

PROJECTION OF HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS IN MAURITANIA 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 Mauritania 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 strengthen HIV case detection, prevention and treatment among high risk groups especially key populations.

Keyword: Exponential smoothing, Forecasting, HIV prevalence.

Introduction

According to UNAIDS, globally 36.7 million people were living with human immune deficiency virus (HIV) in 2015 with 70 percent of people living with HIV were living in sub-Saharan Africa. Low-middle income countries account for 97% of global HIV cases and Sub-Saharan Africa is the most affected region (Kautako-Kiambi et al. 2016). Approximately 3.9 million young people worldwide were infected with HIV in 2017 (Bekele & Fekadu). In addition, an estimated 2.9 million young people living with HIV / AIDS live in eastern and southern Africa (Peltzer & Matseke, 2013). Approximately 15 percent of young women aged 15-24 years in sub-Saharan Africa were aware of their HIV status in 2013 (Meseret et al. 2019). The prevalence of HIV testing among young woman in Africa ranges from 23.5% to 60.10% (Goldani et al. 2003). In Mauritania, the epidemiological situation of HIV infection is not well known (Boushab et al. 2017). Available evidence indicates an estimated seroprevalence rate of less than 1% in the general population (Ba et al. 2015). Based on this prevalence rate, Mauritania can be considered as the least affected country in West Africa (Boushab et al. 2017). The objective of this paper is to model and forecast HIV prevalence among individuals aged 15-49 years for Mauritania using Holt's linear method. The results of this piece of work are envisaged to inform policy, planning and allocation of resources towards targeted HIV programs particularly for Key populations in the country.



Literature Review

Author(s)	Objective (s)	Methodology	Main finding (s)
Dadzie et al. (2024)	To assess the socioeconomic inequalities in HIV testing during antenatal care (ANC) in sub-Saharan Africa.	Sub-Saharan Africa was the focus of this study. Benin, Burundi, Cameroon, Ethiopia, Gambia, Guinea, Liberia, Malawi, Mali, Mauritania, Mozambique, Rwanda, Sierra Leone, Uganda, Zambia, and Zimbabwe were the countries included in the study	There is substantial wealth index-related inequalities in HIV testing, with women of the poorest wealth index disadvantaged in relation to the HIV testing
Mahlalela et al. (2024)	To examine the correlation between HIV-related stigma, HIV testing and ART uptake in older adults.	Applied multivariable logistic regression	-Anticipated stigma was prevalent 85% (95% CI 0.84–0.86), and social stigma was also frequent 25% (95% CI 0.24–0.27). Higher social stigma scores correlated with decreased HIV testing for all participants with social stigma. - Odds of testing decreased with higher stigma scores (OR = 0.66, 95% CI 0.53–0.81, p = 0.000) for a score of 1 and (OR = 0.56, 95% CI 0.38–0.83, p = 0.004) for a score of 3.
Worku et al. (2022)	To investigate the pooled prevalence and associated factors of HIV testing among young women in east Africa.	multivariable analysis	Pooled prevalence of HIV testing among young women was 55.3%: 95% CI (54.97%, 55.69%). In the multilevel multivariable analysis: respondent age, marital status, educational level, occupation, media exposure, having higher and comprehensive knowledge about HIV / AIDS, having some and higher risky sexual behavior, visiting health care facilities, being rural dweller, being from rich households, having multiple sexual partners, early sex initiation and community-level education were significantly associated with HIV testing
Local Burden of Disease HIV Collaborators (2021)	To assess HIV incidence and HIV mortality for all second-level administrative units across sub-Saharan Africa.	Used a model-based geostatistical framework to estimate HIV prevalence at the second administrative level in 44 countries in sub-Saharan Africa for 2000–18 and sought data on the number of individuals on antiretroviral therapy (ART) by second-level administrative unit.	estimates suggested that most second-level administrative units in sub-Saharan Africa are falling short of the targeted 75% reduction in new cases and deaths by 2020
Maulide Cane et al.(2021)	To assess the trends in HIV prevalence by gender in	HIV prevalence data at ages 15–19 years were obtained for 31 countries with a national survey since 2010	HIV prevalence among adolescents declined in almost all countries during the last decade, in both urban and rural settings



	adolescents, as well as urban–rural disparities.	and for 23 countries with one survey circa 2005 and a recent survey circa 2015	
Belachew et al. (2020)	To assess the prevalence of vertical HIV infection and its risk factors among HIV-exposed infants in East Africa.	Scoping review	The pooled prevalence of the mother to child transmission of HIV is way more than the desired target of the World Health Organization, which is less than 5% in breastfeeding populations
Boushab et al. (2017)	To describe the experiences of PLWHA followed at a specialized outpatient center in Nouakchott to assess the forms of stigma from the perspective of those who suffer from discrimination	descriptive and transversal study	The distribution of forms of stigma experienced by PLWHA by demographic category was, in descending order, stigma in interpersonal relationships (78%), self-stigma (20%), and stigma in health services (2%). There was a significant association between the form of stigma and marital status ($p = 0.007$) and between the form of stigma and knowledge of HIV status for a period greater than one year ($p = 0.02$).

Methodology

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

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

Smoothing equation

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

$$0 < \alpha < 1$$

Trend estimation equation

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

$$0 < \beta < 1$$

Forecasting equation

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

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 Mauritania 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 constants	
Alpha (α) for data	0.900
Beta (β) for trend	0.100
Forecast performance measures	
Mean Absolute Error (MAE)	0.043519
Sum Square Error (SSE)	0.158556
Mean Square Error (MSE)	0.005115
Mean Percentage Error (MPE)	-6.486624
Mean Absolute Percentage Error (MAPE)	18.341871

Residual Analysis for the Applied Model

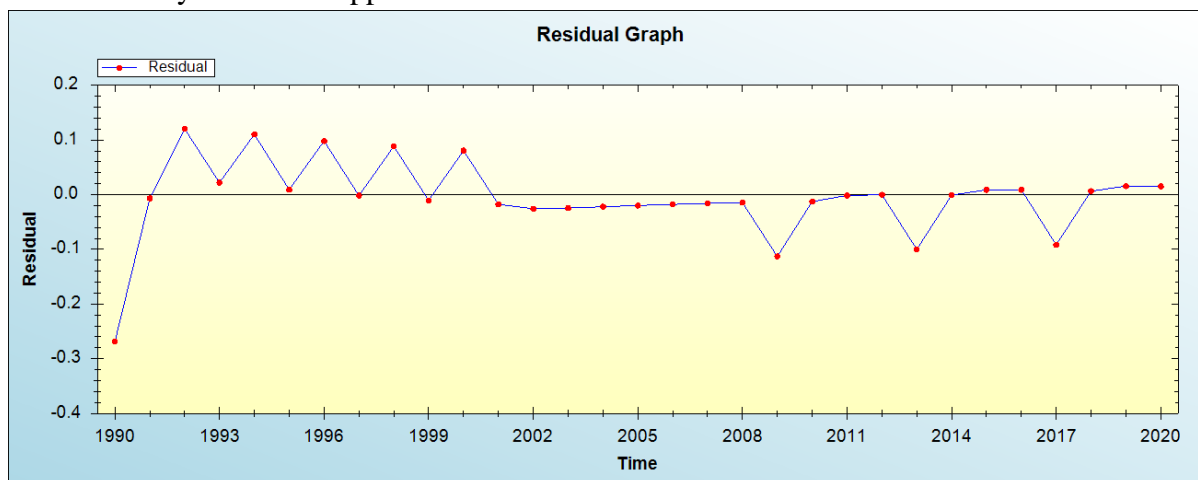


Figure 1: Residual analysis



In-sample Forecast for A

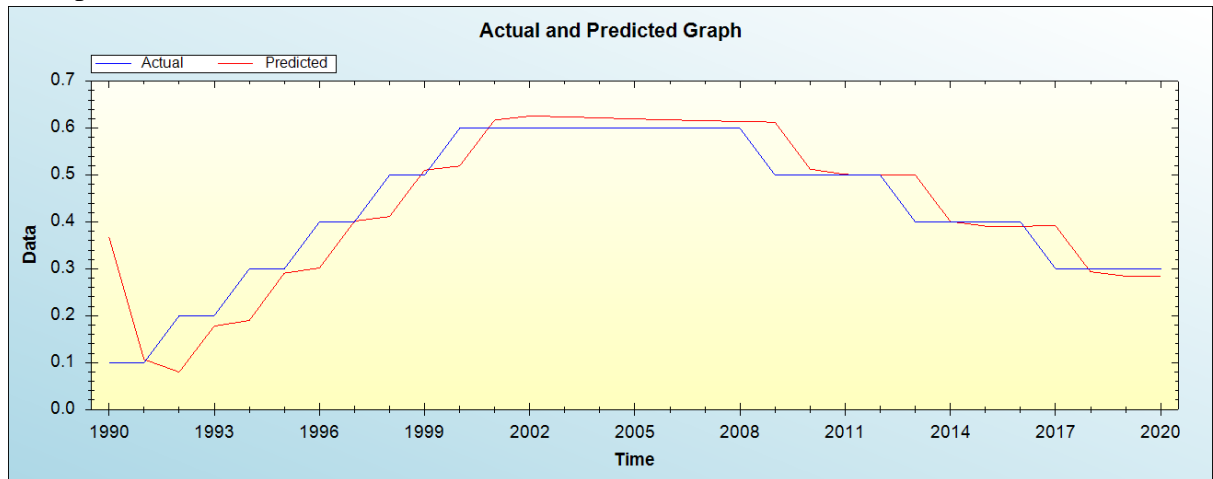


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

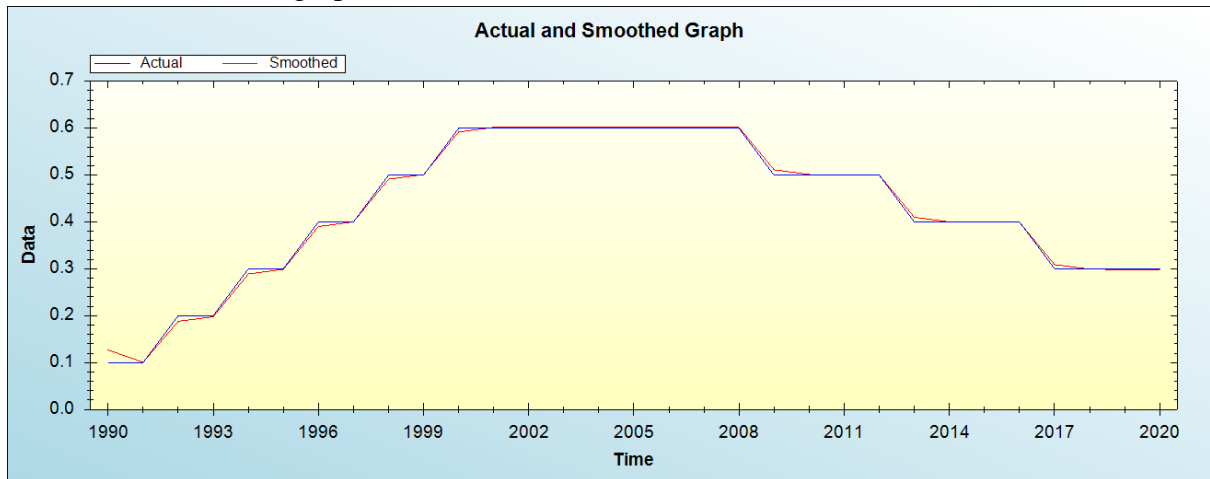


Figure 3: Actual and smoothed graph for A series

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

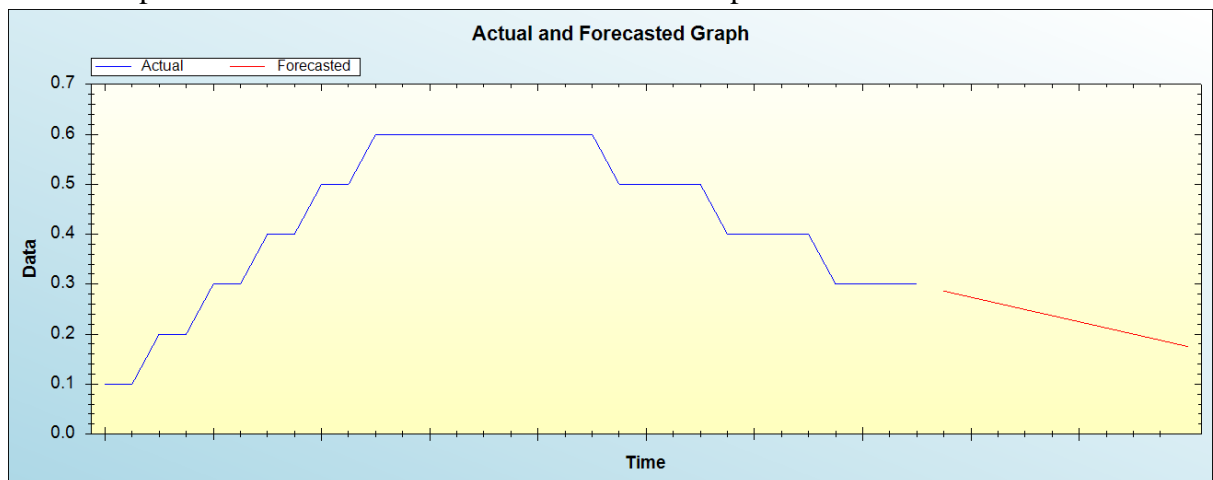


Figure 4: Out-of-sample forecast for A: actual and forecasted graph



Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted HIV prevalence
2021	0.2862
2022	0.2738
2023	0.2615
2024	0.2492
2025	0.2369
2026	0.2246
2027	0.2123
2028	0.2000
2029	0.1877
2030	0.1754

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 model projections indicate 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 strengthen HIV case detection, prevention and treatment among high risk groups especially key populations.

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