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FORECASTING HIV PREVALENCE AMONG INDIVIDUALS AGED 15-49 YEARS IN VENEZUELA 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 Venezuela 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 0.5 and 0.9 respectively based on minimum MSE. The results of the study indicate that annual HIV prevalence among individuals aged 15-49 years will sharply decline over the out of sample period. Therefore, we encourage authorities to strengthen HIV prevention measures and improve HIV case finding especially among high-risk groups.

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

Introduction

UNAIDS data reported revealed 1,900,000 adults and children were living with HIV in Latin America and the Caribbean in 2018, with an overall seroprevalence of 0.5% (UNAIDS data, 2019). The HIV epidemic in Latin America is concentrated among men who have sex with men, transgender women, sex workers and people who inject drugs (UNAIDS, 2019; Degenhardt et al. 2017). Despite several challenges, there was rapid roll out of antiretroviral therapy over the past decades. During the period 2003-2008, the number of people on ART doubled and gradually increased thereafter. In 2017, approximately 1.2 million PLHIV (61%) were receiving ART, lagging only after high-income countries (78%) (UNAIDS data, 2019). In addition, HIV/AIDS related mortality following commencement of ART has reduced and is very similar to that among Latinos receiving HIV care in the USA (Cesar et al. 2016; Carriquiry et al. 2015; Aran-Matero et al. 2011). AIDS-related conditions continue to be the leading causes of death among PLHIV in Latin America despite achievements in access to ART (UNAIDS data, 2019). This might be explained by the consistently high numbers of late HIV diagnosis, which still occurs in almost half of diagnosed adults in Latin America (Belaunzaran-Zamudio et al. 2019; Pineirua et al. 2015). The aim of this paper is to model and forecast HIV prevalence among individuals aged 15-49 years for Venezuela using Holt's double exponential smoothing technique. The research findings are envisaged to guide policy, planning and allocation of

resources towards targeted HIV prevention programs especially for key populations in order to curb new HIV infections in Venezuela.

Literature Review

Author (s)	Objective (s)	Methodology	Key finding (s)
Correa-Salazara et al. (2023)	To examine barriers and facilitators to HIV prevention and care for Venezuelan migrant/refugee women and girls in Colombia	-Theory-informed approach using the Socioecological Model.	Findings describe multi-level barriers to access to HIV prevention and care related to discrimination, gender-based violence, rigid gender norms, lack of information and system fragmentation
Huff et al. (2022)	To explore the interplay between substance use (SU) and HIV in Latin America (LA)	Literature Review	Factors associated with HIV among PWUS included being female, IDU and homelessness ,and PWUS were likely to engage in risky sexual behaviors, start antiretroviral treatment late, have poor adherence, have treatment failure, be lost to follow-up, have comorbidities ,and experience higher mortality rates and lower quality of life, as has been reported in PLWH with SU in other regions.
Gabster et al. (2022)	To explore barriers and facilitators to antiretroviral adherence and retention in HIV care among people living with HIV in the Comarca Nga ¨beBugle ´, Panama	Used the Social-Ecological Theory for Health as a framework	Structural barriers included difficult access to ART care due to travel costs, ART shortages, and uncooperative Western/Traditional medical systems.
Montana et al. (2021)	To study the behavior of the epidemic in the Colombian territory	Applied join point regression model to analyze the annual HIV/AIDS incidence and AIDS mortality rates	-subnational estimates of HIV mortality revealed significant spatial variation and diverging local trends in HIV mortality over time and by age There was an upward trend in HIV/AIDS incidence and a stable trend in the AIDS mortality rate in Colombia. The downward trend in HIV/AIDS incidence and AIDS mortality rate in the 0–14 age group reflects the downwards mother-

			to-child HIV transmission.
Saffier et al. (2017)	To review all published literature on HIV prevalence and risk factors for HIV infection amongst 10-25 year olds in Brazil	Literature review	Literature shows raised HIV prevalence amongst MSM and FSW, as well as amongst those using drugs

Methodology

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

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

Smoothing equation

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

$0<\alpha<1$

Trend estimation equation

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

$0<\beta<1$

Forecasting equation

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

V_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 Venezuela 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	V
Included Observations	31
Smoothing constants	
Alpha (α) for data	0.500
Beta (β) for trend	0.900
Forecast performance measures	
Mean Absolute Error (MAE)	0.025867
Sum Square Error (SSE)	0.046055
Mean Square Error (MSE)	0.001486
Mean Percentage Error (MPE)	-1.080237
Mean Absolute Percentage Error (MAPE)	8.978168

Residual Analysis for the Applied Model

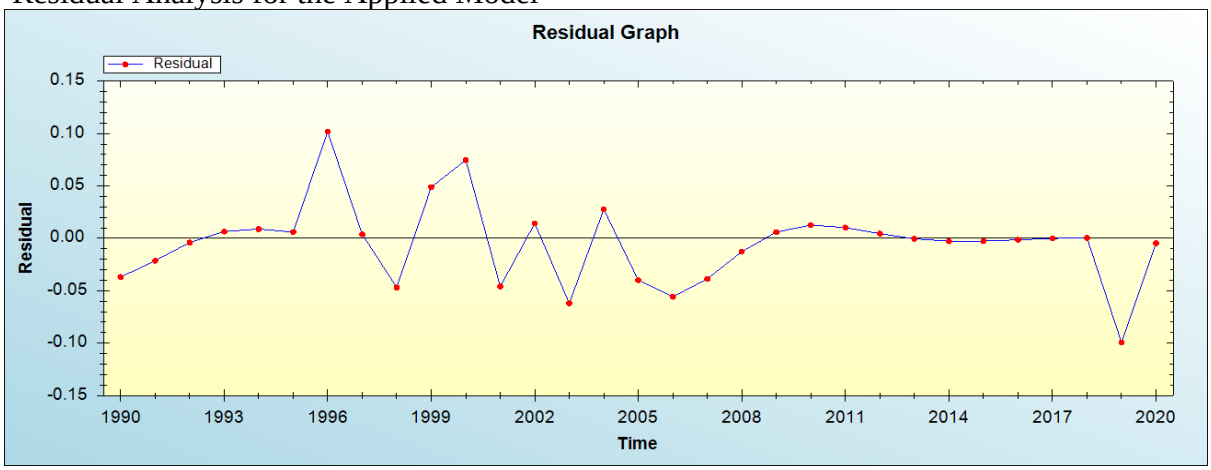

Figure 1: Residual analysis

In-sample Forecast for V

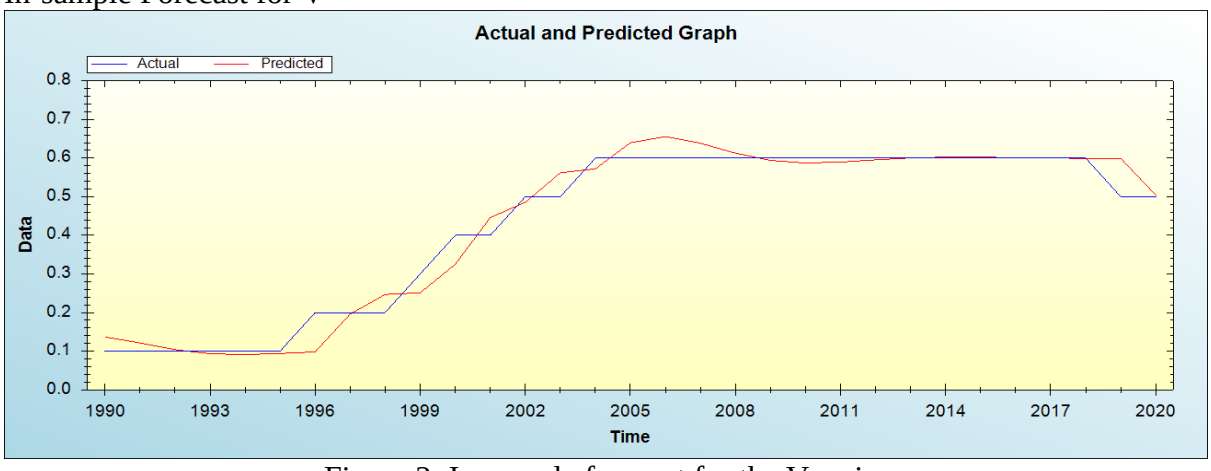

Figure 2: In-sample forecast for the V series

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Actual and Smoothed graph for V series

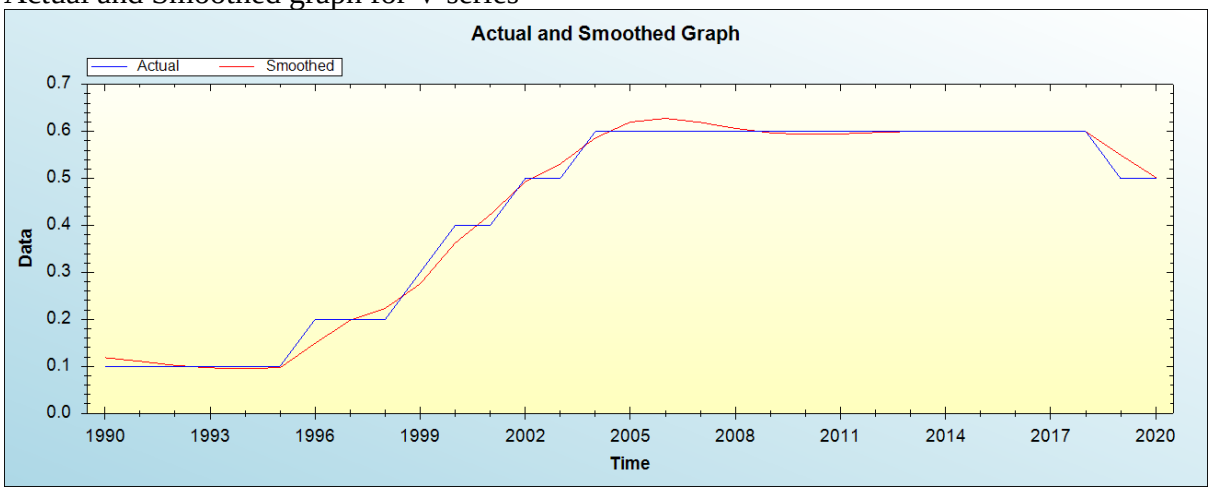

Figure 3: Actual and smoothed graph for V series

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

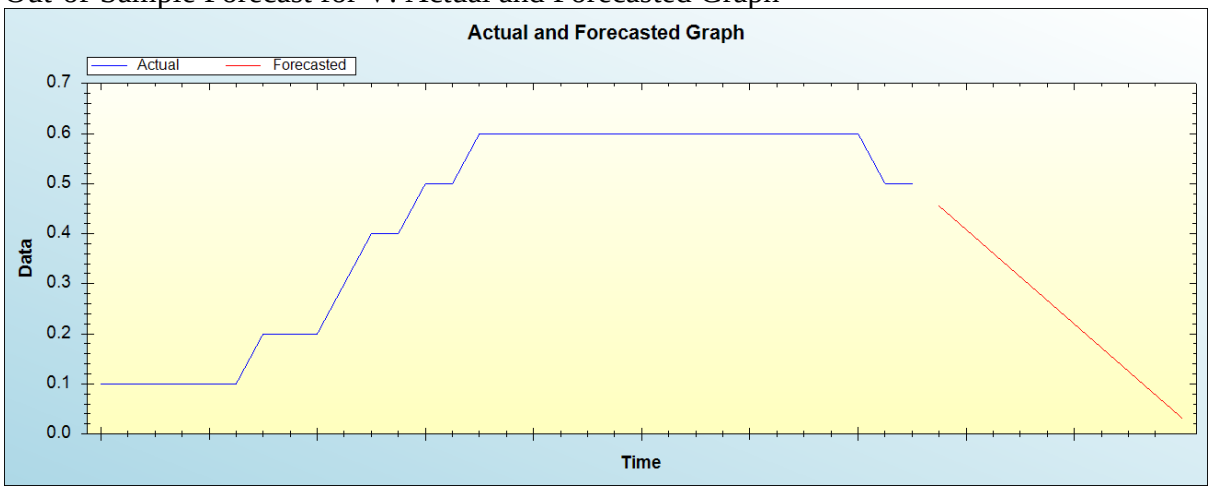

Figure 4: Out-of-sample forecast for V: actual and forecasted graph

Out-of-Sample Forecast for V: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasted HIV prevalence
2021	0.4551
2022	0.4080
2023	0.3608
2024	0.3137
2025	0.2665
2026	0.2194
2027	0.1722
2028	0.1251
2029	0.0779
2030	0.0308

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 decline sharply 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 decline sharply over the out of sample period. This paper calls for the authorities to strengthen HIV prevention measures and improve HIV case finding especially among high risk groups.

References

[1] Joint United Nations Programme on HIV/AIDS (UNAIDS). UNAIDS data 2019. [cited 2020 Feb 24]. Available from: https://www.unaids.org/sites/default/files/media_asset/2019-UNAIDS-data_en.pdf

[2] Joint United Nations Programme on HIV/AIDS (UNAIDS). The gap report: transgender people. [cited 2020 Feb 24]. Available from: https://www.unaids.org/sites/default/files/media_asset/08_Transgenderpeople.pdf

[3] Aran-Matero D, Amico P, Aran-Fernandez C, Gobet B, Izazola-Licea JA, and AvilaFigueroa C (2011). Levels of spending and resource allocation to HIV programs and services in Latin America and the Caribbean. PLoS ONE. 2011; 6:e22373. https://doi.org/10.1371/journal.pone.0022373

[4] Carriquiry G, Fink V, Koethe JR, Giganti MJ, Jayathilake K, and Blevins M (2015). Mortality and loss to follow-up among HIV-infected persons on long-term antiretroviral therapy in Latin America and the Caribbean. J Int AIDS Soc. 2015; 18(1):20016.

[5] Cesar C, Koethe JR, Giganti MJ, Rebeiro P, Althoff KN, and Napravnik S (2016). Health outcomes among HIV-positive Latinos initiating antiretroviral therapy in North America versus Central and South America. J Int AIDS Soc. 19 (1):20684.

[6] Degenhardt L, Peacock A, Colledge S, Leung J, Grebely J, and Vickerman P (2017). Global prevalence of injecting drug use and sociodemographic characteristics and prevalence of HIV, HBV, and HCV in people who inject drugs: a multistage systematic review. Lancet Glob Health. 5(12):e1192–207.

[7] Pi~neirua A, Sierra-Madero J, Cahn P,Guevara Palmero RN, Martınez Buitrago E, and Young B (2015). The HIV care continuum in Latin America: challenges and opportunities. Lancet Infect Dis. 15(7):833–9.

[8] Belaunzaran-Zamudio PF, Caro-Vega YN, Shepherd BE, Rebeiro PF, Crabtree-Ramırez BE, and Cortes CP (2019). The population impact of late presentation with advanced HIV disease and delayed antiretroviral therapy in adults receiving HIV care in Latin America. Am J Epidemiol. 2019; pii: kwz252. https://doi.org/10. 1093/aje/kwz252.