Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/8122
DOI URL: http://dx.doi.org/10.21474/IJAR01/8122

RESEARCH ARTICLE

COMPARISION STUDY OF EFFICIENCY OF TIME SERIES MODELS IN FORECASTING STOCK PRICES IN SRI LANKA.

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Manuscript Info

Manuscript History
Received: 01 October 2018
Final Accepted: 03 November 2018
Published: December 2018

Keywords:-
Stock market, Colombo stock exchange, Exponential smoothing method, Error rates, Sri Lanka.

Abstract

The Colombo Stock Exchange is broadest and entirelyinvoluntarytrade exchange system in Sri Lanka. Investigation and prediction of stock market time series data have elaborated significantattention from the investigators and academics over theprevious decade. In this research article, the Colombo Stock Exchange All Share Prices were figured and predicted the tendency of stock market variations using time series modeling procedures, alike exponential smoothing method and autoregressive integrated moving average technique. The forecasted values of Colombo Stock Exchange All Share Priceswere computed for both models distinctly and also compared the error rates. From the consequences, the autoregressive integrated moving average model accomplishedwell than the exponential smoothing model.

Introduction:-

A share is anundividable component of capital, stating the proprietorship relation among the corporation and the shareholder. Stock signifies an entitlement on the corporation'sproperties and incomes. Most of the shares are dealt on exchanges, which are destinations where purchasers and vendersencounter and agree on a price. The constraint of a stock market is to brandconceivable the exchange of securities between consumers and sellers, dropping the risks of investing. The Colombo Stock Exchange (CSE) is a stock market in Sri Lanka, which was set up in1990 though the trading of shares were initiated in Sri Lanka in 1986 by Share Brokers Association (SBA). SBA was then renamed as Colombo Brokers' Association in 1904 and CSE in 1990. CSE is the primary exchange system in the country to deliver a contemporary, completelyautomatic screen-based electronic exchangescheme which available easy exchangecapability to the depositorsextendthrough the distance and extensiveness of the country. CSE was also influential in making the Central Depository System (CDS) which permits investors to safely hold and exchange their stocks and bonds automatically.

Stock market price is most assiduous about the stock initial price, lowermost price, uppermost price, final price, adjusted closing price and volume. In general, closing stock price of a day of anexchange is not related with the preceding day closing stock price. In this study, the CSE all-share price data of 2017 is primarilyinspected and then double exponential (Holt's) method and Autoregressive Integrated Moving Average (ARIMA) model wereimpliedfor fitting the data. The CSE all-share price (in Rs.) data was utilized. The starting time period is January 2017 and the end period is December of 2017, with 241elements. The data is gained from the commercial part of countryeconomy.com and the calculationswerecompleted by using E-views and Minitab software packages.

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Review of Literature:-

The findings of Lesseps *et al*. (1997) recognized that the stock price trails a long-term tendency with short-term variation and predicts the exchange rate. Farook*et al*. (2014) advanced Box-Jenkins technique for forecasting the worldwide atmospheric carbon dioxide releases data. Adebiyi, *et al.* (2014) made the prediction of **Stock Price** Using the ARIMA Model, which showed **a**strong potential for short-term prediction and can compete favorably with existing techniques for stock price prediction.Box *et al*. proposed the autoregressive integrated moving average model using stationary concept for the forecast determinations. Walderdeliberated time series models for managing econometric study for prediction data.

Methodology:-

Exponential Smoothing (Holt's) Method:-

The time series prediction for the following value is founded on the weights to most recent observation and the currentpredictioncorrespondingly. The elementaryimpressionbehindhand double exponential smoothing is to present a term to allow for the opportunity of a series showing some arrangement of the trend. This slope constituent is itself rationalizedthrough exponential smoothing. It is mentioned to as double exponential smoothing (Holt's) model. This method is suggested when non-seasonality occurs in the time series records. It is built on two formulas: one for the level and one for the trend as follows:

$$S_t = \alpha\, x_t + (1-\alpha)(S_{t-1} + b_{t-1})$$
$$\alpha - smoothing\ constant\ for\ the\ level\ ; \quad 0 < \alpha < 1$$

$$b_t = \gamma(S_t - S_{t-1}) + (1-\gamma)b_{t-1}$$
$$\gamma - smoothing\ constant\ for\ the\ trend\ ; \quad 0 < \gamma < 1$$

…… (1)

Autoregressive Integrated Moving Average (ARIMA) Model:-

In time series study, an ARIMA model is a simplification of an autoregressive moving average (ARMA) model. These models are tailored to time series data either to healthierclassify with the data or to forecastupcoming points in the sequence. It is also recognized as Box- Jenkins technique. Just in case the data is established to be non-stationary, utilized the differencing methodnow the data rehabilitated to stationary procedure. Usually, Box-Jenkins techniquemeant by ARIMA (p, d, q); where limitations are positive integers then p, d, and q denote the autoregressive (φ), differencing, and moving average (θ) also can be stated as:

$$y_t = c + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \ldots\ldots\ldots + \varphi_p y_{t-p} + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \ldots\ldots\ldots - \theta_q e_{t-q}$$

…… (2)

The study is carried out in three phases; those are, data examination, identification of best model and authentication of the model and forecasting. Specially, Box Jenkins methodology was useful for building the appropriate ARIMA model.

Identification:-

In the identification phase, choosing if the time series data is stationary or not and associate the projected Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) to discover a link.

Estimation:-

The parameters are predicted by adapted least squares and maximum likelihood estimation methodssuitable to time series data.

Diagnostic Testing:-

The diagnostic testing is essential to examine the suitability of the nominated model. Model selection can be doneestablished on the minimum values of Akaike Information Criterion (AIC) and Bayesian Information Criteria (BIC).

If the model selection is done, it is necessary to verify the satisfactoriness of the estimated model. This is done by studying the pattern of the residuals if there is any. The estimated residuals can be computed as:

$\hat{e}_t = y_t - \hat{y}_t$; Where $\hat{y}_t$ is the fitted observation at time t.

Forecasting:-
Prediction of values of a variable built on recognizedhistorical values of that variable or other related variables is known as forecasting. If the proper model is establishedreasonable after the model adequacy checking,the fitted model can be applied for forecasting persistence.

Rates of Error:-
Prediction error is a measure of in what wayprecise is our prediction in a particular time period. The performances of Mean Absolute Percentage Error (MAPE), Root Mean Square Error (RMSE), Mean Absolute Deviation (MAD) and Mean Square Deviation (MSD) are given by:

$$MAPE = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{y_t - f_t}{y_t}\right| \times 100 \qquad RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(y_t - f_t)^2}$$

$$MAD = \frac{1}{n}\sum_{t=1}^{n}|y_t - f_t| \qquad MSD = \frac{1}{n}\sum_{t=1}^{n}(y_t - f_t)^2$$

Results:-

Summary Statistics:-
Throughout the period of ASP in CSE, there are no outlier remarks using Whisker-Box plot (Figure 1). The minimum andmaximum of all shareprices are 5974.94and 6766.14(denoted Table 1) correspondingly. The CSE all share prices are perceived at an average of 6424.52with a standard deviation of 224.42 in Table 1.

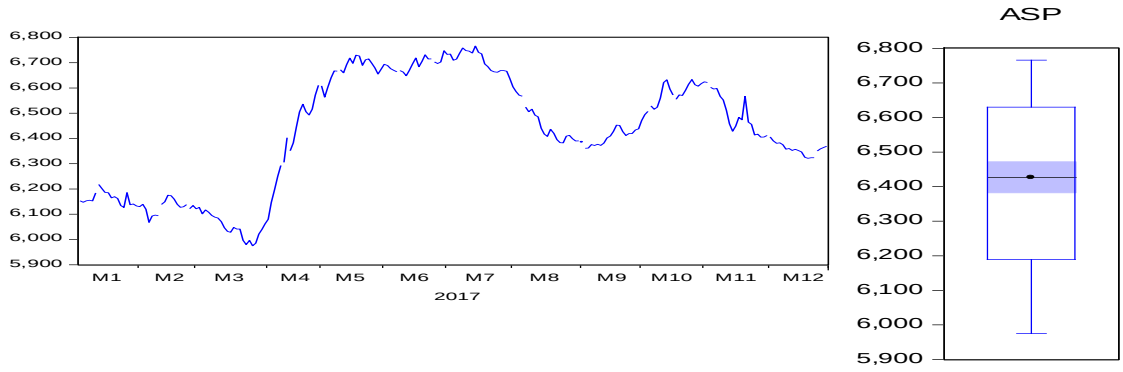

Figure 1:-Time Series Plot and Whisker-Box Diagram of CSE Data for 2017 All Share Price

Table 1:-Summary Statistics CSE all-share price of 2017

	Descriptive	Statistics
CSE All Share Prices	Mean	6424.519
	Median	6428.070
	Maximum	6766.140
	Minimum	5974.940
	Std. Dev.	224.4224
	Skewness	-0.294266
	Kurtosis	1.858303
	Jarque-Bera	16.56714
	Probability	0.000253
	Sum Sq. Dev.	12087701
	Observations	241

Exponential Smoothing Model:-

Time plot of CSE all-share price data exposed that there is growing fluctuations trend in the data. Intended for smoothing of the data, Holt's double exponential smoothing method was originated to be most suitable. Numerousmixtures of α and β both oscillatingbetween 0.1 and 0.9 with increases of 0.1 were a trend and MAPE (0.283) was least for α=0.999 and β=0.1 (Table 2). The fitted model is given by:

$$S_t = 0.999\, x_t + 0.001(S_{t-1} + b_{t-1})$$
$$b_t = 0.1(S_t - S_{t-1}) + 0.9\, b_{t-1}$$

Arima Model:-

A time series plot is initiallyimplied for all the CSE data of 2017 based on all-share prices. As exposed in Figure 1, a strong non-stationary trend can be found, which is consistent to the Sri Lankan economics. Subsequent ARIMA model, a first order differencing is calculated for the data, after that, ACF & PACF of the first order differencing data is revealed in Figure 2.

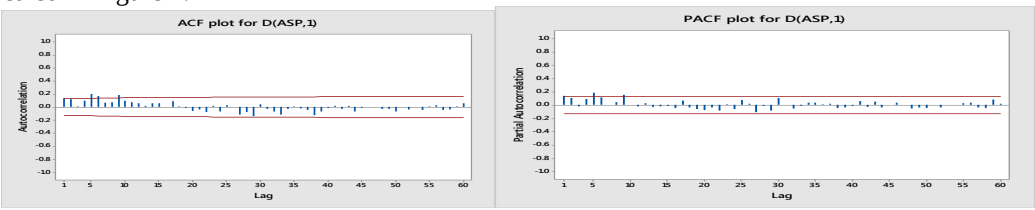

Figure 2:-ACF& PACF of the First-Order Differencing for CSE all-share Price data.

The differencing data shows a stationary pattern and thus the value of d was one. The ACFs (MA) and PACFs (AR) are also completed on the differencing data, which shows a short-term autocorrelation and authorizes the stationary of the differencing data and the order of q can almost be 1 (Figure 2). To build an accurate interpretation of the data, autocorrelation check for residual is done on the differencing data. Based on the results from an ARIMA model be fitted to the original CSE all-share price data of 2017, also the parameters in ARIMA (p, 1, q) need to be resolute.

Table 2:-Arima Model Parameters Of Cse Asp.

		Coefficient	Std. Error	Probability
ARIMA(1,1,1) Model	C	0.925288	3.720234	0.8038
	AR(1)	0.924232	0.050977	0.0000
	MA(1)	-0.833226	0.070121	0.0000
	SIGMASQ	588.6966	37.31382	0.0000

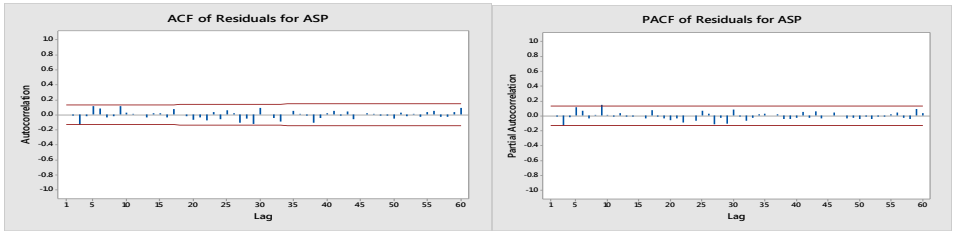

Figure 3:-Residual ACF & PACF Diagram of the Original CSE all-share price Data.

Furthermore, using E-views package for diverse values of p and q (0, 1 and 2), numerous ARIMA models were tailored and the suitable model was selected consistent to minimum value of the information criteria such,Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC). Like this, ARIMA (1, 1, 1) model was established to be the most appropriate model (Tables 2 and 3). The ACF & PACF of the residuals also designates 'good fit' of the model (Figure 3). Thus, the fitted ARIMA (1, 1, 1) model for CSE all-share price is:

$$y_t = 0.92529 + 0.92423 y_{t-1} - 0.83323\, \varepsilon_{t-1} + \varepsilon_t$$

Table 3: Model Error Statistics for CSE ASP

Model Statistics	Holt's Method	ARIMA Model
RMSE	24.797	24.261
MAPE	0.283	0.277
MAD	18.166	17.781
MSD	614.899	588.577

Table 4:-ForecastComparison of CSE ASP

Observ.	Actual	Holt's Method		ARIMA Model	
		Forecast	|Std. Error|	Forecast	|Std. Error|
242	6411.27	6369.31	41.96	6371.12	40.15
243	6463.50	6369.36	94.14	6372.89	90.61
244	6459.66	6369.41	90.25	6374.58	85.08
245	6514.73	6369.46	145.27	6376.19	138.54
246	6540.51	6369.52	170.99	6377.73	162.78

Established on the outcomes, assessment of actual values and forecast values of both methods is given away in Table 4. The projected value is a little diverse from the actual value for Holt's and ARIMA, but ARIMA is exceptionally different from Holt's method. The variation of CSE all-share price data can be instigated by numerous influences, such as Sri Lankan financial interferences, policies of Central Bank of Sri Lanka, international actions, and strategies.

Conclusions:-

In this paper, two-time series forecasting methods were considered. First one is double exponential smoothing (Holt's) method and another one is ARIMA model. Both of them are very applicable in Colombo Stock Exchange All Share Prices but ARIMA model executed better than the other one. From the overheadconsequences, the ARIMA error rates are (RMSE, MAPE, MAD and MSD) very small as compared to Holt's method. The CSEAll Share Prices occupied in the current study illustrates increasing fluctuations trend for upcoming trading existences.

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