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A STUDY ON CAPITAL ASSET PRICING MODEL WITH REFERENCE TO BSE-500 INDEX

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ABSTRACT

The present study examines the Capital Asset Pricing Model (CAPM) for the Indian stock market using monthly stock returns from 250 companies of BSE 500 Index listed on the Bombay stock exchange for the period of January 2000 to December 2010. The findings of this study are not substantiating the theory's basic result that higher risk (beta) is associated with higher levels of return. The theory's prediction for the intercept is that it should equal zero and the slope should equal the excess returns on the market portfolio. The results of the study lead to negate the above hypotheses and offer evidence against the CAPM. The tests conducted to examine the nonlinearity of the relationship between return and betas bolster the hypothesis that the expected return beta relationship is linear. Additionally, this study investigates whether the CAPM adequately captures all-important determinants of returns, including the residual variance of stocks. The results exhibit that residual risk has an effect on the expected returns of portfolios.

KEYWORDS: CAPM, Portfolio Returns, Beta, Risk Free Rate, Systematic Risk

INTRODUCTION

Asset pricing theory is a framework designed to identify and measure risk as well as assign rewards for risk bearing. This theory helps us understand why the expected return on a short-term government bond is a lot less than the expected return on a stock. Similarly, it helps us understand why two different stocks have different expected returns. The theory also helps us understand why expected returns change through time. The asset pricing framework usually begins with a number of premises such as: investors like higher rather than lower expected returns, investors dislike risk and investors hold well-diversified portfolios. These insights help us assess the “fair” rate of return for a particular asset. While there have been many advances in asset pricing over the past 40 years, to understand the issues that we face with asset pricing in emerging markets, it is useful to follow the framework of the first asset pricing theory, the Capital Asset Pricing Model (CAPM) of Sharpe and Jensen’s. Since William Sharpe (1964) and Jensen’s (1965) found a linear relationship between expected returns of assets and their market betas and developed the famous Capital Asset Pricing Model (CAPM)

CAPITAL ASSET PRICING MODEL is a model that starts with a specification of investors‘choice. From the investors‘point of view, investors like overall portfolio reward (expected return) and dislike overall portfolio risk (variance or standard deviation of return). So as a result, investors immediately will grab those projects—that has low risk and high expected rate of return. In fact, those projects with lower risk will ask for a higher price, which in turn immediately drives down the expected rate of return. Consequently, what is available for purchase in the real world must be subject to some trade-off: Projects that have more market-risk must offer a higher expected rate of return if they want to be purchased by

investors. But what exactly does this relation look like? It is actually the domain of the capital asset pricing model.

Capital Asset Pricing Model (CAPM) is based on two parameter portfolio analysis developed by Markowitz (1952). It is the standard risk, return model used by most academicians & practitioners. The underlying concept of CAPM , is that investors are rewarded for only that portion of risk which is not diversifiable. This non-diversifiable variance is termed as beta, to which expected returns are linked.

This model was simultaneously & independently developed by John Linter (1965), Jan Mossin (1966) & William Sharpe (1964).

In the equation form model can be expressed as follows:

$$E(R\,i) = R\,f\,\beta i\,[E(R\,M)\,R\,f. \quad \textbf{(1)}$$

Where, E (R i) = expected rate of return on *id* asset

R f = risk free rate of return

E (R M) = expected rate of return on the market portfolio

β I = estimate of beta for the *its* stock, i.e. The non diversifiable risk of *its* asset.

This relation between the expected rate of return on market portfolio & expected rate of return on asset me, as described by equation (1) also known as Security Market Line (SML). If CAPM is valid, all security will lie in a straight line in the E (R i), β I space, called SML. The SML implies that, the return is a linearly increasing function of risk. Moreover, only the market risk affects the return. The non diversifiable risk is also known as the market risk, which is also referred as "systematic risk". The beta of a stock is a measure of how much market risk faced by a particular stock, i.e. The sensitivity of an asset with respect to market portfolio. Stability of β is very important, since for almost all investment decisions βs are playing a significant role in risk measurement & risk management. Now if βs are not stable over time, then it loses its importance.

The Set of Assumptions Employed to Develop CAPM can be Summarized as Follows

- Investors are risk averse & they have a preference for the expected return & dislike of risk.
- Investors make investment decisions based on the expected rate of return & the variance of the underlying asset return. I.e. Assumptions of two-parameter utility function.
- Investors desire to hold a portfolio that lies along the efficient frontier. (The efficient frontier is also known as diversification frontier)
- These 3 assumptions were made in the development of the Markowitz & Sharpe single index portfolio analysis model. In addition to these three assumptions, CAPM also made the following assumptions:
- There is a risk less asset & investors can lend or borrow at that risk free rate.
- All the investments are perfectly divisible. That is, the fractional shares for any investment can be purchased at any moment.

- All the investors have the homogeneous expectations regarding investment horizon or holding period and to forecasted expected returns & level of risk of securities. At the same time, there is a complete agreement among investors as to the return distribution for each security & portfolio.
- There are no imperfections in the market that prevent the investors in buying or selling the assets. More importantly, there are no commissions or taxes involved with the security transaction. That means, there are no costs involved in diversification & there is no differential tax treatment of capital gain & ordinary income.
- There is no uncertainty about expected inflation, or alternatively, all security prices fully reflect all changes in future inflation expectations.
- The capital market is in equilibrium. That is all the investment decisions have been made & there is no further trading without new information.

Even though, some of the assumptions are clearly unrealistic, since its introduction in the early 1960s,

THE CLASSIC SUPPORT OF THE THEORY

The model was developed in the early 1960‘s by Sharpe [1964], Lintner [1965] and Mossin [1966]. In its simple form, the CAPM predicts that the expected return on an asset above the risk-free rate is proportionately related to the non-diversifiable risk, which is measured by the asset‘s beta. One of the earliest empirical studies that found supportive evidence for CAPM is that of Black, Jensen and Scholes [1972]. Using monthly return data and portfolios rather than individual stocks, Black et al tested whether the cross-section of expected returns is linear in beta. The authors found that the data are consistent with the predictions of the CAPM i.e. The relation between the average return and beta is very close to linear and that portfolio with high (low) betas have high (low) average returns.

Another classic empirical study that supports the theory is that of Fama and McBeth [1973]; they examined whether there is a positive linear relation between average returns and beta. Moreover, the authors investigated whether the squared value of bets and the volatility of asset returns can explain the residual variation in average returns across assets that are not explained by beta alone.

CHALLENGES TO THE VALIDITY OF THE THEORY

In the early 1980s, several studies suggested that there were deviations from the linear CAPM risk, return trade-off due to other variables that affect this tradeoff. The purpose of the above studies was to find the components that CAPM was missing in explaining the risk-return trade-off and to identify the variables that created those deviations.

Banz [1981] tested the CAPM by checking whether the size of firms can explain the residual variation in average returns across assets that remain unexplained by the CAPM‘s beta. The author concluded that the average returns on stocks of small firms (those with low market values of equity) were higher than the average returns on stocks of large firms (those with high market values of equity). This finding has become known as the size effect.

The research has been expanded by examining different sets of variables that might affect the risk return tradeoff. In particular, the earnings yield (Basu [1977]), leverage, and the ratio of a firm‘s book value of equity to its market value (e.g. Statman [1980], Rosenberg, Reid and Lanstein [1983] and Chan, Hamao, Lakonishok [1991]) have all been utilized in

testing the validity of CAPM.

The general reaction to Banz's [1981] findings, that CAPM may be missing some aspects of reality, was to support the view that although the data may suggest deviations from CAPM, these deviations are not so important as to reject the theory.

However, this idea has been challenged by Fama and French [1992]. They showed that Banz's findings might be economically so important that it raises serious questions against the validity of the CAPM. Fama and French [1992] used the same procedure as Fame and McBeth [1973] but arrived at very different conclusions. Fame and McBeth find a positive relation between return and risk while Fama and French find no relation at all. 6

The Fama and French [1992] study has itself been criticized. Kothari, Shaken and Sloan [1995] argue that Fama and French's [1992] findings depend essentially on how the statistical findings are interpreted.

Amihudm, Christensen and Mendelson [1992] and Black [1993] support the view that the data are too noisy to invalidate the CAPM. In fact, they show that when a more efficient statistical method is used, the estimated relation between average return and beta is positive and significant. Black [1993] suggests that the size effect noted by Banz [1981] could simply be a sample period effect i.e. The size effect is observed in some periods and not in others.

Jagannathan and Wang [1993] argues that the lack of empirical support for the CAPM may be due to the inappropriateness of the basic assumptions made to facilitate the empirical analysis. For example, most empirical tests of the CAPM assume that the return on broad stock market indices is a good proxy for the return on the market portfolio of all assets in the economy. However, these types of market indexes do not capture all assets in the economy such as human capital.

Other empirical evidence on stock returns is based on the argument that the volatility of stock returns is constantly changing. When one considers a time-varying return distribution, one must refer to the conditional mean, variance, and covariance that change depending on currently available information.

All the studies above aim to improve the empirical testing of CAPM. There have also been numerous modifications to the models and whether the earliest or the subsequent alternative models validate or not the CAPM is yet to be determined.

LITERATURE REVIEW

- Grigoris Michailidis, Stavros Tsopoglou, Demetrios Papanastasiou (2006) examines the Capital Asset Pricing Model (CAPM) for the Greek stock market. The findings of this article were not supportive of the theory's basic statement that higher risk (beta) is associated with higher levels of return. The tests were conducted to examine the nonlinearity of the relationship between return and betas support the hypothesis that the expected return-beta relationship is not non-linear. Additionally, this paper investigates whether the CAPM adequately captures all-important determinants of returns or not. For that reason the study includes the residual variance of stocks as an explanatory variable. The results demonstrate that residual risk has no effect on the expected returns of portfolios.
- Attiya Y. Javid & Eatzaz Ahmad (2008) attempt to empirically investigate the risk and return relationship of individual stocks traded at Karachi Stock Exchange (KSE), the main equity market in Pakistan. The empirical

findings do not support the standard CAPM model as a model to explain assets pricing in the Pakistani equity market. The critical condition of CAPM, i.e. There is a positive trade-off between risk and return—is rejected and residual risk plays some role in pricing risky assets. 7

- Journal Sarma & Pranita Sarmah (September 2008) empirically study the stability of stock βs using the chow test on the Bombay stock exchange and the result shows that betas are unstable over time.
- Sermon Das (2007) test the stability of betas of individual stocks over a period of time using two econometric tests in NSE Nifty (February 1999 to September 2007), and sub-divided the sample period into 3 sub-periods, two bullish and one bearish. The author found that under one method (regression using time as a variable) 85% of the stocks had a stable beta, while using the second method (regression using dummy variables) 65% of the stocks had stable betas.

This Study will try to address two of the Most Important Questions Regarding CAPM.

- The study will examine whether the relationship between asset return & corresponding β value as posed by CAPM is valid in Indian context or not. For that reason study will examine the validity of CAPM for 10 stocks listed on BSE, and after that it will examine the validity of CAPM for 10 different industries to get a broader idea.
- The study will also examine whether stock βs are stable over time or not, & if not, what are the reasons behind its movement over time. While addressing the question the study will try to examine what are the effects of stock market crash (January 2008) on individual stock βs. I.e. What are the effects of stock market crash on individual stock‘s systematic risk.

The Study is arranged as Follows:

The initial part of the study contains the description of the selected data & the selection criteria.

Then it empirically tests the validity of CAPM. Under this part of the study, there are 4 subsections; first two of them contain the estimation methodology & hypothesis testing. And next two of them contain the empirical finding, interpretation of results & interpretation of results. In the empirical testing part the study first test the validity of CAPM on selected stocks using SENSEX, and then BSE 100, BSE 200 & BSE 500 as the proxy of market index. Then the study empirically tests the validity of CAPM on different industry indices using SENSEX as the proxy market portfolio.

And the final part of the study contains the test for stability of systematic risk. This section is also sub-divided into four sub-sections. First two of them contain the estimation methodology & hypotheses testing. And next two of them contain the result & interpretation of results.

And finally the conclusion of whole study contains in the final conclusion part.

Table 1: Descriptions of Selected Companies

Company Name	Sector	Market Capitalization.(Rs.Cr.)
Infosys Tech.	Information Tech	60321.07
ITC	FMCG	17915.29
State Bank Of India	Finance	11380.82
ICICI	Finance	10782.33
Ranbaxy	Healthcare	7971.61
NIIT	Information Tech	6155.74
HPCL	Oil & Gas	4608.1
Castrol India	Oil & Gas	3889.22
Nestle	FMCG	3587.15
Novartis	Health care	2969.5

All selected securities are traded on the BSE (Bombay Stock Exchange) on a continuous basis.

Next as far as industry indices are concern, the study selected almost all available BSE industry indices except a few to get a broader idea regarding the market. The selected industries & their descriptions are given in the following table (table 2):

Table 2: Descriptions of Selected Industry Indices

Name Of The Index	Description
BSE AUTO	BSE Auto Index comprises all the major auto stocks in the BSE 500 Index
BSE POWER	. BSE POWER is an index to track the performance of companies in the power and energy sector. BSE Power index comprises companies that are into the business of generation, transmission and distribution of electricity.
BSE BANKEX	Bankex was launched by BSE to track the performance of the leading banking sectors as bank stocks are emerging as a major segment of the stock market. Bankex Index includes 12 selected major stocks which represent total 90% market capitalization of all the banking sector stocks listed on the BSE.
BSE FMCG	Products that show a sudden shelf turnover, at comparatively low cost are classified as Fast Moving Consumer Goods. Eatables, soft drinks, and cleaning materials fall in FMCG category. FMCG Index monitors the performance of the major brands in the FMCG category.
BSE HC	Health Care and Pharmacy sector are emerging as strong effectors on the economy of India. BSE Health Care Index monitoring the health care sector performance individually.
BSE IT	Keeping track of the changing trends in Indian Economy, BSE launched new sectoral index named IT Index. Stocks capturing 90% market capitalization from the IT sector are listed on the IT Index.
BSE OIL & GAS	Oil and Gas sector is gaining its own weight age in the economy. The stocks from oil and gas sectors have lot of effect on the stock market movement. The index covers 90% of the sect oral market capitalization and is based on the Free-Float methodology
BSE CD	Products whose life expectancy is at least three years are known as consumer durable. BSE classified the 90% market capitalization stocks in the field of consumer durable in the Sector Series
BSE CG	Consumer goods index is a part of the BSE sect oral Indices.CG Index comprises the companies occupying 90% market capitalization in the field of consumer goods.
BSE METAL	BSE metal index was launched to track the performance of major metal companies in India

Each stocks & industry indices consist of 996 observations of the daily closing prices for the chosen period. For the period 2005 to 2008 the data are taken from BSE website (http://www.bseindia.com/)

On the basis of available information on closing prices the rate of return on a particular asset is computed by using the following formula:

$$Rit = (Pi, t – Pi, t-1)/Pt-1$$

Where, Pi, t = Daily closing price of asset *i* in the time period t,

Pi, t-1 = Daily closing price of asset *i* in the time period t–1,

Rit = Daily rate of return of asset *i* in the time period t

The weekly data on 91 days Treasury bill were used as proxy of risk free rate of return & BSE 30 (SENSEX) were used as a proxy for price of market portfolio. The 91 days Treasury bill were used as risk free asset since it is backed by government of India, thus considered as one of the safest asset in the country. The data for 91 days Treasury bill are taken from the Reserve Bank of India‘s website (http://www.rbi.org.in/). Along with SENSEX, the study also used the BSE 100, BSE 200 & BSE 500 as market proxy to examine the CAPM relationship for the selected stocks for different market portfolios. The descriptions of selected market indices (especially SENSEX) given in the following table

METHODOLOGY

The study starts analysis by empirical model developed by Sharpe (1964) and Lintner (1966) in which a relationship for expected return is written as:

$$E(R i) = R f \beta i [E(R M) R f] \quad \textbf{(2)}$$

Where, E (R i) is expected return on *i* th asset, R f is risk free rate, E (R M) is expected return on market portfolio & β is the measure of risk or market sensitivity parameter defined as:

$$\beta i = Cov(Ri-Rf, Rm-Rf)/Var(Ri-Rf) \quad \textbf{(3)}$$

This equation (3) measures the sensitivity of asset return to variation in market return.

In risk premium form CAPM equation can be written as:

$$E(R i) R f = \beta i [E(R M) R f] \quad (4)$$

Here, [E (R i) R f] is the excess return on ith asset & [E (R M) R f] is the excess return on market portfolio over the risk-free rate. Equation (4) says that the expected excess return on any asset is directly proportion to its β.

Now for estimation of individual asset βs the study uses the CAPM equation in risk premium form with an intercept term:

$$R\,it\ R\,f\,t = \alpha i \beta i [R\,Mt\ R\,ft] + uit \quad \textbf{(5)}$$

Where, R it= the return on stock i (i=1, 2…… 10) at the period t (t=1, 2 …….995)

R ft= the rate of return on a risk-free asset at the period t

R Mt= the rate of return on proxy of market portfolio at the period t

uit= the corresponding random disturbance term in the regression equation.

uit iid N(0, σu2) & uit is independent of RMt.

The intercept term (αi) sometimes called ‗Jensen's alpha'. i is the risk-adjusted performance measure that represents the average return on a portfolio over and above that predicted by the CAPM. i.e. it measures the degree to which a particular asset earning significant returns after accounting for its market risk, as measured by beta. If the asset is earning a fair return for the given portfolio's systematic risk, then would be zero. Jensen's alpha allows the statistical test, whether the *i*th asset gives significantly greater (or less) return than would be expected using the CAPM. Jensen's measure is one of the ways to help determine if an asset is earning the proper return for its level of risk. If the value is positive, then the asset is earning excess returns. In other words, a positive value for Jensen's alpha means the asset has "beat the market".

It is**,**

$$Ri = \gamma 1 + \gamma 2\, \beta\, i + ei \qquad \textbf{(6)}$$

Where, I = Expected rate of return on ith asset =, for all i, i=1,2,…….10

Rit= rate of return from ith asset at the period t,

T=total number of data point (=995 in this study)

The coefficient γ1 is the premium associated with beta risk and an intercept term γ2 has been added in the equation. The equation (6) also known as Security Market Line (SML).

The validity of CAPM is examined in this study by testing two implications of the relationship between expected return and market beta given in Equation (6).

First expected returns are linearly related to their betas and no other variable has marginal explanatory power.

Second the beta premium is positive, meaning that expected return on market portfolio exceeds the expected return on assets whose returns are uncorrelated with the market return.

LIMITATIONS OF THE CAPM

The CAPM allows focus on the risk that is important in asset pricing—market risk. However, there are some drawbacks to applying the CAPM.

- A beta is an estimate of systematic risk. For stocks, the beta is typically estimated using historical returns. But the estimate for beta depends on the method and period in which is it is measured. For assets other than stocks, beta estimation is more difficult.
- The CAPM includes some unrealistic assumptions. Like, it assumes that all investors can borrow and lend at the same rate or all the investors have the homogeneous expectations. But this assumption of homogeneous expectation is unrealistic even if all the investors are equally & fully informed.
- In studies of the CAPM applied to common stocks, the CAPM does not explain the differences in returns for securities that differ over time, differ on the basis of dividend yield, and differ on the basis of the market value of equity (the so called ―size effect‖).

Though it lacks reality and is difficult to apply, the CAPM makes some sense regarding the role of diversification

and the type of risk that should be considered in investment decisions making.

Nowadays almost every investor who wants to undertake a project used to justify his decision partly based on CAPM. The reason is that the model provides the means of calculating the return for a particular asset. This model was the first successful attempt to show how to assess the risk of the cash flows of a potential investment project. The CAPM can estimate the project‘s cost of capital and the expected rate of return that investors will demand if they are to invest in the project.

The model was developed to explain the differences in the risk premium across assets. According to the theory these differences are due to differences in the riskiness of the returns on the assets. The model states that the correct measure of the riskiness of an asset is its beta and the risk premium per unit of riskiness is the same across all assets. Given the risk free rate and the beta of an asset, the CAPM can predict the expected risk premium for an asset.

The theory itself has created an academic debate about its usefulness and validity. In general, the empirical testing of CAPM has two broad purposes:

Test whether or not the theories should be rejected

Provide Information that can Aid Financial Decisions.

To execute (1) tests are conducted which could potentially at least reject the model. The model passes the test if it is not possible to reject the hypothesis that it is true. Methods of statistical analysis could be applied in order to draw reliable conclusions on whether the model is supported by the data or not.

To execute (2) the empirical work uses the theory as a vehicle for organizing and interpreting the data without seeking ways of rejecting the theory. This kind of approach is found in the area of portfolio decision-making, in particular with regards to the selection of assets to the bought or sold. For example, investors are advised to buy or sell assets that according to CAPM are underpriced or overpriced respectively. In this case empirical analysis evaluates the assets, assess their riskiness, analyze them, and place them into their respective categories is very important. A second illustration of the latter methodology appears in corporate finance where the estimated beta coefficients are used in assessing the riskiness of different investment projects

FINDINGS AND SUGGESTIONS

- But the risk return trade off implied by CAPM is not observed i.e., high risk portfolios giving higher returns is not observed.
- Even in the case of individual securities also the study revealed that the intercept term is not significant showing evidence of CAPM.
- CAPM holds only partially in the sense that Market Risk premium is a significant explanatory variable.
- The CAPM predicts that the asset's expected rate of return has a linear relationship with its systematic risk. The findings of the test are in contrast with the above hypothesis and indicate inconsistency with the CAPM.
- Jenson’s alpha, is the intercept of the regression and measures the abnormal return of the portfolio given the correlation of the return on asset *j* with the return on the market portfolio. If CAPM holds in general, correlation

of asset return with the market return (_*j*) alone could provide sufficient explanation to the risk premium, such that *alpha* should be zero. For this reason, a hypothesis testing is performed with null hypothesis *alpha*= 0.

- A t-stat of greater than 1.96 with significance less than 0.05 indicates that the independent variable is a significant predictor of the dependent variable within and beyond the sample. The result from the above table indicates that alpha is not statistically significant.
- According to CAPM the stock expected rate of return is only affected by its systematic risk, i.e., has no relation with non-systematic risk at all. The findings of the test do not fully confirm this hypothesis.

CONCLUSIONS

The major findings of the study are CAPM holds only partially in the sense that Market Risk premium is a significant explanatory variable. There is a positive relationship between excess portfolio returns and betas but there is no evidence indicating that higher risk means higher returns. Further we find that a non-linear relationship between portfolio returns and betas. One of the new improved pricing model is the arbitrage pricing model and it was believed at the time of its introduction that it will solve the theoretical and empirical problems associated with CAPM. However in the case of India the regression analysis show that ex-post macro-economic factors have limited impact on stock returns and here also it is the market risk premium that explains the most of the portfolio returns. Only one of the FF factors do not have significant impact on stock returns and that factor is the size factor. On the basis of adjusted R2 it may be concluded that FF model outperforms CAPM especially for the high beta portfolios.

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