A STUDY OF CAPM TESTING IN INDIAN CONTEXT

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ABSTRACT

In this paper, it is checked whether Capital Assets Pricing Model (CAPM) holds for Indian stock markets or not by studying the excess return-beta relationship for the period ranging from April 2010 to March 2015 for Indian market. If CAPM holds then intercept should equals to zero and the slope should equal the excess returns on the market portfolio. To make results more reliable and effective, portfolios have been created on the basis of betas obtained from time-series regression. This study founds CAPM does not holds for high risk portfolio, whereas excess return- beta relationship is well captured by CAPM for medium and low risk portfolios for the sample period. The findings of this paper might help investors managing their funds and in taking better informed decisions.

***KEYWORDS**: Capital Assets Pricing Model, Portfolio returns, Beta*

1. INTRODUCTION

Capital market is one of the important barometers to assess the financial health of an economy. An industry's and commerce growth are analysed through its stock market returns. The area of pricing of securities and its returns have always attracted researchers. As risk-return relationship helps in pricing of securities and ultimately in taking investment decisions wisely. Risk can be defined as an uncertainty of actual return different from expected return. If an investor takes high risk than expectation of return also get increased.

One of such pricing model is Capital Assets Pricing Model (CAPM), developed independently by Sharpe (1964), Lintner (1965), and Mossin (1968). According to Bodie, et al (2009), " CAPM is a set of predictions concerning equilibrium expected return on risky assets". This model is based on certain assumptions like:

1. Securities or assets are infinitely divisible.
2. There are no transaction costs and there are no taxes.
3. There is perfect competition in the market.
4. All investors take decisions only on the basis of expected values and standard deviations of the returns of their portfolios.
5. No restriction on short selling of shares.
6. Unlimited lending and borrowing is allowed at risk free rate.

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7. All investors are risk-averse and want maximisation of their wealth.
8. All Investors expectations are homogenous.
9. Assets are marketable.

Many of the above assumptions are untenable, and leads to 'if' and 'what if' analysis. Bodie, et al (2009), "summarized that the equilibrium in security markets will prevail in this hypothetical world of securities and investors briefly as all investors will hold a portfolio of risky assets which are representing the Market Portfolio (M). This market portfolio is on the efficient frontier, and it is also a tangency portfolio to the optimal capital allocation line, for each and every investor, ultimately Capital market line (line from risk free rate through the market portfolio M), is also the best attainable capital allocation line, all investor's holds M as their optimal risky portfolio, differing in terms of amount invested in this versus amount invested in risk-free asset."

The risk premium on market portfolio is calculated as:

$$E(r_M) - r_f = \overline{A}\sigma_M^2$$

Where,

$E(r_M) - r_f$= Market risk Premium

r_f = risk free rate

$\overline{A}$ = Investor's average degree of risk aversion

σ_M^2= Systematic risk as Portfolio M is an optimal portfolio.

The risk premium on individual assets will be proportional to the risk premium on the market portfolio, M and the beta coefficient of the security relative to the market portfolio, that is,

$$\beta_i = \frac{COV(R_i, R_M)}{\sigma_M^2}$$

CAPM expected return- beta relationship for any asset i and the market portfolio is:

$$E(r_i) = r_f + \beta_i[E(r_M) - r_f]$$

2. REVIEW OF LITERATURE

As discussed CAPM model has been an area of interest for many researchers as well as for academicians, it is being tested from time to time since 1960s. One of the first testing was done by Lintner (1965) and reproduced by Douglas (1968), "they tested CAPM validity for 1954- 1963 period and their results were not supporting CAPM, as their intercept of stocks return over market risk premium was positive and significant, and their results also had positive and significant residual risk."

Later, Miller and Scholes (1972), showed "some statistical problems when using individual securities' returns in testing the validity of the CAPM as used by Lintner (1965) and Douglas (1968), as their returns distribution was positively skewed, and that's the reason for association between residual risk and return."

One the most prominent testing of CAPM was done by Black, Jensen, & Scholes (1972) for a period of 1926-1966 for securities listed on NYSE. "Firstly, each year they have constructed ten portfolios on the basis of beta observed by time-series regression, and then checked CAPM validity for a period of thirty-five years. They found a linear relationship between the average excess portfolio return and the beta, and for high beta portfolios the intercept tends to be negative and vice-versa for low beta portfolios."

Then Fama & MacBeth (1973), found "a larger intercept term than risk-free rate, also expected return and betas relationship is linear and positive, for a period of 1935-1968." They made twenty portfolios and tested it for different time periods from, and showed linear relationship holds well for longer time period.

Roll (1977) concluded that "the single-factor CAPM could not accepted until the portfolio used as a market proxy was inefficient. Even very small deviations from efficiency can produce an insignificant relationship between risk and expected returns."

Fama & French (2004), said that "the version of the CAPM developed by Sharpe (1964) and Lintner (1965) has never been an empirical success. In the early empirical work, the Black (1972) version of the model, which can accommodate a flatter trade-off of average return for market beta, has some success. But later researchers showed variables like size, various price ratios and momentum that add to the explanation of average returns provided by beta. The problems are serious enough to invalidate most applications of the CAPM."

Mostly tests of CAPM were initially conducted in the US market and later these tests gained significance in developing and emerging markets. Basu & Chawla (2008), tested CAPM validity in Indian context and for this they "examined ten portfolios, covering fifty stocks, over a five year period from 2003 to 2008. They found that CAPM fails completely in the Indian context. The intercept term, which is expected to be zero, is found to be significant for all ten portfolios. They also found a negative relationship between beta and excess returns indicating an inefficient capital market plus residual variance (representing unsystematic risk) was also found significant in certain cases. Moreover, the regressions show poor explanatory power."

Choudhary & Choudhary (2010), examined "the CAPM for the Indian stock market using monthly stock returns from 278 companies of BSE 500

Index listed on the Bombay stock exchange for the period of fourteen years from 1996-2009. Their findings were not substantiating the theory's basic result that higher risk (beta) is associated with higher levels of return. If CAPM holds then intercept of excess return should be equal to zero and the slope should equal the excess returns on the market portfolio. But they found evidence against CAPM and concluded that beta is not sufficient to determine the expected returns on portfolios."

3. OBJECTIVES

In the light of above discussion, the following objectives have been laid down for this study:

1. To examine whether a higher risk stocks yield higher expected rate of return and vice-versa.
2. To test the validity of CAPM model in Indian Context.
3. To Check whether Indian stock are generating abnormal returns or not.

4. DATA AND METHODOLOGY

4.1 DATA

In this study daily adjusted stock price for the sampled thirty companies of S&P BSE SENSEX is being taken for 10 years period ranging from April 2005 to March 2015. But due to non-availability of data for two companies, the final set stands for twenty-eight companies only. BSE Sensex is used as a proxy for market index in India because it has its historical significance and also reflects India's Economic position in the world plus it is also accepted widely as a market proxy among investment researcher as well as practitioners in the country. This index is based on 30 actively traded equity shares. Call money rates are used as a proxy for risk free interest rates as interest rates varies across banks so to have uniform measurement, call money rates have been used for the same. Due to non-availability of daily call money rates data, weekly data is obtained and it is converted into daily rates as it leads to a more robust estimate than using weekly figures. The total number of observations, which is equal to 1246-1250, is believed to constitute a large data set for time series analysis. The call money rates are obtained from various issues of Handbook of Statistics on the Indian Economy and RBI Bulletin published by the Reserve Bank of India. BSE Sensex data is obtained from the Bombay Stock Exchange website i.e., www.bseindia.com.

The following firms have been considered:

S.No.	PARTICULARS	S.No.	PARTICULARS
1	AXIS	15	L&T
2	BHARAT	16	LUPIN
3	BHARTI	17	M&M
4	CIPLA	18	MARUTI
5	DR REDDY	19	NTPC
6	GAIL	20	ONGC
7	HDFC BANK	21	RELIANCE
8	HERO	22	SBI
9	HINDALCO	23	SUN
10	HINDUSTAN	24	TATA C
11	HDFC	25	TATA M
12	ICICI	26	TATA S
13	INFOSYS	27	VEDANTA
14	ITC	28	WIPRO

4.2 METHODOLOGY

As discussed above, CAPM deals in ex-ante returns, but we can observe only ex-post returns. So, to arrive from ex-ante to ex-post returns, we use the Index model, which can be used in excess return form as:

$$R_i = \alpha_i + \beta_i R_M + e_i \qquad \ldots 1$$

Where,

R_i= Observed return on a security

α_i = Intercept

R_M= Market Return

β_i= Systematic risk or Sensitivity of Security return to market return.

e_i= Error terms

To relate these two models, firstly, we derive the covariance between the market index and the returns on stock i. As we know, non-systematic risk is independent of systematic risk, that is, $COV(e_i, R_M) = 0$, so covariance of the excess rate of return on security I with that of the market index is:

$$COV\ (R_i,\ R_M) = COV\ (\beta_i R_M + e_i\ , R_M)$$

$$= \beta_i COV\ (R_M, R_M) + COV(e_i, R_M)$$

$$= \beta_i \sigma_M^2$$

Here, α_i can be dropped from the covariance terms because α_i is a constant and thus has zero covariance with all variables. So, from the above equation:

$$\beta_i = \frac{COV\ (R_i, R_M)}{\sigma_M^2}$$

With the help of above formulae, Index model beta coefficient turns out to be the same beta coefficient of the CAPM model, only difference is theoretical market portfolio of the CAPM is replaced to a well-specified and observable market index.

CAPM expected return- beta relationship for any asset i and the market portfolio is:

$$E(r_i) = r_f + \beta_i[E(r_M) - r_f\ ] \qquad \ldots 2$$

Where,

$E(r_i)$ = Expected return on security i.

r_f= Risk free rate of return.

$E(r_M)$= Expected return on Market return

β_i= Sensitivity of Expected return on Security to Market return

or, $\beta_i = \frac{COV\ (R_i, R_M)}{\sigma_M^2}$

Equation (2) can also be written as:

$$E(r_i) - r_f = \beta_i[E(r_M) - r_f\ ] \qquad \ldots 3$$

Equation (3) shows expected excess return of assets relative to the mean excess return of the theoretical market portfolio. If in Eq. (1) Index M depicts true market portfolio, then the expectation of each side of the equation can be taken to show that the index model specification is:

$$E(r_i) - r_f = \alpha_i + \beta_i[E(r_M) - r_f\ ] \qquad \ldots 4$$

By comparing the index model relationship to the CAPM expected return-beta relationship (Equation 2); the CAPM predicts that α_i should be zero for all assets in Equation 4. The Alpha of a stock (α_i) is its expected return in excess of (or below) the fair expected return as obtained by the CAPM. If stock is fairly priced, its alpha must be zero. If alpha is not zero then market is generating abnormal returns, which is not captured by CAPM model.

If we estimate the index model for several firms using Eq. (1) as a regression equation, then ex-post alpha should centre around zero. The CAPM states that the expected value of alpha is zero for all securities, whereas the index model representation of the CAPM holds that the realized values of alpha should average out to zero for a sample of historical observed returns.

Calculation of Returns

The return on stock is calculated as:

$$R_i = \ln \frac{R_t}{R_{t-1}}$$

Where,

R_i = Return on security i.

R_t = Current price of share

R_{t-1}= Previous price of share

Similarly, Return on Market Portfolio is calculated as:

$$R_M = \ln \left[\frac{R_{Mt}}{R_{Mt-1}}\right]$$

Where,

R_M= Return on market index.

R_{Mt} = Current level of index.

R_{Mt-1}= Previous level of index.

Calculation of Risk free-rate of interest

The weekly per annum call money rates have been converted into daily rates with the help of following formulae:

$$r_f = \left(1 + \frac{R_f}{100}\right)^{\frac{1}{365}} - 1$$

r_f =Daily risk-free rate.

R_f = weekly p.a. rates

5. DATA ANALYSIS

Firstly, the daily returns of all twenty-eight securities and market return were calculated for ten years (April 2005-March 2015). To test the CAPM, large numbers of securities are required, the easier method is to estimate equation for each security and then examine the distribution of alpha's (α_i), but this method is in appropriate as it is assumed that the residuals (e_{it}, e_{jt}) are independent, in reality they are not. To remove this problem time series regression is run on portfolios. Now R_i is the return on portfolio i and β_i is the Beta on portfolio i. This technique is useful because residual variance from regression incorporates the effect of any cross-sectional interdependencies as more than one security is included in a portfolio. The standard error of the intercept is used to test the difference of α_i from zero.

Secondly, Black, Jensen, and Scholes (1972) technique is used to create portfolio's, "they wanted to maximize the spread in Betas across portfolios to measure the effect of Beta on return." Again the easier way is to rank stocks into portfolios by true beta, but they have only Observed Beta, but ranking portfolios on the basis of this leads to selection bias. They said, "Stocks with high observed beta (in the highest group) would be more likely to have a positive measurement error in estimating beta. This would introduce a positive bias into the beta for high beta portfolios and would introduce a negative bias into an estimate of the intercept . To remove this, they used an instrumental variable, which is highly correlated with the true beta but can be observed independently." The instrumental variable is the beta for each security in the previous time period. The exact procedure Black, Jensen, and Scholes (1972) used was "to employ five years of monthly data to estimate Betas and rank stocks accordingly (from highest to lowest)."

Similarly, in this paper, Beta of securities for sixth year is calculated using first five years data, and seventh year beta is calculated using second-sixth year data and so on till tenth year. Then each year securities are ranked (highest to lowest) on the basis of betas obtained. After that, first ten securities are classified into portfolio one (High risk portfolio), last ten securities are classified into portfolio three (Low risk portfolio), all rest securities belongs to portfolio two. This process is repeated each year and all securities belonging to high risk portfolio named as portfolio one and all securities belonging to low risk portfolio named as portfolio three and remaining securities belongs to portfolio two.

Thirdly, returns for portfolio one in each year was considered as a series of returns from a portfolio one, similarly for portfolio two and portfolio three. Then each portfolio is regressed against the market and an intercept, a beta, and a correlation coefficient for the equation computed.

5.1 EMPIRICALANALYSIS

After using the above discussed methodology and data analysis the following results were obtained:

Table 1: BETA ANALYSIS

S.No.	Portfolio	Beta (βi)	t-statistic	p-value(βi)
1.	One (High risk portfolio)	1.344381	37.84232	0.000001
2.	Two (Medium risk portfolio)	0.925935	30.84981	0.000001
3.	Three (Low risk portfolio)	0.623628	26.19632	0.000001

The above table shows the observed beta values for all three portfolios obtained from regression analysis. Results depicts that all the three portfolios have positive and significant beta as their p-value is less than the significance level of 5%. Sensitivity of excess return on portfolio one over market risk premium is 1.344381, Sensitivity of excess return on portfolio two over market risk premium is 0.925935, and Sensitivity of excess return on portfolio three over market risk premium is 0.623628. This means excess returns are being explained by market risk premium.

The following table tells about the abnormal returns:

Table 2: ALPHA ANALYSIS

S.No.	Portfolio	Alpha (α_i)	t-statistic	p-value(α_i)
1.	One (High risk portfolio)	-0.00101	-2.73017	0.006419
2.	Two (Medium risk portfolio)	-0.00057	-1.80513	0.071296
3.	Three (Low risk portfolio)	0.00001	-0.07499	0.940234

For portfolio one (high risk portfolio), p-value is less than our significance level of 5%, and alpha is also negative which means CAPM fails to explain the excess return earned. But portfolio two (medium risk portfolio) and portfolio three (low risk portfolio) is generating returns only as per CAPM model as their p-value is more than the significance level of 5%. In fact portfolio three is highly significant for CAPM model as its p-value is 0.940234.

6. CONCLUSION

In this study, CAPM model is tested for Indian Stock market by taking BSE SENSEX as the benchmark. This study results are based on daily stock returns of twenty eight companies from April 2010 to March 2015. The findings of this paper shows that there is a positive and significant relationship between portfolio returns and market returns as beta for all

three portfolios are 1.344381 for high risk portfolio, 0.925935 for medium risk portfolio, and 0.623628 for low risk portfolio. This means excess returns are being explained by market risk premium for the sample period. In further analysis, it is seen that CAPM does not hold for the high beta portfolio, which means excess return is not being explained by CAPM for highly risky portfolio. But, CAPM holds for medium beta portfolio as well as for low beta portfolio for the sample period.

Further study can be conducted for larger sample data as well as for larger sample period. Also, other factors can also be included to analyse the excess stock returns.

7. REFERENCES

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