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Original Research Article

Forecasting Share Prices of Banks of Colombo Stock Exchange

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ABSTRACT

Scientific forecasting plays a vital role in financial markets for many decades. Forecasting methods of financial market were broadly classified into fundamental analysis and technical analysis. Fundamental analysis involves analyzing economic and firm specific factors while technical analysis is concerned with the price movements and trading volume in the market. Both approaches have been applied in forecasting share prices and stock returns. However, only a limited number of studies have been done on Sri Lankan share market. Existing forecasts made mainly based on Capital Asset Pricing Model has been proved unreliable in the Sri Lankan context. This study aimed to test the suitability of linear models, non-linear models and univariate causal models for forecasting share prices based on the data during 1994-2011 on randomly selected three banks listed in Colombo Stock Exchange (CSE). Findings suggest that univariate causal models were the most suitable in forecasting share prices of individual companies listed in CSE.

Keywords: linear model, non- linear model

INTRODUCTION

Share trading is an important aspect of the economy of a country from both the industry's and the investor's point of view. Predictability of asset returns play a vital role in a stock market as it makes investment decisions easy and more profitable.

Scientific forecasting is based on mathematical modeling. A mathematical model is a simplification of a real world situation into an equation or a set of equations. Mathematical models can be classified in many ways. Some of them are; static models, dynamic models, deterministic models, stochastic models, linear and non-linear models. A model is said to be static when it does not have time-dependent component. In contrast, dynamic models contain time-dependent component. A deterministic model is one in which every set of variable states is uniquely determined by parameters in the model and by sets of previous states of these variables. Deterministic models are not associated with any randomness. Conversely, in a stochastic model, randomness is present and variable

states are described by associated probability distributions. In general stochastic models are referred as Statistical models. A linear model is one whose output is directly related to the input. In a linear model all the model parameters are linear. In a non linear model at least one parameter is non-linear. Linear models have straight line solution locus while non linear models have curved solution locus.

Statistical models can be broadly classified into univariate statistical models and multivariate statistical models. Univariate statistical model is an equation or set of equations that explain the behavior of single random variable over time while multivariate statistical models explain the joint behavior of two or more random variables. 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 future values of a series are a function of past values. Univariate methods include moving average smoothing, exponential smoothing, winters' method, decomposition techniques, Fourier series analysis, Box Jenkin's Auto Regressive Integrated Moving Average (ARIMA) methods, linear and non linear trend models (Stephen, 1998).

Multivariate models make projections of the future by modeling the relationship between a series and other series. It models future values of a series as a function of itself and values of other variables. Multivariate Regression, Multivariate ARIMA or MARIMA, Vector Auto Regression (VAR) are some of the multivariate techniques.

Research and management of large number of fields such as agriculture, medicine, engineering, physics, economics, psychology, sociology, political science, marketing, finance, hospitality & tourism and many more rely on statistical modeling and use them for prediction, control and optimization.

Scientific Forecasting in Stock Market Returns

Scientific forecasting of stock market returns has a long history which goes back to 1950's. Fundamental analysis and Technical analysis were two main strands of investment decisions. Fundamental analysis involves analyzing the economic factors or characteristics of a company namely company value, company earnings etc. while Technical analysis interested in the price movements and / or trading volume in the market. Markowitz (1952) was the first milestone of Fundamental Analysis. Osborne (1959) was the beginning of Technical Analysis. Contribution of both approaches and their improvements were invaluable to the financial markets.

However, technical analysis as well as fundamental analysis was disputed by Efficient-market hypothesis of Fama (1970). Efficient market hypothesis believed that stock market prices essentially unpredictable. But the idea of Fama (1970) had not last long. Malkiel (2003) has examined the attacks on the efficient market hypothesis. According to Malkiel (2003), by the start of the twenty-first century, the intellectual dominance of the efficient market hypothesis had become far less universal. Many financial economists and statisticians began to believe that stock prices are at least partially predictable.

Research Problem

Markowitz (1952) method was extended by Tobin (1958), Treynor (1961), Sharpe (1964), Lintner (1965), Mossin (1966), Black (1972) and many others. Their combined output is known as Capital Asset Pricing Model (CAPM). CAPM is based on the assumption that there exist a linear relationship between expected return and its market (risk). It is the mostly used model in

financial markets. But it has been subject to large number of arguments in past few decades. This was first argued by Banz (1981). Introducing the size effect for the explanation of returns, he has found that average returns of stocks are negatively related to the market equity (ME). Black, Jensen and Scholes (1972), Fama and James (1973) have found that CAPM was hold for pre – 1969 period, but not afterwards. Another contradiction of CAPM model was the positive relationship between average return and the leverage found by Bhandari (1988). He has found that risk (β), market equity and leverage together explain average returns better, but later this was argued by Fama and Kenneth (1999). Basu (1983) has shown that earnings- price ratios (E/P) help explain the cross section of average returns of US stocks. Fama (1992) has shown that for the 1963-1990 periods, only size and BE/ME capture the cross sectional variation of average returns and beta has had no impact at all. These findings given considerable evidence that risk itself cannot explains returns of individual securities and hence the portfolio returns as well as total market return. Nimal (1997) and Samarakoon (1997) have confirmed above findings for Sri Lankan stock market, but Sri Lankan stock market still depends on CAPM.

According to literature, there were several attempts on finding suitable forecasting techniques for Sri Lankan share market. Konarasinghe and Pathirawasam (2013) have used a technical analysis based approach in forecasting returns of Sri Lankan share market. They have tested the dynamic relation between stock returns and trading volume of Sri Lankan companies and found that there is no causal relationship between market returns and trading volumes. Rathnayaka, Seneviratna, & Nagahawatta, (2014) have attempted to identify patterns and trends in stock prices and trading volumes of CSE in order to spot any groups of stocks that exhibit similar behaviors. But Rathnayake et al was unable to find any such patterns, trends or covariance in share prices or trading volume. Konarasinghe and Abeynayake (2014) have tested ARIMA models on forecasting returns and compared forecasting ability of ARIMA and CAPM in Sri Lankan context. Authors have concluded that ARIMA models superior than CAPM, but were not recommended CAPM also due to some weaknesses in fitted models. Therefore it is essential to find reliable forecasting techniques for Sri Lankan share market.

On this basis, this study focused on forecasting share prices of individual companies of Colombo Stock Exchange (CSE). To this end, the study aimed to test the suitability of linear and non –linear time series models for forecasting share prices and to test the suitability of univariate causal models for forecasting share prices of individual companies of CSE. As such this study comes under technical analysis.

MATERIALS AND METHODS

Current study considers three types of time series stochastic models; linear models, non-linear models and univariate causal models.

$$Y_t = \alpha + \beta_1 t + \beta_2 t^2 + \varepsilon \quad (1)$$

$$Y_t = \alpha(\beta^t) + \varepsilon \quad (2)$$

$$Y_t = \frac{A}{\alpha + \beta(\gamma^t)} + \varepsilon \quad (3)$$

$$Y_t = \alpha + \sum_{i=1}^{n} \beta_i Y_{t-i} + \varepsilon \quad (4)$$

The data during 1994-2011 on randomly selected three banks listed in CSE was collected for analysis from the CSE data library.

First, monthly nominal price (P_N) is calculated by using daily closing share prices (P_t) of the company as follows;

$$P_N = \frac{\sum P_t}{n} \quad (5)$$

Where, n= number of trading days of the month t, P_t= closing share price of day t

Then monthly real price (P_R) is obtained by inflation adjusting as;

$$P_R = \left(\frac{CPI_{2010}}{CPI_t} \right) . P_N \quad (6)$$

Where; CPI_{2010}= Consumer price index of the base year taken in the study (2010), CPI_t = consumer price index and P_N=monthly nominal price.

Monthly real prices from 1994-2010 were used for model fitting and monthly real prices of year 2011 were used for model verification. Residual were obtained to examine the goodness of model fit. In addition Anderson Darling test and Durbin Watson test were used to test the normality of residuals and auto correlation of residuals respectively. Forecasting ability of the models was assessed by Adjusted R^2 and Mean Absolute Percentage Error (MAPE). Graphs of actual values vs. fitted values and actual values vs. forecasted values also obtained for visual representation of the forecasting ability of the models.

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 forecast plus error; In other words, "Error = Actual value – Forecast". This error component is known as the residual. A good forecasting model should have a mean error of zero because it should over forecast and under forecast approximately the same (Stephen, 1998).

Measuring errors is vital in forecasting process. If Y_t is the actual value and F_t is the fitted or forecasted value, MAPE is defined as;

$$MAPE = \frac{1}{n} \sum \left| \left(\frac{Y_t - F_t}{Y_t} \right) .100 \right| \quad (7)$$

RESULTS AND FINDINGS

Time series plots for real share prices were obtained, given in Figure 1;

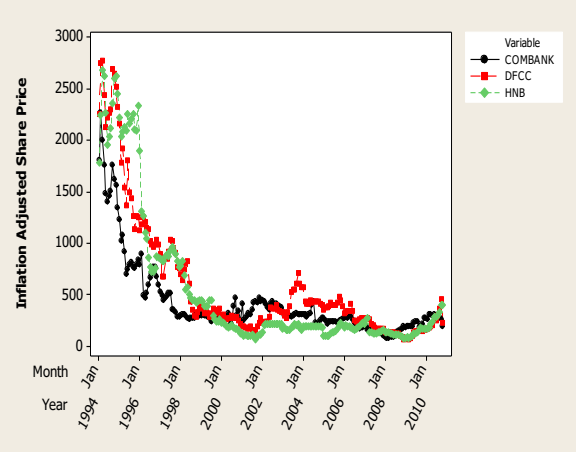

Figure 1: Time Series Plot of Inflation Adjusted Share Prices

Inflation adjusted share prices (actual share prices) of all the three companies showed decreasing trends from year 1994 to 1998 and do not show any trend afterwards. Also all three trends were non-linear and somewhat similar. Therefore, Quadratic models, Exponential Growth models and Pearl-Reed Logistic trend models were tested on each company. Then univariate causality models also were tested for each company.

Analysis of COMBANK

Actual share prices from January 1994 to December 2010 were used for model fitting and data of January to September 2011 were used for model verification. Table 1 gives the summary of outputs.

Table 1: Summary of Outputs in Model Fitting-COMBANK

Model	MAPE in Model Fitting	MAPE in Model Verification
Quadratic trend model: $Y_t = 1285.20 - 16.94t + 0.06t^2$	46.8	45.6
Growth Curve model: $Y_t = 843.6(0.99^t)$	31.1	55.3
Pearl- Reed Logistic model: $Y_t = \frac{10^4}{11.59 + 5.42(1.01^t)}$	30	57.11
Univariate causal model : $Y_t = 25.3 + 0.92Y_{t-1}$.	10.13	8.35

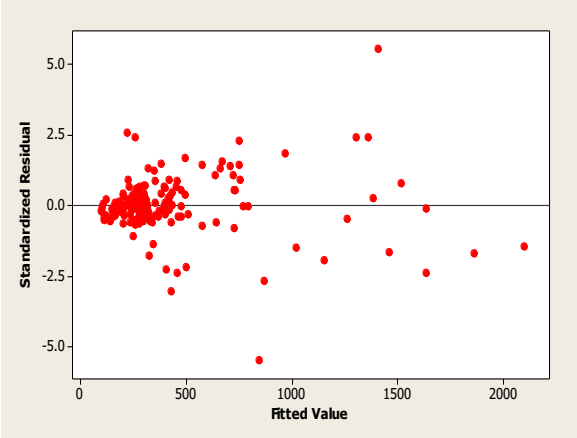

Figure 2: Residual Plot

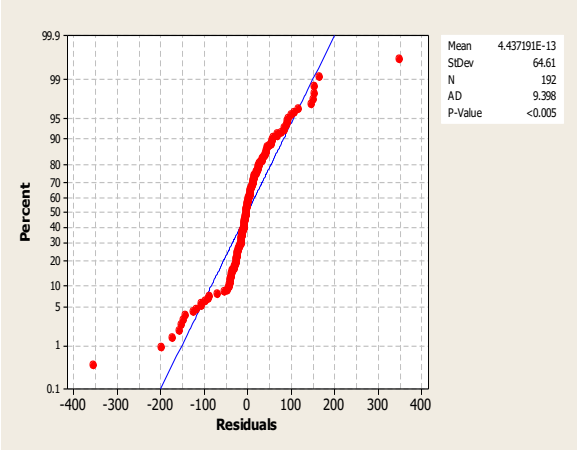

Figure 3: Probability Plot of Residuals

Among all the models in table 1, univariate causal model has the least MAPE in both model fitting and model verification. P value of ANOVA was less than the significance level, confirmed non- zero model parameters. Adjusted R^2 of the model was 96.4%.; means about 97% of the variation of present can be explained by past. Normality of residuals and serial correlations of residuals of causal model were also tested. Figure 2 is the residual plots of univariate causal model and Figure 3 is the probability plot of residuals.

Residuals were scattered above and below zero, but not evenly distributed. It means auto correlation of residuals exist. P value of the Anderson Darling test did not confirm the normality of residuals. Accordingly data does not fit the model adequately. But due to low MAPE's and high adjusted R^2, it was concluded that the best fitting model for forecasting share prices of COMBANK is;

$$Y_t = 25.3 + 0.92Y_{t-1}. \quad (8)$$

Analysis of DFCC

Actual share prices from January 1994 to December 2010 were used for model fitting and data of January to September 2011 were used for model verification. Table 2 gives the summary of outputs.

Table 2: Summary of Outputs in Model Fitting-DFCC

Model	MAPE in Model Fitting	MAPE in Model Verification
Quadratic trend model: $Y_t = 2041.79 - 27.64t + 0.09t^2$	63.9	67.31
Growth Curve: $Y_t = 1289.46(0.99^t)$	46	37.26
Pearl- Reed Logistic: $Y_t = \frac{10^4}{-152 + 155(1.01^t)}$	35.8	22.45
Univariate causal model : $Y_t = 27.1 + 0.909Y_{t-1}$.	15.4	5.20

According to Table 2, univariate causal model has least MAPE in model fitting and model verification. P value of ANOVA was less than the significance level, confirmed non- zero model parameters. Adjusted R^2 of the model was 95.3%. Normality of residuals and serial correlations of residuals of causal model were also tested. Residual plot did not

confirm that residuals were uncorrelated. P value of the Anderson Darling test did not confirm the normality of residuals. But due to low MAPE's and high adjusted R^2, it was concluded that the best fitting model for forecasting share prices of DFCC is;

$$Y_t = 27.1 + 0.909Y_{t-1}. \quad (9)$$

Analysis of HNB

Actual share prices from January 1994 to December 2010 were used for model fitting and data of January to September 2011 were used for model verification. Table 3 gives the summary of outputs.

Table 3: Summary of Outputs in Model Fitting-HNB

Model	MAPE in Model Fitting	MAPE in Model Verification
Quadratic trend model $Y_t = 2264.5 - 33.12t + 0.12t^2$	71.4	54.7
Growth Curve $Y_t = 1058.76(0.98^t)$	57	71.9
Univariate causal model $Y_t = 2.99 + 0.976Y_{t-1}.$	7.9	9.33

It was unable to fit Pearl- Reed Logistic model for share prices of HNB. According to table 3, univariate causal model has very low MAPE values in model fitting as well as model verification. P value of ANOVA was less than the significance level, confirmed non- zero model parameters. Residual plot showed auto correlation in residuals. Anderson Darling test did not confirm the normality of residuals. However, adjusted R^2 of the model was 98.3% and model has very low MAPE's. Therefore it was concluded that the best fitting model for forecasting share prices of HNB is;

$$Y_t = 2.99 + 0.976Y_{t-1}. \quad (10)$$

CONCLUSIONS

This study attempted to test some linear models and non linear models in forecasting share prices of banks of CSE. Results of the study revealed that univariate causal models are suitable in forecasting share prices of banks of CSE. It is necessary to test univariate causal model for more companies covering more business sectors of CSE.

Success of univariate causal model shows auto correlation of share prices of Sri Lankan companies. Also residual analysis showed the auto correlation in residuals. Therefore it is worth testing Auto Regressive models, Moving Average models or Auto Regressive Moving Average models as these models are smart in capturing auto correlations of data series.

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