Research Paper Statistics

Circular Indicator on Measuring Risk of Returns of Sri Lankan Share Market

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ABSTRACT

Statistical modeling is vital in planning, forecasting and management of capital markets. Investments in capital markets are considered as high risk and high return. But investors concern for low risk and high return. Hence forecasting risk and return is essential for share markets. In general, risk of returns is measured by standard deviation or β coefficient of Capital Asset Pricing Model, but both methods are erroneous. This study suggested a new approach for measuring risk of returns. The theory of uniform circular motion of a particle in a horizontal circle was applied in measuring the risk. Suggested risk measurement, named as "Circular Indicator" was tested on Sri Lankan stock market. Result revealed that the method is successful in measuring risk of returns. Circular Indicator may applicable for the data, follows wave like patterns in the fields; Medicine, Agriculture, Meteorology or any other.

KEYWORDS : Uniform Circular Motion

INTRODUCTION

Risk and return are the most important concepts in financial markets (Pande, 2004). Investors expect higher returns at a lower risk; as such, they are very much concerned about the information on the risk and return of individual assets. Therefore, forecasting risk and return of assets were of immense interest over the past decades.

Initially, the average deviation of returns from the mean was used as the measurement of risk. In other words, variance or standard deviation of returns was used as the measurement of risk of returns of individual securities. Later, Markowitz (1952) introduced the **β coefficient for the purpose.** The β coefficient is defined as the ratio of covariance to variance;

$$\beta = \frac{Cov(R_i, R_m)}{\sigma_m^2} \qquad (1)$$

Where R_i is the return of i[th] company assets, R_m is the return of total market.

Problem Statement

If the observations of a data series are independent, then the variance or standard deviation is a suitable measure of dispersion. But time series data are generally auto correlated, as such, variance may not be appropriate in measuring the risk of returns. On the other hand, the existence of covariance between individual company returns (R_i) and total market returns (R_m) were debated by large number of scholars. Konarasinghe, Abeynayake & Gunaratne, (2015) have shown that the above relationship does not exist for many share markets, including Sri Lankan. Therefore ability of β coefficient as a risk measurement is doubtful. Hence the study was focused to find a suitable measurement for risk of returns and to develop an indicator to compare the relative risk of individual companies in their market performances.

METHODOLOGY

The development of stability indicator was based on uniform circular motion of a particle in a horizontal circle (Newton's law). A particle *P* which is moving in a horizontal circle of centre O and radius *a* is given in Figure 1. *V* is the tangential speed of the particle and *ω* is the angular speed of the particle at time t. *F* is the centripetal force,

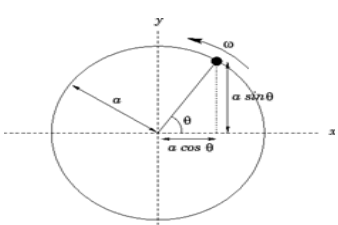

Figure 1: Motion of a Particle in a Horizontal Circle

When the particle moves in a circle, it is constantly changing its direction. Even though the particle is moving under the acceleration with a changing direction, it does not leave the circular path. Therefore, there should be a force acting towards the centre of the circle which prevents particle leaving its locus. This force is named as the centripetal force (Hooker, Jennings, Littlewood, Moran & Pateman, 2009). If the centripetal force is high, particle is more stable in its motion.

When Newton's second law of motion, *F=ma* is applied towards the centre;

$$F = ma\omega^2 \qquad (2)$$

Hence, centripetal force (*F*) is directly proportional to the mass and 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 mass of the particle, its velocity and radius of the circular motion. This law is widely applied in explaining; satellites orbiting the Earth, planets orbiting the Sun, motion of a vehicle in a circular path, motion in a banked track, Playground Merry-go-Rounds etc.

Konarasinghe & Abeynayake (2015) has shown that the individual company returns of Sri Lankan stock market follow wave like patterns. They have used Fourier transformation along with the multiple regression analysis to forecast returns.

Fourier transformation is in cooperated to a uniform circular motion of a particle in a horizontal circle and basic trigonometric ratios. Hence share returns of a company follow a uniform circular motion. If mass of the particle (per share return) assumed to be 1, then from equation (2);

$$F_{i,t} = r_{i,t} .\omega_{i,t}^2 \qquad (3)$$

Where $F_{i,t}$ is the force on returns of *i*[th] company 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 circular motion. By Newton's second law; larger the $F_{i,t}$, higher the relative stability of a company in market performances. As such $F_{i,t}$ can be taken as the risk measurement or stability indicator of the market performances. This $F_{i,t}$, is named as the "Circular Indicator" of the motion.

This study used the forecasting technique of Konarasinghe & Abeynayake (2015) for modeling individual company returns. The tested model, which is named as "Circular Model" is;

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

$$\omega = \frac{2\pi f}{N} \qquad (5)$$

Where a_k and b_k are amplitudes, f = number of peaks/ troughs of series, N= number of observations in the series.

It can be shown that the radius of the reference circle is equals to the amplitude or height of the wave. Hence $r_{i,t}$ was taken as the average of the radii;

$$r_i = (\sum_{i=1}^{n} | a_i | + | b_i |) / n \quad (6)$$

Random sample of ten companies were selected from listed companies of Colombo Stock Exchange. Monthly percentage returns of them were calculated using daily closing share prices. Outlier adjustments, peak detection and model fitting were done by software MATLAB. Then Circular Indicators (*CI*) was calculated by using the fitted Circular Models.

RESULTS AND DISCUSSION

Best fitting Circular Models for sample of companies and the, Circular Indicators of them are given in Table 1;

Table 1: Circular Models & circular Indicators

Company	Best Fitting Model	**Circular Indicator (*CI*)**
ALLI	$R_t = 1.4899 + 0.6092\cos\omega t$	4.522
EAST	$R_t = -0.34951 - 4.3751\sin 5\omega t$	26.105
NESTL	$R_t = 1.5412 - 1.4092\cos 3\omega t$	2.828
BREW	$R_t = 1.665 + 2.4188\sin 4\omega t$	9.048
LOLC	$R_t = 1.0022 + 1.9094\cos 2\omega t$	4.886
ROCE	$R_t = 1.4475 + 2.4641\sin 3\omega t - 3.9941\cos 5\omega t$	13.755
ACME	$R_t = -0.41894 - 2.7181\sin 4\omega t$	10.831
SIGI	$R_t = 0.33287 + 3.0827\sin 3\omega t$	13.932
RICHA	$R_t = -0.35993 + 1.5138\cos 5\omega t$	3.373
PDL	$R_t = 0.1549 - 1.4199\sin 5\omega t - 1.4872\cos 6\omega t$	3.165

Best fitting Circular Models given in Table 1 Comprises one or more trigonometric series. For example; Model of the company "ROCE" comprises series $2.4641 sin3\omega t$ and $3.9941 cos5\omega t$. By equation (6), radius of the circle is 3.229. Angular velocity (ω) of the motion is 1.319. Hence Centripetal force or Circular Indicator (*CI*) is 13.755.

Highest *CI* corresponds to the company EAST (26.105), and the lowest *CI* corresponds to company NESTL (2.828). Accordingly EDEN is the most stable company in share market performances and NESTL is the least stable company in share market performances.

CONCLUSIONS

This study was focused on developing a measurement for the risk of returns of single securities of share markets. Suggested approach was based on the Newton's law of Uniform Circular Motion. As a starting point, it was tested on a random sample of ten companies from Sri Lankan share market.

It was concluded that the Circular Indicator is a suitable measurement for risk of returns.

This technique can be applied only if the returns follow wave like patterns and follow Circular Model.

Wave like patterns is common in natural sciences: Meteorology, Medicine, Agriculture, and many others. As such Circular Indicator may applicable as a risk measurement in these fields. It is recommended to test the *CI* on more companies of Sri Lankan share market and other relevant fields.

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