Is CAPM Still Valid in Today's Market Scenario?

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Abstract

The current study examined the CAPM's applicability in the Indian capital market. The study collected weekly closing price data of 48 companies listed on the NSE Nifty 50 index for 10 years, from April 2011 to March 2021. The five portfolios were formed by taking 10 stocks for each portfolio except the last portfolio, which had eight stocks starting from the highest beta securities to the lowest beta security. Rolling regression methodology was applied where the sample data was divided into 3 years, which kept moving for a quarter. A constrained model proposed by Bajpai and Sharma (2015) was tested, and a comparison was made between the constrained model and the conventional model. In the Indian capital market, CAPM is found to be very important, and the constrained model in this study outperformed the conventional model.

Keywords : **CAPM, stock, NSE, beta**

JEL Classification Codes : G10, G11, G12

Paper Submission Date : June 10, 2021 ; Paper sent back for Revision : April 23, 2022 ; Paper Acceptance Date : April 30, 2022; Paper Published Online : May 15, 2022

In the financial literature, asset pricing plays a vital role in explaining the relationship between risk and risk-premium of a particular asset. During the initial period of the discipline, it was concerned with only the valuation of individual securities and the market environment. But in today's scenario, the subject covers the broader aspects of asset valuation. The capital asset pricing model (CAPM) is considered a pioneer model in asset pricing. It is considered the most popular and fundamentally strong model for asset pricing. The model is commonly used by portfolio managers and investors to assess the risk of investment and the estimated return of the securities (Jagannathan & Wang, 1993). According to the model, there is a variable that can explain the yield of an asset and the risk involved in it, which is the market (or systematic) risk. The market risk or systematic risk is also known as the 'beta' (β) of an asset that cannot be diversified or reduced. The requirement of only one variable in the model is one of the reasons for the model's popularity among the investors and researchers as a single variable model. An investor can use the model to identify the right asset for his/her portfolio. The model analyzes the asset's current value with the help of historical data of the asset and tries to evaluate whether it is under-priced or over-priced.

The model was introduced by William Sharpe (1964) and John Linter (1965). They developed the model based on the work of Harry Markowitz (1959), who introduced the model of portfolio choice or 'mean-variance model.' It was developed in the early 1960s; since then, the model has been used for the valuation of an asset. The model is used to measure an asset's theoretically acceptable necessary rate of return, and therefore, the price can be

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DOI : https://doi.org/10.17010/ijf/2022/v16i5/169518

estimated if firms can forecast the expected cash flows. During the initial period of the model, many academicians found the validity of the model, but later on, many questioned the validity of the model, and so, many other models emerged, which were performing better than the single-factor model. As the model considers only one factor, that is, beta, many academicians observed that the lone factor fails to elaborate the risk-return of an asset. There may be many other factors that may impact the return of an asset and explain the relationship between risk-return better.

Basu (1977) confirmed the earnings-price (E/P) ratio as an explanatory variable for a risky assets' risk premium. Banz (1981) reported the effect of firm size and market capitalization on the stock returns. Bhandari (1988) confirmed the debt-to-equity (D/E) ratio as an important factor explaining the stock's risk premium. Other critical studies conducted by Fama and French (1992, 1993, and 1995) found the size and the P/B (price-to-book) ratio to be two significant variables that can elaborate on the risk premium relationship. They completely declined β as the only variable that can describe a risky asset's risk premium. So, while explaining the risk-return relationship of assets, factors such as size and value also need to be considered. Despite criticism of CAPM, the model has been used widely by researchers, portfolio managers, investment firms, financial experts, etc., around the world, with β as a measure of the performance of assets. This contradiction found in the financial literature motivated us to explore the model and test its validity in the Indian capital market. Understanding the security prices and behavior of the assets is important as it would enable the investors to take appropriate and intelligent investment decisions. The current study intends to answer the following question: Is CAPM still a valid model in the current market conditions? What is the impact of risk variables (β) on security returns?

To answer the above research question, the study analyzes the validity of CAPM in the current market conditions by taking the most recent 10 years data from NSE-listed selected companies. The present study used the study of Bajpai and Sharma (2015), who proposed a new constraint model without intercept term, which performed better than the traditional model. The new constraint model is not tested by any other researchers not only in India but also in other parts of the world.

Review of Literature

Several researchers around the world have already carried out relevant studies in various countries' capital markets with regard to the literature concerning the empirical test of CAPM. The results of those studies are found to be mixed. In the early period of the model, most studies found it to be positive in most markets, especially in the developed stock markets. Black (1972), Fama and MacBeth (1973), and Lau et al. (1974) found a positive linear result for the model, which suggested the fact that β alone could explain the stock returns. However, Basu (1977) rejected the beta factor and gave a new factor, that is, price to earnings ratio, which could explain the returns risk-premium of an asset. Reinganum (1981) also contradicted the beta factor and observed that beta as a lonely factor could not describe the return of the stocks. Banz (1981) found size as an important factor for determining the risk, not the beta factor, as it could not describe the risk premium of an asset. Lakonishok and Shapiro (1986) also confirmed the size factor as an important factor, not the beta. Dowen (1988) argued in favor of the model but insisted not to be solely dependent on the model. He further concluded that the non-systematic risk of an asset may or may not be possible to remove in the way of creating a large portfolio. Cheung et al. (1993) found weak performance of the model in the Hong Kong capital market. Scheicher (2000) argued that expected return could not be predicted through only one factor; instead, we need to use multiple factors. He found that the multivariable model and generalized autoregressive conditional heteroskedasticity (GARCH) model predicted the risk premium more accurately than the CAPM.

The CAPM study also has an important aspect, which is that the majority of early model studies were carried out in the developed markets, while few studies in the developing and underdeveloped markets have been carried out. The studies conducted in these markets provided conflicting results. Cheung et al. (1993) studied the risk-

return relationship in the developing capital markets of Asia by analyzing CAPM in the Taiwan and Korean stock exchanges. The study found that the model was very weak in explaining the risk premium relationship in both exchanges, especially in the Taiwan capital market. Isa et al. (2008) tested the model in the Malaysian capital market and found a positive result. They used weekly data of 60 regularly traded stocks from January 1995 to December 2006. Yasmeen et al. (2012) found the incapability of the model to elaborate the excess return of the securities in the Pakistan capital market; they used KSE100 index stocks from December 16, 2008 – February 26, 2010.

Rehman et al. (2013) tested the model in the Karachi Stock Exchange using monthly data from January 2002 to December 2008, and the model could explain the excess returns of the stocks. Dai et al. (2014) confirmed the validity of the beta factor in the Chinese stock market using the Shanghai Stock Exchange's nine stocks for 200 trading months of all the stocks. Nyangara et al. (2016) found contradicting results in the Zimbabwe Stock Exchange. Karakoc (2016) also found the incapability of the model to explain the stock returns. Similar results were found in the WAEMU (West African Economic and Monetary Union) stock market by Gahe et al. (2017).

Extensive empirical analysis has also been conducted to test the applicability of the model in the Indian securities market. Studies have been conducted in India since the evolution of the model, and mixed results were found. Gupta (1981) tested CAPM using 606 companies' annual average returns for 15 years from 1961 to 1976 from BSE (Bombay Stock Exchange), CSE (Calcutta Stock Exchange), and MSE (Madras Stock Exchange). The study observed the invalidity of the model in the Indian stock market as the model was unable to explain the stocks. Srinivasan (1988) and Yalwar (1988) confirmed the validity of the model in the Indian security market. Choudhary and Choudhary (2010) found a strong relationship between beta and stock returns. Pandey (2016) confirmed the validity of the model in the Indian capital market. Bajpai and Sharma (2015) also confirmed the model's validity in India, but without the intercept term. They found that the traditional model could not explain the return of stocks. Anwar and Kumar (2018) tested the robustness of the model in the Indian security market and found that the model failed to explain the return of securities; whereas, Manjunatha (2008), Basu and Chawla (2010), Diwani (2010), Dash and Rishika (2011), Aziz and Ansari (2014), Choudhary (2016), Johri et al. (2016), Balakrishnan (2016), Panwar (2016), Raghuram and Erickson (2017), Hussain and Islam (2017), Ratra (2017), Arora and Gakhar (2019), and Rabha and Singh (2021) found invalidity of the model.

From the above literature, it is clear that the shreds of evidence supporting the model are mixed. The results are mixed not only in India, but around the world. Although the results are mixed, still, the CAPM is one of the most widely used models around the world, and it plays a vital role in the financial markets for pricing the assets. The current study attempts to evaluate the applicability of the model in today's market conditions by determining whether the model correctly predicts the return of securities in relation to the risk involved. Hence, the objective of the present study is to assess the applicability of the traditional CAPM and the constraint model in the Indian capital market.

Data and Methodology

Data

The present study used data covering 10 years, starting from April 2011 to March 2021. For the study, the weekly closing price of the companies listed on the NSE 50 index was collected. Out of 50 stocks, only those stocks were taken whose complete data were available for the last 10 years. For the present study, 48 companies were found to have complete data for the selected years (i.e., 10 years), and these 48 companies were selected as the sample of the present study.

The first two years' data has been used to calculate the beta of the stocks, and then next year's data is used to

construct five portfolios and its return. The five portfolios are constructed, and their weekly returns are calculated from April 2011 to March 2021. The NSE Nifty 50 Index comprises the top 50 largest and most liquid Indian companies listed on the NSE based on size and liquidity across sectors. The study used the Nifty 500 index as a market proxy, representing approximately 96.5% of the free-float market valuation of the stocks listed on NSE as of March 29, 2019. For the risk-free interest rate, 91-Days T-Bill is selected. The data used in this study is secondary data, which were collected from the National Stock Exchange's official website, the Reserve Bank of India's official website, etc. Various other sources of information for the study were collected from journals, newspapers, books, annual reports, company official websites, etc.

Methodology

The present study used the methodology of Bajpai and Sharma (2015).

The securities return is calculated using the below formula :

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} * 100 \qquad (1)$$

where,

R_{it} = Return of the i^{th} security,

P_{it} = The current week's closing price of a security,

P_{it-1} = The previous week's closing price of a security.

The model has been analyzed in two different stages of regression. Time series regression has been run in the first stage regression, where β of each security/portfolio is calculated by regressing the return of the security/portfolio on the return of the market.

$$R_{it} = \alpha_i + \beta_i R_{mt} + e_{it} \qquad (2)$$

where,

R_{it} = the security/portfolio returns at time *'t,'*

R_{mt} = the market return at time *'t,'*

α_i = the intercept/alpha term of the security/portfolio,

β_i = the slope/beta of the security/portfolio,

e_{it} = the error term of the regression equation.

Equation (2) explains the first stage regression equation of the model.

The β of securities and portfolios are calculated using the equation (2). The calculated β of securities and portfolios is used in the second stage of the model, which is a cross-sectional regression. The excess return of the securities/portfolios is regressed on β of securities/portfolios in the cross-sectional regression. The slope coefficient in the regression represents the market risk premium of the securities/portfolios.

The following equation (3) represents the second-stage regression of the model:

$$R_{it} - R_{ft} = \alpha + \beta_{im} (R_{mt} - R_{ft}) + e_{it} \qquad (3)$$

where,

R_{it} = the average security/portfolio return,

R_{mt} = the market return at time '*t*,'

R_{ft} = Risk-free rate of interest at time '*t*,'

β_{im} = the beta of the security/portfolio,

e_{it} = error term of the regression equation.

The β_{im} is defined as the ratio of covariance between the asset premium and the market premium and the variance of market premium.

$$\beta_{im} = \frac{\text{Cov}\,(R_i, R_m)}{\sigma^2\,(R_m)}$$

where, Cov (R_i, R_m) = the covariance between the stock return and market return,

$\sigma^2\,(R_m)$ = the market return variance.

To ascertain the robustness of the model, the rolling regression technique is used. The data has been divided into small sub-parts to test the CAPM by applying rolling regression. The sub-parts contain data of 3 years, and this data is overlapping data. The overlapping samples are generated through a moving window, that is, a quarter of a year within the collected data. These moving windows keep rolling for a quarter. For example, the first sub-period will contain data from April 2011 to March 2014; the second sub-period will be July 2011 to June 2014 ; and so on.

Data Analysis and Results

In order to assess the importance and also to ascertain the applicability of the CAPM in the Indian capital market, we conducted two stages of regression of CAPM on five different portfolios, each consisting of 10 stocks except the last portfolio, where eight stocks are included. The portfolios are created in each sub-period differently, so the stocks included in each portfolio also change in each sub-period. The beta of each portfolio is calculated in the first stage of regression, and the same beta is used as the independent factor in the second stage of regression, that is,

Table 1. ***CAPM Second Stage Results, Rolling Regressions on Five Portfolios with the Intercept***

$R_{it} - R_{ft} = \alpha + \beta_i (R_{mt} - R_{ft})$				
Sub Periods	**Intercept**	**Market Risk Premium**	**Adjusted *R* - Square**	***F* - Statistic**
Apr 11 – Mar 14	0.339***	–0.211	0.887	32.572***
Jul 11 – Jun 14	0.336***	–0.089	0.122	1.558
Oct 11 – Sep 14	0.428***	–0.080**	0.725	11.536**
Jan 12 – Dec 14	0.394***	0.035	–0.266	0.160

Apr 12 – Mar 15	0.412**	–0.078	–0.177	0.398
Jul 12 – Jun15	0.368***	–0.027	–0.284	0.114
Oct 12 – Sep 15	0.370***	–0.129	0.453	4.313
Jan 13 – Dec15	0.360**	–0.14001	0.277	2.530
Apr 13 – Mar 16	0.281	–0.023	–0.330	0.007
Jul 13 – Jun 16	0.288	0.014	–0.331	0.005
Oct 13 – Sep 16	0.185	0.144	–0.254	0.191
Jan 14 – Dec 16	0.080	0.173	–0.228	0.258
Apr 14 – Mar 17	0.067	0.216	–0.066	0.754
Jul 14 – Jun 17	0.097	0.082	–0.307	0.060
Oct 14 – Sep 17	–0.060	0.238	–0.153	0.470
Jan 15 – Dec 17	0.015	0.191	0.089	1.389
Apr 15 – Mar 18	0.080	0.065	–0.257	0.182
Jul 15 – Jun 18	0.147	0.013	–0.329	0.009
Oct 15 – Sep18	0.056	0.167	0.086	1.376
Jan 16 – Dec 18	–0.043	0.215	0.278	2.544
Apr 16 – Mar 19	0.097	0.134	0.313	2.825
Jul 16 – Jun 19	0.091	0.089	–0.207	0.315
Oct 16 – Sep 19	0.124	–0.034	–0.288	0.107
Jan 17 – Dec 19	0.152	0.034	–0.289	0.104
Apr 17 – Mar 20	0.152	–0.290*	0.561	6.110*
Jul 17 – Jun 20	0.327***	–0.278***	0.860	25.478***
Oct 17 – Sep 20	0.345	–0.276	0.285	2.593
Jan 18 – Dec 20	0.351	–0.194	0.155	1.731
Apr 18 – Mar 21	0.279	–0.032	–0.315	0.042

Source : Computed by the authors by taking data collected from NSE, RBI, Yahoo Finance

Note. * significant at 10%, **significant at 5%, ***significant at 1%.

cross-sectional regression of CAPM. The market risk premium for the stocks/portfolios is represented by the slope of cross-sectional regression (Table 1).

The study considers two factors in testing the validity of CAPM: firstly, a zero intercept term or insignificant, and secondly, a positive and significant market risk premium. The *F* - statistic value for four subperiods is found to be significant, but the intercept term is significant for nine subperiods and insignificant for 20 subperiods. The market risk premium is significant for only three subperiods and is negative for the rest of the subperiods; 13 positive and 13 negative market risk premium. Another important finding of the study is that the majority adjusted *R*-square values are negative, that is, 16 out of 29 subperiods. From the above interpretation, we can conclude that the model does not hold in India as both the intercept term and market risk premium do not meet the criteria set by the model.

Another CAPM model by Bajpai and Sharma (2015) is also tested in the present study. They proposed another version of the CAPM model, which doesn't consider the intercept term. According to the model given by them, the second stage of CAPM, that is, cross-sectional regression without the intercept term, is run to assess the applicability of the CAPM. The analysis results for the new model are depicted in Table 2.

Table 2. ***CAPM Second Stage Results, Rolling Regressions on Five Portfolios Without the Intercept***

$$R_{it} - R_{ft} = \beta_i (R_{mt} - R_{ft})$$

Sub Periods	Market Risk Premium	Adjusted *R* - Square	*F* - Statistic
Apr 11 – Mar 14	0.112	0.109	2.243
Jul 11 – Jun 14	0.234**	0.409	7.714*
Oct 11 – Sep 14	0.306**	0.451	9.399**
Jan 12 – Dec 14	0.383***	0.534	14.504**
Apr 12 – Mar 15	0.298**	0.430	8.481*
Jul 12 – Jun15	0.318***	0.545	15.602**
Oct 12 – Sep 15	0.216**	0.419	8.092*
Jan 13 – Dec15	0.195*	0.366	6.429*
Apr 13 – Mar 16	0.240*	0.343	5.837*
Jul 13 – Jun 16	0.282**	0.483	10.998**
Oct 13 – Sep 16	0.316**	0.434	8.664*
Jan 14 – Dec 16	0.248*	0.346	5.908*
Apr 14 – Mar 17	0.279***	0.545	15.498**
Jul 14 – Jun 17	0.173*	0.265	4.240*
Oct 14 – Sep 17	0.179*	0.305	4.995
Jan 15 – Dec 17	0.204***	0.621	27.092***
Apr 15 – Mar 18	0.140**	0.513	12.881**
Jul 15 – Jun 18	0.150**	0.472	10.372**
Oct 15 – Sep18	0.219***	0.612	25.084***
Jan 16 – Dec 18	0.175***	0.587	20.642***
Apr 16 – Mar 19	0.223***	0.690	63.113***
Jul 16 – Jun 19	0.171**	0.493	11.544**
Oct 16 – Sep 19	0.079	0.257	4.110
Jan 17 – Dec 19	0.172***	0.550	15.983**
Apr 17 – Mar 20	–0.153**	0.516	13.097**
Jul 17 – Jun 20	0.006	–0.246	0.014
Oct 17 – Sep 20	0.023	–0.227	0.095
Jan 18 – Dec 20	0.107	0.116	2.305
Apr 18 – Mar 21	0.206**	0.475	10.539**

Source : Computed by the authors by taking data collected from NSE, RBI, Yahoo Finance

Note. * significant at 10%, **significant at 5%, ***significant at 1%.

In Table 2, we can clearly see that the *F* - statistic in 23 subperiods is significant out of 29 subperiods, suggesting that the CAPM fits 79% of the subperiods. The market returns for the subperiods are significant for 24 out of 29 and positive for 28 except for one period, that is, April 2017 to March 2020. From this analysis, we can interpret that compared to the unconstrained, the constrained model explains the CAPM better.

The adjusted *R* - squared value in Table 2 also supports the newly developed model apart from the *F* - statistics and market risk premium. When we compare the adjusted *R*-squared values for both tables, we find that the

adjusted *R*-squared values in most of the subperiods are high for Table 2, which means that the constrained model performs better than the unconstrained model. Although Table 2 has a higher adjusted *R*-squared than Table 1, it fails to produce high adjusted *R*-squared, suggesting that the traditional model is econometrically weak and performs poorly as even the constrained model produces a low adjusted *R*-squared.

Conclusion

The present study finds that the constraint model performs better than the traditional model, which means that the model without the intercept term outperforms the model with the intercept term. The present findings are linear with the findings of Bajpai and Sharma (2015), who discovered that the explanatory power of the capital asset pricing model increased when the intercept term was not included.

The primary cause for the model's failure is found to be the use of intercept term while running a regression. When we remove the intercept term from the regression, the explanatory power of the model increases by a significant margin. In our study, the model without intercept term explains more than 79% of the stocks' returns, which is very high compared to the traditional model. Another important fact that confirms that the new model without intercept term performs better than the traditional model and also supports the fact that beta is an important variable for understanding the return of an asset is the high adjusted *R*-squared value produced by the new model. Thus, it can be concluded that beta is still a valid variable to explain the relationship between risks and return; hence, the CAPM is valid in the Indian market scenario.

Implications

From the analysis and interpretation, it is clear that due to the use of an inappropriate model, the CAPM fails to elaborate the risk and return relationship of an asset in the Indian capital market. By removing the intercept term from the model and making it econometrically correct, it performs better than the traditional model. The findings of this study will enable the market participants like individual investors, portfolio managers, and financial institutional investors to take appropriate decisions before adding any assets into their portfolios. It will serve as a reference point for risk measurement for an asset, allowing investors to determine whether or not to include an asset in their portfolio at the time of purchase.

Limitations of the Study and Scope for Future Research

The study has been conducted using the weekly data and the chosen market variables such as TBill as the risk-free rate, Nifty 500 as a market proxy, and only 48 companies listed on the NSE Nifty 50 companies. The present study is conducted for only 10 years, which can easily be extended to more than that to see the time horizon effect on the stocks' returns. One can also increase the number of companies by considering companies listed on NSE Nifty100, Nifty 200, and Nifty 500. We have tested only with the weekly data. The model can further be tested using monthly or any suitable periodic data. In today's scenario, the whole world's stock market is considered one market because investors can invest anywhere. The researchers can also test the model's applicability in different developing stock markets.

Authors' Contribution

Debajit Rabha conceived the idea and developed the design to undertake the empirical study. Dr. Rajkumar Giridhari Singh verified the analytical methods and supervised the study. Debajit Rabha and Dr. Rajkumar

Giridhari Singh were responsible for the literature review and drawing the findings. The analysis was done by Debajit Rabha using MS Excel, and he wrote the manuscript under the guidance of Dr. Rajkumar Giridhari Singh.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Funding Acknowledgment

The authors received no financial support for the research, authorship, and/or the publication of this article.

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