

PROJECTION OF HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS IN HONDURAS 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 Honduras 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, treatment and prevention among high-risk groups particularly key populations.

Keywords: - Exponential smoothing, Forecasting, HIV prevalence.

Introduction

Honduras is a lower-middle-income country with widespread poverty and one of the highest inequality rates of the continent (UNDP, 2022). According to UNDP, approximately 19% of the population live in multidimensional poverty and another 22.3% are vulnerable to multidimensional poverty. Honduras is extremely vulnerable to climate change and presents widespread food insecurity and a weak social protection system. Fifty-eight per cent of Honduran households suffer some level of food insecurity. In female-headed households, this rises to 60 per cent, of which 12 per cent – more than 80,000 households – suffer from severe food insecurity. Approximately 24 000 people are living with HIV in Honduras and the HIV epidemic is concentrated among men who have sex with men (MSM), female sex workers (FSWs) and Garifunas (descendants of West African, Central African, Island Carib, and Arawak people) with 0.5% seroprevalence in the general population (UNAIDS, 2015). It is estimated that 60% of people living with HIV (PLHIV) are male with a high proportion of heterosexual transmissions (UNAIDS, 2015; UNAIDS, 2014). The Honduran HIV/AIDS Programme kick started the rapid scale of antiretroviral therapy in 2002 and the country adopted national guidelines on ART for adults and children in 2003. A substantial rise in the number of people on ART was observed after more than 10 years of the implementation of the national ART scale-up programme and around 40% of all HIV infected individuals were receiving ART by 2014 (UNAIDS, 2014). The purpose of this paper is to model and forecast HIV prevalence among individuals aged 15-49 years for Honduras using double exponential smoothing technique. The findings of this research is anticipated to facilitate planning and allocation of resources towards targeted HIV prevention, treatment, care and support programs for the high risk groups in the country.



Literature Review

Author (s)	Objective (s)	Methodology	Main finding(s)
Joseph et al. (2024)	To examine the factors associated with HIV testing among women in Haiti and trends in HIV testing in 2006, 2012, and 2016/17.	Data from the last three Haitian Demographic and Health Surveys (2006, 2012, and 2016/17) were used	HIV testing prevalence increased more than twofold from 2006 (8.8%) to 2017 (21.3%); however, it decreased by 11.6% between 2012 and 2016/17
Antabe & Sano (2024)	To evaluate effectiveness of HIV information dissemination has been in reducing HIV misconceptions.	Utilized the 2005-06, 2012, and 2016-17 Haiti Demographic and Health Surveys and applied logistic regression	Among males, after controlling for demographic, socioeconomic, and behavioral factors at the multivariate level, those in 2012 (OR ¼ 1.55, p<0.001) and 2016-17 (OR ¼ 1.24, p<0.01) were more likely to endorse HIV misconceptions compared to men in 2005-06
Correa-Salazar et al. (2023)	to 1) understand how violence is associated with newly reported HIV/AIDS case rates for women in Colombian municipalities; and 2) describe how social violence impacts HIV risk, treatment, and prevention for Venezuelan migrant and refugee women undergoing transnational migration and resettlement in Colombia	Mixed methods design	The study found that newly reported HIV cases in women were 25% higher for every increase of 18 homicides per 100,000, after adjusting for covariates -participants cited armed actors' control, lack of government accountability, gender-based violence and stigmatization of HIV as sources of increased HIV risk for VMRW
Dorcéus et al. (2021)	To assess these factors as potential barriers to adherence among patients receiving care in central Haiti.	A cross-sectional study was conducted among PLH receiving antiretroviral therapy (ART) at the TB/HIV clinic at St. Therese Hospital in Hinche, Haiti	Nearly 78% had received ART for less than 10 years, 3.41% reported having poor adherence and 28% less than excellent adherence. Factors related to poor adherence in bivariate analysis were age less than 40 years (OR: 6.32, 95% CI 2.04–10.58, p < 0.01) and inability to meet basic needs (OR: 2.70, 95% CI 1.04–7.0, p = 0.03).
Dunbar et al. (2021)	To present the epidemiology, social and cultural factors driving the HIV epidemic among men who have sex with men (MSM) in the Caribbean region and to highlight the regional and national responses, and what remains to be addressed to close the gaps in order to ending AIDS by 2030	literature review	The prevalence of HIV among MSM is high and the rates also do vary among Caribbean countries.

Methodology

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

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

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

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

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 Honduras 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)	0.065567
Sum Square Error (SSE)	0.304335
Mean Square Error (MSE)	0.009817
Mean Percentage Error (MPE)	-0.727338
Mean Absolute Percentage Error (MAPE)	12.321545



Residual Analysis for the Applied Model

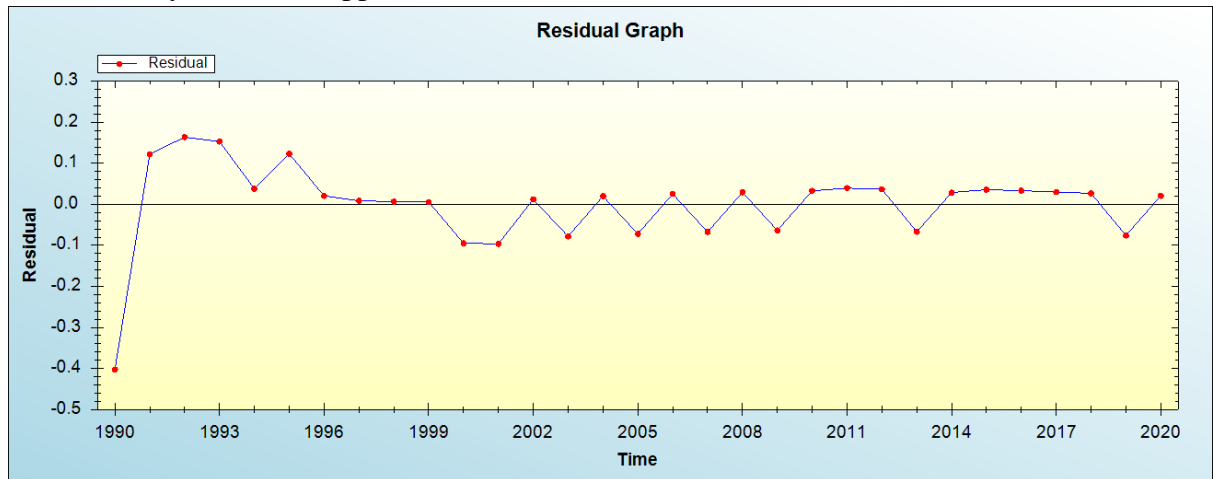


Figure 1: Residual analysis

In-sample Forecast for A

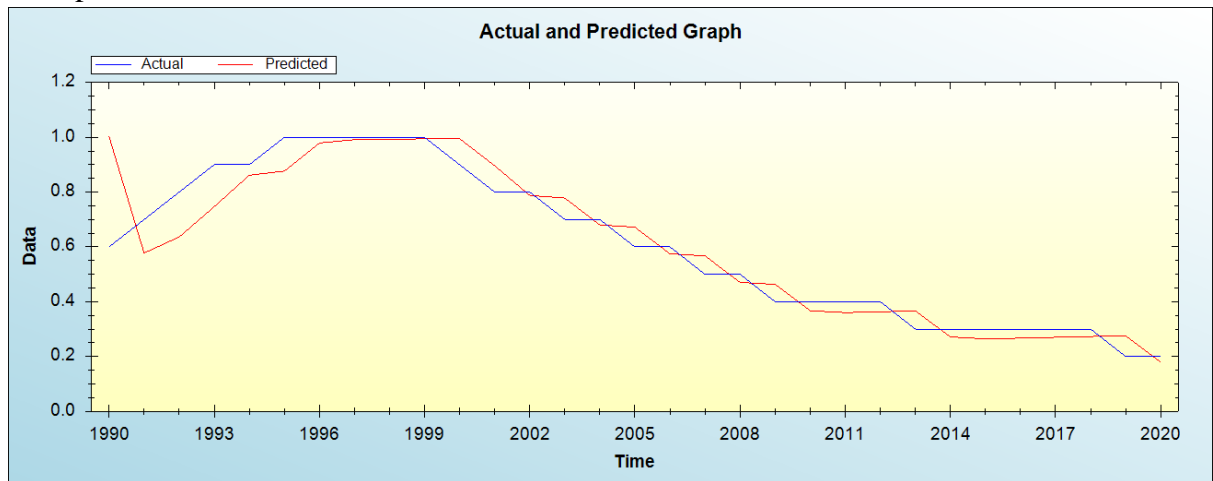


Figure 2: In-sample forecast for the A series

Actual and Smoothed graph for A series

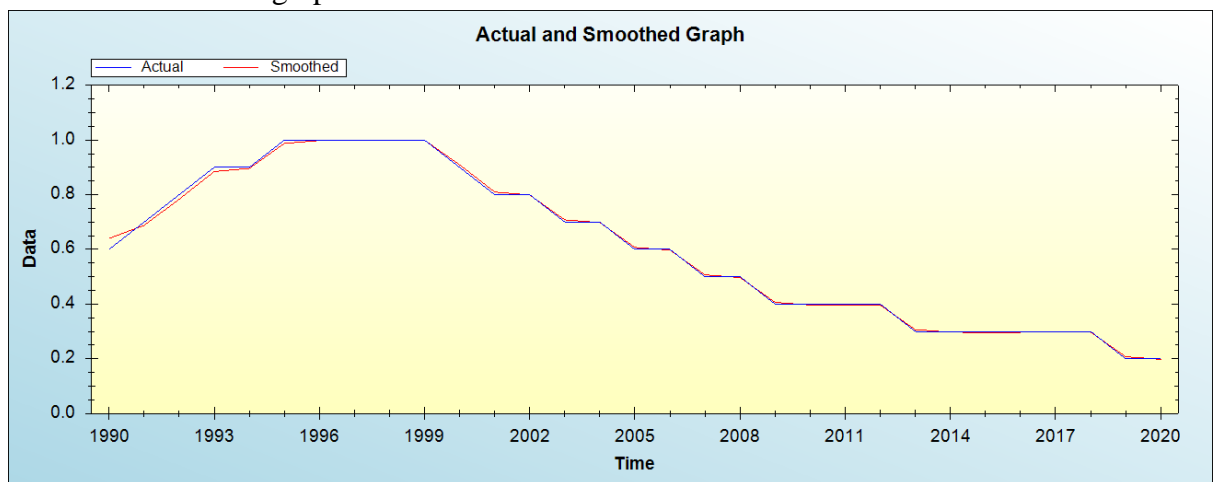


Figure 3: Actual and smoothed graph for A series



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

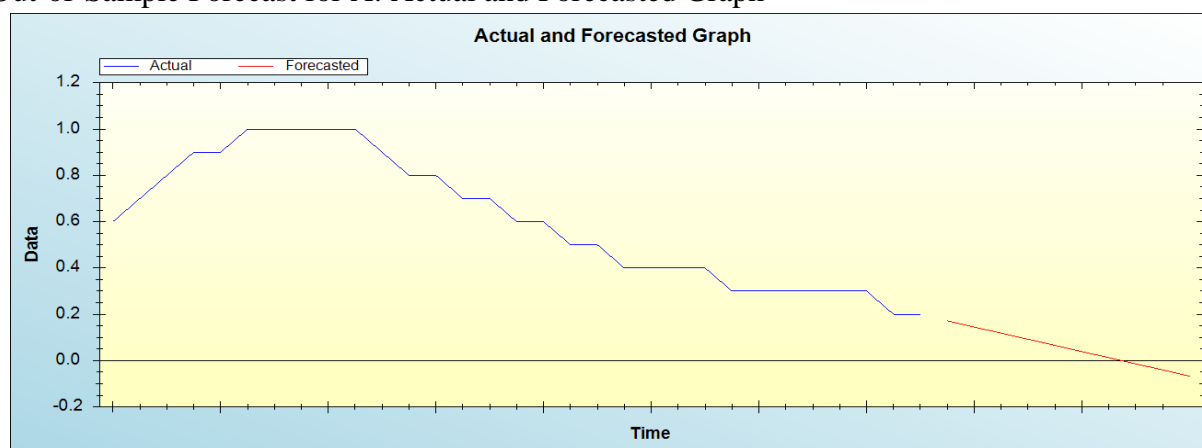


Figure 4: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Predicted HIV prevalence
2021	0.1714
2022	0.1449
2023	0.1184
2024	0.0919
2025	0.0654
2026	0.0389
2027	0.0124
2028	-0.0141
2029	-0.0406
2030	-0.0671

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 paper applied double exponential smoothing and our model predictions indicate that annual HIV prevalence among individuals aged 15-49 years will continue to decline over the out of sample period. Therefore, authorities must strengthen HIV case detection, treatment and prevention among high risk groups particularly key populations.

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