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THE CAPITAL ASSET PRICING MODEL: AN EMPIRICAL TEST ON INDIAN STOCK MARKET

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Abstract

In this paper, the Capital Asset Pricing Model (CAPM) has been applied to the Indian Stock Market using monthly stock returns from 50 companies listed on the Bombay stock exchange (BSE) from October 2012 to October, 2017.Individual securities have been combined into portfolios so that the precision of the beta estimates can be enhanced. The BSE-200 share index is used as a proxy for the market portfolio. India Govt Bond Generic Bid Yield 10 Year rate is used as the proxy for the risk-free asset. The results validate the CAPM's predictions that higher risk (beta) is associated with a higher level of return. However the study contradicts that the intercept should be equal to zero when estimating SML. This in effect, gives mixed response to the application of CAPM as far as India is concerned.

Keywords:
CAPM;
Average Portfolio Excess Returns;
Bombay Stock Exchange;
Beta;
Risk-free rate;
Stocks;

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1. Introduction

The reforms in the working of Indian Stock Markets and sometimes huge returns from this market have attracted the attention of investors and financial researchers around the world in recent times. Researchers, professionals and other knowledgeable stakeholders worldwide are applying many models and approaches in the formation of portfolios.The capital asset pricing model (CAPM), which symbolizes the beginning of asset pricing theory is still used extensively for portfolio formation.This study examines the validity or otherwise of the propositions of the CAPM in the Indian stock market for the period of five years viz.from 2012-2017.This paper is divided into five sections. After this introductory section, under literature review,the theoretical and empirical studies relating to CAPM have been covered in section 2. Thereafter in section 3, the research methodology employed to apply CAPM on Indian Stock Markets is stated. Moreover, empirical results and findings of this study are presented in section 4 while section 5 concludes the study.

2. Theoretical framework and Literature Review

2.1. Theoretical Framework

The Capital Asset Pricing Model (CAPM) of William Sharpe (1964) and John Lintner (1965) is an integral part of the development of the modern capital market theory. It helps in the pricing of risky securities under conditions of uncertainty by establishing the relationship between risk and expected return. The CAPM is widely used in performance evaluation of managed portfolios and is also used for estimating the cost of capital for firms. It gives importance to two important variables viz. Beta and Risk Premium to calculate the expected return of a security. According to this model the expected return on a security is equal to risk free return plus a risk premium multiplied by the risk factor (βi_m) for the individual company .

The CAPM equation is given as:

$$E(Ri) = Rf + [E(Rm) - Rf)]\ \beta_i,\ i=1,\ldots,N. \qquad (2.1)$$

Where

E(Ri)=Expected return on security i.

Rf =Riskfree interest rate,

E(Rm)=Expected Return on the market

β_i =Asset's Market Beta viz. Measure of risk of security *i*

[E(Rm) - Rf)]=Market premium

Investors calculating the required rate of return of a share will only consider systematic risk to be relevant. Equation one (2.1) shows that the expected return on security *i* is a linear combination of the risk-free return and the return on portfolio *M*. The coefficient Beta β_i measures the sensitivity of security's returns to market return. This equation, describing the expected returns for security *i* is referred to as the Security Market Line (SML) and is sometimes called the Capital Asset Pricing Model (CAPM) equation.

In the SML equation, expected returns are linear and the coefficient beta is:

$$\beta i = \frac{\text{COV (Ri,Rm)}}{\sigma^2(\text{Rm})}$$

Where;

$COV(Ri, Rm)$=Covariance of Security i return with the market return.

$\sigma^2(Rm)$= Variance of the market return.

The CAPM model is simple mechanism for investors to evaluate the securities by making a comparison between expected return and required return.Using the expected return for a security derived from the CAPM, an investor can determine whether a security is undervalued, overvalued or properly valued.

- If the expected return using the CAPM is higher than the investor's required return, the security is undervalued and the investor should buy it.
- If the expected return using the CAPM is lower than the investor's required return, the security is overvalued, it is necessary to abort intentions for potential investment in the particular security should be sold.

2.1.1. Assumptions of the Theory

The CAPM is associated with certain assumptions that make this world simplified and natural. The complexities in the real world are assumed to have only a little or no effect. The major assumptions of the CAPM are:

- All investors operate on a common single-period planning horizon. Therefore the model is a one-period model.

- All investors select from alternative investment opportunities by considering expected return and risk.
- All investors are rational and risk-averse who aim to maximize the expected utility from their wealth.
- All investors can borrow or lend unlimited amounts at a at the risk free rate.
- There are no market imperfections such as taxes, regulations, or transaction costs. Information is costless and simultaneously available to all investors
- All investors are price –takers viz, that is, no investor by the scale of his transactions can influence the market price
- All investors have homogenous expectations about securities returns.
- All expected returns have a normal distribution.
- All securities are marketable and perfectly divisible.

2.1.2 Implications of CAPM:

1. Share that exhibit high levels of systematic risk are expected to yield a higher rate of return.
2. On average there is a linear relationship between systematic risk and return, securities that are correctly priced should plot on the SML

2.2. Empirical review

Considerable research has been conducted to test the validity of the CAPM. Some of these findings provide evidence in support of the Capital Asset Pricing Model while others have challenged the validity of the model.

Supporters of CAPM	
Black, Jensen, and Scholes (1972)	In their studies, Black, Jensen and Scholes established a linear relationship between higher risk (beta) and higher level of return. They used the equally-weighted portfolio of all stocks traded on the New York Stock Exchange (NYSE).They calculated the relationship between the average monthly return on the portfolios and the betas of the portfolios between 1926 and 1966, a period

	of forty years. The findings from their study provided a remarkable tight relationship between beta and the monthly return.Howevre, the intercept appeared to be significantly different and greater then the average risk-free rate of return over the period studied.
Fama and MacBeth (1973)	Another supporter of the CAPM is Fama and MacBeth study (1973). They evaluated stocks traded on NYSE with similar period as that of Black, Jensen and Scholes' study. They regressed the result after estimating betas and historical average returns and obtained the following regressions: $r_p = \alpha_0 + \alpha_1\beta_p + \alpha_2\beta^2 + \varepsilon_p$ $r_p = \alpha_0 + \alpha_1\beta_p + \alpha_2\beta^2 + \alpha_0 RV_p + \varepsilon_p$ RV = Average of residual variance The logic of the test is that, given the SML equation holds as predicted by CAPM then, • α_0 should be equivalent to the average risk-free interest rate, • α_1 should be equivalent to the "excess return on the market and •α_2 and $\alpha_3$should be equivalent to zero. Fama & MacBeth performed a significance test and concluded that α_2 and α_3 were not significantly different from zero which serves as an evidence and support to the CAPM theory.
Challengers of CAPM	
Merton (1973)	One of Merton's key results is that the static CAPM does not in general hold in a dynamic setting and "that the equilibrium relationships among expected returns specified by the classical Capital Asset Pricing Model will obtain only under very special additional assumptions". In particular, Merton demonstrates that an agent's welfare at any point in time is not only a function of his own wealth, but also the state of the economy. If the economy is doing well then the agent's welfare will be greater

	than if it is doing badly, even if the level of wealth is the same. Thus the demand for risky assets will be made up not only of the mean variance component, as in the static portfolio optimization problem of Markowitz (1952), but also of a demand to hedge adverse shocks to the investment
Fama and French (1992)	Fama and French concluded that firm size and other accounting ratios are better predictors of observed returns than beta.
Kushankur Dey & Debasish Maitra(2009)	Multifactor CAPM is better to capture variation of the investors the required rate of return and is more robust than the two - factor CAPM.
KapilChoudhary, S. C. (2010)	They examined CAPM for the Indian Stock market using monthly stock returns from companies of BSE 500 index for the period of January 1996 to December 2009.It is found that higher beta is not associated with higher level of returns. The finding of the study contradicts with the hypothesis of CAPM. The study concluded that beta is not sufficient to determine the expected returns of securities
Jecheche, Petros *(2011)*	Monthly stock returns for twenty (28) firms listed on the Zimbabwe Stock Exchange were used. The data ranged from January 2003 to December 2008, a period of six years. The data did not provide evidence that higher beta yields higher return while the slope of the security market line is negative and downward sloping. The data also provide a difference between average risk free rate, risk premium and their estimated values. However, a linear relationship between beta and return is established.
JosipaDzaja, Z. A. (2013)	The study examined CAPM model applicability on Central and South- East Europeon emerging security markets using monthly stock returns for nine cries for the period of January 2006 to December 2010. The study showed that CAPM is not adequate

	for accessing the capital assets on observed stock markets. The study showed that higher beta do not mean higher return. The study further concluded that the stock market returns do not lie on the efficient frontier so they do not represent efficient portfolios.
Oke, B. O(2013)	In this paper the Capital Asset Pricing Model (CAPM) is applied to the Nigerian stock market using weekly stock returns from 110 companies listed on the Nigerian stock exchange (NSE) from January 2007 to February 2010. In order to enhance the precision of the beta estimates and reduce the statistical problems that arise from measurement errors in individual beta estimates, the securities were combined into portfolios. The results generally invalidate the CAPM's predictions that higher risk (beta) is associated with a higher level of return and that the intercept should be equal to zero when estimating SML. The claim by the CAPM that the slope of the Security Market Line (SML) should equal the excess return on the market portfolio is also not supported by this study. This in effect, invalidates the prediction of the CAPM as far as Nigeria is concerned.

3. Methodology

3.1. Aim of the study

Aim of this paper is to study if the CAPM holds on the Indian Stock Exchange, meaning:

1. If higher beta yields higher expected return
2. If the intercept equals zero/average risk-free rate

3.2. Sample and Data Selection

The study uses returns from 50 stocks quoted on the Bombay Stock Exchange (BSE) for the period of October 2012 to October 2017and they are included in the formation of the portfolios. All securities included in the indices are traded on the NSE on a continuous basis throughout the full NSE trading day. Each series consists of 60 observations of the monthly adjusted closing

prices. The data was obtained from Yahoo Finance database. In order to obtain better estimates of the value of the beta coefficient, the study used monthly stock returns instead of yearly. Returns calculated using a longer time period (e.g. annually) might introduce biases in beta estimates. On the other hand, high frequency data such as daily observations covering a relatively short and stable time span can result in the use of very noisy data and thus yield inefficient estimates. The BSE-200 share index is used as a proxy for the market portfolio. This index reflects general trends of the Indian stock market. India Govt Bond Generic Bid Yield 10 Year rate is used as the proxy for the risk-free asset. The yields were obtained from the website "*www.bloomberg.com*". In order to calculate monthly yields on India Govt Bond Generic Bid 10 Year, the yearly yield is divided by 1200.

3.3. Estimation Procedure

3.3.1 Returns Calculation:

Since the data collected were the adjusted closing prices of the stocks, they were converted to returns using the following equation:

$$Rt = \frac{P_t - P_{t-1}}{P_{t-1}}$$

Where:

P_t= price of the asset at time t

P_{t-1}= price of the asset at time t-1

3.3.2 Beta and Intercept Estimation:

The starting point is the estimation of a beta coefficient and intercept for each stock using monthly returns during the estimation period. The study estimates the beta coefficient and intercept for each stock by regressing each stock's monthly return against the market index according to the following equation:

$$R_{it} - R_{ft} = \alpha i + \beta i(R_{mt} - R_{ft}) + \varepsilon_i \qquad (3.1)$$

Where:

R_{it} = return on security i (i= 1 . . . 50)

R_{ft} = rate of return on risk-free security

R_{mt} = the rate of return on market index,

β_i = the estimate of beta for the security i, and

εi = the corresponding random disturbance term in the regression equation

$R_{it} - R_{ft}$= excess return of stock i (i = 1 . . . 50)

R_{mt} - Rft =average risk premium

3.3.3 Portfolio Formation

Thereafter 5 equally-weighted portfolios containing 10 stocks each have been formed. The equally weighted average portfolios are created according to low-high beta criteria. Portfolio one contains a set of securities with the low betas while the last portfolio contains a set of high beta securities. Although portfolios could be formed through ranking of stocks using the true beta, what is however available is the estimated beta as per equation (3.1).However, it is generally accepted that the estimated betas using the regression analysis are biased estimates of the underlying beta of a firm's securities due to some statistical reasons. The underlying beta is likely to be closer to 1 than the sample estimate. In order to make corrections for this bias, present study has adopted the technique developed by Merrill Lynch. After using ordinary least squares equation (3.1) to gain a preliminary estimate of beta, using 60 monthly returns, the company then adjusts beta as follows:

Adjusted beta = 2/3 sample Beta + 1/3 (1) or Raw Beta (0.67) + 1(0.33). (3.3)

This formula gives 2/3 weightage to estimated beta and hence pushes high betas down towards 1.0 and low betas up towards 1.0. Using this technique, the revised estimates are shown under the column "adjusted Beta" in the table. Note that the revised estimates have been pulled closer to the market average of 1.0.

3.3.4. Calculation of average portfolio excess returns of stocks

Thereafter, the average portfolio excess return of stocks (r_{pt}) is computed by following formula:

$$r_{pt} = \frac{\sum_{i=1}^{k} r_{it}}{k}$$

k = the number of stocks included in each portfolio (k =1…10),

p = the number of portfolios (p=1…5),

r_{it} = is the excess return on stocks that form each portfolio comprised of k stocks each.

Using this formula, we obtain 5equally-weighted portfolios containing 10 stocks each.

3.3.5. Calculation of portfolio beta

We further employ the following equation to estimate portfolio betas and alphas:

$$rpt = \alpha p + \beta prmt + \varepsilon pt \quad (3.2)$$

Where:

rpt = the average excess portfolio return,

βp = the calculated portfolio beta.

rmt = Rmt – Rft

3.3.6. Portfolio Ranking

Thereafter portfolios are ordered according to their beta coefficient obtained by Equation 3.2. They are also ordered according to their average portfolio excess returns of stocks.

3.3.7. Estimation of SML

Lastly, the study estimates the ex-post Security Market Line (SML) by regressing the portfolio returns against the portfolio betas obtained by Equation 3.4. The relation examined is the following:

$$rp = \lambda 0 + \lambda 1\ \beta p\ . + \varepsilon pt \quad (3.3)$$

where:

rp = the average excess return on a portfolio p (the difference between the return on the portfolio and the return

on a risk-free asset),

βp = an estimate of beta of the portfolio p ,

λ1 = the market price of risk, the risk premium for bearing one unit of beta risk,

λ0 = the zero-beta rate, the expected return on an asset which has a beta of zero, and

εp = random disturbance term in the regression equation.

Company	α	β		α	β		α	β
Reliance	0.03	0.61	Tata Motors	0.00	1.39	GAIL	0.01	0.92
TCS	0.16	0.16	Wipro	0.02	-0.09	Grasim	0.01	1.32
HDFC Bank	0.03	1.08	Hind Zinc	0.01	0.73	Nestle	0.00	0.89
ITC	0.01	0.35	Axis Bank	0.00	1.71	Hero Motocorp	0.00	0.85
SBI	0.00	1.84	Sun Pharma	0.00	0.09	Motherson Sumi	0.02	1.28
HUL	0.01	0.51	HCL Tech	0.02	-0.10	Titan Company	0.01	1.22
HDFC	0.02	1.06	Vedanta	0.01	1.43	Bharti Infratel	0.01	0.84
Maruti Suzuki	0.02	1.58	UltraTechCement	0.00	1.50	Tata Steel	0.00	1.15
ONGC	0.00	1.40	Asian Paints	0.01	1.03	Godrej Consumer	0.03	0.55
Infosys	0.01	0.15	BPCL	0.07	1.55	JSW Steel	0.02	1.03
ICICI Bank	0.00	1.78	Power Grid Corp	0.00	0.86	Shree Cements	0.01	1.52
Bharti Airtel	0.00	0.96	Bajaj Finance	0.04	1.07	Bharat Elec	0.05	2.20
Kotak Mahindra	0.01	0.99	IndusInd Bank	0.01	1.48	Dabur India	0.00	1.40
IOC	0.03	0.93	M&M	0.00	0.76	Bosch	0.01	0.57
Larsen	0.01	1.16	Adani Ports	0.01	1.41	hindalco	0.00	1.55
Coal India	-0.01	1.04	Eicher Motors	0.03	0.90	britannia	0.03	0.59
NTPC	0.00	1.02	Bajaj Finserv	0.02	1.00			

4. Results:

Table 4.1. Stock Beta (β) and intercept (α) Coefficient Estimates (Equation 3.1)

Table4.2. Portfolio Construction on Basis of Adjusted Beta (arranged in order of Low-High)

Portfolio Construction on Basis of Adjusted Beta					
Portfolio A			Portfolio B		
Company	Adjusted Beta	Average Excess Returns	Company	Adjusted Beta	Average Excess Returns
HCL Tech	0.2619	1.5098%	Reliance	0.7326	1.1975%
Wipro	0.272383	2.1411%	Hind Zinc	0.809615406	1.2425%
Sun Pharma	0.386474	0.3919%	M&M	0.830177561	0.2960%
Infosys	0.426594	0.9985%	Bharti Infratel	0.884109619	1.0448%
TCS	0.437043	1.0017%	Hero Motocorp	0.891	0.9247%
ITC	0.559115	0.9207%	Power Grid Corp	0.896444416	0.6988%
HUL	0.668329	1.1903%	Nestle	0.918007987	0.3809%
Godrej Consumer	0.690185	3.3617%	Eicher Motors	0.92285847	3.8324%
Bosch	0.707833	1.0022%	GAIL	0.938266855	1.1300%
britannia	0.72199	3.6080%	IOC	0.944719434	3.8040%
Average	0.513185	1.6126%		0.876779975	1.45514%
Portfolio C			Portfolio D		
Bharti Airtel	0.961836	0.005066627	Tata Steel	1.090473934	0.010452049
Kotak Mahindra	0.984925	1.4915%	Larsen	1.094343865	1.8870%
Bajaj Finserv	0.991265	2.7515%	Titan Company	1.1352	1.6569%
NTPC	1.003357	0.1407%	Motherson Sumi	1.1748	3.1303%
JSW Steel	1.010262	2.6593%	Grasim	1.2012	1.2242%
Asian Paints	1.012925	1.4877%	Tata Motors	1.246416569	0.3822%
Coal India	1.015542	-0.1368%	ONGC	1.251138194	0.9644%
HDFC	1.0296	1.5752%	Dabur India	1.253996395	1.1852%
Bajaj Finance	1.0362	4.8494%	Adani Ports	1.262125258	1.6963%
HDFC Bank	1.043944	1.2619%	Vedanta	1.272877297	1.3793%

Average	1.008986	1.6587%	Average	1.198257151	1.45510%
Portfolio E					
IndusInd Bank	1.308112	0.02057488			
UltraTechCement	1.317468	0.9944%			
Shree Cements	1.332664	1.8964%			
BPCL	1.350564	7.8887%			
hindalco	1.351479	1.2886%			
Maruti Suzuki	1.37329	2.7579%			
Axis Bank	1.4586	1.3327%			
ICICI Bank	1.507613	1.1047%			
SBI	1.543683	0.5573%			
Bharat Elec	1.78484	6.2236%			
Average	1.432831	2.610180%			

Table 4.3. Statistics of the Estimation of the SML (equation 3.3)

Coefficient	**ALPHA (λ0)**	**BETA (λ1)**
Value	**.0212**	**.0068**
t-value	**2.245647**	**1.595024**
p-value	**0.110382**	**0.208973**
R^2 =.45884 **Adjusted R^2 =.278512** **F-Statistics:2.544101,Significance F:.208972795**		

Table4.4. Ranking of Portfolios on basis of Average Excess Portfolio Returns and Betas

Portfolio	Portfolio Beta	Ranking as per adjusted beta	Average Excess Returns	Ranking as per Average Excess Returns
A	0.71	5	1.61261%	3
B	1.69	4	1.45514%	4
C	₹ 2.06	3	1.65869%	2
D	2.47	2	1.45510%	5
E	3.34	1	2.61018%	1

5. Interpretation:

1. The results generally validate the CAPM's predictions that higher risk (beta) is associated with a higher level of return. The range of the estimated stock betas is 2.1 between the minimum -(0.1)and the maximum of (2.20) (See Table 4.1). The CAPM indicates that higher risk (beta) is associated with a higher level of return. This, however, is supported by the results of this study in majority of the portfolios. The portfolio E with highest Beta (1.432831) has highest returns (2.61018%). The portfolio with the second highest returns (portfolio C) has the third highest beta while the portfolio with the fourth highest returns (portfolio B) has the fourth highest beta.(See table 4.2). However, portfolio 2 does not support CAPM. We can conclude here that there exists a positive relationship between beta and share return as majority of portfolios support the CAPM hypothesis.

2. Since the CAPM indicates that the intercept is zero for every asset, an intercept is therefore added in the estimation of the SML to ascertain whether the CAPM holds true or not. The hypothesis presented by CAPM is that the value of ALPHA (λ0) after regression should be equivalent to zero. The null hypothesis that the intercept λ0 is zero, is rejected at 5% level of significance since the t-value is greater than 2.132 which is a contradiction to the theory of CAPM.

3. Therefore there are mixed responses to CAPM in Indian stock market.

6. Conclusion

The study concludes mixed responses to the applications of CAPM in Indian Stock Market. The study started with the aim of holding CAPM on Indian Stock Market viz. to test whether higher beta yields higher expected return and the intercept equals zero. The results generally validate the CAPM's predictions that higher risk (beta) is associated with a higher level of return. The hypothesis that the intercept λ0 is zero, is rejected at 5% level of significance since the t-value is greater than 2.132 which is a contradiction to the theory of CAPM.

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