

Cameroon is Lagging Behind in the Provision of Art Services: Message from Artificial Neural Networks

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Abstract - In this piece of work, the ANN approach was applied to analyze ART coverage in Cameroon. The employed annual data covers the period 2000-2019 and the out-of-sample period ranges over the period 2019-2023. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting ART coverage in Cameroon. The ANN (9,12,1) model predictions suggest that the country is likely to have a low ART coverage of 53 % over the period 2019-2023. Therefore the government is strongly encouraged to intensify demand creation for HIV testing and ART services ,address barriers for accessing ART and source more funding for ART medicines to meet the increased demand amongst other measures.

Keywords: ANN, ART coverage, Forecasting.

I. INTRODUCTION

Antiretroviral treatment brought significant relief to African nations since many people were helplessly dying from the deadly HIV virus. The highly active antiretroviral treatment (HAART) suppresses the replication of the HIV virus, prolong life, improve quality of life and overall control the HIV epidemic. Since 2005, there has been a decline in AIDS related deaths by 35 % globally and by 39 % in Sub Saharan Africa (WHO, 2020). Improving access to antiretroviral drugs is the goal of many developing countries in order to reduce morbidity and mortality due to AIDS related illnesses. There has been a global goal to make antiretroviral drugs affordable and increase treatment access to more HIV positive people especially in Sub Saharan Africa (WHO, 2015). In Cameroon the number of HIV positive people receiving ART increased from 28,000 in 1998 to about 200,000 in 2013 (Kindzeka, 2013). The percentage of pregnant mothers receiving ART increased from 14% in 2009 to 61% in 2013 (UNAIDS, 2014) and the overall ART coverage increased from 0 % in 2003 to 22 % in 2014 (UNAIDS, 2015; Bank, 2016). ART services are offered at all levels of the health delivery system in the country. The ART program in Cameroon aims to end the AIDS epidemic as a public health threat by 2030 (WHO, 2015). However the country faces a lot of challenges which include poor treatment adherence, treatment interruptions and loss to follow up among patients on ART (Rougemont et al, 2009; Meresse, 2013; Roux, 2011; Mbuagbaw, 2012; Kouanfack, 2008; Pefura-Yone, 2013). In this study the researchers chose to apply the artificial neural network, ANN model to forecast ART coverage in Cameroon. The results of the study will provide an insight of the future trends of ART coverage in the country. This will guide planning and the national response to the HIV epidemic.

II. LITERATURE REVIEW

Adam & Johnson (2009) estimated adult antiretroviral treatment coverage in South Africa using the Markov model. The findings of the study showed that ART coverage in 2008 varied between Provinces from 25.8% in the Free State to 71.7%. In another study, Johnson et al (2017) assessed South Africa's progress towards the 2020 targets and variations in performance by province. A mathematical model was fitted to the HIV data for each of South Africa's provinces and for the country as a whole. The study results revealed that ART coverage varied between 43% in Gauteng and 63 % in Northern Cape and most provinces face challenges in reaching the remaining two 90% targets. Levira et al (2015) evaluated adult ART and pre ART care coverage by age and sex at CD4 <200, <350 and all people living with HIV in the Rufiji district of Tanzania from 2006 to 2010. The ALPHA model was used to predict the number in need of pre ART and ART by age and sex at CD4 <200 and CD4 <350. The study concluded that ART coverage in the Rufiji District was unevenly distributed and far from universal coverage target of 80% in particular among young men. Tun et al (2019) conducted an implementation science study of a community based ART distribution program for HIV positive female sexworkers (FSW) whereby clients received ART services through community based mobile and home based platforms. 6 months treatment related outcomes were compared for the intervention group and the standard group (Clinic ART services). The study showed that internalized stigma and receiving community based ART were significantly associated with ART initiation.

III. METHOD

The Artificial Neural Network (ANN) is generally a data processing system consisting of a large number of simple and highly interconnected processing elements resembling a biological neural system. It has the capability of learning from an experimental or real data set to describe the nonlinear and interaction effects with great accuracy. ANN-based curve fitting technique is one of the extensively applied artificial intelligence methods that are used for forecasting and prediction purpose. It consists of basically three layers i.e., input layer, hidden layer, and output layer, the present work includes the number of years as input layer and the annual TB incidence in Cameroon as output data for the network. In this study, our ANN is based on the hyperbolic tangent function.

Data Issues

This study is based on annual ART coverages (referred to as Y series in this study) in all age groups in Cameroon. The annual data covers the period 2000-2018 while the out-of-sample forecast covers the period 2019-2023. All the data employed in this research paper was gathered from the World Bank online database.

IV. FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
17.316	15.000	0.00000	52.000
Std. Dev.	C.V.	Skewness	Ex. kurtosis
16.097	0.92962	0.72454	-0.46691
5% Perc.	95% Perc.	IQ range	Missing obs.
Undefined	52.000	24.000	0

ANN MODEL SUMMARY FOR ART COVERAGE IN CAMEROON

Table 2: ANN model summary

Variable	Y
Observations	10(After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	9
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.019559
MSE	0.319281
MAE	0.465279

Residual Analysis for the ANN model

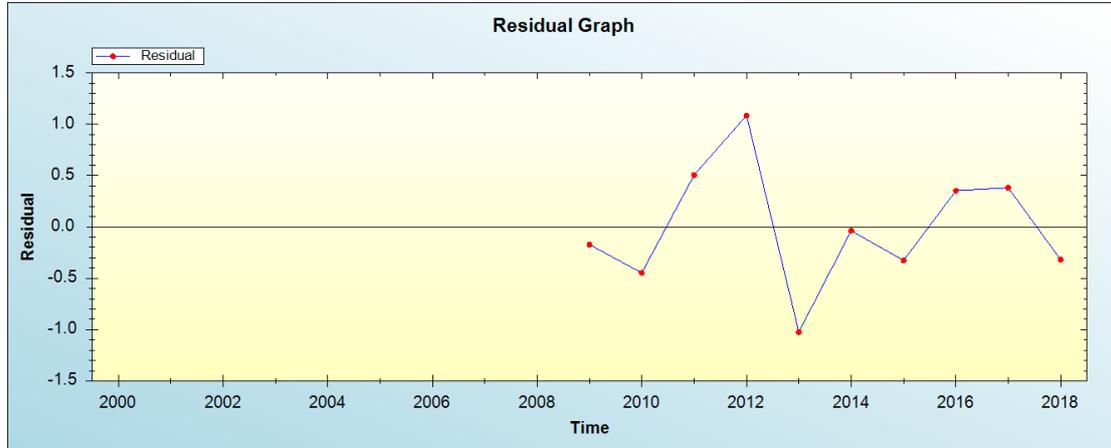


Figure 1: Residual analysis

In-sample Forecast for Y

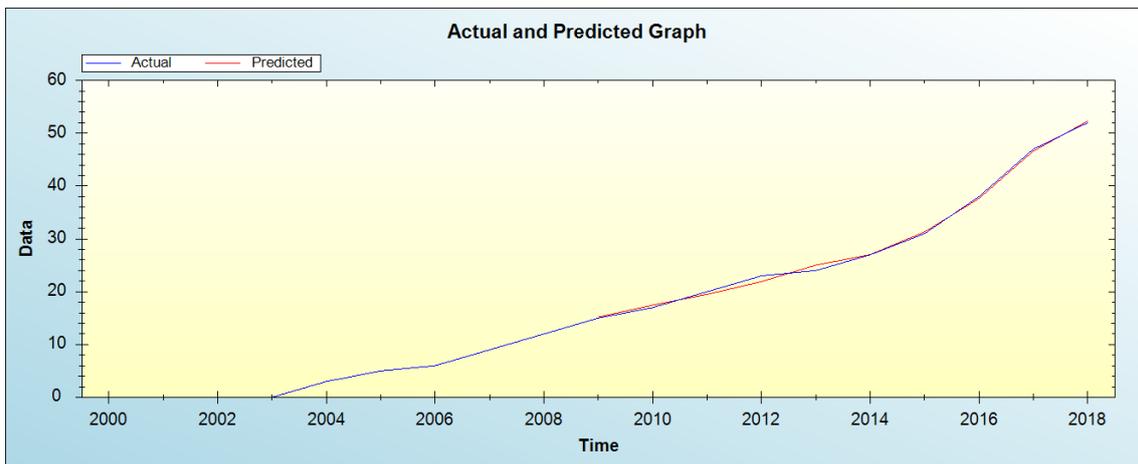


Figure 2: In-sample forecast for the Y series

Figure 2 shows the in-sample forecast for Y series.

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

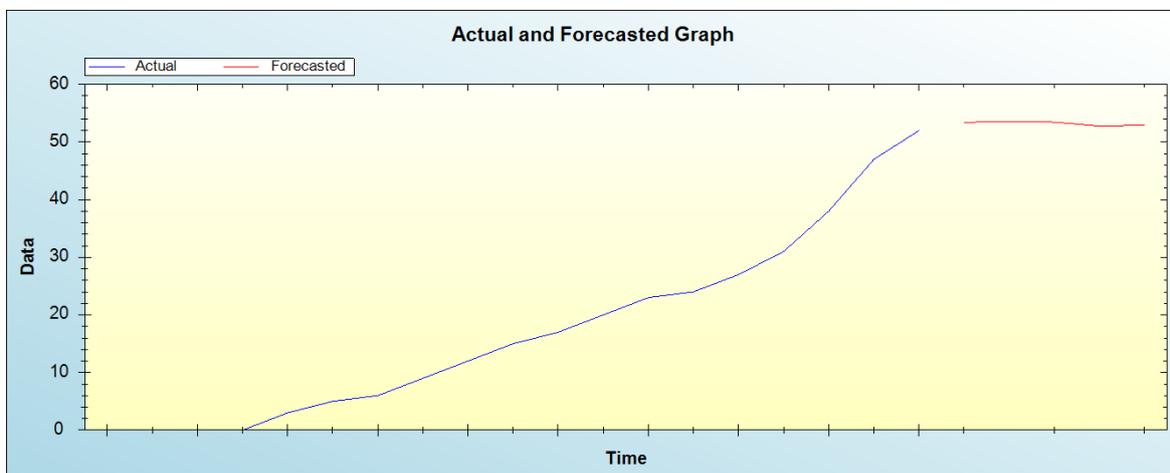


Figure 3: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasted ART coverage
2019	53.4024
2020	53.6012
2021	53.4514
2022	52.7716
2023	52.9326

Over the study period the minimum and maximum ART coverage was 0 and 52 % respectively. The government started offering National ART services in 2004 hence zero recording was noted from 200-2003. The data is positively skewed with an excess kurtosis of -0.46691 meaning that it is not normally distributed. The model evaluation criteria (Error, MSE, MAE) and the residual graph indicate that the model is stable and suitable for forecasting ART coverage in Cameroon. Figure 3 shows the in-sample forecasts and the graph indicates the applied ANN model fits the data well. The out of sample forecasts suggests that the country is likely to record a low ART coverage of around 53 % over the period 2019-2023.

V. CONCLUSION & RECOMMENDATIONS

Cameroon is lagging behind in terms of offering ART services to its population. Over the study period the maximum ART coverage achieved was 52 %. The ANN model predictions suggest that the country will continue to have a low ART coverage of around 53% over the period 2019-2023. This means the country has to do a lot of work in order to significantly improve access to ART services to the general population. The government is strongly encouraged to intensify demand creation for ART and HIV testing services and subsequently source funding for ART medicines in order to meet the increased demand for the services. More Health workers must be trained in integrated and advanced TB/HIV management, strengthen the system of tracking loss to follow up ART clients and address barriers for accessing ART services in both public and private health facilities.

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