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Does CAPM Explains the Relationship Between Risk and Return in the Indian Stock Market

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Abstract

The aim of this study is to determine whether the capital asset pricing model exists in the Indian stock market. Using the integrated concepts of Black Janson and Scholes and Fama and Macbeth technique on portfolios rather than individual stocks. We have taken the sample of 150 midcap stocks from 2021 to 2023 (36 months). The study provides empirical evidence that there is a risk anomaly in the Indian equities market while the capital asset pricing model's assertion that risk and return are directly correlated. The study findings also demonstrate the non-linearity between portfolio betas and returns which goes against the CAPM theory. This study also explores whether the CAPM fully accounts for stock variance to test the effectiveness of unsystematic risk and our findings suggest that the residual risk is insignificant, which is according to the Capital Asset Pricing Model.

Keywords: Indian stock exchange, Beta anomaly, portfolios, residual risk.

Introduction

Capital markets plays an important role in the development of economy and is an integrated part of financial system. CAPM predicts that the expected return of an asset is linearly related to systematic risk which is measured by beta. The main objective of the stock market is to access capital and equity for firms. A company can raise more money for fresh capital by issuing additional shares to the open market and the problem is how to more accurately set the stock's price in this competitive market. Since 1960, the asset pricing model has been used as a tool for assessing financial assets return as per their risk in the stock market. The model assumes that market risk alone is a sufficient explanation for the expected return on an asset. It also assumes that market returns to investors are based on how much market risk prevail.

The CAPM model was developed by Sharpe, Linter, and Markowitz which was actually extension of Markowitz modern portfolio theory in 1960. In addition to examining the empirical relationship between risk and return in the Indian stock market, the Low-beta anomaly which is primarily reported from developed markets. This anomaly is particularly interesting because it contradicts the conventional asset pricing theory which holds that securities with higher risks have higher expected returns. The Efficient Market Hypothesis which asserts that markets are informationally efficient and the mean-variance efficiency of the market portfolio was anticipated by the Capital Asset Pricing Model (CAPM) a conventional asset pricing theory. As a result, higher expected returns for high-risk assets should be offered. However, it was discovered through several research conducted in both the foreign and Indian contexts where low beta stocks outperform with high beta stocks and this phenomenon is known as the low-risk anomaly. According to the CAPM model, investors assumes higher returns for taking higher degree of risk. It is a single-component model and only systematic risk can explain the required rate of return of an asset. Despite difficulties, limited assumptions and conflicting data regarding its validity, the CAPM is widely employed in applications including calculating a company's cost of capital and assessing the performance of managed portfolios.

Assumptions of Capital Asset Pricing Model

1. Every investor is logical and risk-averse.
2. All investors anticipate the same expected returns for all securities and correlation coefficients.
3. At the risk-free rate of return all investors are permitted to borrow or lend an unlimited amount of money.
4. Transaction fees and taxes are absent.
5. Investors have no preference between capital gains and dividends because there are no personal income taxes.
6. The capital markets are balanced.

Basic form of Capital Asset Pricing Model

$$\boldsymbol{Ri} = \boldsymbol{RF} + (\boldsymbol{RM} - \boldsymbol{RF})\, \beta \boldsymbol{i} \qquad (1)$$

Where;

E Ri = the expected return of Asset

RF = Risk-free rate of interest; Return on government securities is usually used

RM = Return on market portfolio; broad market index is typically used as a proxy.

βi = Systematic risk

Review of Literature

This literature review seeks to investigate the basic theories, empirical evidence, and critiques of the Capital Asset Pricing Model (CAPM), especially relating to studies carried out in India. By analysing existing research, this section emphasizes the model's applicability, drawbacks, and the diverse findings observed in various time frames, market environments, and research approaches. Gaining insight into this academic framework offers a strong foundation for assessing CAPM within the Indian stock market and identifying areas for further research.

The first empirical evaluation of the CAPM was carried out by Linter (1965) using a two-stage regression. His experiments led him to support the CAPM, but his two-stage regression method was applied to individual stocks rather than entire portfolios and made it possible for the beta estimation error. Black, Jensen and Scholes in (1972) Tests the CAPM on portfolios and discovered evidence in support of the CAPM. According to Fama and Macbeth (1973) beta squared and unsystematic variances failed to adequately describe the structure of security returns but the riskless rate and beta shows the relationship. These findings together with those reported in several studies that supported the viability of CAPM. Early research conducted by (Haugen & Bake 1975) helped to establish the low volatility anomaly. Following this, other research in the US market (Chan, Karce ski, & Lakonishok, 1999, Schwartz, 2000, Jagannathan & Ma, 2003; etc.) revealed that the minimum variance portfolio (MVP) had higher returns and lower realized risks than the capitalization-weighted benchmark (MWP).

Fama and French (1992) discovered in their article "The cross-section of expected stock returns" that the straightforward relationship between an average return vanishes between the years 1963 and 1990. The primary prediction of the SLB model that average stock returns are positively connected to market activity is not supported by their tests.

According to Blitz and Van Vliet (2007) portfolios of the stocks with the lowest historical volatility exhibit Sharpe-ratio increases that are higher than those reported by Clarke et al. (2006) and have a statistically significant positive alpha. They discovered that high-beta stocks performed poorly but low-beta stocks had larger returns than expected.

Baker and Haugen (2012) examined the Capital Asset Pricing Model from 1990 to 2011 and found that equities from 21 developed and 12 emerging markets and they discovered that low-risk stocks outperformed. The low volatility anomaly was investigated in India by Vidisha Garg and Sahaj Wadhwa (2014) who concluded that high risk is the only way for investors to achieve large returns. Later research by Fama and French (1992) indicated that business size and market-to-book ratios rather than stock betas were better at explaining long-term return relationship. Companies with low price-to-earnings ratios perform better than companies with higher P/E ratios. According to Fama and French (1992) and Basu (1977) the P/E ratio and firm size together greatly outperform the CAPM at forecasting securities returns.

The literature provides mixed kind of evidence in relation to CAPM. Additionally, there is an enormous amount of research evidence on the aforementioned anomalies for overseas markets, but there is little study on low-risk anomalies and the applicability of CAPM in the Indian setting. Although the results seem inconsistent and the main objective of the current study is listed below.

Objectives of study

1. To investigate whether stocks with higher or lower risk have higher or lower expected rates of return.
2. To explore whether the expected rate of return and the stock's systematic risk or beta are linearly related.
3. To examine whether non-systemic risk has an impact on the returns of the portfolios.
4. To determine whether the existence of Beta Anomaly in the Indian stock market.

Hypotheses of the study

H1: Intercept (Yo) is not significantly different from zero.

H2: Slope (Y_1) is significantly different from zero.

H3: (Y_2) = 0, there is a linear relation between beta and stock returns.

H4: (Y_3) = 0, there is no effect of non-systematic risk on the returns of stocks.

H5: There are significant patterns in the returns of the portfolio.

Data Selection

This section describes the sources of data, the criteria for sample selection, and the empirical techniques used to evaluate the Capital Asset Pricing Model (CAPM) within the framework of the Indian stock market. The CAPM establishes a theoretical relationship between the expected return of a security and its systematic risk, indicated by beta. To evaluate the model's validity, historical data from selected Indian stocks and pertinent market indices are utilized. This research utilizes secondary data that includes monthly returns on stocks, market returns, and risk-free rates throughout a specified timeframe. The investigation aims to assess the validity of CAPM in the context of contemporary market conditions in India, thus providing insights into its relevance and predictive power in an emerging market environment.

Universe for the present study is the Indian stock market, more than 1800 companies are listed on NSC, therefore it was not possible to study all the companies. Accordingly, Nifty 150 has been chosen for the present study. The reference period for the study is 3 years from January 2021 to December 2023. The study is based on secondary data which has been collected from the Prowess database of CMIE, official website of Reserve bank of India. The market portfolio is represented by the NSE Nifty Index's monthly closing values. Additionally, the yield on 91-day Indian government treasury bills is included in the risk-free return. Prices of stock cannot be used directly for analysis as a time series data is a non-stationary process. To convert this, we have used log returns of stocks and make series stationary for data analysis. The market index return and the sample return are calculated as follows:

$$Rit = LN\ (Pit\ /\ Pit\ 1) \qquad (2)$$

Where,

Pit = share price at time t for the share i.

Pit-1 = share price of a share of an entity at time t-1.

$$Rmt = LN\ (It\ /\ It\ 1) \qquad (3)$$

Where,

It = daily market index value at time t.

It-1 = the market index's daily value at time t-1.

Procedure of CAPM Testing

The methodology developed by Black, Jenson, Scholes and Fama and Macbeth (1973) is used to examine the Capital Asset Pricing Model and forecast the expected return. Due to the substantially shorter testing duration, the methodology of Fama and Macbeth has been changed to accommodate the data.

Fama and Macbeth tested the CAPM by using a time series test on portfolios. which can be expressed by the equation below.

$$R_{it} = R_{mt} = \alpha i + \beta i\ (R_{mt} - R_{ft}) + eit \qquad (4)$$

Where,

Rit = Return on the asset I (or portfolio) at time t,

Rft = Risk-free rate at time t,

Rmt = Return on the market portfolio at time t.

Bi = Beta of stock I.

Eit = Random disturbance term

The first step is to estimate a beta coefficient for each stock using their monthly returns. The beta is estimated by regressing each stock's monthly return against the market index (NSE Nifty). Based on the estimated betas the sample of 150 stocks are divided into 6 portfolios each comprised of 25 stocks based on their betas. The first portfolio has the 25 lowest betas and the last portfolio has the 25 highest betas.

The second step is to calculate the portfolios' betas by using the following equation

$$Rpt = \alpha p + \beta prmt + ept \qquad (5)$$

Where,

Rpt = is the excess portfolio return at time t,

βp = is the estimated portfolio beta.

The third step is to estimate the Security Market Line (SML) for the testing period by regressing the portfolio average returns against the portfolio betas.

If we view $E(Ri) = R_f + \beta i\ (Rm\text{-}Rf)$ as the Security Market Line (SML) we can estimate Y_0, Y_1 in the following equation and use the estimated beta from the last step.

$$Rp = Y_o + Y_1\beta p + ep \qquad (6)$$

Where,

Rp = Average excess return on a portfolio p,

βp = Beta of portfolio p

Ep = Random disturbance term

If the CAPM is true, Y_0 should be equal to zero and the slope of SML Y_1 is the market portfolio's average risk premium.

Non-linearity and Non Systematic Risk Test

$$R_p = \Upsilon_0 + \Upsilon_1\beta_p + \Upsilon_2\beta^2{}_p + e_p \qquad (7)$$

$$R_p = \Upsilon_0 + \Upsilon_1\beta_p + \Upsilon_2\beta^2{}_p + \Upsilon_3\sigma^2(e_p) + e_p \qquad (8)$$

Where,

Y_2 = Shows the potential nonlinearity of the return, and Y_3 determine the non-systemic risk to explain variation in return. Therefore, the CAPM is held true only when:

Where,

Y_3 and Y_2 should be equal to 0.

Results and Discussion

This chapter presents the data analysis and interpretation of results derived from applying the Capital Asset Pricing Model (CAPM) within the framework of the Indian stock market. The main objective is to assess the validity and predictive capability of CAPM by investigating the relationship between risk (beta) and expected returns of chosen stocks or portfolios. The study employs historical market data to calculate beta coefficients and compares the actual returns with those predicted by CAPM. The results are then examined in relation to theoretical expectations and earlier empirical research to assess the model's relevance in the context of the Indian stock market. The results aim to offer insights into investor behavior, market efficiency, and the impact of systematic risk on asset pricing. The results of the first pass regression have been displayed in the table 1 given below:

Table. 1 Results of First-Pass Regression

	Intercept	*T- value*	*P-value*	*Beta*	*T-value*	*P-value*	*R-Square*	*Standard Error*
P1	-0.00167	-0.25195	0.802597	-0.98363	-5.80874	0.0000	0.498092	0.039564
P2	-0.00733	-1.07596	0.289519	0.476755	2.743468	0.009633	0.181248	0.040602
P3	0.001336	0.262305	0.794669	0.393123	3.02481	0.004712	0.212041	0.030365
P4	0.001062	0.184527	0.854696	0.337066	2.294836	0.02804	0.134117	0.034317
P5	0.004869	1.037916	0.306635	0.251344	2.099763	0.043246	0.114791	0.027967
P6	-0.00577	-0.72337	0.474401	0.519931	2.556105	0.015224	0.161191	0.047524

Source: Date obtained from (CMIE)

The results are quite promising that the intercept term for all the portfolios are insignificantly different from zero which is according to the CAPM theory, while the beta of all six portfolios are significantly different from zero at a 5% level of significance.

Table 2: Inputs for Cross-Sectional Regression.

Portfolio	*Beta*	*Beta Square*	*Variance of Residuals*	*Portfolio Average Returns*
P1	-0.98363	-1.96726	0.001521	-0.00601
P2	0.476755	0.227295	0.001601	-0.00523
P3	0.393123	0.154545	0.000896	0.003068
P4	0.337066	0.113613	0.001144	0.002548
P5	0.251344	0.063174	0.00076	0.005976
P6	0.519931	0.270328	0.002194	-0.00347

Source: Date obtained from (CMIE)

Security Market Line Estimation

The next step is to perform second-pass regression where average excess returns are regressed against their estimated betas.

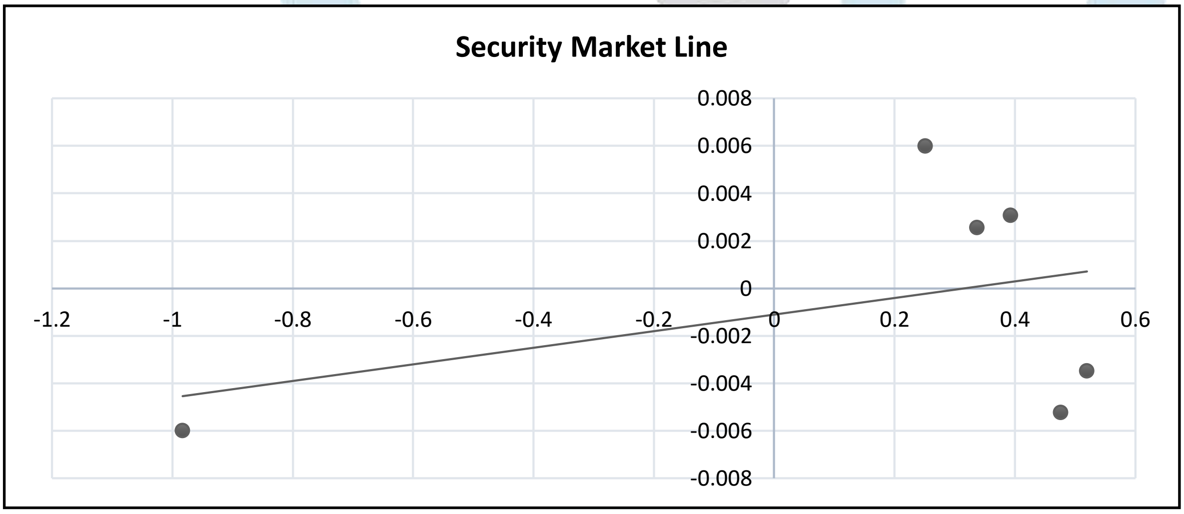

Figure 1: Estimation of security market line on the Indian stock market. Testing period 2021 to 2023

The above Figure No 1 shows the graphical representation of the estimated security market line on the Indian stock market. Intercept is not zero but the SML is not support the idea of CAPM that expected returns are positively and proportionally related to beta. However, to draw any conclusion we must examine the regression results.

Table 3 Second Pass Regression Results

	Coefficients	*T Statistics*	*P-value*	*R Square*	0.158331
Y0	-0.0011	-0.4987	0.64417	*Standard Error*	0.005138
Y1	0.003489	0.867446	0.434638		

Source: Date obtained from (CMIE)

As we can see from Table 3 the estimated SML doesn't support the CAPM theory. The estimated value of Y0 is insignificant which is according to the CAPM. The slope Y1 must be positive and significant but it is the opposite which is inconsistent with the model. As we can say there is another factor that explains the expected return of stocks and beta is not a single factor. Finally, the R – square value is very low suggesting that only a small portion of the variation in stock returns can be explained by the beta.

Non-Linearity Test

Table 4: Second Pass-Regression Results with Non-Linearity Test.

	Coefficients	*Standard Error*	**T-statistics**	*P-value*	*R Square*	0.874471
Y0	0.024402	0.006241	3.909657	0.029729	*Adjusted R Square*	0.790784
Y1	-0.08438	0.021315	-3.95863	0.02878	*Standard Error*	0.002291
Y2	0.057633	0.013931	4.137013	0.025636		

Source: Date obtained from (CMIE)

The intercept Y0 is significantly different from zero which is inconsistent with the CAPM hypothesis. The parameter Y1 is significantly different from zero which is consistent with the CAPM Hypothesis. The estimated value of the coefficient Y2 is significantly different from zero which implies no linear relationship between stocks beta and return.

Non-Systematic Risk Test

Table 5: Second Pass-Regression Results with Non-Systematic Risk Test

	Coefficients	T-Statistics	*P-value*	*R Square*
Y0	0.020441	2.336055	0.144546	0.900356
Y1	-0.05717	-1.2897	0.32617	
Y2	0.03978	1.3689	0.304498	
Y3	-2.91	-0.72081	0.545893	

Source: Date obtained from (CMIE)

The estimated value of coefficient Y3 is insignificantly different from 0 which is following the CAPM hypothesis. It implies that the non-systematic risk does not influence stock returns. While Y1 is not significantly different from zero which is inconsistent with the CAPM hypothesis.

Risk Anomaly Test

The Capital Asset Pricing Model (CAPM) has long served as a foundational tool in asset pricing, asserting that a security's expected return is directly linked to its systematic risk, which is quantified by beta. however, empirical data from various markets, including India’s stock market has questioned this core assertion. The "beta anomaly" highlights the discrepancy where low-beta stocks often outperform high-beta stocks when assessed on a risk-adjusted basis—contradicting the predictions made by CAPM. This anomaly prompts a question about the model's applicability in emerging markets such as India, where market inefficiencies and investor behavior may impact asset returns. This research aims to explore the existence and extent of the beta anomaly within the Indian context, thereby assessing the practical relevance of CAPM in explaining stock returns. The results of which have been displayed in table 6 given below:

Table 6: Results of Beta Anomaly Test

Statistical Properties /Portfolios	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
Average Returns	-0.00031	-0.00554	-0.00247	0.0001	0.006057	0.002582
Number of Months	36	36	36	36	36	36
Standard Deviation	0.055185	0.029625	0.025284	0.019458	0.029829	0.060303
Standard Error	0.009198	0.004938	0.004214	0.003243	0.004972	0.01005
T-Statistics	-0.03356	-1.12104	-0.58538	0.024915	1.21838	0.256936

Source: Date obtained from (CMIE)

The results of low volatility anomaly test are not supportive in Indian stock market that high beta portfolio gives higher return and low beta portfolio gives low returns at 5% level of significance with critical region of 2.030.

Summary of Findings and Conclusion

One of the first asset pricing models to be used in security valuation was the Capital Asset Pricing Model (CAPM) and it has received some criticism both empirical and theoretical because of its simplicity and intuitive appeal. Although, it has been emerged as a practical tool. We have examined the CAPM by using 3-year data on 150 equities traded in the NSE. Overall, our regression results indicate that the standard CAPM is unable to explain the relationship between risk and return in the Indian stock market.

According to the CAPM Hypotheses, the CAPM forecast for the intercept is that it should be equal to zero and insignificant. The average risk premium should be equal to the slope of SML. The results show that the aforementioned theory is false and provide proof that the CAPM's predictions for the years 2021 to 2023 were failed to explain the linear relationship between the stock's expected rate of return and its systematic risk. Additionally, the beta anomaly test demonstrates the existence of a low-risk anomaly in the Indian stock market.

Limitations of the study and Direction for future Research

The CAPM model accounts only for risk due to market factor while as some researchers argue that market factor is not alone to explain the expected returns and permits more variables than simply beta to influence securities' rate of return. Following this, there are now alternate asset pricing models that incorporate other risk factors like momentum, size etc.

In nutshell, the study findings suggest that the CAPM model is not fully capture the dynamics of the Indian stock market. Therefore, stakeholders in the financial markets should be caution, diversify their risk approaches, and consider other factors while making policy decisions in the Indian stock market.

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APPENDIX

TABLE 1: Beta Estimation period (2021 to 2023)

Stocks	Beta	Stocks	Beta	Stocks	Beta
1	0.288942	51	-1.61011	101	0.105327
2	0.9619	52	1.057762	102	-0.49734
3	-0.32922	53	-0.00853	103	1.291303
4	0.418361	54	-0.8855	104	-0.9593
5	0.003861	55	-0.51817	105	0.197406
6	-0.56956	56	0.460184	106	0.346509
7	0.383283	57	0.712878	107	-0.61765
8	-0.1713	58	0.051892	108	0.984604
9	0.230917	59	-0.18175	109	-0.87461
10	0.275693	60	-0.28282	110	0.151154
11	-1.07019	61	-0.15975	111	0.476568
12	1.503305	62	0.018648	112	-0.22125
13	-0.6526	63	-0.76395	113	0.645319
14	-0.73941	64	0.376814	114	-0.25773
15	0.285001	65	0.250855	115	-0.57845
16	-0.17108	66	0.401965	116	1.22254
17	1.361831	67	-0.55593	117	-0.96639
18	-0.70945	68	0.620135	118	0.241935
19	-0.6069	69	-0.673	119	-0.63993
20	0.694429	70	0.905386	120	-0.09945
21	-0.60468	71	0.437082	121	0.533098
22	1.02509	72	-0.4963	122	0.400165

23	-1.55074	73	0.002743	123	-0.54466
24	1.006835	74	0.154418	124	0.388473
25	1.055924	75	-0.79374	125	-0.62845
26	0.756284	76	0.282196	126	-1.1663
27	0.488729	77	0.476686	127	1.508793
28	-0.09092	78	-0.13425	128	-1.06316
29	-1.32396	79	-0.76167	129	-0.07543
30	0.49632	80	0.34644	130	0.578169
31	-0.67306	81	-0.28151	131	-0.814
32	0.354154	82	0.614269	132	0.670842
33	0.229497	83	0.704016	133	0.261619
34	-0.23385	84	0.2821	134	-0.53959
35	0.045026	85	-1.43153	135	0.347589
36	0.698606	86	0.183266	136	0.840528
37	-0.84388	87	0.612704	137	-1.5169
38	0.306512	88	-0.17122	138	-0.5538
39	0.579263	89	0.718166	139	0.896381
40	-0.21331	90	-0.99362	140	-0.47402
41	-0.81291	91	-0.71487	141	0.827488
42	0.306296	92	0.712789	142	-0.42503
43	0.062783	93	-0.95826	143	0.240691
44	-0.00313	94	1.841306	144	-0.04208
45	-0.33845	95	-0.42514	145	-0.35213
46	0.338259	96	-0.1267	146	0.230755
47	-0.3116	97	-0.01892	147	0.302081
48	0.107859	98	-0.36992	148	0.424956
49	-0.49716	99	-0.04883	149	-0.62495
50	0.135635	100	0.825974	150	0.579442