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Testing of Forecasting Beta under Capital Asset Pricing Model (CAPM) : A Study with Reference to National Stock Exchange (NSE) Listed Companies

Dr. M. Selvam*, Dr. M. Babu**, A. Jeyachitra

Abstract

Capital Asset Pricing Model (CAPM) provides an equilibrium linear relationship between expected returns and risk of an asset. The present paper investigates a risk-returns relationship with the application of CAPM framework for the companies which are listed in NSE. This study discusses how an investor can reduce expected risk through diversification, why this risk reduction results from "proper" diversification, and how the investor may estimate the expected returns and expected risk level of a given portfolio of assets. The present study examined the individual stocks as well as size sorted portfolios. This study found that the CAPM model establishes that the variables having significant relationship with stock returns, are still too alive on this ground.

Key words: Capital asset pricing model, equilibrium linear relationship, returns, size, historical Beta and Forecasted beta.

Introduction

The portfolio analysis begins where the security analysis ends and this fact has important consequences for investors. Portfolios, which are combinations of securities, may or may not take on the aggregate characteristics of their individual parts. Portfolio analysis considers the determination of future risk and returns in holding various blends of individual securities. Portfolio expected returns is a weighted average of the expected return of individual securities but portfolio variance, in sharp contrast, can be something less than a weighted average of security variances. As a result, an investor can sometimes reduce portfolio risk by adding another security with greater individual risk than any other security in

the portfolio. This seemingly curious result occurs because risk depends greatly on the covariance among returns of individual securities.

The risk of a portfolio depends not only on the risk of its securities, considered in isolation, but also on the extent to which they are affected similarly by underlying events. Since unsystematic risk can be eliminated simply by holding large portfolio, investors are not compensated for bearing unsystematic risk. Investors holding diversified portfolios are exposed only to systematic market-related risk. Therefore, the relevant risk in the market's risk/expected returns trade-off is systematic risk, not total risk. The investor is rewarded with higher expected returns for bearing systematic, market related risks. Only systematic risk is relevant in determining the premiums for bearing risk. Thus, the model predicts that a security's returns are related of that portion or risk that cannot be eliminated by portfolio combination.

Capital Asset Pricing Model (CAPM)

The CAPM is an economic model that describes how securities are priced in the marketplace. It has its roots in the normative mean-variance

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approach to investing that was first developed by Markowitz. That is, if certain assumptions are made, one of which is that all investors follow Markowitz's approach, then it can be shown that the expected returns of an asset will be positively and linearly related to the level of its beta.

The CAPM Model was introduced in early 1960's by Sharpe (1964), Linter (1965) and Mossin (1966). In simple form, the CAPM predicts that the expected returns on an asset above the risk-free rate is linearly related to the non-diversifiable risk, which is measured by the asset's beta. The earlier studies, which found supportive evidence for CAPM, are that of Black, Jensen and Scholes (1972). Using monthly returns data and portfolio rather than individual stocks, Black et al tested whether the cross-section of expected returns is linear in beta. By combining securities into portfolios, one can diversify away most of the firm-specific component of the returns, thereby enhancing the precision of the beta estimates and the expected rate of returns of the portfolio securities. This approach mitigates the statistical problems that arise from measurement errors in beta estimates. The studies found that the data are consistent with the predictions of the CAPM i.e. the relation between the average returns and beta is very close to linear and the portfolios with high betas have high average returns.

The CAPM provides a convenient measure of systematic risk. This measure, called beta (β), gauges the tendency of a security's returns to move parallel to the overall market's returns. A stock with a beta of 1 tends to rise and fall with the same percentage as the market. Thus, $\beta = 1$ indicates an average level of systematic risk. Stocks with $\beta > 1$ tend to rise and fall by a greater percentage than the market. They have a high level of systematic risk and they are very sensitive to market changes. Similarly, stocks with $\beta < 1$ have a low level of systematic risk and they are less sensitive to market swings. These results determine the risk / expected returns trade-off under the CAPM. In general,

$$R_s = R_f + \text{Risk Premium}$$

If the CAPM correctly describes market behaviour,

$$R_s = R_f + \beta_s (R_m - R_f)$$

The expected returns on a security (R_s) is equal to the risk-free rate plus a risk premium. With the CAPM, the risk premium is β multiplied by the returns on the market (R_m) minus risk free rate. The CAPM has been used to select securities, construct portfolios, and evaluate portfolio or equity share performance.

The historical returns and beta are useful to evaluate the performance of the portfolio or asset. Portfolios with negative risk-adjusted returns (negative alpha) are said to have under performed, and those with positive risk-adjusted returns (positive alpha) are said to have shown superior performance. Before using risk-adjusted returns to evaluate performance, the magnitude of returns should be reckoned.

Review of Literature

Many studies have been conducted on the CAPM model. This section contains a selected list of empirical resources available in the area of CAPM Model.

Raj. S. Dhankar. P. D. S (1996) in his study entitled, "An empirical testing of Capital Asset Pricing Model in the Indian Context", attempted to find out linear relationship between expected returns and risk of the security market line with the help of CAPM Model. This study found that CAPM is the appropriate model to evaluate the variables in the market, industry and company meaningfully.

Grigoris Michailidis, Stavros Tsopoglou, Demetrios Papanastasiou and Eleni Mariola (2006) in their study on, "Testing the Capital Asset Pricing Model (CAPM): The Case of the Emerging Greek Securities Market", applied the CAPM model to the Greek Stock Market by using weekly stock returns from the sample listed on the Athens Stock exchange. This paper examined whether linear relationship between expected returns and beta exists or not by using the CAPM model.

Vipul (1998) in his paper, "CAPM: Does it Help in Indian Capital Market?", used the CAPM Model to test the unit beta and zero beta. He found from his studies that future returns on the security of a given risk class depended on the expected returns on market portfolio and the expected zero beta returns. The result of the study confirmed the presence of time variability in zero beta returns. The study concluded that market model is clearly helpful to an investor in taking his investment decisions.

A paper entitled, "An Empirical Testing of Risk Factors in the Returns on Indian Capital Market", by Manjunatha T and Mallikarjunappa T (2008), revealed that CAPM helps us to understand the complex relationship between securities' returns and risk. It showed that the intercept of the CAPM is equal to the risk-free rate of returns but none of univariate variables, taken individually, explains the portfolio returns in the Indian Market. Beta is a significant explanatory variable for percentage returns when portfolio constructed with market value. This concluded that CAPM is a most popular model to find out the excess returns in the Indian stock market.

Statement of the Problem

The Indian studies as well as other studies on developed markets have used ex-post realized returns without any correction of beta. Investors buy securities based on their future prospects. Hence they are generally more interested in future beta than in historical beta. However, investors do not compute future beta. But the CAPM emphasis risk free rate, beta of an asset and the expected returns. CAPM provide a better indicator to know the asset risk and the required rate of return. Many researchers have examined the risk and returns relationship and the effect of diversification on the portfolio risk. Hence the present study examines the individual stocks as well as size sorted portfolios.

Need for the Study

There are empirical evidences which show that the Indian Stock Market has become semi-strong

efficient. Earlier studies tested the CAPM model without adjusting betas and using realized returns. The present study empirically tests whether CAPM empirical analysis carried out within the necessary time period in the present Indian Capital Market, is valid.

Objectives of the Study

- To examine the direct relationship between expected returns and risk.
- To know whether the intercept of CAPM equation model is equal to risk free returns or not.
- To find out whether the slope of the Security Market Line (SML) is less than the difference between the returns on market portfolio and the risk free rate.

Hypothesis of the Study

- There is no linear relationship between expected returns and risk.
- The intercept of CAPM equation is equal to the risk free rate of returns.
- Slope of security market line is equal to the difference between the returns on the market portfolio and the risk free rate.

Methodology of the Study

a) Sample Size

The present study attempts to test portfolio-wise, historical and forecasted beta, along with portfolio returns and the results are tested by the use of CAPM Model. The sample companies were taken from Nifty of National Stock Exchange. After perusal, only 40 companies were selected, which are traded frequently in the market from April 2005 to March 2008. The daily adjusted share price of the sample companies were taken into account for this study. S&P CNX NIFTY Index of NSE were used as a benchmark for this study.

b) Period of the Study

The present study is mainly intended to cover three years from 01.04.2005 to 31.03.2008.

c) Sources of Data

The present study mainly depends on secondary data. The data regarding adjusted daily closing share prices and nifty index were obtained from PROWESS corporate data base, Mumbai. The other relevant informations were obtained from books, journals and various web sites.

d) Tools Used for Analysis

- i) To test the CAPM model stock returns and market returns, were calculated with the help of the following formula:

$$R_m = \frac{\text{index}_t - \text{index}_{t-1}}{\text{index}_{t-1}} \times 100$$

$$R_i = \frac{P_t - P_{t-1}}{P_{t-1}} \times 100$$

Where,

P_t = Closing Price of the stock

P_{t-1} = Opening Price of the stock

- ii) The risk measures like market beta (β) for each selected companies were calculated with the help of time series cross-sectional regression analysis, using the following equation:

$$R_i = \alpha_i + \beta_i R_m + e_i$$

Where

R_m = Rate of return the market portfolio

R_i = Rate of return on a individual security

α_i = Intercept of Security i

β_i = Slope of the Security i

e_i = the random error term

- iii) Based on the market beta, the selected securities under Nifty were grouped into 8 portfolio of 5 stocks each, after arranging securities in an ascending order based on market betas. The beta for each portfolio was calculated as follows.

$$\beta_p = \sum_{i=1}^n x_i \beta_i$$

Where

$i = 1, 2, 3, 4, 5$

$x_i = 0.2$

β_p = beta on the portfolio

X_i = Proportion of total Portfolio invested in security i

- v) Blume's methods were used for finding the forecasting future betas. It was taken as the basis for estimating the future betas in the Indian context
- vi) The t-test, coefficient of determination (R^2) and F-test were carried out to determine the goodness of fit or the regression line. While computing the expected rate of returns on securities, a 5% per cent risk-free return has been assumed.

Analysis of the Study**a) Company wise Annual Returns and Beta (in ascending order)**

Table- 1 shows alpha and beta (systematic risk) of all the sample companies with ascending order of beta. It is observed that the average return is 13.33 per cent, with average beta of 0.9178 for all selected sample companies. The systematic risks (beta) of the selected securities (companies) were arranged in an ascending order and then those securities were grouped into 8 portfolios of 5 stocks each. For each portfolio, the historical beta and actual observed returns was calculated by averaging the beta and returns of stocks under each portfolio. The average beta, which is near to 1, indicates that the stock returns of this company moved with the market in the same direction. This, in turn, has shown the some stocks under Nifty 50 tend to replicate the movement of the market.

b) Portfolio-wise Historical Beta and Forecasted Beta along with Portfolio Returns

The historical and future (forecasted) betas, along with observed returns of all portfolios,

are depicted in the **Table- 2**. It is clearly understood from the table that the forecasted betas of all 8 portfolios were computed with use of historical beta. However, perusal of the table further reveals that there is perfect linear relationship between forecasted betas and their expected returns of all portfolios except portfolios 2, 4, and 5. A non-linear relationship can be seen in portfolios 2, 4, and 5. **Figure 1** presents graphically the relationship between future beta and expected returns of portfolio.

c) Observed and Estimated Returns of Portfolio

Table -3 presents the observed, expected and residual returns (difference between observed and expected). The estimated returns were calculated with the use of CAPM model. Risk free rate (6.42+7.35+7.80) was calculated as the average of 91 days Treasury bill for this paper during the study period (2005-2008). It can be observed from residual returns that 4 portfolios have yielded positive returns from the market and other 4 portfolios recorded negative higher returns (4.54%), indicating that companies under this portfolio earned better returns, in excess of expected returns above the risk free rate. So the first hypothesis that "There is no linear relationship between expected returns and risk" is rejected.

d) Results of regression for Portfolio Return with Forecasted Beta

A cross sectional regression on the 8 portfolios, with forecasted beta as independent variable and the returns as the dependent variable, was run. The results of the regression are depicted in **Table 4**. It is clearly observed from the table that portfolio returns are significantly determined by the systematic risk. The slope of security market line is significant at 5 per cent level (beta of

beta = 13.5821, $t = 2.4985$, $p < 0.05$). The absolute value of t for the intercept at 0.0733 is much less than the table value 2.365, indicating that intercept was not significant. This has revealed that the returns from the portfolios due to market risk were not higher the risk free returns. So the hypothesis "The intercept of CAPM equation is equal to the risk free rate of returns" are rejected.

e) Analysis of Variance for Regression – Result of F-Value

The results of ANOVA for regression are presented in the **Table -5**. The coefficient of determination at 50.99 per cent ($R^2 = 0.5099$) is quite substantial exposing, the fact that betas and the expected returns are linearly related. This leads to the rejection of null hypothesis, that is, $R^2 = 0$, in turn leads to acceptance of alternate hypothesis as $R^2 > 0$. The F value at 6.2429 is greater than the table value of 5.32. It indicates that beta and expected returns are significant with each other.

Conclusion

From the results of the analysis in the paper, it is concluded that there are strong evidences in favour of the basic relationship between beta of a portfolio and its expected returns. Though the beta of a portfolio is the significant predictor of expected returns, slope is much higher and the hypothesis that intercept is equal to risk free returns is rejected. It is further concluded from the empirical testing of CAPM model that the Indian stock market is efficient despite having faced with some basic problems like lack of transparency, lack of strict regulation against illegal investors and defaulters, letting the inside information for making abnormal profit. The present study indicates that investors could apply CAPM model to the capital markets but cautiously as some companies in the market tend to involve themselves in cheating the actual information about them.

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Table 1 : Company wise Annual Return and Beta (in ascending order)

Company Name	Av.Ret/p.a	alpha	beta
1 Sun Pharmaceutical Inds. Ltd.	15.0152	0.1502	0.5306
2 Dr. Reddy'S Laboratories Ltd.	8.2404	0.0824	0.5674
3 Hero Honda Motors Ltd.	5.4095	0.0541	0.5744
4 Cipla Ltd.	12.3998	0.1240	0.6563
5 Bharat Petroleum Corpn. Ltd.	4.6024	0.0460	0.6611
	9.1335		0.5980
1 Ranbaxy Laboratories Ltd.	0.6465	0.0065	0.7029
2 Infosys Technologies Ltd.	13.3261	0.1333	0.7762
3 Hindustan Unilever Ltd.	9.7846	0.0978	0.7846
4 I T C Ltd.	5.4050	0.0540	0.8052
5 Zee Entertainment Enterprises Ltd.	12.6606	0.1266	0.8212
	8.3646		0.7780
1 A B B Ltd.	23.6856	0.1331	0.8342
2 Tata Consultancy Services Ltd.	3.6004	0.0360	0.8417
3 H D F C Bank Ltd.	14.3290	0.1433	0.8619
4 Bharti Airtel Ltd.	20.3917	0.2039	0.8666

5	A C C Ltd.	13.8054	0.1381	0.8708
		15.1624		0.8550
1	Mahindra & Mahindra Ltd.	16.1574	0.1616	0.8752
2	Satyam Computer Services Ltd.	11.3200	0.1132	0.8782
3	GAIL (India) Ltd.	11.9476	0.1195	0.8793
4	Housing Development Finance Corpn. Ltd.	18.9543	0.1895	0.8831
5	National Aluminium Co. Ltd.	16.5092	0.1651	0.9033
		14.9777		0.8838
1	Maruti Suzuki India Ltd.	11.3588	0.1136	0.9116
2	Grasim Industries Ltd.	12.3952	0.1240	0.9216
3	N T P C Ltd.	13.4953	0.1350	0.9237
4	H C L Technologies Ltd.	6.8688	0.0687	0.9297
5	State Bank Of India	14.9360	0.1494	0.9495
		11.8108		0.9272
1	Wipro Ltd.	5.9935	0.0599	0.9510
2	Tata Motors Ltd.	7.4996	0.0750	0.9522
3	Tata Power Co. Ltd.	19.4700	0.1947	0.9929
4	Siemens Ltd.	20.6885	0.2069	1.0023
5	Punjab National Bank	6.4686	0.0647	1.0045
		12.0240		0.9806
1	Oil & Natural Gas Corpn. Ltd.	9.3902	0.0939	1.0228
2	I C I C I Bank Ltd.	11.7042	0.1170	1.0334
3	Larsen & Toubro Ltd.	26.9016	0.2690	1.0504
4	Reliance Industries Ltd.	21.3420	0.2134	1.0721
5	Bharat Heavy Electricals Ltd.	24.9067	0.2491	1.0841
		18.8489		1.0526
1	Hindalco Industries Ltd.	7.4430	0.0744	1.1896
2	Tata Communications Ltd.	18.2959	0.1830	1.2255
3	Tata Steel Ltd.	12.6464	0.1265	1.2288
4	Reliance Infrastructure Ltd.	16.1955	0.1620	1.3062
5	Sterlite Industries (India) Ltd.	27.1180	0.2712	1.3860
		16.3397		1.2672
	Average Return	13.3327		
	Average Beta			0.9178

Source: Prowess Data Base

TABLE 2 Portfolio-Wise Historical and Forecasted Beta Along With Portfolio Return

Portfolios	Historical Beta	Forecasted Beta	Portfolio Return (%)
1	0.5980	0.7023	9.13
2	0.7780	0.8765	8.36
3	0.8550	0.9510	15.16
4	0.8838	0.9789	14.97
5	0.9272	1.0209	11.81
6	0.9806	1.0726	12.02
7	1.0526	1.1422	18.85
8	1.2672	1.3499	16.34

FIGURE -1
RELATIONSHIP BETWEEN PORTFOLIO BETAS AND THEIR
EXPECTED RETURNS

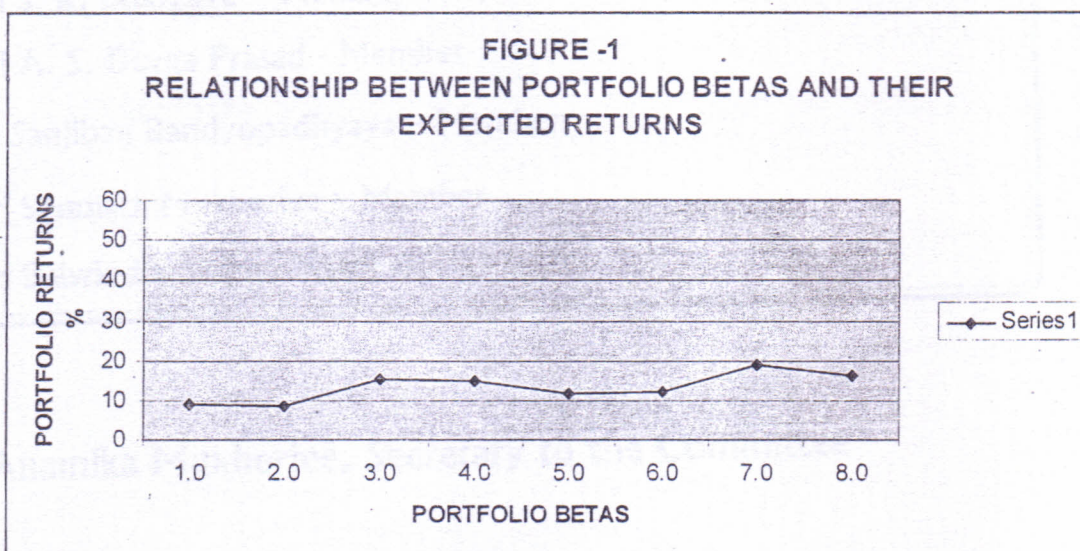


Table- 3 Portfolio-Wise Portfolio Return and Estimated Return with Use of CAPM Model

Portfolios	Observed	Estimated	Residual
1	9.13	11.29	-2.17
2	8.36	12.49	-4.12
3	15.16	12.99	2.16
4	14.97	13.18	1.79
5	11.81	13.47	-1.66
6	12.02	13.82	-1.80
7	18.85	14.30	4.54
8	16.34	15.72	0.62