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Trend Analysis of Inflation Rate of Bangladesh – Modelling Approach

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Abstract

In this paper, we have conducted an analysis on a set of data of the inflation rate of Bangladesh from the period July2002 to June2007 collected from Bangladesh Bank. We endeavored to deduce a unique and conventional model to assess the trend of the inflation rate of Bangladesh. For this purpose, we adopted the trend analysis modeling method. We used four statistical models, such as, Linear Trend model, Quadratic Trend model, Exponential Growth Trend model and S-curve Trend model to assess the trend of Inflation rate of Bangladesh. From this study, we have found that Linear Trend model, Quadratic Trend model and Exponential Growth Trend model are not pertinent for our concerned data set. S-curve Trend model with parameters β_0=13.7210, β_1=21.1242, and β_2=0.929396 is appropriate for our data set. So we can suggest that for assigning the trend of the inflation rate of Bangladesh, one can use the S-curve Trend model as it gives better result than any of the three other models that we used in our study. But one must verify the validity of the model at different time period before using this, because the validity of a model may differ at different situations with the change of time.

I. Introduction

Trend analysis plays a vital role in economics and in economical time series analysis to see the present condition of some phenomena and depending on the existing pattern the decision makers take appropriate steps to economic conditions. It is a visual representation of what is the actual present state of some phenomena of our interest. A trend analysis is usually carried out in order to provide an aid to decision-making and in planning the future. The need for trend analysis is increasing as management attempts to decrease its dependence on chance and becomes more scientific in dealing with its environment.

Inflation (Dewett (2005))hurts people on fixed incomes by reducing their purchasing power. This has a significant effect on GDP. Rising inflation can prompt trade unions to demand higher wages, under the circular logic that wages must keep up with inflation. In the case of collective bargaining, wages will be set as a factor of price expectations (P.E.). P.E. will be higher when inflation has an upward trend.

The concern with inflation emanates not only from the need to maintain overall macroeconomic stability, but also from the fact that inflation hits the poor particularly hard as they do not possess effective inflation hedges. Inflation may be described as the "single biggest enemy of the poor". Consequently, maintaining low inflation is seen as a necessary part of an effective anti-poverty strategy.

This is why we need to have a clear idea about the current trend of inflation rate of Bangladesh. In business, industry and government policymakers must anticipate the future behavior of many critical variables before they make decisions. Trend analysis can help them in this regard.

Trend analysis (Box, G.E.P. (2008)) on inflation rate data is quite necessary for making valid economic policy. In this study, it is tried to select a suitable forecasting model to observe the trend of inflation rate of Bangladesh. For this purpose, we considered the model selection procedure in the context of Linear Trend Model, Quadratic Trend Model, Exponential Growth Curve Model and S-curve Model. Furthermore, we compared these four models to obtain a unique model for trend analysis of inflation rate of Bangladesh.

II. Data and Variables

This study was conducted on inflation rate of Bangladesh. As the aim of the study was to find out a suitable model for analyzing the trend of inflation rate of Bangladesh. In this study, we took inflation rate as our variable.

Data on monthly inflation rate of Bangladesh have been used for the study and the data were obtained from the"Economic Trend" a monthly report published by Bangladesh Bank. In this study,we used data on inflation rate measured by 12 months average method, which is considered as standard.

III. Methodology

In this study, we performed trend analysis on inflation rate of Bangladesh during the period from July2002 to June2007 (Monthly Economic Trend, Statistics Department, Bangladesh Bank). This analysis showed overall pattern of change over the concerned time period. Trend analysis fits a trend line using a Linear Trend model, a Quadratic Trend model, an Exponential Growth Trend model and an S-curve Trend model. Each model generates a time series plot that shows the original data and the fitted trend line. The main goal is to find an appropriate formula so that the residuals are as small as possible and exhibit no pattern. The models used in trend analysis are based on statistical concepts and principles and are able to model a wide spectrum of time series behavior.

Linear Trend model

The linear trend model (Minitab (2000). Release 13 User's Guide 2: Data Analysis and Quality Tools) model consists of a linear trend with an added random variation. The linear trend model is defined by the following equation-

$$Y_t = \beta_o + \beta_1 t + e_t$$

In this model, β_0 is the intercept and β_1 is the slope, e_t is the random error component. The constant β_0 is the mean of the trend at time zero. β_1 represents the average change from one period to the next. The random variables e_t are independent observations on a population with a normal distribution with mean zero and a constant variance σ^2.

Quadratic Trend model

The Quadratic Trend model (Minitab (2000). Release 13 User's Guide 2: Data Analysis and Quality Tools) accounts for curvature in the trend. It is defined by the following equation:

$$Y_t = \beta_o + \beta_1 t + \beta_2 t^2 + e_t$$

In this model β_0 is the mean of Y_t when $t = 0$. β_1 is the linear effect parameter and β_2 is the quadratic effect parameter.

Exponential Growth Trend model

The Exponential Growth Trend models (Minitab (2000). Release 13 User's Guide 2: Data Analysis and Quality Tools) are used in situations with an element of growth(or decay) in them. For example, a savings account might exhibit exponential growth. An Exponential Growth Trend model can be defined by the following equation:

$$Y_t = \beta_o \beta_1^{\,t} + e_t$$

Where, Y_t is the dependent or forecast variable and t is the explanatory or predictor variable. β_0 and β_1 are two parameters and e_t is the random variation.

S-curve Trend model

The S-curve model (Minitab (2000). Release 13 User's Guide 2: Data Analysis and Quality Tools) fits the Pearl-Reed logistic trend model. This accounts for the case where the series follows an S-shaped curve. An S-curve Trend model can be defined by the following equation:

$$Y_t = \frac{10^a}{\beta_o + \beta_1\left(\beta_2^{\,t}\right)}$$

Where Y_t is the dependent variable and t is the explanatory or predictor variable. β_0, β_1 and β_2 are three parameters.

IV. Model Selection Procedures

In this study, we have followed the minimum residual variance or minimum mean prediction error (Montgomery (2008)) procedure for the purpose of selecting the best model among competing alternatives models for the trend analysis of the inflation rate of Bangladesh. This procedure has been described below:

Minimum Residual Variance or Minimum Mean Prediction Error Procedure:

In this approach, models are selected by the minimization of some function of model' s error, such as, mean absolute percentage error(MAPE), mean absolute deviation(MAD), mean squared deviation(MSD), mean error(ME), mean prediction error(MPE). The model with the smallest average error will be considered as the best model and it will give the best fitting trend line for our data set.

Accuracy measures of error

The model that gives the minimum measures of error will be our desired model for trend analysis. Suppose, Y_t is the actual observation for time period t and $\hat{Y}_t$ is the fitted value for the same period. Then, the error is defined as $(Y_t - \hat{Y}_t)$. If there are observations for n time periods, then there will be n error terms, and the following standard statistical measures can be defined:

Mean Absolute Percentage Error (MAPE): It expresses accuracy as a percentage.

$$\text{MAPE} = \frac{1}{n}\sum_{t=1}^{n}\left|Y_t - \hat{Y}_t\right| / Y_t \times 100$$

Mean Absolute Deviation (MAD): It expresses accuracy in the same units as the data, which helps conceptualize the amount of error.

$$\text{MAD} = \frac{1}{n}\sum_{t=1}^{n}\left|Y_t - \hat{Y}_t\right|$$

Mean Squared Deviation (MSD): It is very similar to MSE, mean squared error, a commonly used measures of accuracy of fitted time series values.

$$\text{MSD} = \frac{1}{n}\sum_{t=1}^{n}\left(Y_t - \hat{Y}_t\right)^2$$

Mean Error(ME): The mean error gives the average error and is given by,

$$\text{ME} = \frac{1}{n}\sum_{t=1}^{n}\left(Y_t - \hat{Y}_t\right)$$

Mean Prediction Error(MPE): The MPE is the mean of the relative or percentage error and is given by,

$$\text{MPE} = \frac{1}{n}\sum_{t=1}^{n}\left(\frac{Y_t - \hat{Y}_t}{Y_t}\right)\times 100$$

V. Analysis of Data

This study involves 60 observations of inflation rate of Bangladesh from the time period July 2002 to June 2007. Four models, such as, linear trend model, quadratic trend model, exponential growth trend model and S-curve trend model have been fitted to these 60 observations using MINITAB and then residuals have been carefully studied to see whether they show any difference. Average residuals have been compared for each model and the model for which this average residual is the least, we consider that model as the suitable model.

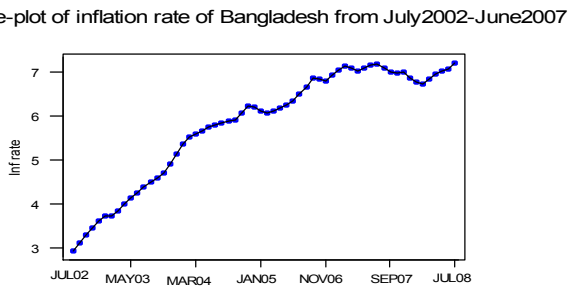

Fig. 1. The time-plot of inflation rate of Bangladesh from July2002-June2007.

In this time-plot of figure-1, we observe that there is an upward trend of inflation rate during July2002-June2007.

Linear Trend model

Fitted Trend Equation for Linear Trend model

$$\hat{Y}_t = 3.72963 + 6.28E - 02 * t$$

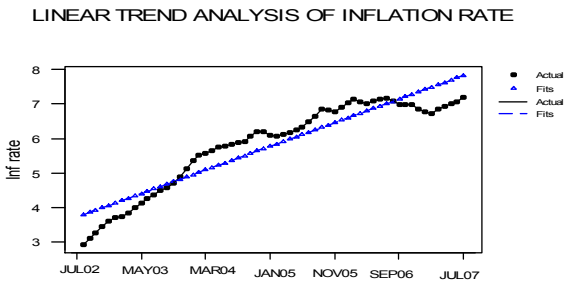

Fig. 2. Linear Trend analysis for inflation rate against time period from July2002-June2007.

From the above graph, we can visualize that, our actual data deviate much from the fitted values.

Quadratic Trend model

Fitted Trend Equation for Quadratic Trend model is:

$$\hat{Y}_t = 2.75062 + 0.162990 * t - 1.55E - 03 * t**2$$

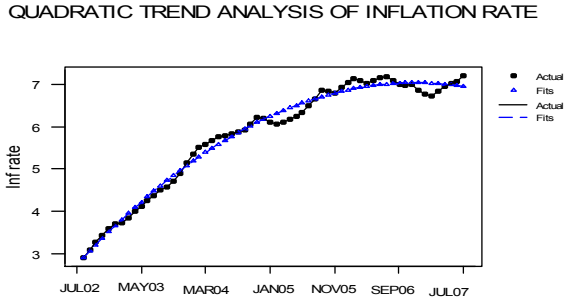

Fig. 3. Quadratic Trend analysis for inflation rate against time period from July2002-June2007.

From the above graph, we can visualize that, our actual data gives a close fit to the fitted values.

Exponential Growth Trend model

Fitted Equation for Exponential Growth Trend model is:

$$\hat{Y}_t = 3.79903 * (1.01310 **t)$$

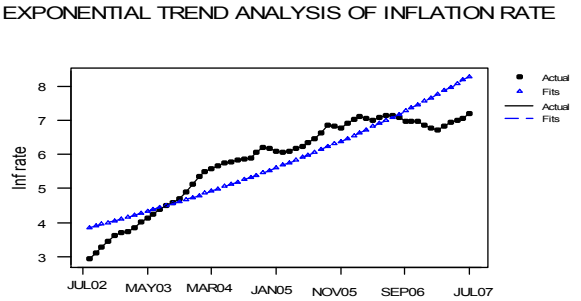

Fig. 4. Exponential Growth Trend analysis for inflation rate against time period from July2002-June2007.

From the above graph, we can visualize that, our actual data deviate much from the fitted values.

S-curve Trend model

Fitted Trend Equation for S-curve Trend model:

$$\hat{Y}_t = (10 **2)/(13.7210 + 21.1242 * (0.929396 **t))$$

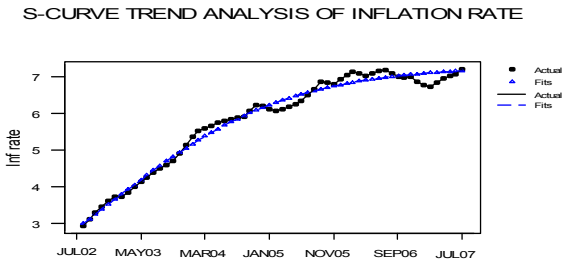

Fig. 5. S-curve Trend analysis for inflation rate against time period from July2002-June2007.

From the above graph, we visualize that, our actual data gives a very close fit to the fitted values.

VI. Comparison among Linear Trend model, Quadratic Trend model, Exponential Growth Trend model and S-curve Trend model

The trend analysis performances of the Linear Trend model, Quadratic Trend model, Exponential Growth Trend model and the S-curve Trend model have been compared with each other with respect to different measures of error and the summary measures are listed in the table below:

Table1. Comparison among Linear Trend model, Quadratic Trend model, Exponential Growth Trend model and S-curve Trend model:

Measures of error	Linear Trend model	Quadratic Trend model	Exponential Growth Trend model	S-curve Trend model
MAPE	7.39565	2.07863	9.00254	2.13465
MAD	0.393985	0.120445	0.499908	0.127268
MSD	0.193762	0.020316	0.331453	0.0232022
ME	-4.40E-17	-1.70E-07	0.016075	0.002405
MPE	1.035611	-0.04761	-0.54404	-0.00224

From the table1, we see that for the average of all the measures of error, the S-curve Trend model gives the better result over other models. So we can say that the S-curve Trend model provided the best fit for the purpose of analyzing the upward trend of inflation rate of Bangladesh than that of other models.

VII. Conclusion

Our prominent goal in this study was to select a model for the trend analysis of the inflation rate of Bangladesh. For this purpose, we used four models, such as, Linear Trend model, Quadratic Trend model, Exponential Growth Trend model and S-curve Trend model. From the analysis of the data, we found that Linear Trend model, Quadratic Trend model and Exponential Growth Trend model are not suitable for our concerned data set. S-curve Trend model with parameters β_0=13.7210, β_1=21.1242, and β_2=0.929396 is appropriate for our data set. The trend analysis performances of these four models were compared with respect to the different accuracy measures of errors. From this comparison, we found that S-curve Trend model gives less error than that of the other three models. So we can say that the S-curve Trend model gives the best fit to our given set of data.

So we can suggest that for the purpose of trend analysis of the inflation rate of Bangladesh, one can use the S-curve Trend model. But we should be careful that all models are not suitable for all situations. A good trend technique for a specific situation may be misleading for another situation. The validation of a particular model must be examined with the change of time and situation.

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1. Box, G.E. P., G. M. Jenkins, and G. C. Reinsel, (2008), Time Series Analysis: Forecasting and Control, 4th Edition Wiley Series in Probability and Statistics.
2. Dewett, K.K.(2005), Modern Economic Theory, Shyam Lal Charitable Trust.
3. Monthly Economic Trends, Statistics Department, Bangladesh Bank.
4. Minitab (2000). Release 13 User's Guide 2: Data Analysis and Quality Tools.
5. Montgomery, D. C., C. L. Jennings, and M. Kulahc, (2008). Introduction to Time Series Analysis and Forecasting. Wiley Series in Probability and Statistics.