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VALIDITY OF CAPITAL ASSET PRICING METHOD IN INDIAN STOCK MARKET: BLACK, JENSEN AND SCHOLES AND FAMA AND MACBETH METHODS

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Abstract

A number of empirical studies have been conducted to test the validity of the Capital Asset Pricing Model (CAPM) since its origin. However, few have considered the Indian Stock Market. The purpose of this paper is to test the CAPM to see if it holds true in the Bombay Stock Exchange (BSE). The study uses monthly stock returns from 72 companies listed on the BSE during Nov, 2012 to Nov, 2017.Black, Jensen and Scholes (1972) and Fama and MacBeth methods were used to test the CAPM. We found that the excepted returns and betas are linear related with each other during the study period, which implies a strong support of the CAPM hypothesis. On the other hand, as the CAPM hypothesizes for the intercept, it should equal zero and the slope should equal to the average risk premium, the results from the test support the CAPM that Intercept term of the cross sectional regression is not significantly different from zero. However, the study refutes the CAPM by accepting the hypothesizes that the average excess returns on stocks are not significantly greater than zero and offer evidence against the CAPM. The results from study period show that non-systemic risk has no effect on the return.

Keywords:

CAPM;

Bombay Stock Exchange (BSE);

Beta;

t-tests;

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1. Introduction

Sharpe, Lintner and Mossin introduced the Capital Assets Pricing Model (CAPM) to the world. CAPM has remained one of the most challenging topics in financial economics and to be a major development of Capital theory. The CAPM predicts that the expected return on an asset is linearly related to systematic risk, which is measured by the asset's beta. Higher beta will yield higher return and lower beta will yield lower return. Many managers justify their decisions partly based on CAPM. CAPM predicts that only the systemic risk has the explanation power on the rate of return and non-systemic risk does not affect the portfolios' returns.

The study has been divided into sections. Section one introduces the general background of the topic and the purpose of this study. Section two introduces the literature review covering evidence in support of CAPM and against it. Section three introduces the research method. The methods of testing the CAPM are introduced as well. How the data and the sample were collected is also describe in this section. Section four focuses on applying the methods that the study mentioned in the research methodology to the empirical data, in order to find out whether the CAPM holds true. Section five focuses on summarizing the detailed outcome of the findings from the empirical analysis, and concludes the results from these findings.

1.2. Purpose of Study

The purpose of this paper is to examine whether the CAPM holds true in the stock market of India, i.e.:

1. Whether a higher/lower risk will yield higher/lower expected rate of return;
2. Whether the expected rate of return is linearly related with the stock beta, i.e. its systematic risk.
3. Whether the non-systemic risk affects the portfolios' returns. (CAPM predicts that only the systemic risk has the explanation power on the rate of return)

1.3. Hypotheses to be tested:

Following hypotheses have been put to empirical test in order to evaluate the robustness of CAPM in the context of India.

Hypothesis 1	$\gamma o=0$(Intercept) (Sharpe Lintner CAPM)	H01:Intercept term of the cross sectional regression is not significantly different from zero Ha1: Intercept term of the cross sectional regression is significantly different from zero
Hypothesis 2	$\gamma 1=(Rmt-Rft) > 0$ Positive expected return risk trade off	H02 : Average excess returns on stocks are not significantly greater than zero Ha2:Average excess returns on stocks are significantly greater than zero
Hypothesis 3	$\gamma 2=0$ (Linearity)	H03:Average coefficient of linearity(explained by βp) is not significantly different from zero Ha3:Average coefficient of linearity(explained by βp) is significantly different from zero
Hypothesis 4	$\gamma_3 =0$ (no systematic effect of non beta Risk)	H04:Average coefficient of the residual term of stocks is not significantly different from zero Ha4:Average coefficient of the residual term of stocks is significantly different from zero

2. Review of Literature

2.1. Evidence against the CAPM:

Mateev (2004)	The study used Fama and Macbeth cross sectional method tested the validity of the CAPM on the Bulgarian Stock Exchange (BSE). The study found that other than beta, other variables that had a significant role in explaining the Bulgarian stocks. The study concluded that traditional CAPM has failed to correctly and adequately describe the price behavior in the Bulgarian stock market.
Fama and French (2004)	They argue that several anomalies have been verified in most developed markets, and that even in studies that validate the model, the observed relationship between beta risk and return is too flat.
Nimal (2006)	The study rejects the linearity of the beta risk-return relation on the Taiwan Stock Exchange.
Yang & Xu(2006)	The study test the CAPM in the Shanghai Stock Exchange (SSE).They found that the excepted returns and betas are linear related with each other during the entire period of 2000.1.1 to 2005.12.31, which implies a strong support of the CAPM hypothesis. On the other hand, as the CAPM hypothesizes for the intercept, is it should equal zero and the slope should equal to the average risk premium. However, the results from the test refute the above hypothesizes and offer evidence against the CAPM. According to the findings of the empirical test, the study concludes that the Capital Asset Pricing Model does not give a valid description of the Chinese Stock Market during 2000.1.1 to 2005.12.31
Dzaja and Aljinovic (2013)	They found that they find that higher yields do not mean higher beta. The authors conclude that the CAPM beta alone is not a valid measure of risk.
Conrad et al. (2013)	The study found that there exists a positive relationship between kurtosis and subsequent returns and also concluded that negatively (positively) skewed stocks yield subsequent higher (lower) returns.
Hussain & Islam(2017)	They tested the validity of CAPM in India on the stocks listed on the National Stock Exchange by using Fama andMcBeth (1973) two step procedure. Our results show absence of any significant relationship between betas and risk premiums and therefore we conclude that CAPM is not a valid test in explaining the risk-return characteristics of assets listed on the National Stock Exchange over the sample period.

2.2. Evidence in favor of the CAPM:

Black et al(1972)	The authors found that the relation between the average rate of return and beta is very close to linear with each other and the portfolios with high/low betas have high/low average rate of returns.
Fama and McBeth (1973)	They found that there is a positive linear relationship between average return and beta.
Laubscher (2002)	The study concluded that there exists useful risk-return relationship on the Johannesburg Stock Exchange (JSE). However it is also reported that other factors may also be useful in explaining share returns.
Reddy and Thomson (2011)	They used regression analysis to test the CAPM on the JSE for the period from June 1995 to June 2009.They concluded that the CAPM could be rejected for certain periods, though the use of the CAPM for long-term actuarial modeling in the South African market can be reasonably justified.
Köseoğlu and Mercangoz (2013)	The study found linearity of the beta risk-return relation in Istanbul Stock Exchange. In addition, they find that the alpha constants from the estimated models are equal to the risk free rate.

3. Research Methodology

3.2. Sample Selection

The study covers the period from Nov, 2012 to Nov, 2017. The selection of stocks was made on the basis of market capitalization in order to cover top companies as per market capitalization as on 31st Nov, 2017 which has been in total 100 stocks. However due to unavailability of monthly data in certain stocks during the study period only 72 stocks fit our requirements. For the purpose of the study, 72 stocks top in terms of market capitalization were then selected from the pool of these 100 stocks.

3.3. Data Selection

The study uses monthly stock returns for the sampled 72 companies listed on the Bombay Stock Exchange for the period of Nov, 2012 to Nov, 2017. The data was obtained from Yahoo Finance. In order to obtain better estimates of the value of the beta coefficient, the study utilizes monthly stock returns. The reason the monthly returns were chosen is that returns calculated using a shorter time period (e.g. daily) might result in the use of very noisy data and thus incur inefficient estimation. The monthly return of the S&P BSE 500 Index is used as a proxy for the market portfolio. . S&P BSE 500 index represents nearly 93% of the total market capitalization on BSE. S&P BSE 500 covers all 20 major industries of the economy.Furthermore, in order to find the precise risk free asset, The implied yield on the month-end India 10-Year Bond Yield Historical Data has been used as a risk-free proxy. The data source for monthly adjusted closing process of stocks is www.in.finance.yahoo.com and for India 10-Year Bond Yield is www.in.investing.com. The formula for changing India 10-Year Bond Yield from an annual percentage rate to a monthly one is **Monthly rate = (1 + annual rate) (1/12) – 1**

3.4. Procedure of CAPM testing

Since the purpose of this study is to test the prediction of CAPM, we use the same method as Black et al in 1972. Due to the short observation period, we use the Initial Estimation Period to estimate the beta of the portfolios, and only use the Testing Period to compute the results (See Table 1). The first 48 months serve as the Portfolio formation and estimation period and the next 12 months constitute the model-testing period.

Table 1: Portfolio Formation, Estimation and Testing Periods

Portfolio formation period	Nov,2012-Nov,2015(36 months)
initial estimation period	Nov,2015-Nov,2016(12 months)
Testing period	Nov,2016-Nov,2017(12 months)
No. of securities	72

Black, Jensen and Scholes introduce a time series test of the CAPM. They estimated betas for the last year and used these in the grouping of the next year portfolios, in order to mitigate statistical errors from the beta estimation. The test is based on the time series regressions of excess stock return on excess market return, which can be express by the equation below:

$$Rit - Rft = \alpha i + \beta i (Rmt - Rft) + eit \quad (1)$$

Where:

Rit is the rate of return on asset i (or portfolio) at time t,

Rft is the risk-free rate at time t,

Rmt is the rate of return on the market portfolio at time t.

βi is the beta of stock i. [can be also express by Cov(Ri , Rm)/Var(Rm)]

eit is the is random disturbance term in the regression equation at time t.

Step 1

The first step was to estimate a beta coefficient for each stock using monthly returns corresponds to Portfolio Formation Period Nov,2012-Nov,2015(36 months). The beta was estimated by regressing each stock's monthly return against the market index according to the equation (1).

Based on the estimated betas we divided the 72 stocks into 10 portfolios; each comprised 7 stocks based on their betas except portfolio 8,9 and 10 which comprise 8 stocks each. The first portfolio—portfolio 1 has the 7 lowest betas and the last portfolio—portfolio 10 has the 8 highest betas. Combining securities into portfolios will diversifies away most of the firm-specific part of returns thereby enhancing the precision of the estimates of beta and the expected rate of return on the portfolios (Michailidis, 2006).

Step 2

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

$$rpt = \alpha p + \beta p\ rmt + ept \quad (2)$$

Where:

rpt is the average excess portfolio return at time t,

βp is the estimated portfolio beta.

ept is random disturbance term in the regression equation at time t.

Step 3

Estimation of the ex-post Security Market Line (SML): To test CAPM, Fama and MacBeth run a monthly cross-sectional regression of excess return of the portfolio on the estimated betas.

Therefore the third step is to estimate the ex-post Security Market Line (SML) for the Testing Period Nov, 2016-Nov, 2017(12 months) by regressing the portfolio returns against the portfolio betas. Here the study uses the estimated beta from the second step and estimate γ0, γ1;

$$rp = \gamma 0 + \gamma 1\ \beta p + e\ p \quad (3)$$

Where:

rp is the average excess return on a portfolio p,

βp is beta of portfolio p,

ep is the is random disturbance term in the regression equation.

If the CAPM is true, γ0 should be equal to zero and the slope of SML, γ1, is the market portfolio's average risk premium.

Step 4

Test for nonlinearity between total portfolio returns and betas:

To test for nonlinearity between total portfolio returns and betas the study using the following equation:

$$rp = \gamma 0 + \gamma 1\ \beta p + \gamma 2\ \beta^2 p + ep \quad (4)$$

If the CAPM hypothesis is true; i.e., portfolios' returns and its betas are linear related with each other, γ2 should be equal to zero.

Step 5

Finally, we examine whether the expected excess return on securities are determined only by systematic risk and are independent of the nonsystematic risk, as measured by the residuals variance;

$$rp = \gamma 0 + \gamma 1\ \beta p + \gamma 2\ \beta^2 p + \gamma 3\ \delta^2(ep) + ep \quad (5)$$

Where:

γ2 measures the potential nonlinearity of the return,

γ3 measures the explanatory power of non-systemic risk.

$\delta^2(ep)$ measures the residual variance of portfolio return.

If the CAPM hypothesis is true, γ3 should be equal to zero.

3.5. t-test

In order to statistically test the CAPM, t-tests has been used. The level of significance of 95% has been chosen, which means, that a significant result at the 95% probability level tells us that our data are good enough to support a conclusion with 95% confidence. Hence, there is also a 5% chance of being wrong. The 95% critical value from the t-distribution is 1.96. Thus we will use 1.96 in a later analysis in order to verify the precision of the estimation results. If the "t" values are less than 1.96 our hypothesis holds i.e. the intercept is significantly equal to zero. If they are greater than 1.96, then the hypothesis does not hold and the model is rejected in the BSE.

4. Empirical Analysis

4.1 Beta Estimation utilizing the equation (1)

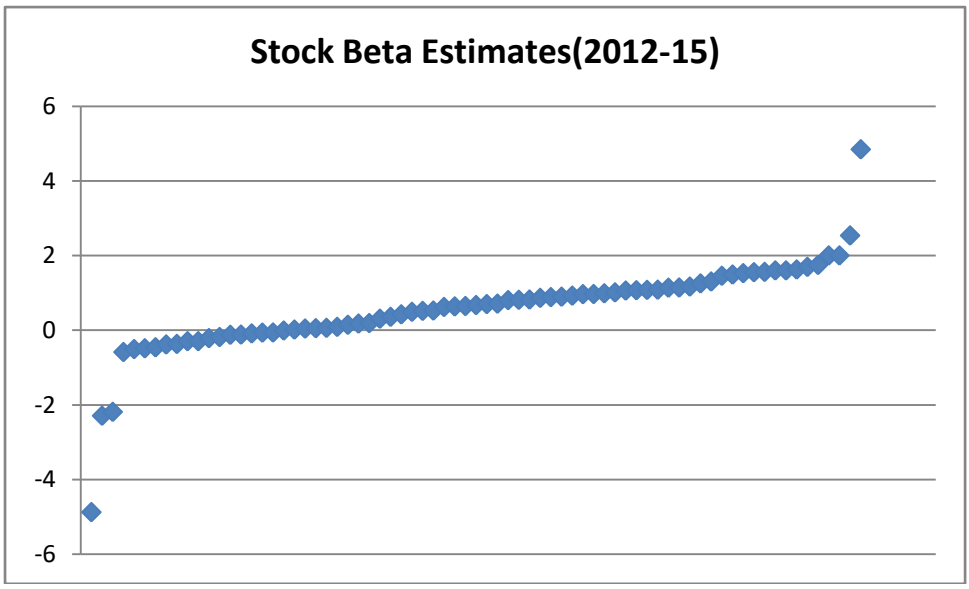
The betas of the 72 stocks arranged in ascending order are listed below along with portfolio formation:

Table2: Estimated Stock Betas and Portfolio Formation(2012-15)

Stock	Beta	Portfolio No.	Stock	Beta	Portfolio No.	Stock	Beta	Portfolio No.
Bajaj Finance	-4.87	1	Tech Mahindra	-0.380	2	PNB	-0.116	3
Yes Bank	-2.29	1	TCS	-0.366	2	Cipla	-0.085	3
JSW Steel	-2.18	1	DLF	-0.293	2	Infosys	-0.064	3
Sun TV Network	-0.58	1	Zee Entertain	-0.292	2	ACC	-0.060	3
Idea Cellular	-0.50	1	Siemens	-0.210	2	ITC	-0.008	3
Bosch	-0.48	1	HCL Tech	-0.182	2	United Spirits	0.019	3
Oracle Fin Serv	-0.46	1	Bank of Baroda	-0.121	2	Pidilite Ind	0.045	3
Sun Pharma	0.05	4	Shree Cements	0.360	5	NMDC	0.649	6
Bajaj Holdings	0.06	4	Ashok Leyland	0.426	5	Vakrangee	0.675	6
IndusInd Bank	0.09	4	SAIL	0.494	5	Bajaj Finserv	0.701	6
Ambuja Cements	0.15	4	Aurobindo Pharm	0.519	5	TVS Motor	0.712	6
Godrej Consumer	0.18	4	HUL	0.527	5	IOC	0.806	6
Piramal Enter	0.19	4	UPL	0.623	5	Nestle	0.815	6
Hindalco	0.31	4	GAIL	0.638	5	BHEL	0.823	6
			Marico	1.014	8	Petronet LNG	1.254	9
M&M	0.87	7	HDFC	1.062	8	Eicher Motors	1.306	9
Bharti Airtel	0.89	7	Adani Ports	1.071	8	BPCL	1.458	9
Hero Motocorp	0.90	7	Motherson Sumi	1.080	8	Grasim	1.491	9
Hind Zinc	0.93	7	Asian Paints	1.085	8	SBI	1.528	9

Kotak Mahindra	0.97	7	HDFC Bank	1.139	8	Coal India	1.554	9
Bharti Infratel	0.97	7	Container Corp	1.144	8	Larsen	1.562	9
Power Grid Corp	0.99	7	NTPC	1.169	8	UltraTech Cement	1.602	9
Maruti Suzuki	1.60	10	General Insuran	2.00	10			
ONGC	1.63	10	Power Finance	2.54	10			
ICICI Bank	1.70	10	Cadila Health	4.85	10			
Reliance	1.75	10						
Axis Bank	2.00	10						

Figure 1: Stock Beta Estimates



The range of the estimated stock betas is between -4.87, the minimum, and 4.85, the maximum, in period Nov, 2012-Nov, 2015(36 months) (Figure 1). The 72 stocks are divided into 10 portfolios based on their betas estimates according to chapter 3.4.

4.2. Average excess portfolios' returns and beta using equation (2)

The results are shown in Table 2 below.

Table 3: Average excess portfolio returns and betas (Nov, 2015-Nov, 2016(12 months))

Year 2015-2016	rp	βp
Portfolio 1	0.012478	0.627804
Portfolio 2	-0.0043	0.475597
Portfolio 3	-0.00725	0.568322
Portfolio 4	0.019292	0.506825
Portfolio 5	0.007612	0.108977
Portfolio 6	0.02096	0.584059
Portfolio 7	0.004719	0.615152

Portfolio 8	0.003739	1.007929
Portfolio 9	0.015197	0.969644
Portfolio10	0.007267	1.088214

4.3. Estimation of the SML (Equation 3)

Table 4: Statistics of the estimation of the SML (Nov, 2016-Nov, 2017(12 months))

	Coefficients	Standard Error	t Stat	P-value
γ0	0.034086	0.027418	1.243204	0.24899
γ1	-0.00737	0.038499	-0.19153	0.85288

The results from the estimation of the SML are shown in Table 3 above. The t-tests accept the null hypothesis because the absolute t-value (1.243204) of concerning the intercept, γ0, is less than 1.96. This means that γ0 is statistically insignificant, i.e., insignificant different from zero. Hence, the result is consistent with the CAPM hypothesis. The t-tests reject the null hypothesis concerning the slope because the absolute t-value (1.24431) is smaller than 1.96. This means γ1 is not significantly different from zero. The CAPM predicts, that γ1 should be equal to the average risk premium, which should be greater than zero. Thereby, the result is inconsistent with the CAPM hypothesis. Thus, the CAPM has mixed results for the study period.

4.4. Test for Non-linearity Equation (4)

Table 4: Testing the non-linearity Nov, 2016-Nov, 2017(12 months)

	Coefficients	Standard Error	t Stat	P-value
γ0	0.00293	0.048088	0.060932	0.953117
γ1	0.111707	0.154367	0.723643	0.492752
γ2	-0.09241	0.11583	-0.79784	0.451175

The estimation results from Table 4 show that:

1. The value of the intercept, γ0, is not significantly different from zero, since the absolute t-value (0.060932) is smaller than 1.96, which is consistent with the CAPM hypothesis.
2. The t-test concerning γ1 do not reject this null hypothesis because the absolute t-value (0.723643) is smaller than 1.96. Hence, it is not significantly different from zero. Since the CAPM predicts that, γ1 should be equal to the average risk premium. The result is inconsistent with the CAPM hypothesis.
3. The value of γ2 is not significantly different from zero since the absolute t-value (-0.79784) is smaller than 1.96, which is consistent with the CAPM hypothesis. Since γ2 is not significantly different from zero, this indicates that the expected rate of returns and betas are linearly related with each other. Thus, CAPM cannot clearly be rejected.

4.5. Test of the Non-Systematic risk (Equation 5)

Table 5: Test the non-systematic risk (Year 2016-17)

	Coefficients	Standard Error	t Stat	P-value
γ0	-0.01308	0.081514	-0.16041	0.877825
γ1	0.118973	0.168299	0.706914	0.506133
γ2	-0.09452	0.124722	-0.75789	0.477221
γ 3	2.003983	7.894316	0.253851	0.808085

If the CAPM is valid, γ0, γ2 and γ3 should be equal to zero; while γ1 should be equal to the average risk premium.

The estimation results are shown in Table 5 indicate that:

1. The value of the intercept, γ0, is not significantly different from zero because the absolute t-value (-0.16041) is smaller than 1.96. This is consistent with the CAPM hypothesis.
2. The t-tests concerning γ1 do not reject the null hypothesis since the absolute t-value (0.706914) of γ1 is smaller than 1.96. This means γ1 is not significantly different from zero, which is inconsistent with the CAPM hypothesis.
3. The value of γ2 is not significantly different from zero because the absolute t-value (-0.75789) is smaller than 1.96. This is consistent with the CAPM hypothesis.
4. Because γ3 is not significant different from zero, we can conclude that the non-systemic risk has no effect on the portfolios' returns, which is consistentwith the CAPM hypothesis, i.e. the non-systemic risk is not important for portfolios' returns.

5. Conclusion

The results from study period show the value of the intercept, γ0, is not significantly different from zero, a linear relationship between portfolios' expected returns and its betas. And that non-systemic risk has no effect on the return. The CAPM hypothesis is, however, rejected when considering estimates of the SML, since higher/lower risk does not yield higher/lower rate of return. Thus, we conclude that CAPM is not fully valid in study period.

6. Refernces

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