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Letter from the Editor-in-Chief

Myanmar and Korea have many similarities and are complementary relationship. Therefore, we believe that research exchange will expand mutual understanding between Myanmar and Korea, and will be the cornerstone for mutual development.

KOMYRA and YUE have co-published The Myanmar Journal since August 2014. So far, many scholars have published numerous papers through the journal, and We are sure that this journal has helped many people understand Myanmar and Korea more clearly and closely.

The Myanmar Journal covers various issues in Myanmar and Korea. It covers various topics that can promote bilateral development and mutual understanding, not limited to specific topics such as economy, industry, society, education, welfare, culture, energy, engineering, healthcare, and agriculture.

We hope that this journal will continue to promote understanding of the current status and potential capabilities of Myanmar and South Korea and promote in-depth international exchange and cooperation.

We would like to express our deepest gratitude to the editorial board and YUE and KOMYRA for their valuable support in The Myanmar Journal publication.

February 28, 2022

Youngjun Choi yj choi

Editor-in-Chief of THE MYANMAR JOURNAL
Vice-President of KOMYRA
Email: yjchoi@khu.ac.kr
Office: +82-2-961-0485
Web address: komyra.com/doc/scope.php

INFORMATION ABOUT
The Myanmar Journal

The Myanmar Journal (ISSN 2383-6563) is the official international journal co-published by Yangon University of Economics (YUE) and Korea Myanmar Research Institute (KOMYRA).

This journal aims to promote the mutual cooperation and development of Myanmar and Korea through intensive researches in the entire filed of society, economy, culture, and industry.

It will cover all general academic and industrial issues, and share ideas, problems and solution for development of Myanmar.

Articles for publication will be on-line released twice a year at the end of February and August every year on the Myanmar Journal webpage (http://www.komyra.com/bbs/board.php?bo_table=articles).

Forecasting of the Epidemiology of Tuberculosis in Myanmar (1994-2018)

Daw Khet Khet Hnin* · Daw Thet Mar Lwin**
Yangon University of Economics

ABSTRACT : Tuberculosis is an infectious disease which can be lethal. Hence, achieving of models prediction its potential outbreak can be very useful in its preventative strategies. Tuberculosis (TB) is a major public health problem in Myanmar. The people with untreated infectious TB are the source of transmission. Mathematical modeling and time series analysis have become useful tools in TB surveillance monitoring and elimination effects. Incidence and mortality due to tuberculosis (TB) have been decreasing worldwide. In this paper, several functions (Linear, Quadratic, Cubic, Exponential, etc) model were compared to describe a TB curve and the best fitting model was chosen by reason of some accuracy measures namely coefficient of determination (R2), Adjusted (R‾^2), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), mean absolute percent error (MAPE), mean standard error (MSE) and root mean squared error (RMSE). Based on these criteria, the Cubic model was selected for predicting TB cases of year 2019 to 2021. The forecasting result is decline for the next few years.

Key words : *Tuberculosis in Myanmar, time series growth models and the model criteria.*

I. Introduction

By the bacterium Mycobacterium Tuberculosis (MTB), Tuberculosis (TB) is an

* Lecturer, Department of Statistics, Yangon University of Economics.
** Lecturer, Department of Statistics, Yangon University of Economics.

infectious disease caused. Generally, Tuberculosis affects the lungs but can also affect other parts of the body. Most infections do not have symptoms, in which case it is known as latent tuberculosis. Tuberculosis is spread through the air when people who have active TB in their lungs cough, spit, speak or sneeze. People with latent TB do not spread the disease.

Estimate from the World Health Organization (WHO) reveals that each year about 2 million people die worldwide with this condition many of these are never aware they have this disease. Tuberculosis continues to be a major public health problem in many countries, predominantly in developing third world nations.

Myanmar is among the 30 highest TB burden countries worldwide. TB Case notification increased significantly between 1999 and 2007. In Myanmar, there are subsets of the population who are at higher risk for TB given their occupational or socio-economic conditions. Over the last few years there has been rapidly increased in the number of notified TB cases. In 2010, 137,403 TB cases were notified (all new and previously treated cases) corresponding to a case notification rate of 279 cases per 100,000 population (Ministry of Health and Sports, MOHS, 2016).

The objectives for this study are to examine the pattern of the data for total TB cases in Myanmar over time in order to determine which forecasting model would most accurately predict the total TB cases in Myanmar, and also to forecast the number of total TB cases after 2018.

II. REVIEW OF LITERATURE

Prat (2003) studied that tuberculosis is a prehistoric American human disease. This paper reviews the literature and discusses hypotheses for origins and epidemiological patterns of prehistoric tuberculosis. From the last decades, 24 papers about prehistorisis were published and 133 cases were reviewed. In South America most are isolated case studies country to North America where more skeletal series were analyzed. Disease was usually located at the deserts of Chile and Pera, Central plains in USA, and Lake Ontario in Canada. Skeletal remains represent most of the cases. But 16 mummies have also been described.

Ogunsakin et al. (2014) expressed tuberculosis is a chronic infection usually of life long during caused by two species of Mycobateria: Mycobacterium and Mcyobacter-iumBovis. In the past, Tuberculosis was a major health problem in North America and Europe, while the incidence of Tuberculosis has declined in the US since the 1995's when it was the leading cause of death in the United States.

WHO Report (2016) described that the end TB strategy has these high-level indicators: the TB incidence rate, the absolute number of TB deaths and the percentage of TB patients and their households that experience catastrophic cost as a result of TB disease. Targets for these indicators have been set for 2030 and 2035, with accompanying milestones for 2020 and 2025.

The 2020 milestones of the end TB strategy are a 35% reduction in the absolute number of TB deaths and a 20% reduction in the TB incidence rate, compared with level in 2015, and that no TB affected households face catastrophic costs. WHO has defined three lists of high burden countries for the period 2016-2020, for TB, TB/HIV and MDR-TB. Each list includes 30 countries.

Imam (2008) tried that to find out the appropriate models using latest model selection criteria that could express the best growth pattern, to measure the instability, to determine the efficient time series models, to forecast the future pigeon pea, chickpea and field pea pulse production in Bangladesh. Forecasting attempts have been the models namely, deterministic type growth models. The magnitude of instability was estimated by computing the coefficient of variation (CV) and the percentage deviation from three years moving average values.

Abbasi et al. (2015) demonstrated that different models have been applied to achieve the best fit model based on linear trend model, quadratic trend model, exponential growth model and S-curve model. It is found that S-curve model is recommended for projections.

III. MATERIALS AND METHODOLOGY

Time series data for this study (1994-2018) were collected from Myanmar Mission Report (2019). For forecasting purpose, various models are available and for seeking the best model. Time series model are applied in this study for forecasting the future distribution TB cases in Myanmar. In this study nine growth models are considered for analyzing purpose. Their functional forms and formulas for calculating growth rates are given in table (1).The natures of the different growth rate for different models are different.

The growth rate in the linear model is constant in it absolute value throughout the time interval and the growth rates in the exponential and logistic models are constant throughout the time interval in it percentage value. But the growth rates for other models are dependent on time. Table (1) shows that the natures of the different growth rate for different models are different.

Table 1. The mathematical models and formulas of the growth rates

model	Mathematical form	Meaning and assumption
Linear	$Y = a + bt + \varepsilon$	Y is the time series considered. t represents time taking integer values starting from 1. ε is the regression residual $a, b, c\ and\ d$ are the coefficients of the models.
Logarithmic	$Y = a + b\log_e t + \varepsilon$	
Inverse	$Y = a + \frac{b}{t} + \varepsilon$	
Quadratic	$Y = a + b + ct^2 + \varepsilon$	
Cubic	$Y = a + bt + ct^2 + dt^3 + \varepsilon$	
Power	$Y = at^b + e^\varepsilon$	
S	$Y = e^{a+\frac{b}{t}+\varepsilon}$	
Exponential	$Y = ae^{bt+\varepsilon}$	
Logistic	$Y = \frac{1}{1+ae^{bt+\varepsilon}}$	

Source: Haque (2004)

In addition, criteria measure of accuracy was used to find out the best fitted model. Goodness of fit the data are also calculated so that the accuracy of fit can be assessed. Then, the forecast values for the total TB cases are computed based on the fitted trend.

Model Accuracy Measures

To select the best type of growth model for forecasting the data for a particular time series the latest available model selection criteria are R2 ,R¯^2, AIC, BIC, MSE, RMSE and MAPE. These criteria are briefly given in table (2).

where Yt and Y˄_t are the actual and the predicted values of the variable of interest in time period t, n is the sample size and k is the total number of estimable parameters. The model with minimum AIC, BIC, MSE, RMSE and MAPE are assumed to describe the data series more adequately. Moreover, R^2 and R¯^2 of the fitted model must be the highest.

Table 2. Model Selection Criteria

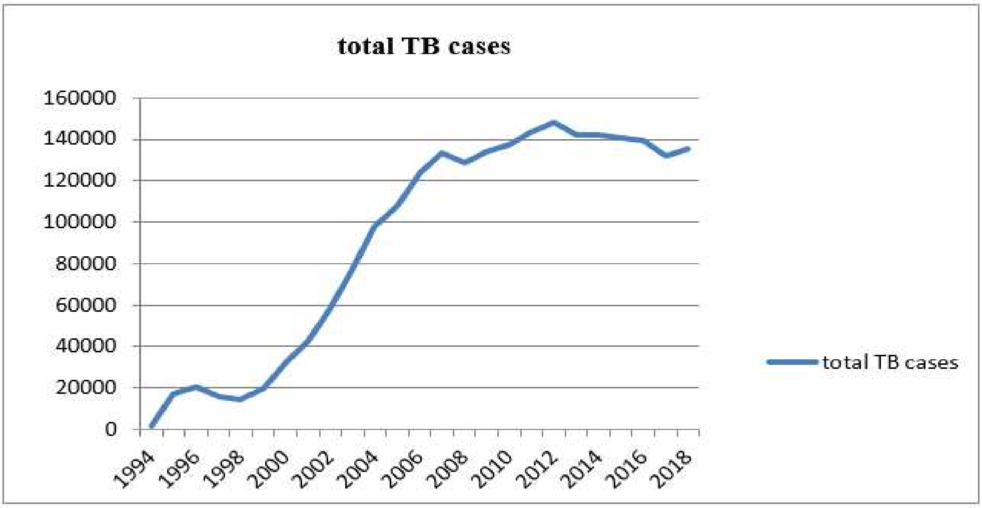
Model	Formula
Coefficient of determination (R^2)	$R^2 = \frac{Regression\ Sum\ of\ Square}{Total\ Sum\ of\ Square}$
Adjusted Coefficient of Determination ($\bar{R}^2$)	$\bar{R}^2 = 1-(1-R^2)\frac{n-1}{n-k}$
Akaike Information Criterion (AIC)	AIC = n log (MSE) + 2k
Bayesian Information Criterion (BIC)	BIC = n log (MSE) + k log n
Mean Squared Error (MSE)	$MSE = \frac{\sum(\varepsilon_t^2)}{n-k}$
Mean Absolute Percent Error (MAPE)	$MAPE = \frac{\sum APE}{n}, APE = \frac{\lvert\varepsilon_t\rvert}{Y_t} \times 100$
Root Mean Square Error (RMSE)	$RMSE = \sqrt{\frac{1}{n-k}\sum_{i=0}^{n}\varepsilon_t^2}$

Source: Haque (2004)

IV. DATA ANALYSIS

Firstly, the original data pattern was studied before the appropriate fitted model for the total TB cases in Myanmar is selected from the nine growth models. The number of total TB cases in Myanmar (1994-2018) shown in figure (1).

Figure 1. Total TB cases in Myanmar (1994-2018)



Source : Myanmar Mission Report (2019)

According to the figure (1), it is shown that the Total TB Cases in Myanmar 1994-2018 were gradually increased from 1994 to 2012. However, in the years after 2013, the total TB cases decreased slightly.

Selection of the Best Model for the total TB cases in Myanmar

All the models considered for this study are estimated for the time series of total TB cases in Myanmar during 1994 to 2018 and shown in Table (1). The parameters in those models are significant at 1 percent (single star).

Table 3. Parameter estimates of the models of total TB cases in Myanmar

Model	Parameter			
	α	β	γ	δ
Linear	3016.150 (0.734)	6799.976 (0.000)*		
Logarithmic	-45706.852 (0.003)*	59100.935 (0.000)*		
Inverse	118679.640 (0.000)*	-178617.000 (0.000)*		
Quadratic	-34237.483 (0.002)*	15078.561 (0.000)*	-318.407 (0.000)*	
Cubic	2244.225 (0.807)	-274.343 (0.927)	1129.280 (0.000)*	-37.120 (0.000)*
Power	3104.526 (0.000)*	1.297 (0.000)*		
S	11.805 (0.000)*	-4.944 (0.000)*		
Exponential	11713.874 (0.001)*	0.129 (0.000)*		
Logistic	0.0000854 (0.001)*	0.879 (0.000)*		

* indicate significance at 1% level of probability

According to table (3), the analysis reveals that constant term and all the regression coefficient of nine models are highly significant at 1% level. However, the constant term of the linear and cubic model (included one coefficient) was insignificant. Moreover, all of these nine models are significant at 1% level.

And then, all the model selection criteria that have been used in this study to identify the best fitted model for forecasting purpose and also for explaining the growth pattern are calculated are given in table (3). In interpreting the model selection criteria, consider that higher the value of R2 and R⁻^2, the better is the fitness of the model.

On the other hand, the smaller the value of MSE, RMSE, AIC, BIC, and MAPE, the better is the fitness of the model. It is obvious that a better model yields smaller forecasting error.

Table 4. Diagnostic Measures for Selection of Best Forecasting Model for total TB cases in Myanmar

Model	R2	$\bar{R}^2$	AIC	BIC	MSE	RMSE	MAPE
Linear	0.853	0.847	220.3434	219.1393	450546647.6	21226.08413	50.8789
Logarithmic	0.828	0.820	222.0512	220.8471	527291321.4	22962.82477	165.2338
Inverse	0.463	0.440	234.4021	233.1980	1644694311	40554.83092	243.5591
Quadratic	0.930	0.924	214.7079	212.9017	223006131.7	14933.38983	83.6138
Cubic	0.972	0.968	207.3030	204.8948	93782831.2	9684.153613	20.3231
Power	0.905	0.901	226.2005	224.9964	772722063.6	27797.87876	29.4434
S	0.806	0.797	228.7253	227.5212	975024710.1	31225.38567	50.1655
Exponential	0.700	0.687	242.0161	240.8120	3316243025	57586.83031	66.5977
Logistic	0.700	0.687	242.0161	240.8120	3316243025	57586.83031	66.5977

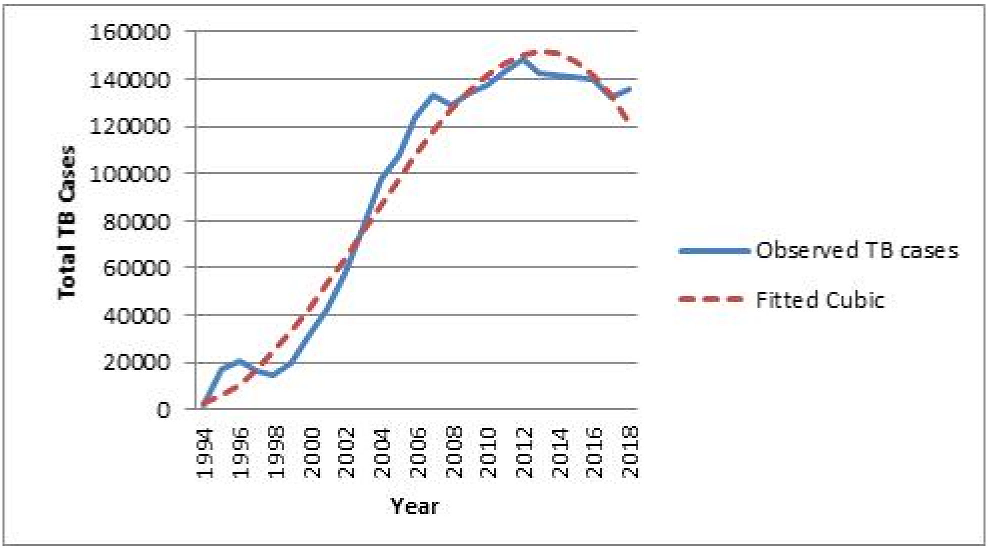
Source: SPSS output

In the study, the main mathematical techniques for the forecasting of the total TB cases in Myanmar with nine growth models are examined. R2 and adjusted R2 values of the growth models (except Inverse model) were similar and close to 1, indicating that almost 95% of the data fit the models.

It appears from the table that the value of R2 (0.972), adjusted R2 (0.968) are higher and the value of AIC (207.3030), BIC (204.8948), RMSE (9684.1536) and MAPE (20.3231) are lower for cubic model. Hence, the value of R2 and adjusted R2 are very low for the inverse model and other criteria are sufficiently large compared to cubic model.

Therefore, the model that may be applied for examining the growth model of the total TB cases in Myanmar and making forecast with minimum forecasting error is the cubic model.

Figure 2. Actual and Fitted Total TB Cases for the fitted model



Furthermore, the above figure (2) is also found that the actual and fitted total TB cases of the cubic model are much closed. Thus, based on the above information, cubic model was determined to be the best fitting model to the total TB cases in Myanmar.

The cubic model is

Y=a+bt+ct^2+dt^3+e_t

The estimated cubic trend model is

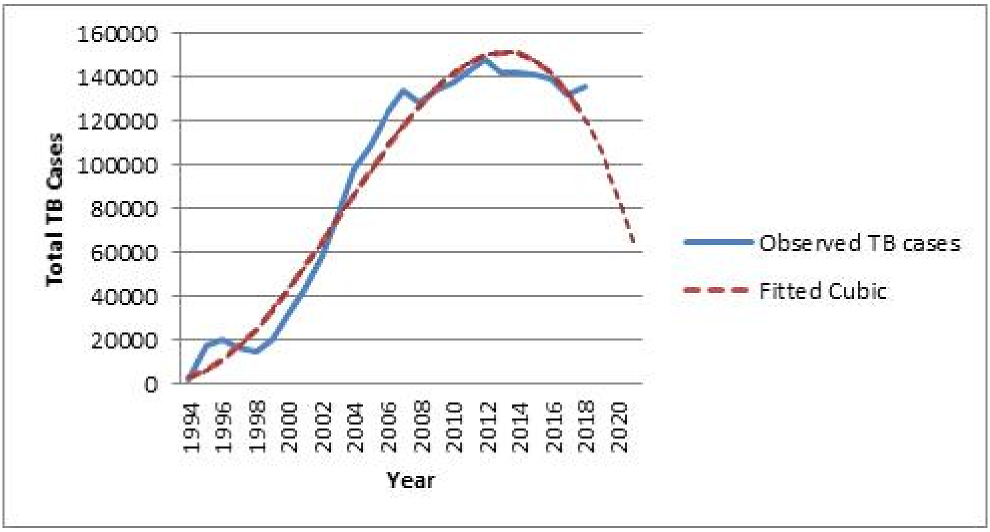
Yˆ=aˆ+bˆt+cˆt^2+dˆt^3

Yˆ=2244.225-274.343t+1129.280t^2-37.120t^3

Forecasting the total TB cases in Myanmar (2019-2021)

The forecasted number of TB cases in Myanmar on the basis of the cubic model from 2019 to 2021 is presented in figure (3).

Figure 3. Forecasting result by the fitted model



From the table (4), the projected results of the total TB cases from 2019 to 2021 are 106084, 87449 and 65060. It is obvious from analysis that the total TB cases in Myanmar were decline in the coming years.

V. CONCLUSION AND RECOMMENDATION

According to the WHO for TB, MDR-TB and TB/HIV co-infection, Myanmar is amongst the 30 high-burden countries. WHO predicts (Global Report, 2018) the incidence of all forms of TB as 358 per 100,000 population and TB mortality, excluding TB-HIV, as 51 per 100,000 (MMR, 2019). Therefore, it is necessary to plan to achieve requirements of country. For this purpose, forecasting is the key tool to alarm about the need of country in advance. In this study, the growth models have been developed to forecast the total TB cases in Myanmar from 1994 to 2018. The best model is selected on the basis of model selection criteria. It is found that the best model for the total TB cases forecasting is cubic model because it has highest R squared and adjusted R squared and lower AIC, BIC, MSE, RMSE and MAPE as compared to other fitted models. In order to forecast for three years forward by using the best model, it is found that the number of TB forecast is expected to decrease for the three year. It is fact that Myanmar has developed a National TB Strategic Plan 2016-2020, which put forward key interventions in order to meet the Sustainable Development Goal (SDG) targets of the End TB Strategy (MOHS, 2016).

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