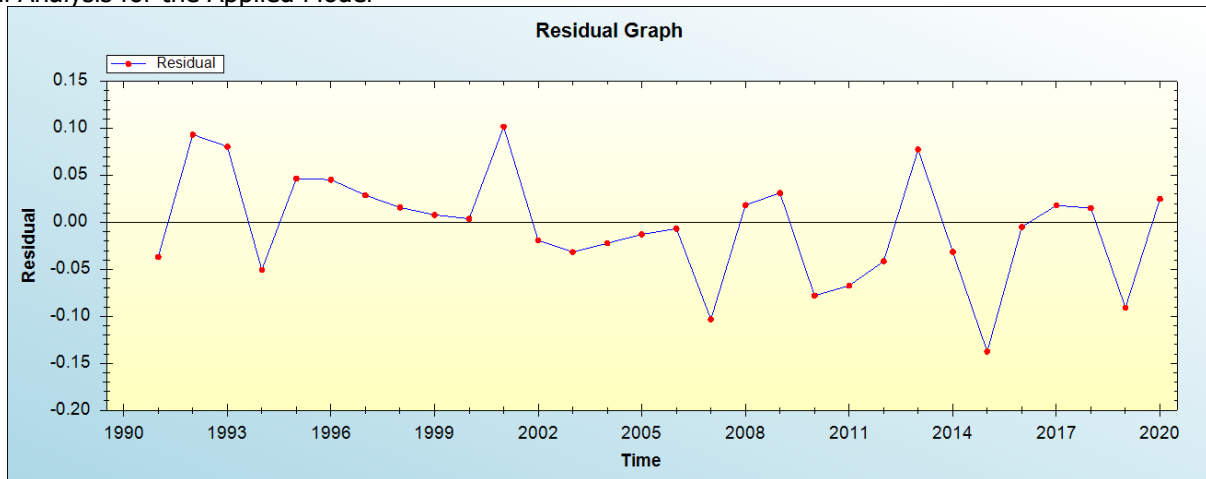


Figure 1: Residual analysis

In-sample Forecast for A

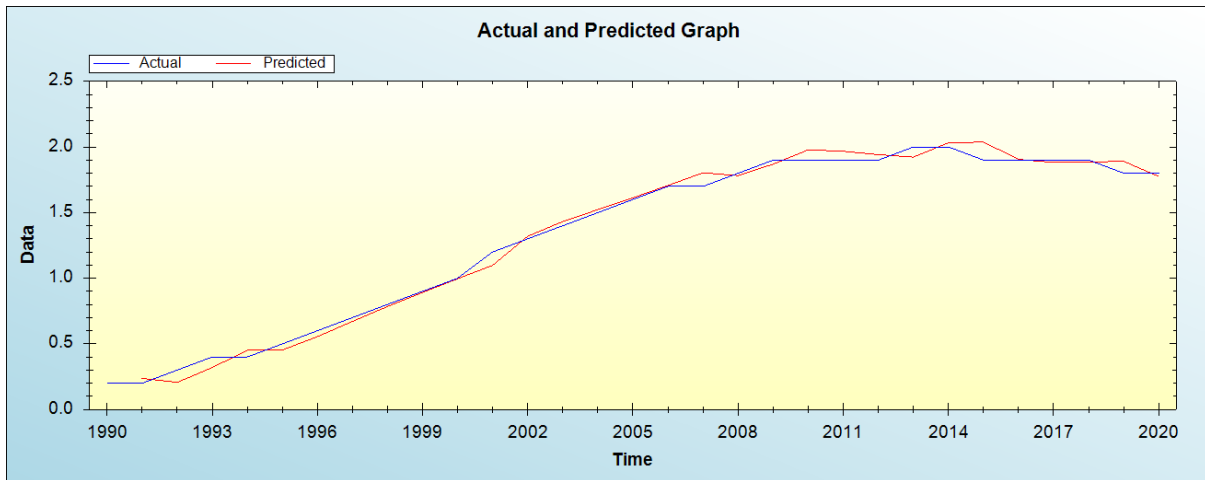


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

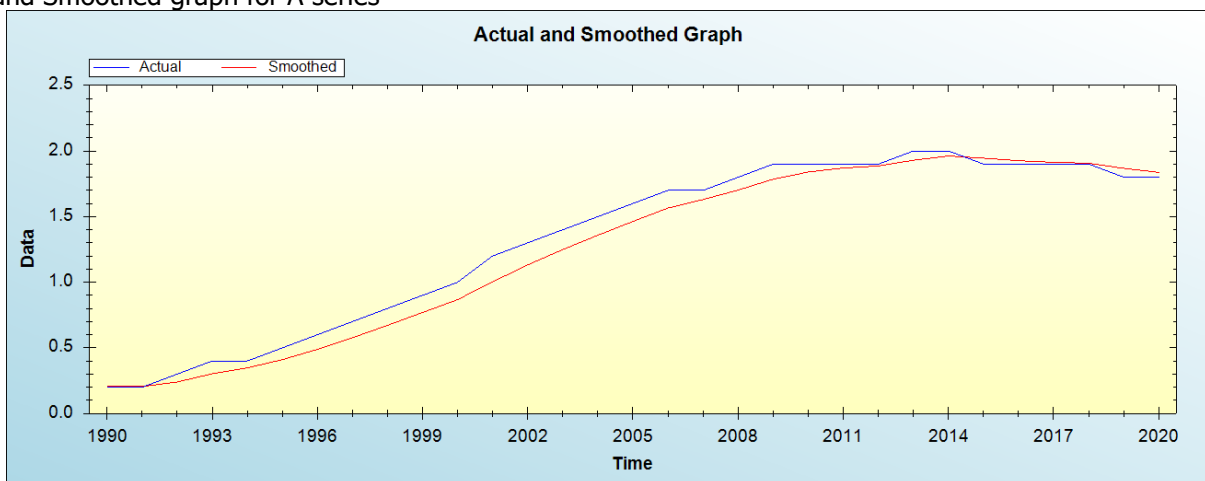


Figure 3: Actual and smoothed graph for A series

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

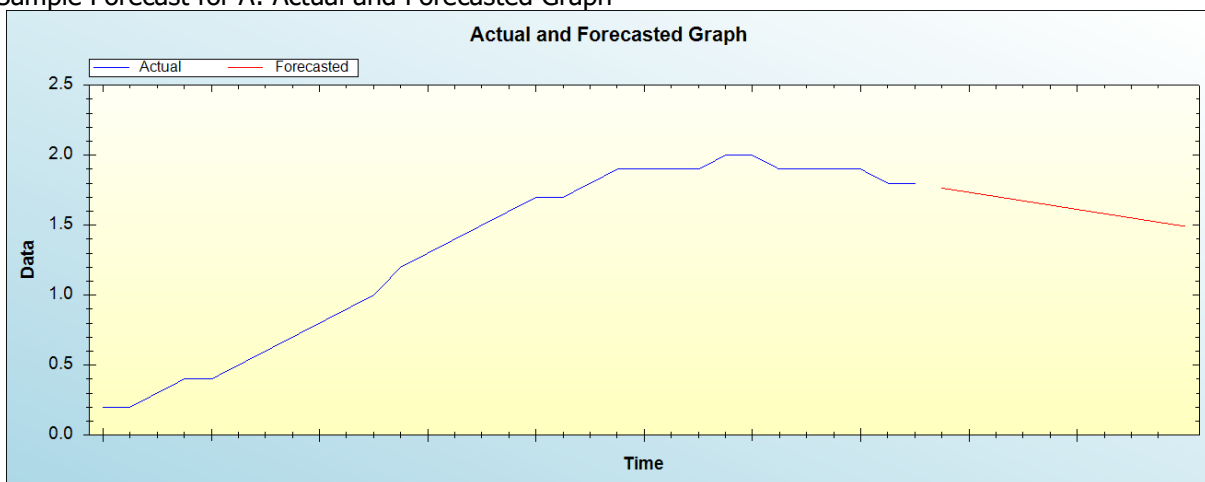


Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only



Table 2: Tabulated out-of-sample forecasts

Year	Predicted HIV prevalence
2021	1.7655
2022	1.7350
2023	1.7045
2024	1.6740
2025	1.6434
2026	1.6129
2027	1.5824
2028	1.5519
2029	1.5214
2030	1.4909

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 people aged 15-49 years will decline slightly over the out of sample period.

Policy implications and conclusion

Exponential smoothing techniques are still useful in time series forecasting. In this study we applied Brown's exponential smoothing technique to forecast HIV prevalence for Angola and the results indicate that the annual HIV prevalence among people aged 15-49 years will decline slightly over the out of sample period. Therefore, policy makers are encouraged to address local drivers of HIV transmission, strengthen detection of new HIV cases and prompt ART initiation, and strengthen HIV preventive measures as well.

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