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Is Capital Asset Pricing Model Relevant to Indian Stock Market?

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Abstract

This study examined the empirical validity of Capital Asset Pricing Model (CAPM) in the Indian Capital Market by using the data from 70 companies listed in the BSE 100 Index. To test the validity of the Capital Asset Pricing Model, the study used Black, Jensen and Scholes (1972) Methodology and examined the relation between systematic risk and return. From the analysis it was found that there was linear relationship between beta and return and CAPM was validated during the study period. Further, the study conducted the test of SML and the test of Non-Linearity and found that beta was linearly related and the data showed weakness in explaining the postulates of CAPM.

Keywords : *CAPM, Intercept, Beta, Security Returns, Portfolio Returns, SML, Black, Jensen and Scholes Methodology.*

1. Introduction

Resilient, well-regulated financial system is essential for economic and financial stability in a world of increased capital flows (www.imf.org). The financial sector and the financial products are becoming increasingly popular and financial system plays an important role in the mobilization of funds, provides number of possibilities for investors, provides a mechanism for spatial and temporal transfer of resources, pooling of funds and managing uncertainty and risk.

The capital market is one of the important investment avenues in India and the investor is in a dilemma in selecting the best investment option from the market. A good investor must embark on a strategic investment program which would identify the right stock to fulfill the desired return. The important problems faced by the investor include the identification of the best investment opportunity which would optimize the risk and increase the reward, combine growth and income in achieving their basic investment objectives. The identification of the best opportunity involves the selection of alternatives, collection and analysis of various data relating to the performance of the economy as well as securities in which one wishes to invest.

Investment is a complex activity because it is a cycle of action which requires creative

and deliberate efforts. A good investor should use his potential, his ability and skill to analyse the opportunities, take timely decision and to assume risk akin to his investment. Today the capital market is over flooded with numerous types of financial instruments but many of them are very complex and the investors often fail to understand the risk and return they offer. The evaluation of the performance of the securities or portfolio involves the study of the performance of the same in satisfying the required return and the risk experienced by the investor. Number of models and tools are used for analyzing the risk and return associated with the investment and Capital Asset Pricing Model (CAPM) is one of the widely used and tested models for calculating risk- return relation.

The CAPM helps an investor to evaluate a security, portfolios or any other investment. This model helps in pricing the risk associated with all securities and portfolios and helps in assessing the returns an investor can expect for taking risks. The model was developed by William Sharpe, John Lintner and Jan Mossin in the mid 1960's and the model postulates that beta completely captures the cross-sectional variation of expected returns. But there have been many debates about the applicability of this model and its efficacy in explaining risk return relationship. Many tests have been carried out in the US and other parts of the world to determine whether the CAPM Model holds and also to find out the factors influencing the return. Here it is planned to test the suitability and empirical validity of Capital Asset Pricing Model in the Indian Capital Market by using 9 year data covering a period of 01-01-2001 to 31-12-2009.The study used Black, Jensen and Scholes (1972) Methodology and Fama Macbeth Methodology and found that CAPM is valid in the Indian Capital Market.

This study was organized as follows. Section 2 presents a brief review of the literature on the empirical testing of CAPM model. Section 3 gives a brief theoretical background, details of test procedure and data and Section 4 presents the details of the empirical work. Section 5 deals with findings, summary and conclusion.

2. Previous Research

The Capital Asset Pricing Model is considered the most widely applauded model used to explain the return and the risk associated with investment. A large number of studies have been carried out to elucidate the relationship between return and the various factors which affect return. The evidence from the literature questions the applicability in different markets throughout the world. But the evidence did not fully reject the model. The findings from the various empirical tests revealed that there is a mixed opinion on the applicability of CAPM in predicting the risk return relationship. The studies conducted by Fischer Black, Michael C. Jensen, and Myron Scholes (1972), Fama and MacBeth (1973), found valid relation between beta and expected return. Pettengill et al. (1995) found valid relationship between beta and returns by using a modified methodology of Fama and MacBeth (1973). Jagannathan, R, and Z. Wang (1996) strongly support conditional CAPM when betas and expected returns are allowed to vary over time by assuming that the CAPM holds in

each and every period Terregrossa S.J.(2001) and Rahman et.al (2006). Samit Majumdar et al. (2007), are supportive of the standard Capital Asset Pricing Model.

But a number of studies raised serious issues against the empirical validity of the Capital Asset Pricing Model and found that beta itself cannot explain the risk return relationship and some of the studies firmly acknowledge that a systematic relationship between market beta and average return across the assets, does not exist. Attiya y. Javid(2009) on Pakistan market, Pablo Rogersan et al.(2007) on Brazilian market, Cudi Tuncer et al .(2007) on Turkey market, Xi Yang et al.(2006) on Chinese market , Stephen C.Fan (2004), Jan Bartholdy (2004) on NYSE stocks, Mirela Malin et al. (2004) on UK, France and German markets, Arduino Cangnetti(2001) on Italian market, Elsas (2000) on German market Yue Cheong Chan(1997) on Hong Kong market Madhusoodanan (1997) in the Indian Context, are some of the studies which reject the CAPM Model.

Roll (1977) opined that CAPM is useless since the true market portfolio is not identifiable and argued that market portfolio cannot be proxied by a single market index and rejected CAPM totally and supported Ross's APT (Arbitrage Pricing Theory) as the alternative explanation to risk-return relationships. But APT fails to replace CAPM in pricing assets.

As per the studies reviewed, only few studies were conducted for analyzing risk return relationship in Indian Capital Market and studies by Varma et.al,(1988)., Srinivasan (1988) have generally supported CAPM. The studies by Rao and Bhole (1990), Vaidyanadathan (1995), Sehgal (1997), Sehgal (2001,2003), Mohanthy (2002),Manjunatha and Mallikarjunappa (2007) questioned the validity of CAPM in the Indian context. While examining the literature it is clear that most of the studies in India used monthly or yearly data and only few studies used daily and weekly data. Therefore in this study, it is planned to examine the CAPM Model by using daily data of 70 companies listed in the BSE100-Index.

3.1. Objectives of the Study

The primary objective of the study is to test the empirical validity of the CAPM frame work in the Indian context by using Black et al (1972) Methodology and also use the Fama and Macbeth(1973) Methodology to test the non linearity. The main objectives of the study are described below:

1. To revisit the empirical validity of CAPM frame work in the Indian Capital Market by using portfolios having different number of securities.
2. To ascertain the relationship between return of securities and market return
3. To check whether higher or lower risk generate higher or lower rate of return.
4. To check whether expected rate of return is linearly related to systematic risk.

3.3. Source and Period of Data

The regular trading in the share on stock exchange implies a continuous valuation of share by the market. In this study, the test was organized to investigate the empirical validity of CAPM Model in the Indian context by considering the data of BSE 100 Stock Index, a

broad-based index, launched in 1989, with the base year of 1983-84. The sample for the study covers daily data for a nine year period from 01-01-2001 to 31-12-2009 and the data used in this study were sourced from RBI , SEBI, BSE websites and Prowess- a data base of CMIE., (Center for Monitoring Indian Economy), a leading private sector economic research data provider in India. The average percentage of daily return of shares was used to calculate the risk of the companies. Share prices returns in Prowess database were calculated by considering all benefits accrued / losses incurred by the share holder by way of change in price on the exchange, benefits received or losses incurred due to bonus issues, rights issues, and adhoc gains/losses. The return calculation also ensures that any split or consolidation has no effect on the return, except in the event of the prices changing due to market activity and return is calculated on closing prices. The data consist of financial results of 70 companies spread over various types of industries listed in BSE 100 Index. The study considered 70 actively traded stocks listed in this Index, including financial institutions. Daily data were used in this study. Further, the study considered 91 day Treasury Bill Rate as the proxy for the return from risk free assets, which is available in weekly format in the Reserve Bank of India site. The 91 day Treasury Bill is specifically chosen because it reflects better the short term changes in the financial market and also because a number of studies used the same. Here the data were analyzed in two stages. In the first stage, the daily percentage return were used to calculate the beta of the scrips and in the second part of the analysis, attempt was made to test the applicability of Capital Asset Pricing Model in the Indian context.

3.4. Methodology for the basic Capital Asset Pricing Model

Black, Jensen and Scholes (1972) introduced a time series test of the CAPM to test the relationship between risk and return systematically. They carried out the study by using 1931-1965 data of all the NYSE stocks, calculated the beta and formed portfolios and regressed them to get the portfolio beta. Mallikarjunappa (2007), Valeed A Ansari (2000), in their studies on Indian Capital Market and Xi Yang (2006) on Chinese stock market, Grigoris Michailidis (2006) on Greek market etc. used the same methodology. The present study also followed a similar methodology followed by the Black et al (1972).

3.5 Models Used in this Study

This study tested the CAPM Model for the period from 2001 to 2009 and used the same method followed by Black, Jenson and Scholes in (1972). This methodology used portfolio technique and also time series regression of excess portfolio return on excess market return and also cross sectional regression in risk premium form, which can be expressed by the equation below.

The first step under this formula is to measure betas (also known as the systematic risk) of individual securities. The beta coefficients of individual securities were calculated for the study period. A time series regression between the daily percentage return against the market return was used to get the beta coefficient of

each security in the sample and the model is shown below.

$$Ri_t - Rf_t = \alpha i + \beta i (Rm_t - Rf_t) + ei_t \quad (1)$$

Where Ri_t is the rate of return on asset i (or portfolio) at time t, Rf_t is the risk-free rate at time t, Rm_t is the rate of return on the market portfolio at time t. βi is the beta of stock i, ei_t is the error term in the regression equation at time t. The equation can also be expressed as

$$ri_t = \alpha i + \beta i\ rm_t + ei_t \quad (1A)$$

Where :

$Ri_t - Rf_t = r\ i_t$ and $Rm_t - Rf_t = r\ m_t$

$r\ i_t$ is the excess return of stock i

$r\ m_t$ is the average risk premium and the αi is the intercept

The study used the percentage of daily return of security return on index (BSE 100) and the risk free return. The daily return of securities and the market for the period were regressed by taking the company return as dependent variables and the market return as the independent variable.

In the second stage, the portfolios were constructed by using the calculated betas. For the formation of portfolios, the individual beta for each stock was arranged on an ascending order and the stocks were grouped into portfolios, having 10 stocks each, according to their beta value .The first portfolio comprised of the first 10 securities with the lowest beta, the next portfolio with the next 10 securities. The same method was followed for the formation of other portfolios and thus the last portfolio was formed, with the securities having the highest beta. At this stage, the portfolio betas were calculated by using the following regression model.

$$r_{pt} = \alpha_p + \beta_p\ r_{mt} + e_{pt} \quad (2)$$

Where

r_{pt} is the average excess portfolio return on time t,

β_p is the estimated portfolio beta, and

e_{pt} is the error term in the regression equation at time t.

In the third step, in order to estimate the ex post security market line for each testing period, the portfolio return were regressed against portfolio betas. The model for the calculation is

$$r_p = \lambda_0 + \lambda_1\ \beta_p + e_p \quad (3)$$

Where

r_p = is the average excess return of the portfolio P

β_p is the beta of the portfolio P, and

e_p is the error term in the regression equation

According to this theory, if the CAPM is true, λ_0 should be equal to zero and the slope SML, λ_1 is the average risk premium of the market portfolio.

Further, the study tested the non-linearity between the total portfolio return and betas by using the following equation.

$$r_p = \lambda_0 + \lambda_1 \beta_p + \lambda_2 \beta^2_p + e_p \quad (4)$$

3. 6 Black, Jenson and Sholes Methodology

Miller and Scholes (1972) diagnosed that while using individual stock betas, there is a problem because betas are measured with error and the measurement error in right hand variable biases down regression coefficients. Fama and

MacBeth (1973), Black, Jenson and Scholes (1972) addressed this problem by grouping stocks into portfolios. Portfolio Betas are better measured because the portfolio has lower residual variance. Further, the individual betas vary over the time as the size, leverage and risk of the business change. Secondly, the individual stock return is so volatile that you cannot reject the hypothesis that all average returns are the same. Hence this present study planned to use this methodology.

3.7 Limitation of the Study

The size of the sample and the number of companies used to construct the portfolio is one of the important limitations. Only seven portfolios were formed and tested in the present study and this may affect the statistical result and may be biased in view of limited observations. The market portfolio plays an important role in the test results. But the present study used only nine year data and conducted the test with return from only one index.

4. CAPM Frame work in Indian Capital Market (Using Ten Securities)

According to CAPM, unsystematic risk can be diversified and therefore the only issue that has to be considered by an investor is the systematic risk (beta) which cannot be diversified. Hence the investors only need to consider beta of securities for his investment decision. Further, the theory also suggests that the expected returns from the securities or portfolios are linearly related to the stock beta. In other words, risk and return can be considered as the two sides of a coin and they are the basic facets of an investment.

In this section, an attempt has been made to test the suitability of Capital Asset Pricing Model in the Indian Capital Market by using the Black, Jensen and Scholes Methodology. Under this methodology, the stocks are grouped into portfolios and portfolio betas are better measured because the portfolio has lower residual variance. As a part of the test, the market risk, the beta of each security in the study sample, was estimated for the whole study period. Further, the test for SML and the test for non- linearity were conducted and the results are presented systematically.

4.1. Calculation of Beta

The first step in the empirical testing of CAPM is measuring the systematic risk (beta). The beta coefficient shows the riskiness associated with a security or portfolio .The basic CAPM theory clearly argues that the efficient market is expected to compensate only the systematic risk which is denoted by beta (β).The beta represents the market responsiveness to change in share price of an individual company against the change in the market index.

Under the first step, the beta coefficients of individual securities were calculated for the whole period. A time series regression model – (1) was run between the daily percentage return against the percentage of market return and it was used to get the beta coefficient of each security in the sample.

$$R_{it} - R_{ft} = \alpha i + \beta i \, (R_{mt} - R_{ft}) + eit \quad \text{—} \quad (1)$$

The betas for individual securities by using the above model were calculated for both the study periods. The result shows that the range of estimated beta for the whole period lies

between (0.21766) the minimum and (1.55590) the maximum.

4.1.1Average Excess Portfolio Return and Beta

Different studies indicate that combining securities into portfolios definitely helps to diversify the risks due to the firm specific factors and enhances the precision of estimates of beta and the expected return on the portfolios. At this stage of the study, the portfolios were constructed by using the calculated betas. The average excess return was calculated for each portfolio and the following regression model (2) was used to calculate the portfolio beta.

$$r_{pt} = \alpha_p + \beta_p\, r_{mt} + e_{pt} \quad \text{——————} \quad \textbf{(2)}$$

On the basis of the regression results, the CAPM was tested for different periods.

4.2. CAPM for the Whole Study Period (2001-2009)

The study investigated the applicability of CAPM and the data used in this study consisted of 5259 day observations of 70 stocks listed in the BSE 100 Index over the period 01-01-2001 to 31-12-2009. The results for the whole period, by using the model (2), are shown in the **Table -1,** which includes the information on average excess portfolio return (rp), the constant alpha, beta of the portfolio, SE, R^2, F value, p value of beta coefficients, average market return (rm), average risk free return (rf) and also the information about the significance of constants.

The **Table -1** shows that the portfolio 1, with the lowest beta, earned the minimum return of (0.11130) and the portfolio 5, with a beta value of 1.05378, recorded the maximum return (0.19971). During the study period, the average risk free return was 0.01626 and the average excess return on the market was 0.06687. All the portfolios, including the portfolio 1, with the lowest beta, provided more return than the average excess market return and also the risk free return. The CAPM postulates that higher risk beta is associated with higher rate of return and the result of the study partially supports this argument. Out of the seven portfolios, both the beta and the return show an increasing trend up to the portfolio 5 – ((the return (0.19971) and beta (1.05378)) but in portfolio six, the return (0.162712) was decreasing while the beta (1.17683) recorded an increase from 1.05378. In the case of portfolio 7, both the beta (1.32345) and return (0.18238) increased when compared with the portfolio 6, but it recorded less return than the portfolio 5, with beta at 1.05378.

R-square explains the relative amount of the variance in return of a particular portfolio with the return on index. In the case of portfolio 1, the R^2 value is 0.54509, which indicates less than adequate correlation with the market index. But in portfolio 5, R^2 value is 0.80541, which indicates that above 80 per cent of the variation in the scrip could be explained by the relationship with the index. If we further look into the **Table -1**, it is noted that the constants are statistically significant and it has positive values. Thus the result indicates that in all the cases, the alpha coefficients were not significantly different from zero and hence we reject the null hypothesis. But it is to be noted that as per CAPM, the intercept should be equal to zero

and the positive constants suggest that the portfolios earned higher returns than the CAPM has predicted. Further, all the p values of estimated betas were found to be statistically significant at 99% level and hence we reject the null hypothesis that the portfolio beta is not a significant determinant of portfolio return. Thus from the analysis, it is clear that the β was a predictor of return in the Indian Capital Market during the study period.

4.2.1. Estimation of Security Market Line (2001-2009)

In the third step, result from the second stage was used to estimate the security market line by using the model (3), which is shown below. The SML is the graphical representation of the CAPM which displays the expected rate of return of an individual security as a function of systematic risk (beta) and it is considered as a useful tool in determining whether an asset is being considered for a portfolio and which offers a reasonable expected return for the risk suffered by the investor. As per the model, the intercept should be equal to zero and the λ_1 should be equal to the average risk premium of the portfolio. Generally the SML is used to compare the investment returns against different portfolios and the market line helps analysts to distinguish what level of risk is reasonable against a certain level of return.

$$r_p = \lambda_0 + \lambda_1 \beta_p + e_p \quad \text{——} \quad (3)$$

The test results from the estimation of the security market line are shown in the **Table - 2**. From the Table, it is clear that the t-test accepts the null hypothesis that ë 0 is not significantly different from zero. The calculated value of the intercept is 0.05437 and it is not significantly different from zero. Statistically, the result shows that the t- value is less than 2.57 at 95% confidence level. Hence the λ is statistically insignificant. It means that the result is statistically consistent with CAPM.

Further, from the Table it is clear that the t-test rejects the null hypothesis that the slope (ë1) is not equal to the average risk premium. Here the t- value is greater than 2.57 at 95% confidence level, which means that ë1 is significantly different from zero and it is statistically significant. As per the CAPM, ë1 should be equal to the average risk premium, which should be greater than zero. Hence it is concluded that the result is consistent with the CAPM and the model is accepted for the whole study period.

4.2.2 Test of Non-Linearity (2001-2009)

Test for the non-linearity helps one to check whether there exists non-linearity between portfolio return and beta. As per the theory, if CAPM holds true, λ_0 and λ_2 should be equal to zero and the λ_1 should be equal to the average risk premium. The non-linearity was tested by using the following regression model (4)

$$r_p = \lambda_0 + \lambda_1\beta_p + \lambda_2\beta^2_p + e_p \text{——} \quad (4)$$

The results of the estimated values are summarized in the **Table-3** and it shows that the value of the constant ë0 is not significantly different from zero. Statistically, the t - value is 0.8377, which is less than 2.7765 at 5% significant level and thereby it is consistent with the argument of CAPM.

In the case of λ1, the t- value (0.1159) is smaller than 2.7765 and it is not significantly different from zero. As per the CAPM, the λ1

should be equal to the average risk premium and hence the result is inconsistent with the CAPM hypothesis. In the case of $\lambda 2$, the value (0.03990) and the t- value are less than 2.7765 at 5% significance level and hence it is consistent with the CAPM hypothesis. Thus, from the analysis it is clear that the value of the $\lambda 2$ is not significantly different from zero. Thus we can say that the betas are linearly related with expected return. Hence CAPM cannot be summarily rejected during the study period.

5. Summary and Conclusion

The CAPM is one of the widely used and tested models in the history of finance to measure the risk return relationship. From the literature, it is clear that there is need for testing the validity of the model in different markets before practising it. In India, only few studies have been conducted to test the empirical validity of the one factor CAPM Model by using daily data. In this context, this study was organized to test the empirical validity of CAPM Model in the Indian Capital Market by using daily data of 70 companies listed in BSE100 Index.

This study tested the empirical validity of the CAPM Model by using the portfolio approach of Black, Jensen and Scholes (1972) and also conducted the test of SML and test of nonlinearity. The consolidated test results under different tests are shown in **Table -4** and the following conclusion can be derived.

The tests, by using portfolios, based on percentage return with equally weighted portfolios having 10 securities, supported the empirical validity of CAPM in the Indian Capital Market during the study period. But if we consider the whole tests, we cannot see conclusive evidence in support of CAPM .As an example, portfolio5, P (5), with beta (1.05378) earned more return than the portfolios P(6) and P(7) with beta(1.17683) and (1.32345) respectively. These correlations violate the principle that higher beta values earn higher return and show the weakness of the data to explain the postulates of CAPM. If we consider the whole study period, the tests generally support CAPM. Further, the study revealed that in almost all the cases, the constants have positive values, which suggest that the portfolio bagged more return than the CAPM has predicted.

In analyzing the risk - return relationship, for most of the cases, the R^2 shows a value over .65 (approximate), which shows that above 65% of the variation could be explained by the relationship with the index. Test for SML and non linearity support for CAPM still show the weakness of the data to fully explain the model during the study period. In short, most of the test results support the CAPM and they are in favor of the model but it fails to fully explain the postulates of CAPM and we cannot see conclusive evidence in support of CAPM to wrap up the question of the validity of CAPM in the Indian Context.

The proxy for market return plays an important role in testing CAPM and thereby one can test the CAPM and establish the difference by using different indices and one can also test the model with different number of portfolio combinations to find out an effective pricing mechanism, which will be our future work.

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Table - 1
Average Excess Portfolio Return and Portfolio Betas for Whole Study Period (2001 – 2009) (N= 5259)

Port folio	Portfolio Return (rp)	Intercept	Beta	Standard Error	R^2	F value df =1	P Value of beta at 99%
P1	0.11130	**0.07971**	0.47233	0.76289	0.54509	2688.93	0.0000
P2	0.11554	**0.06680**	0.72892	0.97319	0.63685	3935.33	0.0000
P3	0.12702	**0.06868**	0.87242	0.79571	0.78981	8432.46	0.0000
P4	0.13047	**0.06646**	0.95720	0.90286	0.77844	7884.51	0.0000
P5	0.19971	**0.12924**	1.05378	0.91577	0.80541	9288.38	0.0000
P6	0.16271	**0.08401**	1.17683	1.09133	0.78425	8156.95	0.0000
P7	0.18238	**0.09388**	1.32345	1.20891	0.78931	8406.92	0.0000
Avg Rf	0.01626	Average rm = (Rm-Rf)		0.06687	The constants P1, P2, P3, P4, P5, P6, P7, are significant at 99 % level.		

Table - 2
The Estimation of SML for the Whole Study Period (2001 - 2009)

	Coefficients	Std error	t-value	p-value
λ_0	0.05437	0.03149	1.727	0.1448
λ_1	0.09848	0.03224	3.054**	0.0283

** Shows significant at 95% level.
Critical Value for 5-Degrees of Freedom (2.57)

Table - 3
The result of the test of Non-Linearity for the whole period (2001 - 2009)

	Coefficients	Std error	t- value	p-value
λ_0	0.08368	0.09989	0.8377	0.4493
λ_1	0.02685	0.23162	0.1159	0.9133
λ_2	0.03990	0.12751	0.3130	0.7699

Critical Value for 4-Degrees of Freedom (2.7765)