



XVIII Annual International Conference of the Society of Operations Management (SOM-14)

An Empirical Testing of Capital Asset Pricing Model in India

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Abstract

This study focuses on empirical testing of Capital Asset Pricing Model (CAPM) in the Indian equity market. The study is conducted for a period of 10 years ranging from January 2004-December 2013 and the data is daily data for 10 years. This study is done with the help of rolling regression methodology, which helps in giving robust results. Rolling regression is applied on a rolling sample of three years where a window of three years keeps moving for a quarter. Further, the model developed for the second stage regression is a constrained model, in which the intercept term is assumed to be zero. A comparison between the developed model and the traditional model, has been made. The results show that CAPM is very much significant in the Indian equity market and the model developed in this study, performs better than the traditional model.

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Peer-review under responsibility of the scientific committee of XVIII Annual International Conference of the Society of Operations Management (SOM-14).

Keywords: CAPM, Rolling regression, Indian equity market.

1. Introduction

The Capital Asset Pricing Model (CAPM) is the most fundamental and popular model in asset pricing. This model explains the relationship between the return of any asset and the risk component involved with that return. The model explains there is only one component which explains the return generating process of any asset, which is

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the systematic risk or the market related risk of that asset. This is why, CAPM is also known as single factor model. This model provides an equilibrium relationship between risk and return, which helps in identifying the underpriced and overpriced assets. This equilibrium relationship is also known as the security market line (SML). SML explains the relationship between the return of asset and beta of asset. But in the late twentieth century the model started losing its popularity as various other theories/ model of asset pricing came into existence, which contradicted the model and claimed that the single factor, beta, cannot explain the return generating process of assets. There are various other factors which influence risk return relationships and those factors should also be taken into account.

This kind of ambiguity prevailing in the financial literature has given the motivation to authors to empirically study the model in Indian context and analyse its nuances. Further the majority of studies have been conducted in the developed market, while developing markets have a very limited studies related to the testing of CAPM. This gap has also provided enough motivation to conduct this kind of study.

The study covers a period of ten years ranging from January 2004 to December 2013. The Results of this study show that the model is still significant. A new model with some econometric corrections, has been made, which show a significant improvement in the applicability of the CAPM in the practical world.

2. Literature Review

Capital Asset Pricing Model is the foundation of all asset pricing theories. The model has been tested across the globe empirically and the results of these tests are mixed.

The empirical tests conducted by Friend and Blume (1970), Black, Jensen and Scholes (1972) and Fama and MacBeth (1973) show support to CAPM and concluded that return of risky assets are a linear function of the beta factor.

On the contrary Basu (1977) reported the earning price ratio explains the returns of risky asset. Banz (1981) explained the size effect and the relationship between the stock returns and market capitalization. In the same way Bhandari (1988) explained that debt-equity ratio effect, plays a significant role in explaining the return generating process.

The most important work of Fama and French (1992, 1993 and 1995) declined the fact that 'Beta' is the only factor which can explain the return generating process of risky assets. However, size factor and book to market ratio factor are two other important factors, which helps in explaining the risk return relationship.

The major studies of empirical testing of CAPM are done in the US market. While developing countries have a dearth of such empirical tests of CAPM. In India too there are very few studies, which have addressed the same issue. Findings of these studies are also mixed.

Yalwar (1988) and Verma (1988) supported the CAPM and said that CAPM is applicable in the Indian stock market. While Gupta and Sehgal (1993), Ray (1994), Obaidullah (1994), Madhusoodan (1997) and Sehgal (1997) denied the applicability of CAPM in Indian stock market.

Ansari (2000) again supported the CAPM and reported that game is not lost for CAPM in the Indian market. Dhankar and Kumar (2007) explained that CAPM helps in explaining the risk return relationship in the Indian market.

The literature provides the mixed kind of evidences in support of CAPM. Now in the 21st century the Indian equity market has turned into a bigger and a better market. In this phase of the Indian equity market, testing of CAPM becomes essential. This empirical testing of CAPM will give a new and big picture of CAPM and the Indian equity market.

These issues and developments provide motivation to study the CAPM and its applicability in the Indian equity market.

3. Data and Methodology

3.1 Data

This study considers a period of 10 years starting from January 1, 2004 to December 31, 2013. Data is adjusted closing daily prices of stocks listed on the NSE CNX 500 and NSE CNX 500 index itself. Out of 500 stocks only those stocks have been considered which have been traded for a ten years period of study continuously.

Daily closing prices of stocks cannot be used directly for analysis as the time series of prices is a non-stationary process. To convert this non stationary process into a stationary process, we have taken the first order logarithmic difference of the prices of stocks. In other words, we have taken the log returns of the stocks.

$$R_t = \ln(P_t/P_{t-1}) \quad (1)$$

Equation 1 gives the formula to calculate logarithmic returns of stocks. In this equation P_t is the price of stock at time 't', P_{t-1} is the price of the same stock at time 't-1'. In the same way logarithmic returns of NSE CNX 500 index has been calculated. These index returns are used as a proxy for the market return. Proxy for risk free rate of return is the average implicit yield at cut off price of 91 days Government of India Treasury bills.

Center for Monitoring Indian Economy (CMIE)'s database Prowess is the source of data collection for the adjusted daily closing prices of stocks and for closing data of NSE CNX 500 index as well.

3.2 Methodology

The CAPM is tested in two stages of regression. The first stage of regression is time series regression, in which beta of each security is calculated by regressing the return of security/portfolio on the return of the market.

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (2)$$

Equation 2 explains the first stage regression equation of CAPM.

In equation 2 R_{it} and R_{mt} are the return of stock/portfolio 'i' and the market return respectively at 't' point of time. α and β are intercept and slope coefficient of the regression equation. ε is the error term of the regression equation.

With the help of equation 2 beta (β) of each security/portfolio is calculated and this is used in the second stage of CAPM which is a cross sectional regression. In this cross sectional regression the excess return of stock/portfolio is regressed on beta of stock/portfolio. The slope coefficient in this regression is the market risk premium of stock/portfolio.

$$[E(R_{it}) - R_{ft}] = \beta_{im}[E(R_{mt}) - R_{ft}] \quad (3)$$

Equation 3 is the equation form of the second stage regression of CAPM. In this equation $E(R_{it})$ and $E(R_{mt})$ are the average return of stock/portfolio and market respectively. R_{ft} is the risk free rate of return at time period 't'. β_{im} is the systematic risk of security/portfolio with respect to market.

This beta (β_{im}) is defined as the ratio of covariance between the asset return and market return and the variance of market return.

$$\beta_{im} = Cov(R_i, R_m) / \sigma^2(R_m) \quad (4)$$

We test the CAPM by applying the rolling regression technique. This rolling regression technique is used to test the robustness of the model. For this purpose, the data has been divided into small sub periods. These sub periods contain data of three years and this data is overlapping data. These are overlapping samples of three years which is generated by moving the window of a quarter year within the original data of ten years. This moving window keeps rolling for a quarter or three months. For example, the first sub period will contain data from January 2004 to December 2006 and second sub period will contain data from April 2004 to March 2007 and so on. So we can see that to cover a period of the next three years we have shifted the initial data point by three months/ a quarter of a year period. This technique has created 29 overlapping sub periods. Each sub period contains returns of 290 stocks for three years (252 trading days x 3 = 756 trading days).

Further to remove the errors, which may be created by the unsystematic risk factor of the stocks we have created portfolio of stocks. We have created 10 portfolios of stocks and each portfolio consists 29 securities. These

portfolios have been created on the basis of the ranking of the beta of stocks. All stocks have been ranked according to their beta in each sub period. The first portfolio in each sub period will contain the highest beta securities and tenth or last portfolio will contain the lowest beta securities.

In each sub period, these portfolios may contain different securities as the beta of each security may get change with the change in time period.

After creating the portfolio the two stage regression methodology of CAPM has been applied on these portfolios. In literature during the second stage of CAPM an intercept term is included and for a model fit it is assumed that intercept term should be zero or insignificant in the regression model. But in the equation 3 it is clearly visible that there is no intercept term in the equation. To test whether a model performs better in the presence of an intercept term or not, the second stage regression is done by applying both the methodology that is including an intercept term and excluding the intercept term.

4. Results and Analysis

To test the significance of the CAPM in the Indian equity market, we have run two stages of regression of CAPM on 10 portfolios created in each sub period separately. In the first stage we have calculated beta of each portfolio. This beta calculated in the first stage of regression has been used as the independent factor in the second stage of CAPM, which is a cross sectional regression. The slope of cross sectional regression is the market risk premium for the securities/portfolios. The results of the second stage of CAPM is given in the Table 1.

Table 1
Results of the Second stage of CAPM, rolling regressions on ten portfolios with an intercept

$$E(R_p - R_f) = \alpha_p + \beta_p [E(R_m - R_f)]$$

Sub Periods	Intercept	Market Risk Premium	Adjusted R Squared	F statistic	Sub Periods	Intercept	Market Risk Premium	Adjusted R Squared	F statistic
Jan04-Dec06	0.31**	-0.062	-0.006	0.943	Jul07-Jun10	0.204** *	-0.2***	0.767	30.691***
Apr04-Mar07	0.303**	-0.02	-0.114	0.078	Oct07-Sep10	0.352** *	-0.367** *	0.934	128.708** *
Jul04-Jun07	0.193*	0.173*	0.349	5.827*	Jan08-Dec10	0.386** *	-0.505** *	0.909	90.762***
Oct04-Sep07	0.107	0.219*	0.441	8.111*	Apr08-Mar11	0.381** *	-0.387** *	0.733	25.74***
Jan05-Dec07	0.047	0.282*	0.523	10.861*	Jul08-Jun11	0.454** *	-0.407**	0.64	17.014**
Apr05-Mar08	0.055	0.106	0.15	2.587	Oct08-Sep11	0.472** *	-0.43**	0.707	22.735**
Jul05-Jun08	0.04	0.023	-0.101	0.177	Jan09-Dec11	0.452** *	-0.337**	0.602	14.609**
Oct05-Sep08	-0.082	0.037	-0.073	0.387	Apr09-Mar12	0.418**	-0.191	0.273	4.379
Jan06-Dec08	-0.223*	0.045	-0.083	0.309	Jul09-Jun12	0.401**	-0.364**	0.605	14.803**
Apr06-Mar09	-0.203*	-0.064	-0.032	0.723	Oct09-Sep12	0.365** *	-0.405** *	0.839	47.908***

Jul06- Jun09	-0.129	0.129	0.16	2.709	Jan10- Dec12	0.314** *	- 0.373** *	0.855	54.023***
Oct06- Sep09	-0.056	0.081	0.143	2.502	Apr10- Mar13	0.29***	- 0.433** *	0.875	63.877***
Jan07- Dec09	0.027	-0.004	-0.124	0.004	Jul10- Jun13	0.269**	- 0.452** *	0.838	47.648***
Apr07- Mar10	0.128*	-0.075	0.065	1.625	Oct10- Sep13	0.251*	- 0.516** *	0.795	35.844***
					Jan11- Dec13	0.199*	- 0.416**	0.713	23.398**

To test the validity of CAPM, we consider two factors, first the intercept term should be zero or it should not be significant in the model and second the market risk premium term should be significant and positive. In Table 1, we can see that the F statistic is significant for 17 sub periods. But in these 17 sub periods the intercept term is significant for 15 sub periods. Only two sub periods are there when the intercept term is not significant. According to literature, if the intercept term is not zero or it is significant then the model does not hold in that case.

Prima-facie CAPM does not hold in the Indian equity market. In this study we have developed a new model, the constrained one, where we do not take into account the intercept term as it is not given in the model as described in the equation 3. We put a constraint of the intercept term being equal to zero. In this case we run the second stage of CAPM by removing the intercept term from the cross sectional regression equation. The results of the second stage of CAPM without an intercept term is given in the Table 2.

Table 2

Results of the Second Stage of CAPM, rolling regressions on ten portfolios without intercept

$$E(R_p - R_f) = \beta_p [E(R_m - R_f)]$$

Sub Periods	Market Risk Premium	Adjusted R squared	F statistic	Sub Periods	Market Risk Premium	Adjusted R squared	F statistic
Jan04-Dec06	0.234***	0.838	52.543***	Jul07-Jun10	0.026	0.065	1.69
Apr04-Mar07	0.273***	0.87	67.949***	Oct07-Sep10	0.023	-0.052	0.505
Jul04-Jun07	0.362***	0.956	217.459***	Jan08-Dec10	-0.082*	0.301	5.297*
Oct04-Sep07	0.325***	0.96	241.485***	Apr08-Mar11	0.04	0.008	1.078
Jan05-Dec07	0.33***	0.958	231.291***	Jul08-Jun11	0.103	0.286	5.001
Apr05-Mar08	0.161***	0.908	99.388***	Oct08-Sep11	0.092	0.24	4.161
Jul05-Jun08	0.064**	0.68	22.256**	Jan09-Dec11	0.152**	0.523	11.979**
Oct05-Sep08	-0.049*	0.454	9.316*	Apr09-Mar12	0.248***	0.785	37.593***
Jan06-Dec08	- 0.194***	0.832	50.413***	Jul09-Jun12	0.041	0.009	1.096
Apr06-Mar09	- 0.284***	0.924	122.956***	Oct09-Sep12	-0.036	0.008	1.085
Jul06-Jun09	-0.016	-0.052	0.504	Jan10-Dec12	-0.054	0.184	3.253
Oct06-Sep09	0.019	0.102	2.132	Apr10-Mar13	-0.141**	0.679	22.146**
Jan07-Dec09	0.026	0.158	2.87	Jul10-Jun13	- 0.181***	0.782	36.918***

Apr07-Mar10	0.067**	0.569	14.217**	Oct10-Sep13	- 0.259***	0.866	65.67***
				Jan11-Dec13	-0.21***	0.832	50.561***

In Table 2 it is clear that the model is fit for 62% sub periods, which can be inferred from the F statistics which are significant in 18 sub periods out of 29 cases. The constrained model is better in explaining the CAPM as compared to the unconstrained one.

Except the F statistics the other factor which supports the constrained model is the adjusted R squared term. If we make a comparison between the adjusted R squared value given in Table 1 and Table 2, we will find that Table 2 has higher adjusted R squared in most of the sub periods. The sub periods which do not contain data of the recession period (July 2008-July 2010 in general), are able to explain the constrained model. Whereas the constrained model fails in providing high adjusted R squared values, which supports the fact that the unconstrained model is not the econometrically correct model and gives poor performance.

From the above analysis it is evident that the failure of CAPM in the Indian market is not because it is unable to explain the risk return relationship, however, the use of an inappropriate model while testing the CAPM, is the cause of failure of CAPM.

5. Conclusions

This study finds out that CAPM can be estimated by removing the intercept term from the second stage of the model, which is a cross sectional regression equation. With the help of this constrained model CAPM performs better, in comparison to the unconstrained model.

Using the intercept term in the second stage of CAPM leads to a total failure of the model in the context of the Indian equity market, while removing the intercept term gives a new model which explains the risk return relationship in the Indian equity market for more than 62% times. As the high value of adjusted R squared in case of the constrained model gives support to the fact that the systematic risk is the only factor which helps in explaining the return generating process of risky assets

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