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Empirical Validity of CAPM through Security Market Line and Non Linearity Tests: Indian Experience

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Abstract: Capital Asset Pricing Model (CAPM) is one of the important talk factors in finance and it has been widely discussed and tested in different capital markets throughout the world. This study examines the validity of capital asset pricing model in Indian Capital Market by using the data of 70 companies listed in BSE 100 index The study used Black, Jensen and Scholes (1972) methodology and Fama Macbeth methodology (1973) to test the empirical validity of the model. The results showed linear relationship between beta and return, and also it showed weakness in explaining the various assumptions of CAPM.

Key Words*: CAPM, Intercept, Beta, Portfolio Returns, SML, Black Jensen and Scholes Methodology. Fama and Mac- Beth methodology.*

1. Introduction:

The need for investment may be different to different people, and it may be to appreciate his idle savings or to make a provision against uncertainty in the future. Every investment is likely to have risk and return. Further risk and return are considered as two sides of a coin and the measurement of risk without considering return is extraneous. The concept of risk is an important factor in security analysis and its valuation. Today risk management is a core area in all investment decisions, which protects the investor from financial loss and ensures that he is properly compensated for the risks he assumes. Through measurement of risk, one evaluates the possibility and tries to quantify the extent of risk and measures the likely fluctuation in return associated with his investment. Through the analysis one can identify how much will return vary from desired return or the likely changes in the actual return from the anticipated return

The risk can be mainly classified in to Systematic risk and Unsystematic risk. The un systematic risk is unique and specific to a firm or industry and these risk factors do not play an important role in investment decisions because it is diversifiable. The measurement of systematic risk is vital and the investor should give due care in assessing systematic risk, which is denoted by Beta (β). For the calculation of Beta we use the historical data of the individual security and the return of the representing market index. Beta present the volatility of a stock to general market movement and it measures the systematic risk added to a diversified portfolio. Security‘s Beta depends on how the security‘s return is closely correlated with the overall market‘s return, and the relative volatility of the security to the market.

The investment theories provide tools to enable an investor and portfolio managers to handle their investment safely under wide range of complex situations. The investors are ―price takers‖ and always expect a reasonable or higher return on his investment. The Markowitz portfolio model provides a useful framework for optimizing and combining risky funds to form a suitable portfolio. The portfolio theory of Markowitz derived the efficient frontier of risky assets; and point out the importance of security return correlation in the formation of portfolios. However the theory is not simple to explain the risk – return relationship of an investment

The modern portfolio theory explains that there is a clear trade of between risk and return The Markowitz portfolio selection model helps one to plot the efficient frontier of risky assets and provides a useful framework for selecting an optimal combination of risky funds. The Capital asset pricing Model which was contributed William Sharpe (1964), John Lintner (1965), and Jan Mosssin (1966), (often referred as Sharpe – Lintner - Mosssin Capital Asset Pricing Model) explains the equilibrium relationship between the expected return on risky assets . This model is really an extension of the portfolio theory of Markowitz and explains the behavior of security prices .The model provide a mechanism to assess the role of a particular asset in the overall portfolio risk and return and it uses the result of capital market theory to derive the relationship between expected return for the risky assets. The model is used widely in security valuation, risk analysis, estimation of cost of capital and evaluation of the performance of portfolios.

The capital asset pricing model (CAPM) is a theoretical model of equilibrium ex ante or expected returns on risky assets. The model specifies the relationship between risk and required rate of return for assets held in well-diversified portfolios.The essence of this model is that the expected return on any asset is a positive linear function of its beta ,the only measure of risk that explain the cross-section of expected returns. All the securities are expected to yield a certain amount of return proportionate to the riskiness as measured by the beta and the relationship is also valid for all portfolios irrespective that whether it is efficient or inefficient. But the literature says that there is controversial opinion about the validity of the model and a number studies which questioned the applicability of the Model especially in developed markets. Therefore the model should be tested and validated for each and every market and this study will test the empirical validity of the CAPM by using 9 years daily data

This study is 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 with details of data used in the study and Section 4 presents the details of the empirical work. Finally section 5 deals with findings, summary and conclusion.

2. Previous Research

The capital asset pricing model is one of the most discussed models in the history of finance. The evidence from the literature indeed insinuates on the inefficiency of the Capital Asset Pricing model and questioned the applicability in different market throughout the world but not fully reject the model. Various empirical tests revealed that there is a mixed feeling 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 Mac Beth (1973), Sauer and Murphy (1992), Andor Gyorgy *et.al* (1999) for the Hungarian capital market are

generally supportive and the results were in favor of the using the model. 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. Ming-Hsiang Chen (2003) established that empirical performance of the CAPM is encouraging and the CAPM outperforms the CCAPM in terms of goodness of fit. Further Suh (2009) opined that in a highly volatile market, Parameter estimates of the CAPM are generally superior to those of the Fama French three factor models

But many studies aroused serious questions against the validity of the model and challenged the validity of the model in late Seventies, Eighties and Nineties. It was found that beta itself cannot explain the risk return relationship and some studies firmly acknowledge that a systematic relationship between market beta and average return across the assets does not exist. Javid, Attiya.y (2009) studied about Pakistan market, Pablo Rogers and et al.(2007) analysed the Brazilian market, Gursoy and et al .(2007) done on Turkey market, Xi yang etal.(2006) conducted study on Chinese market, Fan Stephen C. (2004), Bartholdy Jan (2004) for NYSE stocks, Malin mirela and etal. (2004) studied about UK, France and German markets, Cagnetti (2001) studied about Italian market, Yue Cheong Chan(1997) analysed the Hong kong market and Madhusoodanan (1997) studied the Indian context and most of them reject the CAPM model. Further the studies conducted by Roll (1977), Harris and et al.(2003) argued against CAPM,. Nopbhanon Homsud and *et. al*. (2009) found that Fama French model explain return better than the traditional one factor Asset Pricing model.

In Indian context, only few studies were conducted for analyzing risk return relationship and studies by Varma (1988), Srinivasan (1988) have generally supported CAPM. The studies by Rao and Bhole (1990), Vaidyanathan (1995), Sehgal (1997) Connor and et.al (2001), Sehgal (2003) Mohanty (2002),Manjunatha and Mallikarjunappa (2006) questioned the validity of CAPM in Indian context. Further it is clear that most of the studies in India used monthly or yearly data and only few studies used daily and weekly data. The studies in Indian context to examine the validity of Capital Asset Pricing Model are scanty and thereby it is planned to examine the CAPM model by using daily data of 70 companies listed in 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 Indian context by using Black *et.al* (1972) and Fama and Mac Beth (1973) methodology and the study specifically intended:

- To ascertain the relationship between return of securities and market return
- To check whether higher or lower risk generate higher or lower rate of return.
- To check whether expected rate of return is linearly related with systematic risk.

3.2. Source and Period of Data

It is to investigate the empirical validity of CAPM models in Indian context by considering the data of BSE 100 stock Index, a broad-based index, launched in 1989 with the base year 1983-84. The period for the study covers nine years daily data for a period from 01-01-2001 to 31-12-2009 and the data used in this study were sourced from RBI (Reserve Bank of India), SEBI(Security Exchange Board of India), BSE (Bombay Stock Exchange)websites and Prowess- a

data base of CMIE (Center for Monitoring Indian Economy). Further the study considers 91 day Treasury bill rate as the proxy for the risk free assets as it reflects the short term changes in the financial market.

3.3. Methodology Adopted:

This study will test the CAPM model by using the same method followed by the Black, Jenson and Scholes in (1972) over the period from 2001 to 2009 and the non linearity is tested with Fama Macbeth (1972) methodology. The following are the steps adopted in the analysis:
First individual securities beta are measured by using the following model:

$$Ri_t - Rf_t = \alpha_i + \beta_i (Rm_t - Rf_t) + ei_t \quad \text{----------} \quad (1)$$

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. β_i is the beta of stock i, ei_t is the is the error term in the regression equation at time t.
Secondly the portfolios are constructed by using the betas calculated above. For the formation of portfolios the individual beta of each security is arranged in ascending order and the stocks were grouped in to portfolios having five stocks each according to their beta value .The first portfolio comprises of first five securities with the lowest beta, the next portfolio with the next five securities. The same method is followed for the formation of other portfolios and there by the last portfolio is formed with the securities having the highest beta.

Thirdly portfolio betas are determined by using the following regression model.

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

Where
r_{pt} is the average excess portfolio return on time t, β_p is the estimated portfolio beta, and e_{pt} isthe error term in the regression equation at time t.

Fourthly ex post security market line is determined by regressing the portfolio return portfolio betas with the following model:

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

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

Fifthly the non- linearity between the total portfolio return and betas is measured by using the following equation.

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

Here the theory says that if the CAPM is true, the portfolio returns and its betas are linearly related with each other and λ_2 will be equal to zero.

4.1. CAPM Frame Work in Indian Capital Market

In this study an attempt is made to test the empirical validity of the model by using portfolios having five securities. The theory says that through diversification one can strategically reduce the risk by allocating the available funds in many securities by forming balanced portfolios. Further, it will also help to compare the results with earlier studies with same set of data and also to check whether the number of securities in a portfolio has any influence on measuring the efficiency and validity of CAPM.

4.1.1. Testing CAPM through Portfolio Beta

The Capital Asset Pricing model postulates that, the components of the expected return exceeding the risk free rate will be linearly related to the idiosyncratic risk. Further the model predicts that, there is a linear relationship between stock beta and return and also higher risk beta is associated with higher rate of return.

Table 4 .1
Table Showing Portfolio Betas for the Study Period (2001 – 2009)

Port folio	Portfolio Return(rp)	Constant	Beta	Standar d Error	R^2	F value	P Value 99%
P1	0.08861	**0.06414**	0.36583	0.92121	0.33020	1106.26	0.0000
P2	0.13393	**0.09521**	0.57899	1.09383	0.46691	1965.43	0.0000
P3	0.12553	**0.07899**	0.69593	1.38381	0.44153	1774.18	0.0000
P4	0.10556	**0.05461**	0.76191	1.05857	0.61823	3633.93	0.0000
P5	0.13207	**0.07543**	0.84704	1.06828	0.66276	4410.18	0.0000
P6	0.12198	**0.06193**	0.89781	1.09352	0.67816	4728.54	0.0000
P7	0.13557	**0.07309**	0.93429	1.14146	0.67682	4699.57	0.0000
P8	0.12536	**0.05982**	0.98011	1.22015	0.66855	4526.25	0.0000
P9	0.18670	**0.11754**	1.03411	1.11044	0.73053	6083.59	0.0000
P10	0.21272	**0.14094**	1.07345	1.30458	0.67912	4749.29	0.0000
P11	0.18653	**0.10890**	1.16086	1.68331	0.59786	3336.14	0.0000
P12	0.13889	**0.05912**	1.19280	1.29372	0.72657	5962.97	0.0000
P13	0.18345	**0.10019**	1.24502	1.51927	0.67734	4710.72	0.0000
P14	0.18131	**0.08756**	1.40188	1.44521	0.74628	6600.44	0.0000
Avg Rf	**0.01626**	Average rm =(Rm-Rf)		**0.06687**	**All constants are significant at 99% level**		

From the Table 4.1, it is clear that the portfolio 1 (P1) with lowest beta earned the minimum return (0.08861) and the portfolio10 with the beta (1.30458) earned the maximum return (0.21272). Out of the14 portfolios, with the increase in beta we cannot see any increasing trend in the average portfolio excess return; rather it goes up and down. The study also supplements that, during the study period all the portfolios including the portfolio with lowest beta earned more than the average excess market return and also the risk free return. Further the positive

constants suggest that, the portfolios earned higher returns than the CAPM has predicted. In the case of first three portfolios (P1, P2, P3), the value of R^2 is less than 0.50 and which points a less than adequate correlation with the market index. But in the case of other portfolios, R^2 values are in between (0.59) and (0.73), which means that 59% to 73% of the variation in the scrip has been explained by the relationship with the index. Further from the Table, it can be noted that the all constants are not significant and it has positive values. Thus the result indicates that, the alpha coefficients are significantly different from zero and hence we reject the null hypothesis .Further all the p values of estimated betas are found to be statistically significant at 99% level; thereby we reject the null hypothesis that the portfolio beta is not a significant determinant of portfolio return. Thus from the analysis we can say that the β is a predictor of return during the whole study period (2001-2009).

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

From the Table 4.2, it is clear that the t- test rejects the null hypothesis that λ0 is significantly different from zero. Here the calculated value of the intercept is (0.10800) and it is significantly different from zero. Statistically, the result shows that the t- value is greater than (2.18) at 95% confidence level and the λo is statistically significant. Thus the result is statistically inconsistent with CAPM.

Table 4.2

	Coefficients	**Std error**	**t- value**	**p-value**
λ_0	0.10800	0.04244	2.545 **	0.0257
λ_1	0.10565	0.04344	2.432 **	0.0316

Table showing the estimation of SML for the whole Study Period (2001- 2009)

Note: ** shows significance at 95% level

Critical value for t– test with 12-Degrees of freedom at 95 % level (2.18)

Further, from the table, it is clear that the t- test reject the null hypothesis that the slope (λ1) is not significantly different from zero because the t value is greater than (2.18) at 95% confidence level. As per the CAPM λ1 should be equal to the average risk premium, and should be greater than zero, Hence the result is consistent with the CAPM and hence the CAPM can be accepted along with the rejection of Ho for λ0=0.

4.1.3. Test of Non-Linearity (2001-2009)

The theory of CAPM holds true, when λ0 and λ2 equal to zero and the λ1 equal to the average risk premium. The results of the estimated values are summarised bellow in the Table 4.3.

Table 4.3

Table showing the result of the test of Non-Linearity for whole Study Period (2001- 09)

	Coefficients	**Std error**	**t- value**	**p-value**
λ_0	0.08295	0.11404	0.7274	0.4822
λ_1	0.16592	0.25691	0.6458	0.5316
λ_2	−0.03321	0.13937	−0.2383	0.8160

Critical value for t-test with 11-Degrees of freedom at 95% level (2.2010)

The test of the non-linearity checks the relation between stocks returns and the estimated betas. Here the t-value (0.7274) of the intercept λ_0 is less than (2.2010), and is not significantly different from zero, thereby it is consistent with the CAPM hypothesis. The parameter λ 1 is not significant different from zero and the t-value (0.6458) is smaller than (2.2010), which is inconsistent with the CAPM hypothesis. The absolute t-value (0.2383) of λ2 is smaller than (2.2010), i.e. it is not significantly different from zero, which is consistent with the CAPM hypothesis. Thus, beta is linearly related with expected return and the CAPM cannot clearly be rejected during the test period. Further the test shows the weakness of the data to explain the postulates of the CAPM.

Table4.4
Consolidated result for the Different Test periods

Period	CAPM	SML		Non-Linearity		
	Beta	**λ0**	**λ 1**	**λ0**	**λ1**	**λ2**
2001-2009	Support	Inconsistent	Consistent	Consistent	Inconsistent	Consistent

5. Conclusion

The consolidated results of tests are shown below in Tables 4.4 and following inference can be derived. The test of portfolios based on percentage return with equally weighted portfolios having 5 securities mostly favored and is in support of CAPM. In almost all the cases the constant 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 explain the relative amount of variance in return of the portfolio. Further it is found that, generally higher beta provides higher return to the investor; but it does not mean it is fully true in all the cases. The Test for SML and Non linearity also support CAPM but it still shows the weakness of the data to fully explain the model during the study period. In short most of the test result supports the CAPM and is 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 Indian context.

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