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Original Research Article

Circular Model & Circular Indicator on Measuring Return & Risk of Hotel & Travel Sector of Sri Lankan Share Market

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ABSTRACT

Share trading is an important part of the economy of a country. Share market investments are considered as high risk, high return investments. But investors are concerned about low risk, high return investments. Hence forecasting of risk and return is essential for share markets. The Capital Asset Pricing Model (CAPM) is the most commonly used model for forecasting share returns. Auto Regressive Integrated Moving Average Models (ARIMA) and Vector Auto Regression (VAR) models also were successful for the purpose. However; CAPM and VAR models were totally failed in Sri Lankan context. The standard deviation of returns and the beta coefficient of CAPM are the used measurements of risk of returns; but both methods are erroneous. Tourism industry is a fast growing industry in Sri Lanka. Therefore, investor attraction towards the industry has been increasing. This study was focused on forecasting risk and returns of individual companies in Hotel & Travel (H&T) sector of Sri Lankan share market and finding the stability of them in market performance. The ARIMA model and the Circular Model were tested on measuring returns; the Circular Indicator was used in measuring risk of returns and the Coefficient of Stability was used for finding the stability of market performance. Monthly returns for the period from year 1994 to 2016 were used for data analysis. Model validation was based on Residual plots, Auto correlograms of residuals, Anderson Darling test, Durbin- Watson test, Root Mean Square Error and Mean Absolute Deviation. The ARIMA model was successful on 67% of the companies while the Circular Model was successful in 80% of the companies. The forecasted values of ARIMA models did not follow the patterns of the actual returns, but the forecasted values of CM followed the actual returns. As such, it was concluded that the CM superior to ARIMA in forecasting returns. Risk of returns was measured by the Circular Indicator (CI) and the stability of market performance of a company is evaluated by the Coefficient of Stability (CoS). Investors are rational; their risk preferences are subjective. As such; a risk taker can make use the CI together with the forecasted return for investment decision; a risk averse investor's choice could be in cooperated to CI. The CoS can be used to get the overall picture of the performance of individual companies.

Key Words: Circular Model, Circular Indicator, Coefficient of Stability

INTRODUCTION

Scientific forecasting plays a vital role in research and management of a large number of fields. Scientific forecasting is mainly depends on statistical modeling. A statistical model is defined as a set of probability distributions on the sample space S. [1] The three main categories of statistical models are: parametric statistical models, semi- parametric statistical models and non-parametric statistical models.

The Statistical models also can be broadly classified into two parts: univariate statistical models and multivariate statistical models. A univariate statistical model is an equation or set of equations explaining the

behavior of a single random variable over time while the multivariate statistical models explain the joint behavior of two or more random variables. The univariate statistical modeling procedure is based on the past internal patterns in data to forecast the future and no external variables are required in forecasting. The basic concept of these methods is that the future values of a series are a function of past values. Well known univariate methods are: Moving Average Smoothing, Exponential Smoothing, Winters' method, Decomposition techniques, Box Jenkin's Auto Regressive Integrated Moving Average (ARIMA) methods, Linear and Non-linear trend models. [2] The Circular Model (CM) is a recently developed univariate forecasting technique.

Share Market Forecasting in Sri Lanka

Share trading in Sri Lanka commenced in the 19th century, with the formation of Colombo Share Brokers Association. Later it was renamed as 'Colombo Stock Exchange (CSE). At present, CSE is the secondary capital market or share market of the country.

Share trading is an important part of the economy of a country. Share trading affects all the stake holders. Share market investments are exposed to two types of risks; systematic risks and unsystematic risk. Systematic risk cannot be mitigated, but the unsystematic risk can be reduced by diversification. As such, Portfolio investments are preferred than the investments in a single asset. Portfolio selections are based on risk and return of the investment. Hence; forecasting of risk and return were immense interest over the past decades.

The Capital Asset Pricing Model (CAPM) and its improvements, Auto Regressive Integrated Moving Average Models (ARIMA) and Vector Auto Regression (VAR) models were the mainly used models for forecasting share returns. According to; [3] CAPM and VAR models are not suitable for forecasting individual company returns of the Sri Lankan share market. In general, the risk of returns is measured by standard deviation or beta coefficient of Capital Asset Pricing Model (CAPM), but both methods are erroneous. [3]

Research Problem

Tourism industry is a fast growing industry in Sri Lanka. Over the past years, it has shown growth in two ways; volume and value. [4] As such, attraction of the investors towards the industry increases. Therefore it is essential to have proper techniques for forecasting risk and returns of Hotel & Travel (H&T) sector of the Sri Lankan share market. Reliable and accurate forecasting techniques make investment decisions efficient. They help making optimum benefits to investors, and leads to a healthy stock market.

Portfolio selection in Sri Lankan share market is based on either intuition or β coefficient of CAPM. The CAPM is given by the formula;

$$E(R_i) = R_f + \beta(R_{m,} - R_f) \qquad (1)$$

Where; R_i is the return of ith company assets, R_m is the return of total market, R_f is the risk free rate of return and $\beta = \frac{Cov(R_i, R_m)}{\sigma_m^2}$. It is considered that, if β = 0, the share price is not at all correlated with the market, therefore no risk; if β = +1, an average level of risk; if β >1, security returns fluctuates more than the market returns, at high risk; if β<1, asset inversely follows the market. [5] Beta (β) coefficients for listed companies are published by CSE on quarterly basis and they are being used for investment decisions.

As shown by, [3] there is no linear relationship between individual company returns and total market returns in Sri Lankan context. Therefore β coefficient is not a suitable method for measuring risk. However, the Circular Indicator of [3] has filled the knowledge gap; yet, applicability of CM and CI may quite complicate for a general user. As such, the "Coefficient of Stability (CoS)" was introduced. [6] The CoS measures the stability of an individual

company in market performance. It can be easily used for portfolio selections.

Objectives of the Study

Based on the above, this study was focused to;

i. To test Circular Model (CM) and ARIMA on forecasting returns of individual companies of H&T sector of Sri Lankan share market.
ii. To use Circular Indicator on measuring risk of returns of individual companies of H&T sector of Sri Lankan share market.
iii. To use Coefficient of Stability in measuring the stability of market performances of H&T sector of Sri Lankan share market.

MATERIALS AND METHODS

Thirty companies were listed in H&T sector of CSE, in year 2016. It was intended to use all thirty companies for the analysis, but it happened to remove some companies due to two reasons; some companies were listed in CSE for few years; therefore data series were not sufficient; trading activities of some companies were discontinued. As such, daily closing share prices of fifteen companies from year 1991 to 2016 were used for analysis. Monthly average returns were calculated by formula;

$$R_t = \left(\frac{P_t - P_{t-1}}{P_{t-1}} \right) 100 \qquad (2)$$

Where; P_t is the share price at time t.

Outliers existed in all the data sets. They were adjusted by adopting the moving average technique. Then the CM and ARIMA were tested on outlier adjusted data sets. Goodness of fit tests and measurements of errors were used in the model validation.

If the CM is well fitted, then the Circular Indicator (CI) and the Coefficient of Stability (CoS) were calculated.

Statistical Methods and Terminology Used in the Study

Statistical techniques used in the study are briefly described below.

The ARIMA model

The ARIMA is well known univariate forecasting technique, given by formula;

$$\phi_p(B)\Delta^d Y_t = \theta_q(B)\varepsilon_t \qquad (3)$$

Where, Y_t is the actual value, ε_t is the random error at time t, φ_p and θ_q are the coefficients of autoregressive and moving average, respectively. B is the back shift operator. The ARIMA model is applicable only for stationary series.

The Circular Model

The Circular Model (CM) also a univariate forecasting technique, developed to model wave like patterns. Development of the model was based on the Fourier transformation and Multiple Regression analysis. [3]

The Fourier transformation is incorporated to a uniform circular motion of a particle in a horizontal circle and basic trigonometric ratios. A particle P, moving in a horizontal circle of centre O and radius a, is given in Figure 1. ω is the angular speed of the particle;

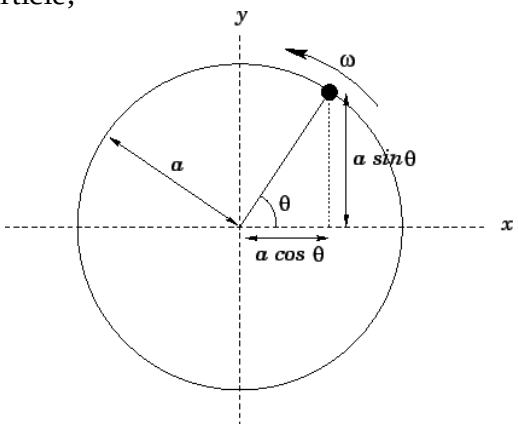

Figure 1: Motion of a particle in a horizontal circle

The Circular Model is;

$$R_t = \sum_{k=1}^{n} (a_k \sin k\omega t + b_k \cos k\omega t) + \varepsilon_t \qquad (4)$$

Where; R_t is the return at time t, a_k and b_k are amplitudes, k is the harmonic of oscillation. [3]

The Circular Indicator

Development of the Circular Indicator was based on the theory of uniform circular motion (Newton's law). Reference to Figure

1; position vector of a particle at time *t* is;

$$\overrightarrow{op} = a(\cos\theta\,\mathbf{i} + \sin\theta\,\mathbf{j})$$

In usual notations;

Velocity of the particle; $v = a\omega$

Acceleration of particle; $\mathbf{a} = a\omega^2$

When particle moves in a circle, it is constantly changing its direction. At all instances, the particle is moving tangent to the circle; as such, the acceleration of the particle also tangent to the circle. Even though the particle is moving under the acceleration with a changing direction, it does not leave the circular path. Therefore, there should be force acting towards the centre of the circle which prevents particle leaving its locus. This force is named as the centripetal force. [7]

Using the Newton's second law of motion; $\mathbf{F} = m\mathbf{a}$ towards the centre;

$$\mathbf{F} = ma\omega^2 = m\frac{v^2}{a}$$

The centripetal force (F) is directly proportional to the mass and the square of the velocity, but inversely proportional to the radius of the circle. In other words the stability of a motion of a particle depends on the mass of the particle, its velocity and the radius of the circular motion.

As per, [3] share returns of a company follow a uniform circular motion. If mass of the particle (per share return) assumed to be 1; then;

$$F_{i,t} = r_{i,t}.\omega_{i,t}^2 \qquad (5)$$

Where $F_{i,t}$ is the force making returns to be in a circular motion of a company *i* at time *t*, $r_{i,t}$ is the radius of the circular motion of i^{th} particle at time *t* and $\omega_{i,t}$ is the angular speed of the particle at time *t*. The indicator, $F_{i,t}$; named as the "Circular Indicator" was used as the measurement of risk. That is; larger the $F_{i,t}$; lesser the risk of returns of a company in market performances.

The CM is;

$$R_t = \sum_{k=1}^{n}(a_k \sin k\omega t + b_k \cos k\omega t) + \varepsilon_t$$

For a fitted model;

$$\bar{R}_t = \sum_{k=1}^{n}(a_k \sin k\omega t + b_k \cos k\omega t) \qquad (6)$$

According to (5), motion comprises of several circular motions with radius a_k, and b_k. Hence $r_{i,t}$ was taken as the average of the radii;

$$r_i = (\sum_{k=1}^{n} |a_k| + |b_k|)/n \qquad (7)$$

The Coefficient of Stability (CoS)

The "Coefficient of Stability (*CoS*)" is defined as;

$$CoS = \left(\frac{F_t}{R_t}\right).100 \qquad (8)$$

Where; R_t is the return and F_t is the risk of return. [6] The *CoS* expresses the risk as a proportion of return. If the Circular Indicator value (F_t) is high, the stability is high. As such, higher Coefficient of Stability (*CoS*) indicates the lesser risk in investment.

Outlier Adjustment

Outliers are extremely large or small values outside the overall pattern of a data set. The outlier detection and adjustment are essential in data analysis. Boundaries of outliers are defined in many ways. Following rule is often used in outlier detection. [8]

$$L = Q_1 - 1.5 * IQR$$
$$U = Q_3 + 1.5 * IQR \qquad (9)$$

Where Q_1 *and* Q_3 are the lower quartile and upper quartile respectively, *IQR* is the inter quartile range, *L* is the lower boundary and *U* is the upper boundary. Any data value above *U* or below *L* was considered as outliers. Such data points were adjusted by adopting moving average technique.

Goodness of fit tests

Goodness of fit tests and measurements of errors were used in the model validation. The goodness of fit of a statistical model describes how well it fits a set of observations. The plots of residuals versus fits, Auto Correlation Functions (ACF) and Partial Autocorrelation Functions (PACF) of residuals and Ljung-Box Q statistics (LBQ) were used to test the independence of residuals. Histogram of residuals, Normal

probability plot of residuals and Anderson Darling test were used to test the normality of residuals.

Measurements of Forecasting Errors

Forecasting is a part of a larger process of planning, controlling and/ or optimization. Forecast is a point estimate, interval estimate or a probability estimate. One of the fundamental assumptions of statistical forecasting methods is that an actual value consists of a forecast plus an error; In other words, "Error = Actual value – Forecast". This error component is known as the residual. A good forecasting model should have a minimum average of absolute error and zero average of error mean because it should over forecast and under forecast approximately the same. [9]

Measuring errors is vital in the forecasting process. The measurements of errors are divided into two parts; the Absolute measures of errors and the Relative measures of errors. Some absolute measures of errors are; Mean Error (ME), Mean Absolute Deviation (MAD), Sum of Squared Errors (SSE), Root Mean Squared Error (RMSE) and Residual Standard Error (RSE). Some relative measures of errors are: Percentage Error (PE), Mean Percentage Error (MPE) and Mean Absolute Percentage Error (MAPE). However, relative measures of errors mislead when data values are extremely small. Also relative measures become undefined when data values are equal to zero. [3]

RESULTS

Results of the study are given in three parts; The ARIMA on forecasting returns; The CM on Forecasting Returns; Estimating Circular Indicator and Coefficient of Stability.

The ARIMA on Forecasting Returns

The ARIMA model was tested on sample of fifteen companies. Stationary of the series were tested by: ACF, PACF and the Augmented Dickey Fuller Test. Five of the fifteen series were not stationary type. Table 1 gives the summary of best fitting models;

Table 1: Summary of ARIMA Models for Sector H&T

Company	Best Fitting ARIMA Model
EDEN	ARIMA (0,1,1)
GHLL	ARIMA (0,0,1)
PEGA	ARIMA (0,1,1)
TAJ	ARIMA (0,1,1)
TRAN	ARIMA (0,1,1)
HUNA	ARIMA (0,1,1)
PALM	ARIMA (0,1,1)
SIGI	ARIMA (0,1,1)
AHOT	ARIMA (0,1,1)
AHUN	ARIMA (0,1,1)

Assumptions of the residuals were satisfied by all the fitted models. Measurements of errors of them are given in Table 2:

Table 2: Measurements of Errors of ARIMA

Company	Model Fitting		Model Verification	
	RMSE	MAD	RMSE	MAD
EDEN	8.2	6.8	7.8	6.3
GHLL	8.1	6.4	7.5	6.3
PEGA	9.1	7.2	6.8	5.4
TAJ	8.0	6.3	7.4	5.8
TRAN	7.8	6.7	6.9	5.4
HUNA	7.2	5.8	3.6	2.8
PALM	7.4	5.7	8.4	6.7
SIGI	7.5	6.28	4.6	3.5
AHOT	6.6	5.8	5.3	4.4
AHUN	8.2	7.0	5.8	5.4

The RMSE and MAD were small in both model fitting and verification. Therefore ARIMA models are successful in forecasting returns of the individual companies of sector H&T.

Table 3: Circular Model in Forecasting Returns of Sector H&T

Company	Best Fitting Model
EDEN	$R_t = -0.58 + 1.82\sin 4\omega t + 1.68\cos 3\omega t - 2.10\cos 4\omega t$ (10)
GHLL	$R_t = -1.49 - 0.80\cos 4\omega t$ (11)
PEGA	$R_t = -1.48 + 2.13\cos\omega t$ (12)
TAJ	$R_t = -0.63 - 1.20\sin 4\omega t + 1.46\sin 5\omega t + 1.20\cos 4\omega t$ (13)
TRAN	$R_t = 0.56 - 1.51\sin\omega t$ (14)
HUNA	$R_t = 0.34 - 2.51\cos\omega t$ (15)
PALM	$R_t = 1.66 - 3.67\cos 5\omega t$ (16)
SIGI	$R_t = 0.33 + 3.08\sin 3\omega t$ (17)
AHOT	$R_t = 0.85 + 1.62\sin 4\omega t$ (18)
AHUN	$R_t = 1.33 - 1.99\sin 5\omega t$ (19)
ASIA	$R_t = -0.31 + 2.91\sin 4\omega t$ (20)
JKH	$R_t = 0.43 + 2.29\cos 3\omega t$ (21)

The CM on Forecasting Returns

The CM employs multiple regression technique for estimating amplitudes a_k and b_k ; regressing R_t on $sink\omega t$ and $cosk\omega t$ for k is from 1 to 6. Summary results of the analysis are given in Table 3;

The CM was well fitted to twelve out of fifteen companies. Assumptions of residuals; normality and independence were satisfied by all the fitted models. Measurements of errors of the fitted models are given in Table 4:

Table 4: Measurements of Errors of CM

Model	Model Fitting		Model Verification	
	RMSE	MAD	RMSE	MAD
(10)	7.9	6.3	5.7	4.4
(11)	8.1	6.4	6.7	5.7
(12)	8.9	7.1	7.0	5.6
(13)	5.8	4.6	5.7	4.3
(14)	7.3	5.7	5.9	4.6
(15)	6.9	5.5	3.4	2.1
(16)	8.6	6.7	8.8	7.0
(17)	7.47	6.0	4.0	3.3
(18)	6.4	5.5	4.3	3.4
(19)	8.6	7.0	5.8	4.4
(20)	8.9	7.1	8.5	7.1
(21)	7.3	5.8	4.5	3.4

The RMSE and MAD were small in both model fitting and verification. Therefore CM is successful in forecasting returns of the individual companies of sector H&T. Models (10) and (13) comprise several trigonometric series whilst the other models contain only one trigonometric series each. Period of oscillation of some of the series were are than one year; some are less than a year and some have both types. Accordingly, returns may have cyclical variation, seasonal variation or both. For example; model (10) comprises three trigonometric functions; $sin4\omega t$, $cos3\omega t$ and $cos4\omega t$. Period of oscillation of theses waves are, fifteen months; five months; sixteen months respectively. It means, returns of company EDEN have both seasonal and cyclical variations.

Estimating Circular Indicator and Coefficient of Stability

Individual company returns of the Sri Lankan share market move in circular paths. In stock market performances, market demand would be the centripetal force. The Circular Indicator (CI) was calculated by using the formula; $F_{i,t} = r_{i,t} . \omega_{i,t}^2$

The Coefficient of Stability (CoS) were calculated for one month; September 2016; by using the forecasted returns of CM and CI's, given in Table 5;

Table 5: Coefficient of Stability (CoS)

Company	F_t *(CI)*	R_t	CoS (%)
EDEN	4.6	2.2	209.09
GHLL	4.3	4.7	91.48
PEGA	5.0	1.5	333.33
TAJ	3.5	4.3	81.39
TRAN	3.8	2.0	190.00
HUNA	9.3	1.8	516.66
PALM	18.6	4.5	413.33
SIGI	13.2	2.8	471.42
AHOT	4.6	0.7	657.14
AHUN	4.7	0.9	522.22
ASIA	3.1	1.6	193.75
JKH	4.8	2.1	228.57

The CI values of the sample vary from 3.1 to 18.6. The company PALM has the highest *CI* and the company ASIA has the lowest *CI*. Accordingly, the lowest level of risk is incorporate with the company PALM and the highest level of risk is in corporate with the company ASIA. Forecasted returns of all the companies were positive. It indicates that the investments in none of the companies would results losses in the aforesaid period. Per share returns (%) of the companies vary from 0.7 to 4.7; recording the highest for company GHILL. However the highest CoS is for the company AHOT. In other words, most stable company of the sector L&P in share market performances is AHOT.

DISCUSSION AND CONCLUSION

The Hotel & Travel (H&T) is the third income generator of the country. [4] It is a fast growing industry after the thirty years of civil war. Hence the investor's attraction towards the sector is increasing. As such, it is essential to find suitable techniques for helping investment decisions. The study found both ARIMA and CM as suitable techniques for forecasting individual company returns of the industry. The ARIMA was successful in 67% of the

sample, while the CM was successful in 80% of the same. Forecasting errors of both models were satisfactorily small, but the errors of CM were smaller in most of the cases. The forecasted values of ARIMA models did not follow the patterns of the actual returns, but the forecasted values of CM followed the actual returns. Figure 2; actual returns, ARIMA forecasts and CM forecasts for the company SIGI is an example for patterns of actual returns Vs ARIMA and CM.

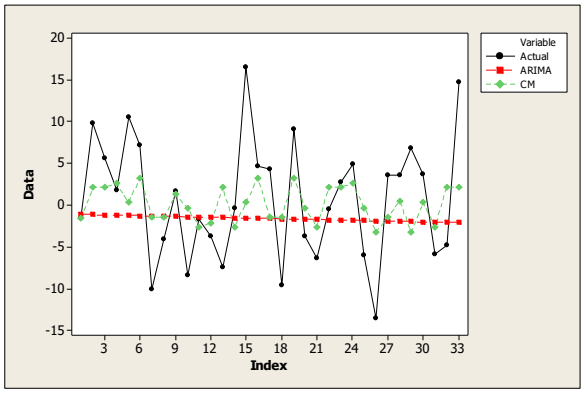

Figure 2: Time Series Plot of Actual Vs Forecast

Hence, it was concluded that the CM is superior to ARIMA in forecasting individual company returns of H&T sector of the Sri Lankan share market.

Risk preference of investors is subjective; some are risk takers, some are risk averse and others are risk neutral. A risk taker can make use the CI together with the forecasted return for his /her investment decision. For example; the company GHLL has the highest per share return; as such a risk taker might invest in GHLL, even though CI is less. A risk averse person can think of PALM, as it has the highest value of CI. The CoS can be used to get the overall picture of the company. It makes an investment decision easy and reliable.

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